Modern-Day Shakespeare: Training Set Experiments with a Generative Pre-Trained Transformer

Applied Project Final Report

By

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Dedication

I dedicate this applied project report to Dr. Andres Fortino of the Master of Science in Management and Systems Program. Thank you for your guidance, mentorship, and tireless support to ensure the academic success of all students within the program.

When asked to describe my experience graduate student experience in one word, I replied – inspiring. Today, I draw inspiration from my project:

Inspiration,
and all the best that can be said
to a summer where men are as lords,
richer than heaven, more blessed than earth,
more lovely than summer's forests, more temperate,
though without all the rigour of west,
though without all the luxury of sea,
but all this all at once, all at once,
comes home, and dreams of more, more,
glorious than fair in any of her paints.

Inspiration, thought, or feeling,
makes in thee the frame wherein 'tis held,
as in the frame of a painter,
made more or less by his skill;
as, for example, I am directed,
like a painted painter, to greater or less;
but, like a painted painter, he needs a page,
which, being filled with his painted image,
makes trim of his painter's block, and puts his picture
in my work.

GPT-2 Simple, Unbiased Shakespeare

Declaration

I, Roksolana Maria Sheverack declare that this project report submitted by me to School of Professional Studies, New York University in partial fulfillment of the requirement for the award of the degree of Master of Science in Management and Systems is a record of project work carried out be me under the guidance of Dr. Andres Fortino, NYU Clinical Assistant Professor of Management and Systems. I grant powers of discretion to the Division of Programs in Business, School of Professional Studies, and New York University to allow this report to be copied in part or in full without further reference to me. The permission covers only copies made for study purposes or for inclusion in Division of Programs in Business, School of Professional Studies, and New York University research publications, subject to normal conditions of acknowledgment. I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Acknowledgements

I sincerely thank Dr. Andres Fortino, Gary Rinkerman, and Dr. Roy Lowrance for their contribution as sponsors and mentors during this project. I also want to thank the instructors of the Master of Science in Management and Systems Program with who I have taken courses and learned a great deal.

Abstract

The project's goal is to explore the field of natural language processing, particularly the use of a generative pre-trained transformer (GPT) to produce poetry. In piloting the project, New York University's School of Professional Studies (NYUSPS) and the Master of Science in Management and Systems (MASY) sought to determine the effect of changing the characteristics of the training sets on the nature of the text generated by generative pre-trained transformer model. Presenting the University with the opportunity to lead the conversation on ways industries may seek to leverage this technology. The project entails two major components, a research component of identifying a generative pre-trained transformer model and a technical part of re-training the selected language model on a custom dataset. During the research, the team developed selection criteria to help assess the availability and functionality of several generative pre-trained transformer models. Within the technical component, the project set out to investigate using the literary work of two contemporary poets Shakespeare and Donne, as training sets and other seed poetry to evoke responses from the selected GPT language model. The project team utilized GPT-2 Simple, a fine-tuned version of OpenAI's GPT-2, transformer-based language model to perform a set of experiments. GPT-2 Simple was re-trained with three custom datasets, Shakespeare's sonnets unbiased, a combination of Shakespeare and Donne's sonnets, and Shakespeare's sonnets biased. In utilizing GPT-2 Simple, the project team had the opportunity to gain an in-depth understanding of the architecture and the Python code used to train the language model. The team performed 30 experiments, receiving a total of 150 text outputs. The gathered outputs will allow the project sponsor to further explore the impact of artificial intelligence in the generation of intellectual property within the present-day publishing and fine-arts industries.

Keywords: OpenAI, GPT-2, Transformer-Based Language Model, Generative Pre-Trained Transformer

Abbreviations and Definitions

Abbreviations

BERT	Bidirectional Encoder Representations from Transformers
DPB	Division of Programs in Business
GPT	Generative Pre-trained Transformer
GPU	Graphics Processing Unit
MASY	Master of Science in Management and Systems Program
NLP	Natural Language Processing
NYU	New York University
NYUSPS	New York University's School of Professional Studies
WBS	Work Breakdown Structure

Definitions

Attention	input processing techniques for neural networks that allows the network to focus on specific aspects of a complex input, one at a time until the entire dataset is categorized. The goal is to break down complicated tasks into smaller areas of attention that are processed sequentially (DeepAI, 2019).
Google Colaboratory	are Jupyter notebooks that run in the cloud and are highly integrated with Google Drive, making them easy to set up, access, and share.
OpenAI	an artificial intelligence research and deployment company. The organization was founded in San Francisco in late 2015 by Elon Musk, Sam Altman, and others, who collectively pledged US$1 billion. Musk resigned from the board in February 2018 but remained a donor.
Python	is an interpreted, object-oriented, high-level programming language with dynamic semantics.
Transformer	a component used in many neural network designs for processing sequential data, such as natural language text, genome sequences, sound signals or time series data. Most applications of transformer neural networks are in the area of natural language processing (DeepAI, 2020).

Introduction

Background Information

Generative Pre-trained Transformers (GPT) is a form of artificial intelligence that is an autoregressive language model that produces human-like text. Many research institutions and industries are currently exploring the potential power of transformer language models; therefore, the field holds many unanswered questions. New York University School of Professional Studies (NYUSPS) and Master of Science in Management and Systems Program (MASY) program recognize the opportunity to explore the exciting field of working with a generative pre-trained transformer in determining the effect of changing the characteristics of training sets on the nature of the generated text. Building on the work started in Fall 2020, the project team was tasked to research and select an open-source GPT model to be re-trained on a custom dataset. The team investigated using different contemporary poets (Shakespeare and Donne) as training sets and other seed poetry to evoke responses from the GPT model. Furthermore, the project investigated biasing the training set to create the desired effect (the theme of the resulting poem) and the responses by varying the input seed text. The project was done through defined experiments, allowing the project team to document the training process and produced outcomes.

Company Name and Background

New York University's School of Professional Studies, M.S in Management and Systems

New York University (NYU), located in the epicenter of New York City, is a private research university that provides a rigorous education to more than 50,000 students, representing over 133 countries, and undertakes nearly $1 billion in research annually (About NYU, n.d.). Founded in 1831, the University comprises 19 schools and colleges, including the School of

Professional Studies (SPS), founded in 1934 (NYU at a Glance, n.d.). Hailed as a leader in global education and innovator of higher education, New York University is one of the most prominent and respected research universities in the world. Graduates of the University represent a vast alumni network of successful professionals across industries and continents.

The University's School of Professional Studies (NYUSPS) offers 20 graduate degree programs that provide the cutting-edge knowledge and skills necessary to stand out in the competitive marketplace across industries (Master's Degrees, n.d.). With courses developed and taught by industry experts, students from diverse backgrounds and skill levels are brought together into cohesive learning teams, promoting collaborative learning, and preparing students to become the next generation of industry leaders and innovators. The Master of Science in Management and Systems (MASY) is offered through the Management and Technology Department within the Division of Programs in Business (DPB), is designed to prepare students to lead and manage information technology initiatives and projects on a local and global scale. The program's 42-credit curriculum provides students with experiential learning opportunities to develop strong management and leadership skills and gain a comprehensive knowledge of current information technologies. The curriculum comprises of core courses and a choice of four concentrations, intended to aid students in acquiring a body of knowledge in key technology and systems areas, including Systems Management, Enterprise Risk Management, Strategy and Leadership, and Database Technologies (Management and Systems, n.d.).

Sponsor Information

The project sponsor is Mr. Gary Rinkerman, Esq., Intellectual Property Attorney. Mr. Rinkerman is interested in utilizing the produced experiment outputs to explore the impact of artificial intelligence within the present-day entertainment, publishing, and fine-arts industries.

Business Opportunity

Artificial intelligence is all around us, from digital assistants, text editors to search algorithms designed to improve and simplify the user's everyday tasks. Within natural language processing, text editors and text generation dominate the field of study. Users rely on spell check and writing assistants to catch mistakes and make recommendations on formatting a sentence. Natural language processing comprises linguistics, computer science, and artificial intelligence to examine how software programs process and analyze language data. In recent years, transformer, a deep learning model that employs the mechanism of attention, has become the leading model for resolving natural language processing (Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin, 2017). The deep learning model supersedes the older recurrent neural network models, allowing it to be trained on a large dataset. The following advancement in machine learning pushed for the development of pre-trained language models, OpenAI's Generative Pre-trained Transformers (GPT), and Google's Bidirectional Encoder Representations from Transformers (BERT) (Gillioz, Casas, Mugellini, and Abou Khaled, 2020).

Since 2018, OpenAI developed three Generative Pre-trained Transformers: GPT-1, GPT-2, and GPT-3 (Radford, 2018). With GPT-3 not being available to the public, the project team set out to explore the power of GPT-2. The transformer-based model holds 1.5 billion parameters, trained on a dataset of 8 million web pages (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). The objective of GPT-2 is to predict the next word, given all the previous words within the text (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). Moreover, the model allows it to be fine-tuned and re-trained with a selected dataset, allowing researchers to closely examine the language model and seek ways to produce text that incorporates different writing styles, themes, and moods. In recent months, the discussion around

GPT-2 developed great interest from academic research institutions to examine ways the language model may benefit society, presenting opportunities to employ artificial intelligence in healthcare research, journalism, and software development. (Simić & Bačanin Džakula's 2019). However, while GPT-2 holds great potential, it must be used with caution; for a while, the model may be trained to produce poetry within the style of notable authors. It may also be mishandled, producing destructive text such as propaganda (Simić & Bačanin Džakula's 2019).

In undertaking the project to re-train GPT-2 with a selected dataset, the New York University School of Professional Studies and Master of Science in Management and Systems program will explore the fast-growing field of language models within artificial intelligence. Presenting University and program with the opportunity to be recognized as a leader and innovator in exploring emerging research trends. The project will enable the team to gain an in-depth knowledge of working with the transformer language model. Therefore, examine the advancement of artificial intelligence in producing human-like poetry with a desired theme or writing style. Moreover, the completed project work will set the foundation for future projects within the natural language processing field of study. Leading teams to examine leading contenders of OpenAI's or seek ways the technology may be leveraged to improve business practices or lead to new product development.

From a conceptual standpoint, the project will examine the legal and ethical implications of a GPT text generator. As Mr. Gary Rinkerman is an intellectual property attorney, the presented project work may be used to explore whether the produced text outputs may hinder the original authors' work ownership rights. Therefore, spearheading the conversation on how language models may impact the publishing and entertainment industry — allowing Mr. Gary Rinkerman to strengthen his position on the emerging trends of artificial intelligence from a legal

standpoint. Moreover, the project's outcome may also present the opportunity for Mr. Gary Rinkerman to explore ways transformer language models may be leveraged and employed by industries to their advantage.

Importance of the Project

New York University prides itself in fostering and preserving new ideas, insights, and knowledge; therefore, it undertakes nearly $1 billion in research annually (About NYU, .n.d.). Its research activities promote and nurture scientific progress, develop artistic and creative expression, and sustain an informed democratic society (Research NYU, n.d.). In being recognized as the nation's premier leader of higher education and academic research across all fields of study, New York University and the Master of Science in Management and Systems stands before a unique opportunity to enter a new area of research within artificial intelligence. The yielded project results may be published or presented at scholarly conferences to advance further New York University's esteemed reputation as a research institution.

In undertaking the project, the team will gain in-depth knowledge of transformer language models and the progression of artificial intelligence in producing human-like poetry. The delivered work will allow the project sponsor, Mr. Gary Rinkerman, Esq., to examine the legal and ethical standpoint of a GPT text generator. Therefore, explore whether the produced work may hinder the original authors' work ownership rights and spearhead the conversation about the role of machine learning in the fine arts and publishing industry. Moreover, as Mr. Gary Rinkerman, Esq. as an intellectual property attorney, the gathered research and experiment sets may be utilized in legal processing to defend a claim. Lastly, project work will lay the foundation for future project ventures to use the language to improve initiatives and potentially produce future revenue.

From an educational standpoint, the project fulfills the requirements for completing a Master of Science in Management and Systems program. The project will serve as an academic requirement of an applied project capstone course, allowing the student to demonstrate the mastery of the coursework and program knowledge. Therefore, the project presents learning outcomes in project management, data analysis, and in-depth understanding of a programming language. The project directly collates with coursework completed within the graduate program, allowing the student to apply the concepts from course lectures to real-world work:

Project Management in the Information Age and Agile Project Management – Apply project planning skills and methodology learned in two project management courses to effectively communicate with the project's stakeholders. Develop reports (weekly progress, project charter), implement a change request process (if/when required), create a work breakdown structure to set and track deadlines.

Research Process and Methodology – Apply acquired skills to gather research, adhere to APA writing style, and deliver a professional-level research report.

Managing Big Data – Apply the understanding of data types, utilize research strategies of selecting appropriate datasets. Develop presentation and public speaking skills in presenting the business benefits of the completed project work.

Alternate Solutions Evaluated

The project's experimental nature called for identifying an open-source generative pre-trained transformer model that could be re-trained on a custom dataset. Building on work completed in the Fall 2020 term, during which the preceding team set out to create a recurrent neural network model to produce text outputs based on a trained dataset. The Spring 2021 team took a different course of direction, selecting to work with an industry-available language model. Within the research on natural language processing, the team learned that transformer, a deep learning model that employs the mechanism of attention, has become the leading model, outperforming recurrent neural network models (Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin, 2017). Therefore, the team decided to research two leading transformer models, OpenAI's Generative Pre-trained Transformers (GPT) and Google's Bidirectional Encoder Representations from Transformers (BERT).

To determine which model would best fit the project's needs, the project team developed a solution evaluation criteria to act as a set of guidelines to ensure the needs of the project sponsor and the team were met. Moreover, the team understood that the following project would comprise to a more significant research opportunity. Therefore, it was important for the team to select a language model previously researched by several academics and industry organizations, allowing the team to reference their work. In looking at Google's BERT, the project team was not successful in finding a reserve of well-documented projects executed using the BERT model. Moreover, the BERT model held many intricacies and called for advanced knowledge of Python. In accessing the team's technical skills, the team did not feel confident in working with BERT.

As a result, the team chose to work with OpenAI's GPT-2, which has been researched by several scholars and industry professionals. The transformer-based model holds 1.5 billion

parameters, trained on a dataset of 8 million web pages (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). The objective of GPT-2 is to predict the next word, given all the previous words within the text (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). Moreover, the model allows it to be fine-tuned and re-trained with a selected dataset, an aspect that was crucial for the success of the new project. Lastly, similar projects in re-training the GPT-2 model on a custom dataset have been done, which allowed the team to reference the prior work as guides to preparing the envisioned experiments.

Solution Evaluation Criteria

The project entails two major components, a research component of identifying a generative pre-trained transformer model and a technical part of re-training the selected language model on a custom dataset. During the research, the team developed selection criteria to help assess the availability and functionality of several generative pre-trained transformer models. In developing the evaluation criteria, the project team considered the team's needs for tools and the technical experience required to utilize the tools. Furthermore, the team prioritized the project sponsor's requirements in selecting the appropriate tools, ensuring the project work may be presented in legal proceedings. Therefore, one of the critical criteria elements required the project team to examine the user license of the selected language model and the utilized software. Table 1 details the criterial elements and rationale behind the need for each component.

Table 1. Solution Evaluation Criteria

Criteria Element	Rationale
Open-Source	Seek to utilize an industry open-source generative pre-trained transformer model cost-free
Compatibility	Ensure the model may be installed and executed on the team's operating system, a Mac and PC.
Support Tools	Verify software requirements to operate and train the language model are open-source and free of cost for the project's duration.

Technical Skill	Ensure the project team has sufficient knowledge of the programming language and software to execute the work and meet the project goals.
User License	Ensure the utilized model and software state ownership rights (OpenAI, n.d.)

Selection Rationale

In adhering to the established solution evaluation criteria, the team first gathered research on the industry-available open-source generative pre-trained transformer (GPT) language models. The project team identified two model options: OpenAI's Generative Pre-trained Transformers (GPT) and Google's Bidirectional Encoder Representations from Transformers (BERT). In further analysis of the two models, their technological advancements, and complexities, the team agreed to work with OpenAI's Generative Pre-trained Transformers-2. (GPT-2). Google's BERT proved to be a more complex language model, requiring a longer project period and advanced technical skillset to accomplish the work.

OpenAI's GPT-2 is developed in Python, therefore reassured the team the necessary tools, Anaconda and Jupiter Notebook, would be cost-free and open-source. In starting the project with OpenAI's GPT-2, the project team encountered an issue with the condition of GPT-2, requiring additional fine-tuning to be re-trained on a custom dataset. As the team holds elementary to intermediate knowledge of Python, the programming language needed to build the components necessary to fine-tune GPT-2, the team knew the project work would not be completed with the available skillset or within the set timeframe. Therefore, the team employed a contingency plan and chose to work with GPT-2 Simple, an open-source fine-tuned version of OpenAI's GPT-2. Table 2 illustrates a side-by-side comparison of the two language models based on the key elements.

Table 2. Selection Rationale

Key Elements	OpenAI's GPT-2	GPT-2 Simple Fine-Tuned
Open-Source	Yes	Yes
Compatibility	Mac and PC	Mac and PC

Support Tools	Python/Anaconda	Python /Google Colaboratory
Technical Skill	Intermediate-Advance	Beginner-Intermediate
User License	Modified MIT (OpenAI, n.d.)	Modified MIT (OpenAI, n.d.)

GPT-2 Simple, developed by Max Woolf, a fine-tuned model that can be easily re-trained within Google Colaboratory, a Jupyter notebook environment that runs in the browser using a free Google account. The use of GPT-2 Simple on Google Colaboratory further simplified the project work. It did not require installing the model or additional software on the team's local computers. Moreover, in utilizing GPT-2 Simple, the project team had the opportunity to gain an in-depth undertaking of the Python code used to re-train GPT-2 with detailed guidelines provided by Max Woolf.

In preparing the experiments, the team created three separate Google accounts, Shakespeare Unbiased, Shakespeare and Donne, and Shakespeare Biased, to host each of the three trained models while ensuring there is no cross-contamination between the models. With the employment of GPT-2 Simple, the project team successfully trained three separate models with three different datasets, evoking 150 text outputs within 30 documented experiments. Table 3 details the account information for the three trained models, allowing future project teams to refer to the completed work. The Google Colaboratory Notebooks are private to the public; therefore, it is recommended to sign in to the appropriate account before accessing the notebook. Moreover, each account also holds the guidelines for working with the re-trained model and the custom dataset used during initial re-training.

Table 3. Google Colaboratory Notebook Accounts

Dataset	Email	Password	Link
Shakespeare Unbiased	shakespearebiased@gmail.com	nyumasy21	https://colab.research.google.com/drive/1D3mZDQncMhIqRCK3XA2hTBttkKdo-fxy?authuser=1
Shakespeare and Donne	shakespearedonne@gmail.com	nyumasy21	https://colab.research.google.com/drive/1oxdxGzC9-7N69fNbWP78Jta2HRjpNuws?authuser=2
Shakespeare Biased	shakespearebiased@gmail.com	nyumasy21	https://colab.research.google.com/drive/1ooXo0sR4iwI4SwaDh05AtebaxgVowfKr?authuser=3

Approach and Methodology

A project life cycle is the series of phases that a project passes through from its start to its completion, providing a basic framework for managing the project (Project Management Institute, 2017). In acknowledging the project's experimental nature, the team determined that successful initiation and completion of the work called for a hybrid project life cycle, a combination of a predictive and an adaptive life cycle. As a result, elements of the project that are well known or have fixed requirements followed a predictive development life cycle. Project elements that were still evolving followed an adaptive development life cycle (Project Management Institute, 2017).

Employment of a Predictive Life Cycle

In adhering to a predictive development life cycle, the project team had the opportunity to assess the previously completed project within a similar field of study as points of reference and prepare plan documents. As the project held a research component of identifying and selecting a generative pre-trained transformer model, the process of initiation and planning ensured careful consideration project's objectives and requirements. In executing the experiments, the project team intergraded the predictive and adaptive development life cycles.

1 **Initiation**: processes performed to define a new project by obtaining authorization to start the project (Project Management Institute, 2017). Within the initiation phase, the project team met with the project's sponsor, Mr. Gary Rinkerman, Esq., to discuss the need and opportunity of the project. In evaluating the project's requirements, the team researched and developed the following documents for formal approval from the project sponsor:

    1.1 Project Proposal

1.2 Sponsor Agreement and Project Acceptance

1.3 Project Charter

2 **Planning**: processes required to establish the project's scope, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve (Project Management Institute, 2017). During planning, the project team worked to develop and prepare the following documents and processes:

2.1 Literature Review and Reference List

2.2 Situational Analysis and Cost-Benefit Analysis

2.3 Schedule Plan and Work Breakdown Structure

2.4 Change Management Plan

2.5 Risk Management Plan

3 **Execution**: processes performed to complete the work defined in the project management plan to satisfy the project requirements (Project Management Institute, 2017). In commencing the work, the team incorporated elements of the adaptive life cycle, as detailed in the Employment of the Adaptive Life Cycle section of Approach and Methodology:

3.1 Validate Acceptance Criteria Requirements

3.2 Acquire Software and Open-Source GPT-2 Model

3.3 Install and Set-up Tools and GPT-2 Model

3.4 Experimental Phase

3.5 User Tutorial Presentation to the Project Sponsor

3.6 Produce the Final Product to the Sponsor

4 **Monitor and Control**: processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes (Project Management Institute, 2017). Throughout the execution of work, the project team tracked the project's progress in adherence to the

processes plan documents. The team completed tasks in meeting the set deadlines, documented requested changes, and responded to arisen risk events:

4.1 Monitor Project Work and Schedule Deadlines

4.2 Monitor and Record Changes

4.3 Monitor Risk and Document Issues

5 **Closeout**: processes performed to formally complete or close the project (Project Management Institute, 2017). In concluding the project work, the team updated all reports and plan documents for future reference. Lastly, the team developed the final project report for the successful completion of the capstone coursework.

5.1 Final Project Report

5.2 Formal Acceptance from the Project Sponsor

Employment of an Adaptive Life Cycle

Recognizing the unknown nature of re-training a generative pre-trained transformer called for a portion of the project to implement an adaptive life cycle. Adaptive life cycles are agile, iterative, or incremental. The detailed scope is defined and approved before starting an iteration (Project Management Institute, 2017). The use of an adaptive life cycle was applied within the following project events:

Research: The project's goal was to use an open-source generative pre-trained transformer (GPT) model that could be re-trained with a custom dataset and perform a set of experiments. With the project team's elementary knowledge of a programming language, the team sought to find a language model that matched the experiment's needs and fit the technical qualifications of the team members. Moreover, the team had to ensure the acquired model and tools would be free of cost for the project's duration. In gathering research, the project team identified two: OpenAI's Generative Pre-trained

Transformers (GPT) and Google's Bidirectional Encoder Representations from Transformers (BERT). In further analysis of the two models, their technological advancements, and complexities, the team agreed to work with OpenAI's Generative Pre-trained Transformers-2. (GPT-2). Developed in Python, the GPT-2 model reassured the team, the required tools would be cost-free and open-source.

Re-Training GPT-2: GPT-2 is a large transformer-based language model with 1.5 billion parameters, trained on a dataset of 8 million web pages. The goal of the project was to re-train the language model with an individually selected dataset. In taking a closer look at OpenAI's GPT-2 model, the team determined that the language model must be fine-tuned first to be then re-trained of a select dataset. Therefore, to ensure the timely delivery of the completed project, the team agreed to utilize a fine-tuned version of the language model, GPT-2 Simple, by Max Woolf. The fine-tuned model is open-source and can be easily re-trained within Google Colaboratory, a Jupyter notebook environment that runs in the browser using Google Cloud. The sudden request to change the transformer-based language model was an anticipated risk event through the planning process and allowed for nimble adaptation to the newly selected model.

Communication: In providing weekly updates to the project sponsor and key stakeholders, the team adopted a daily scrum format of answering three questions: What did you do? What will you do? Are there any impediments in your way? The approach allowed the team to effectively communicate the weekly status updates on the project's progression and alert the key stakeholders to encountered issues or concerns. Moreover, the daily scrum questions allowed the team to identify potential risk events and set contingency plans.

Project Objectives and Metrics

Goal of the Project

Generative Pre-trained Transformer (GPT) is an autoregressive language model that creates human-like text. Working with GPT is currently being explored by many researchers and businesses, therefore, holding many unanswered questions. The project's goal is to train an available industry open-source GPT text generator with various training data sets to determine the nature of the data sets. By exploring this field, it will allow the New York University's School of Professional Studies and M.S. in Management and Systems Program to lead conversations on the opportunities of GPT within various industries and the future of technology.

Project Deliverables and Metrics

Project Objective 1 – Research and investigate open-source GPT text generators. Select one based on designed acceptance criteria and client's approval.

Metric A: Acceptance criteria will be developed under the guidance of Dr. Fortino and presented to the client for approval.

Metric B: In meeting the acceptance criteria, the selected language model will be presented to the client for final approval.

Project Objective 2 – Create the appropriate training data sets provided under the client's guidance. The project will consist of a collection of experiments. For each experiment, the project lead will keep inventor notebook-style notes detailing the process, observations, outcomes, and raised questions.

1. Investigate using different contemporary poets as training sets and various seed poetry to evoke responses from the GPT model

2. Investigate biasing the training set to create the desired effect (the theme of the resulting poem)
3. Investigate techniques to create the desired outcome mood
4. Investigate the responses of each trained GPT to varying the input seed text

    Metric A: Deliver detailed weekly reports on each experiment's tested techniques and their outcomes. The reports will provide an overview of the work accomplished for the set week and inventor's notebook-style notes, detailing the process, results, and observations.

    Metric B: Based on the outcome, propose any necessary changes following the Change Management Plan.

Project Objective 3 – Present a well-documented and organized report on the completed work: including all gathered research, the noted experiments, and project management artifacts. Prepare a presentation, providing an overview of the project, detail the work processes, the outcomes, and future research.

Metric A: Deliver all required chapters of the report in an APA format by May 5th, 2021, via a shared Google Drive to Mr. Rinkerman.

Metric B: Deliver the final project report and presentation by May 5th, 2021, to Dr. Fortino via NYU Classes.

Project Objective 4 – Deliver a live demonstration of the working product and a tutorial, documenting all steps in the process of setting up experiments and attaining an outcome.

Metric: Deliver the tutorial and three trained models of GPT-2 Simple by May 5th, 2021, via a Google Colaboratory Notebook.

Risk Analysis

Risk is a prevalent aspect of all projects; therefore, it is vital for the project team to identify and analyze anticipated risk events. Risk analysis involves examining how project outcomes and objectives might change due to the impact of the risk event (Lavanya & Malarvizhi, 2008). During the project's planning phase, the team detailed out anticipated risk events that may arise throughout the project's life cycle. In establishing a list of risk events, the team identified qualitative and quantitative factors of the risk events, the probability of occurrence, the impact, the point of time within the project's development life cycle the risk event may occur, and the frequency of the risk event. In listing the anticipated risk events, the team noted several of the risk events held a very low probability of occurring. For the risk events identified as having a higher likelihood of occurrence, the team developed contingency plans to mitigate the impact. Each anticipated risk is assigned a probability score and impact score. Table 4.1 and Table 4.2 detail the scoring values and definitions of probability and impact in relation to the given score.

Table 4.1 Impact Score

Scale	Score	Time Delay	Quality
Slight	1	1 to 3 Days	None to minor impact on overall project
Moderate	2	5 to 7 Days	Some to significant impact on overall project
High	3	7 to 14 Days	Very significant to major impact overall project

Table 4.2 Probability Score

Scale	Score	Probability of Occurrence
Very Unlikely	1	< 1 to 30%
Possible	2	31 to 50%
Expected	3	51 to >70%

The project team utilized the impact and probability scores by assigning each risk event an appropriate rank, as presented in Table 5. The total scores are presented as the product of the

probability score multiplied by the impact score, therefore illustrating which events hold the most significant risk and should be prioritized.

Table 5. Anticipated Project Risks

No.	Risk	Probability Score	Impact Score	Total Score
1	Ensuring the open-source GPT-2 model and necessary software will remain free and available throughout the project period.	1	2	**2**
2	The client may decide to cancel the project.	1	3	**3**
3	OpenAI's GPT-2 model is not sufficient to be trained without additional finetuning.	2	3	**6**
4	The user license of the GPT-2 model may change, and OpenAI may try to claim ownership rights to the produced output.	1	1	**1**
5	The project calls for advanced knowledge of Python.	3	3	**9**

To better visualize the risks that may pose a more significant impact, the project team inputted the anticipated risk events into a Risk Matrix, probability scores against the impact scores. The matrix allows for the relative priority of individual risks to be evaluated within each priority level (Project Management Institute, 2017). Table 6 illustrating the severity of risk events three and five, which led the team to examine the following two risks more closely.

Table 6. Risk Matrix

		Risk (Exposure)		
		1.Slight	**2. Moderate**	**3. High**
Probability	**1. Very Unlikely**	4	1	2
	2. Possible			**3**
	3. Expected			**5**

The project team developed a contingency plan to alleviate the two highest risks during the project's execution phase per the total risk score and the risk matrix—Table 7 details the strategies set in place for the two significant risk occurrences.

Table 7. Contingency Plan

Risk	Risk Description	Probability	Exposure	Contingency Plan
3	OpenAI's GPT-2 model is not sufficient to be trained without additional finetuning.	2	3	There are two open-source GPT-2 fine-tuned models available, which may be employed to perform the experiments.
5	The project calls for advanced knowledge of Python.	3	3	Reference tutorials and available resources to resolve coding issues. Refer to Roy Lowrance for further guidance.

In choosing to work with OpenAI's GPT-2 model, the team encountered an anticipated issue that the pre-trained model would require additional fine-tuning to be successfully re-trained on a new dataset. The following issue correlated closely with risk events three and five, as to successfully fine-tune OpenAI's GPT-2 model, the team would require advanced knowledge of Python's programming language. Recognizing the team's limited knowledge of Python and scarcity of time to deliver the completed project, the team referred to the contingency plan of utilizing one of the open-source GPT-2 fine-tuned models to perform the experiment sets.

Issues Encountered

In undertaking the project work, the team encountered several risk events. Having anticipated the potential issues, the team developed risk management and contingency plan strategies in response to the impact of the possible risk events. The minor issues, such as code errors and software versioning, were swiftly resolved and did not significantly impact the quality or schedule deadlines for delivering the final product. For issues with error codes, the team referred to Dr. Roy Lowrance for further guidance to better understand the displayed error message and how to resolve the error in future instances. The mismatch of software versioning called for a simple solution of updating the macOS and Anaconda software to the latest version. Once the software updates were successful, the team could download and install OpenAI's GPT-2 pre-trained language model.

One of the more significant issues encountered was the need for additional fine-tuning OpenAI's GPT-2 pre-trained language model. In gathering research, the project team questioned if OpenAI's GPT-2 model would be sufficient to be re-trained without additional fine-tuning. Moreover, if additional fine-tuning is required, the team reflected if it held the technical skillset to build the components necessary to fine-tune and re-train OpenAI's GPT-2 model on a custom dataset. In anticipating the risk event, the project team developed a contingency plan that would allow for the project work to continue without delay. Therefore, as OpenAI's GPT-2 model did not meet the project's need to be re-trained on the custom dataset, the project team referred to the contingency plan in utilizing one of the open-source GPT-2 fine-tuned models to perform the experiments. In selecting a readily available open-source fine-tuned model, the team could successfully complete the project with an elementary knowledge of Python.

Through gathered research on fine-tuned models, the team chose GPT-2 Simple, a fine-tuned text-generating model w/ GPU, which can be re-trained with a custom dataset on Google Colaboratory. The use of GPT-2 Simple on Google Colaboratory further simplified the project work. It did not require installing the model or additional software on the team's computers. Moreover, in utilizing GPT-2 Simple, the project team had the opportunity to gain an in-depth undertaking of Python code used to re-train GPT-2 with detailed guidelines provided by the author of GPT-2 Simple, Max Woolf. With the employment GPT-2 Simple, the project team successfully trained a model with three different Shakespeare and Donne datasets, evoking 150 text outputs within 30 documented experiments.

Project Chronology and Critique

The Training Set Experiments with a Generative Pre-Trained Transformer Project commenced on February 3rd, 2021 and will conclude on May 5th, 2021. Within three months, the project team dedicated approximately 250 hours to complete the required work. The project team executed the work in accordance with the project life cycle's process groups of initiation, planning, execution, monitor and control, and closeout.

To illustrate the order of the project's work within each process group, the project team developed two visualization charts to represent the Work Breakdown Structure (WBS). The Tree Structure and The Hierarchical Structure illustrate the hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables (Project Management Institute, 2017).

The Tree Structure (Table 8): represents decomposition, a technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts (Project Management Institute, 2017). In Table 8, the Work Breakdown Structure (WBS) is decomposed by the project life cycle's process groups and provides an overview of the tasks to be completed within each process group.

The Hierarchical Structure (Table 9): offers a more detailed overview of the project's tasks. Organized by the five process groups, Table 9 lists the project tasks in chronological order, indicating the anticipated and final dates of completion for each artifact. Comparing the anticipated and final deadlines allows the project team and project sponsor to ensure timely completion and delivery of the project's deliverables.

Table 8. The Tree Structure

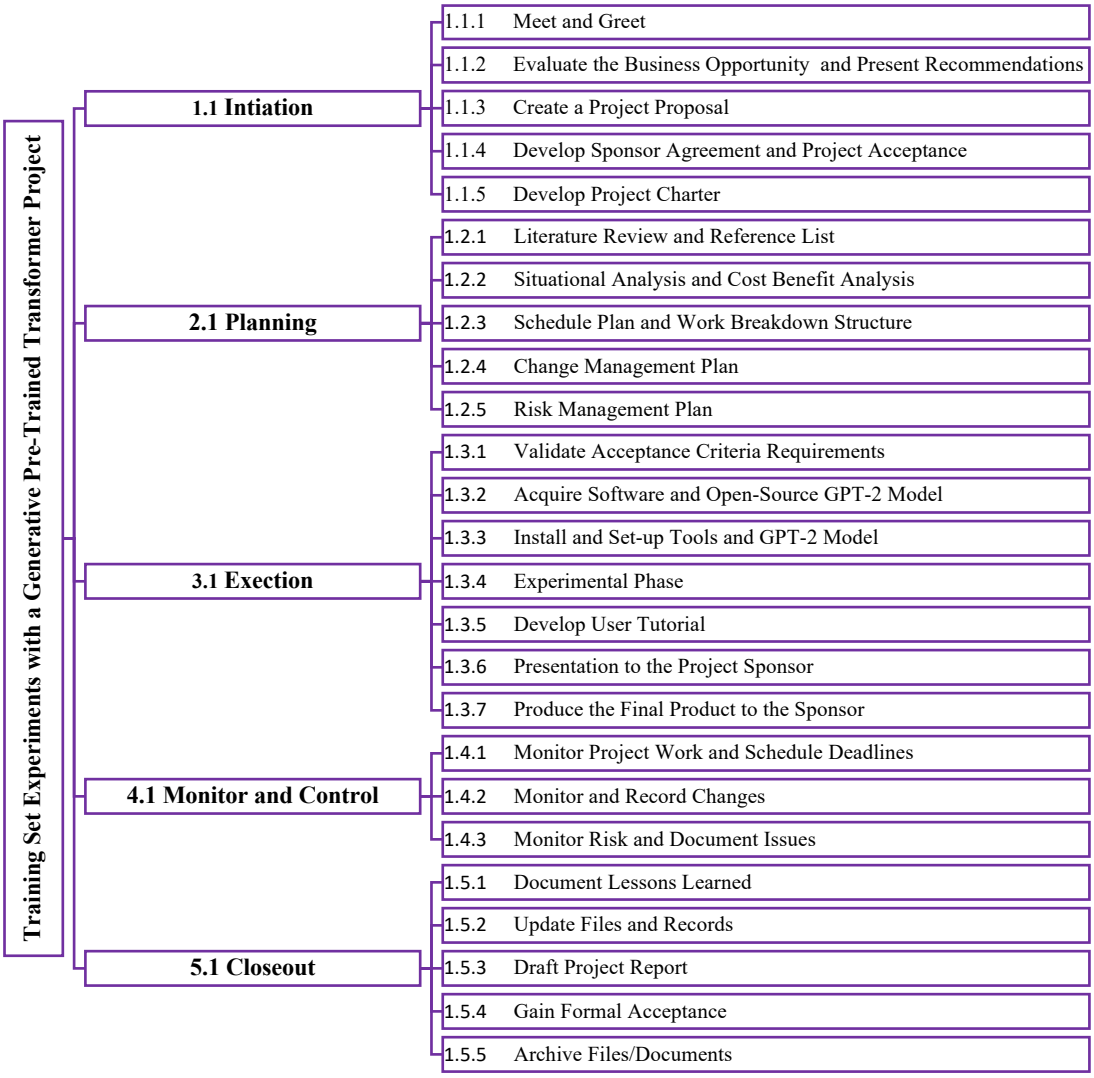

Table 9. The Hierarchical Structure

Milestone	Project Tasks	Anticipated Date of Completion	Final Date of Completion
1.1	Initiation		
1.1.1	Meet and Greet with Project's Sponsor	02/04/2021	02/04/2021
1.1.2	Evaluate the Business Opportunity and Recommendations	02/10/2021	02/10/2021
1.1.3	Create Project Proposal	02/10/2021	02/10/2021
1.1.4	Develop Sponsor Agreement and Project Acceptance		
	1.1.4.1 Submit Documents to the Sponsor for Review	03/08/2021	03/08/2021
	1.1.4.3 Documents are Signed and Approved	03/10/2021	03/10/2021
1.1.5	Develop Project Charter	03/17/2021	03/17/2021
1.2	Planning		
1.2.1	Literature Review and Reference List	02/24/2021	02/24/2021
1.2.2	Develop a Situational Analysis and Cost Benefit Analysis	03/03/2021	03/03/2021
1.2.3	Develop a Schedule Plan and Work Breakdown Structure	03/03/2021	03/03/2021
1.2.4	Develop Change Management Plan	03/31/2021	03/31/2021
1.2.5	Develop Risk Management Plan	04/14/2021	04/14/2021
1.2.6	Develop Communication Management Plan	03/11/2021	03/11/2021
1.3	Execution		
1.3.1	Validate Acceptance Criteria Requirements	03/11/2021	03/11/2021
1.3.2	Acquire Software and Open-Source GPT-2 Model	03/11/2021	03/11/2021
1.3.3	Install and Set-up Tools and GPT-2 Model	03/14/2021	03/14/2021
1.3.4	Experimental Phase		
	1.3.4.1 Project Status - Report A	03/31/2021	04/02/2021
	1.3.4.2 Project Status - Report B	04/14/2021	04/17/2021
1.3.5	Develop User Tutorial	05/05/2021	05/05/2021
1.3.6	Presentation to the Project Sponsor	05/07/2021	05/07/2021
1.3.7	Produce the Final Product to the Sponsor	05/07/2021	05/07/2021
1.4	Monitor and Control		
1.4.1	Monitor Project Work and Schedule Deadlines	05/05/2021	05/05/2021
1.4.2	Monitor and Record Changes	05/05/2021	05/05/2021
1.4.3	Monitor Risk and Document Issues	05/05/2021	05/05/2021
1.4.4	Monitor Communications	05/05/2021	05/05/2021
1.5	Closeout		
1.5.1	Document Lessons Learned	04/28/2021	04/28/2021
1.5.2	Update Files and Records	05/05/2021	05/05/2021
1.5.3	Draft Project Report	04/28/2021	04/28/2021
	1.5.3.1 Final Project Report	05/05/2021	05/05/2021
1.5.4	Gain Formal Acceptance	04/28/2021	04/28/2021
1.5.5	Archive Files/Documents	05/05/2021	05/05/2021

In reflecting on the completed project work, the two significant areas which called from improvement are technical skillset and further research on generative pre-trained transformers:

Technical Skillset: In working with OpenAI's transformer-based language model, intermediate to advance knowledge of a programming language, Python, is vital to understanding the model's architecture. Additionally, a robust technical background would allow for faster resolution to encountered code errors during project work.

Further Research: The study of generative pre-trained transformers is in the developing stage and is currently being explored by many research institutions. Therefore, the following project may serve as a foundation for future work on developing experiment sets and seeking ways to leverage this technology.

Lessons Learned

The Training Set Experiments with a Generative Pre-Trained Transformer Project was delivered as planned with expected quality and timeframe. The project's success was made possible by the dedicated team members and support from all the project sponsors and key stakeholders. Throughout the project work, the team learned project management processes within a hybrid approach, integrating a predictive and an adaptive life cycle. Furthermore, in executing the setup and training of a generative pre-trained transformer model, the project team examined the required skill set and experience to accomplish the project's technical objectives. Therefore, allowing the team to reflect on the completed work and gather lessons in managing a project and the technical requirements for future work.

Project Management Lessons Learned

The project followed a hybrid project management approach, a combination of a predictive and an adaptive life cycle. As a result, elements of the project were well known or have fixed requirements, followed a predictive development life cycle. Project elements that were still evolving followed an adaptive development life cycle (Project Management Institute, 2017). Within the predictive development life cycle, the project team adhered to the five project management process groups of initiation, planning, execution, monitor and control, and closing. The process groups aided the team in achieving specific project objectives in gathering research, assessing physical resources, and evaluating the technical skillset of the project team. In the planning process, the team outlined a clear understating of the project sponsor's requirements for the final product and set forth contingency plans for anticipated risk event which may be encountered during the execution of the project work. Furthermore, the project's planning

process group allowed the team to develop a situational analysis, which led to a better understating of the industry through Porter's Five Forces, identified competitors, and categorized stakeholders.

The adaptive development life cycle, including agile, iterative, or incremental, allowed the team to respond to change and communicate status updates. The weekly status updates to the project sponsor and key stakeholders followed a daily scrum format of three questions: What did you do? What will you do? Are there any impediments in your way? The daily scrum format allowed the team to provide updates on the project's progression and alert the team to encountered issues or concerns. In recognizing arisen impediments, the adaptive development life cycle allowed the team to swiftly respond by applying a contingency plan in effect or considering an alternative solution. The decision of selecting a hybrid project management approach of integrating a predictive and an adaptive life cycle proved to be significantly beneficial in encountering an issue with the initially selected OpenAI's GPT-2 model called for additional fine-tuning work. In response, the project team could pivot and utilize a contingency plan on using an already fine-tuned GPT-2 Simple model while ensuring the final product is within the defined scope.

Technical Work Lessons

In setting up and training a generative pre-trained transformer model, the project team encountered a few issues, as documents in Risk Analysis' Issues Encountered. With several contingency plans in place, the project work progressed and did not experience any significant setback. However, it allowed the team to examine the technical skillset required to complete the set experiments and resolve the encountered issues. In particular, the task of fine-tuning the generative pre-trained transformer model to be re-trained with a custom dataset proved to be a

challenge. The team could not re-train OpenAI's GPT-2 model on a select dataset without first fine-tuning the model, and this process required a strong knowledge of Python. In recognizing the challenge, the team referred to a contingency plan to utilize an open-source fine-tuned model, GPT-2 Simple, to complete the set experiments. The nimble adaptation to the newly selected model ensured the on-schedule progression of the project work. Moreover, in utilizing GPT-2 Simple, the project team had the opportunity to gain an in-depth undertaking of Python code used to download and re-train GPT-2 with detailed guidelines provided by the author of GPT-2 Simple, Max Woolf. In conclusion, if the team decides to undertake future projects of similar technical nature, it would be recommended for the team to complete series of workshops on the required programing language with DataCamp or LinkedIn Learning.

Conclusion and Summary

The Training Set Experiments with a Generative Pre-Trained Transformer Project was successfully completed. Under the guidance of Dr. Andres Fortino, the team divided the project into two main components, a research component to select a generative pre-trained transformer (GPT) model and a technical part of re-training the chosen language model on a custom dataset. In gathering research on industry-available generative pre-trained transformer models, the team developed selection criteria to assess the availability of use and functionalities which would fit the project's needs. As a result, the team selected to work with GPT-2 Simple, a fine-tuned version of OpenAI's GPT-2, transformer-based language model to perform a defined set of experiments. GPT-2 Simple was re-trained with three custom datasets, Shakespeare's sonnets unbiased, a combination of Shakespeare and Donne's sonnets, and Shakespeare's sonnets biased. With the re-trained models, the team performed 30 experiments, receiving a total of 150 text outputs. The gathered outputs fulfilled the project requirements and will allow the project sponsor to further explore the impact of artificial intelligence within the present-day publishing and fine-arts industries. The presented figures provide a sample of the evoked test outputs within the Shakespeare Unbiased and the Shakespeare and Donne datasets.

Figure 1. Shakespeare Unbiased, Hamlet Prefix

```
gpt2.generate(sess,
              length=30,
              temperature=0.7,
              prefix="To be, or not to be, that is the question",
              nsamples=5,
              batch_size=5
              )
```

```
To be, or not to be, that is the question.
I have seen writ that your memory would be foented
lose memory quite, if it were stolen
```

Figure 2. Shakespeare and Donne, Hamlet Prefix

```
gpt2.generate(sess,
              length=30,
              temperature=0.7,
              prefix="To be, or not to be, that is the question",
              nsamples=5,
              batch_size=5
              )
```

```
To be, or not to be, that is the question?
reason, your image, in my bosom doth lie—
and, truth be no praise, but truth be first,
for
```

Figure 3. Shakespeare Unbiased, Whitman Prefix

```
gpt2.generate(sess,
              length=30,
              temperature=0.7,
              prefix="I loaf and invite my soul, I lean and loaf at my ease observing a spear of summer grass.",
              nsamples=5,
              batch_size=5
              )
```

```
I loaf and invite my soul, I lean and loaf at my ease observing a spear of summer grass.
but when my heart beats with instinct,
mine own thoughts, too much filled with hate,
with thoughts of hate, thoughts
```

Figure 4. Shakespeare and Donne, Whitman Prefix

```
gpt2.generate(sess,
              length=30,
              temperature=0.7,
              prefix="I loaf and invite my soul, I lean and loaf at my ease observing a spear of summer grass.",
              nsamples=5,
              batch_size=5
              )
```

```
I loaf and invite my soul, I lean and loaf at my ease observing a spear of summer grass.
yet grace and patience are twice alike hated,
and in themselves the world's most ghastly lust is crucified.
```

The completed project laid the foundation for future work to be explored within the field of study. Future project teams may choose to examine the leading contender of OpenAI's GPT-2, Google's BERT model, or consider developing a user interface versus running code within a notebook environment. Therefore, presenting New York University's School of Professional Studies (NYUSPS) and the Master of Science in Management and Systems (MASY) with the opportunity to lead the conversation on ways industries may seek to leverage generative pre-trained transformer models within a business context to improve processes and develop exciting new products.

Limitations, Recommendations and Scope for Future Work

While the completion of the project delivered a successful outcome, the project team identified two limitations that may be mitigated in future work. As the project explored a field of study currently in its infancy, the project laid the foundation for future projects. Allow for New York University and the M.S in Management and Systems to further explore opportunities of leveraging the use of a generative pre-trained transformer within a variety of industry fields. Reflecting on the completed work and prospects, future teams must consider the following aspects when deciding to work with a generative pre-trained transformer.

Limitations

Technical Experience: In encountering several code errors during the installation and setup of GPT-2, the project team determined that more advanced knowledge of Python would have allowed the team to resolve issues more promptly. Future project teams should seek to have an intermediate understanding of the programing language required to set up and train the model.

GPT-2 Simple Parameters: The completed experiment set's adhered to the pre-set GPT-2 Simple parameters, which limit the experimentation analysis of potentially adjusting the tone and mood of the generated output. In further studying the paraments, the future team may seek ways to introduce adjustments and analyze if the change within the paraments impacts the generated output and to what degree.

Recommendations

Technical Resources: In undertaking future projects of working with GPT-2, it is vital to ensure the computer hardware has Graphics Processing Unit (GPU). Otherwise, the team will have

difficulty training a GPT-2 model locally on the computer. The following issue should be considered part of the project's risk analysis; a likely contingency would be to seek a cloud-based approach to training a model. For instance, GPT-2 Simple may be utilized via a Google Colaboratory notebook with GPU.

Scope of Future Work

Measure the Bias: Further study the experiments' results to determine whether the three trained models can be differenced based on the produced responses. Moreover, examine whether the evoked text outputs differentiate amongst each other based on the prompted seed poetry. The team may utilize a similarity scoring application to compare the model outputs against the poetry used to evoke a response, therefore determining the nature of the model outputs.

Fine-Tuning GPT-2: The completed project allowed the team to examine GPT-2 Simple as a foundation for working with transformers. Further work to be undertaken may lead the future team to seek to fine-tune Open AI's GPT-2 model versus utilizing an online source. In choosing to fine-tune GPT-2, the project team could detail the work required to prepare a GPT-2 model to be re-trained with a custom dataset.

Experiment Sets with BERT: The future project team may choose to examine the leading contender of GPT-2, Google's BERT model. The team may design a series of experiments with BERT and compare the outputs of the two language models. The project would further lead the discussion about transformer models and how the experiment sets may be applied across various fields of study and industries.

GPT-2 User Application: The re-trained language model may be utilized to deploy a web application to render responses within a user interface versus running code within a notebook

environment. The application would allow for the M.S in Management and Systems program to present the tool to the academic community for further research within the field of study.

Literature Survey

From smart home applications to self-driving cars, advancements in technology and artificial intelligence have revolutionized nearly all aspects of everyday tasks in the way consumers shop, study, communicate, and travel. Industry leaders look towards technology to develop and refine business practices, streamlining product development through automation while training machine learning models to recognize trends and make predictions. The field of natural language processing (NLP) has gained attention over the past few years as deep neural network-style machine learning methods of producing human-like text illustrate the evolution of the information age. A generative pre-trained transformer such as GPT-2, is an open-source transformer-based language model that can translate text from a foreign language, answer questions, summarize articles, and produce text that may be hard to distinguish from one that is written by an individual (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). GPT-2 was created by an artificial intelligence research laboratory, OpenAI, which released a small-scale model of GPT-2 to the public for research and experimentation (Radford, Wu, Amodei, Amodei, Clark, Brundage, & Sutskever, 2019). As an in-depth analysis of GPT-2 is currently being explored by many research institutions, thus, presenting a unique opportunity to study the language model and potentially contribute to better understating the architecture and inner workings of GPT-2. Before commencing the proposed project, it was necessary first to gather available research and examine the impact of GPT-2 from a broader context of how it may be leveraged and impact various industries. Therefore, the following literature review is organized into three main categories for a more in-depth understanding of the architecture behind GPT-2, weighing the risks and benefits of larger-scale transformer-based language models:

- An analysis of the architectural design of a transformer-based language model

- Review of similar project previously conducted in generating human-like text
- The impact of generative pre-trained transformers in academia and print media industry

Architectural Design of GPT-2

GPT-2 is a transformer-based language model, which utilizes the attention technique to mimic cognitive attention (Vig, 2019). The technical document drafted by OpenAI provides an overview of machine learning, multitask training of natural language processors, utilizing training dataset, and a summary of experiments to illustrate the performance of GPT-2 (Radford, Wu, Child, Luan, Amodei, and Sutskever, 2019). The researchers provide a wealth of information and a detailed approach to training a dataset – choosing to move away from utilizing a single domain of text and pursue an approach of building a large and diverse dataset. The team discusses their process of working with sources such as Common Crawl and WebText to create their resulting dataset (Radford, Wu, Child, Luan, Amodei, and Sutskever, 2019). However, the project team plan to take a step back for the indented project and focus on the previous approach to train a language model on a collection of similar text domains, a poetry collection. The shift in the utilized datasets will allow the team to learn how the model works on a small scale and examine the notion of bias in a more controlled environment, correlating to the conversation on social and economic implications of language models. Peng, Li, Frazier, and Riedl's (2020) research supports the team's intended approach in training and fine-tuning GPT-2 to generate text with fewer descriptions or variations. While Peng, Li, Frazier, and Riedl (2020) focus more on decreasing the risk of inappropriate language, the project team intends to reference the conducted experiments as a guide in setting up the project's experiments.

Research conducted by Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin (2017) presents the transformer's architecture founded on the attention mechanism,

with a documented experiment on translation tasks. The model illustrated that it trained significantly faster than architectures based on recurrent or convolutional layers and output quality results. The attention technique is described as mapping a query and a set of key-value pairs to an output, where the query, keys, values, and output are all vectors (Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin, 2017). Attention enhances the critical parts of the input data and fades out the rest; determining which data is more important depends on the context. It learns through training data by gradient descent (Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin, 2017). Furthermore, Gillioz, Casas, Mugellini, and Abou Khaled's (2020) research builds on Vaswani's et al. study examining transformer-based models, GPT and BERT, performing natural language processing tasks (NLP). The two studies will help the project team to understand how transformer-based networks have changed the face of NLP tasks, going beyond the results obtained with RNNs with more accuracy and speed (Gillioz, Casas, Mugellini, and Abou Khaled, 2020). Moreover, to further examine the inner workings of attention, Vig's (2019) research introduces a visualization tool in a GPT-2 transformer-based language model. The visualization tool comprises of three views, an attention-head view, a model view, and a neuron view (Vig, 2019). Furthermore, Vig (2019) presents three use cases for GPT-2, showing how the visualization tool might provide insights into adjusting or improving the model. Vig's (2019) research and visualization tool helps better understand the attention technique's inner workings inside a transformer-based language model. To further explore the structure of attention in a transformer-based language model, GPT-2, Vig and Belinkov (2019) present gathered research on the transformer architecture, concluding the structure of attention correlates closely to the training objective (Vig and Belinkov, 2019).

Previous Projects on Training GPT-2

In developing a project comprised of training set experiments with a generative pre-trained transformer, the team is curious to learn about similar projects and the resulting outcomes. The experiment conducted by Bena and Kalita (2020) examines the techniques in training a deep learning system to generate a work of poetry from a dataset of poems and modeling the corpus to adhere to a particular style in tone. The two authors detail their process in setting up the project and gathering data to generate the desired dream-like poetry style (Bena & Kalita, 2020). Moreover, Bena and Kalita note that in concluding their work, the gathered research may serve as a foundation for further research and experiment projects to produce human-like text and evolve the tone or emotion. However, our project team intends to move away from examining emotion and instead explore style and bias within the produced text. Köbis and Mossink (2021) provide a different perspective, as their research takes a behavioral science approach. The study examines creative artificial intelligence and surveys individuals on whether participants can distinguish between poetry drafted by man and machine. The gathered research contributes to the methodological toolkit of studying the impact of natural-language generation algorithms on human behavior (Köbis & Mossink, 2021). Therefore, presenting the groundwork for better understanding the implications of language models in academia, print media and raises the question of how research on algorithms and models, such as GPT-2, will evolve over the next few years.

Social and Economic Implications of GPT-2 for Print Media

The ethical and financial risks of artificial intelligence are an ongoing conversation, which examines how technological advancements, intended to improve everyday life quality may also pose a threat. Simić and Bačanin Džakula's (2019) research examines industry growth

opportunities of employing artificial intelligence in healthcare research, journalism, and software development. The authors present a comprehensive overview of machine learning and analyze how the main three subcategories: unsupervised, supervised, and reinforcement learning, differentiate from one another (Simić & Bačanin Džakula's 2019). The overview lays the foundation for introducing GPT-2 and provides examples of model-generated text compared to human-written text. Simić and Bačanin Džakula (2019) do not detail the architectural design or datasets of GPT-2 – but focus on the advantages and disadvantages of utilizing GPT-2 in a business environment. The research notes that GPT-2 is far from perfect and can easily be retained to produce destructive text, such as propaganda (Simić & Bačanin Džakula's 2019). Bender, Gebru, McMillan-Major, and Shmitchell (2021) further support the risks of volatility in the misuse of GPT-2 as their research notes that the training dataset's size does not explicitly guarantee diversity. Therefore, illustrating that produced text may hold biases in selecting words, which can exhibit racism, misogyny, and ableism (Bender, Gebru, McMillan-Major, & Shmitchell, 2021). In developing the training-sets experiments with GPT-2, it is vital to reference previous research work to recognize the opportunities for further research and be aware of posing risks. Bender, Gebru, McMillan-Major, and Shmitchell (2021) reinforce the importance for researchers working with language models and natural language processors to weigh the risks and investigate the use of many techniques to set experiments. While the study of GPT-2 is in the developmental state, the research of Simić and Bačanin Džakula (2019) and Bender, Gebru, McMillan-Major, and Shmitchell (2021) is vital to recognizing the severe implications if the language model, GPT-2, is misused.

Conclusions

The existing research around transformer-based models illustrates the growing industry interest to analyze and experiment with language models, such as GPT-2, to understand how a model is trained to perform natural language processing tasks. Moreover, scholars are working towards providing resources and tools to help other researchers better understand the evolving subject of language models. The gathered research will allow for an in-depth understanding of the architectural design of language models and serve as a guide in setting up the project's experiments. Most of the research reviewed concluded that the transformer and attention mechanism have pushed the reasoning skills to human-level abilities and can go beyond results obtained by RNNs concerning consistency and time (Gillioz, Casas, Mugellini, and Abou Khaled, 2020). Recognizing the technological advancements within transformer-based language models, particularly GPT-2, hold the potential to provide support and opportunity to help industries evolve for decades to come. However, industry leaders must also remain mindful of the risks language models may pose if mishandled.

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Appendix A

Project Acceptance Document

Project Name: Training Set Experiments with a Generative Pretrained Transformer

Student Name: Roksolana Maria Sheverack
Sponsoring Organization: New York University's School of Professional Studies

Project Sponsor Name and Title: Gary Rinkerman, Esq., Intellectual Property Attorney
Project Sponsor Contact Information: grinkerman@gmail.com

PROJECT PLAN

PLAN

Project Goal: Generative Pretrained Transformer (GPT) is an autoregressive language model that creates human-like text. Working with GPT is currently being explored by many researchers and businesses, therefore, holding many unanswered questions. The project's goal is to train an available industry open-source GPT text generator with various training data sets to determine the nature of the data sets. By exploring this field, we will allow the New York University School of Professional Studies and M.S. in Management and Systems Program to lead conversations on the opportunities of GPT within various industries and the future of technology.

Objective #1: Research and investigate open-source GPT text generators. Select one based on designed acceptance criteria and client's approval.

Objective #2: Create the appropriate training data sets provided under the client's guidance. The project will consist of a collection of experiments. For each experiment, the project lead will draft an anticipated outcome hypothesis and keep inventor's notebook-style notes detailing the process, observations, outcomes, and raised questions.

Objective #3: Present a well-documented and organized report on the completed work: including all gathered research, the noted experiments, and project management artifacts. Prepare a presentation, providing an overview of the project, detail the work process, the outcomes, and future research.

Objective #4: Deliver a live demonstration of the working product and a tutorial, documenting all steps in the process of setting up experiments and attaining an outcome.

I agree with the above planned project goal, project objectives, and related metrics.

Andrea Fortino	3/10/21
Project Sponsor Signature	**Date**

PROJECT RESULTS

RESULTS

Planned Start Date: 2/3/2021 **Planned End Date:** 5/5/2021
Actual Start Date: 2/3/2021 **Actual End Date:** 5/5/2021

If actuals differ from planned dates, the revised dates (Actual) are accepted by the sponsor if initialed here: **Sponsor Initials** _____

Project Goal

Was the project goal achieved as planned? ☒Yes ☐No

If NO, please explain why this is an acceptable deviation.

Sponsor Initials AGF

Objective #1: Research and investigate open-source GPT text generators. Select one based on designed acceptance criteria and client's approval.

Did the student's project meet this objective with associated measures and metrics as established at project inception?

Objective#1 ☒has or ☐has not been met. **Sponsor Initials** AGF

If not met please explain why this is or is not an acceptable deviation.

Objective #2: Create the appropriate training data sets provided under the client's guidance. The project will consist of a collection of experiments. For each experiment, the project lead will draft an anticipated outcome hypothesis and keep inventor's notebook-style notes detailing the process, observations, outcomes, and raised questions.

Did the student's project meet this objective with associated measures and metrics as established at project inception?

Objective#1 ☒has or ☐has not been met. **Sponsor Initials** AGF

If not met please explain why this is or is not an acceptable deviation.

Objective #3: Present a well-documented and organized report on the completed work: including all gathered research, the noted experiments, and project management artifacts. Prepare a presentation, providing an overview of the project, detail the work process, the outcomes, and future research.

Did the student's project meet this objective with associated measures and metrics as established at project inception?

Objective#1 ☒ has or ☐ has not been met. **Sponsor Initials** AGF

If not met please explain why this is or is not an acceptable deviation.

Objective #4: Deliver a live demonstration of the working product and a tutorial, documenting all steps in the process of setting up experiments and attaining an outcome.

Did the student's project meet this objective with associated measures and metrics as established at project inception?

Objective#1 ☒ has or ☐ has not been met. **Sponsor Initials** AGF

If not met please explain why this is or is not an acceptable deviation.

Sponsor's Overall Evaluation of Student's Performance:

Excellent work. We will be able to use the train models to run the experiments that we envisioned.

PROJECT ACCEPTANCE

ACCEPTANCE

☒ Project was completed satisfactorily and is hereby accepted
☐ Project was completed satisfactorily but did not meet all objectives, as shown above. The Project is, nevertheless, accepted.

Andres Fortino — **Project Sponsor Signature**
4/27/21 — **Date**

Roksolana Sheverack — **Student Signature**
4/27/21 — **Date**

Appendix B

Project Sponsor Agreement

1. Goals of the Program

For Participating Organizations

- Begin relationship with New York University
- Receive help from highly trained NYU graduate student
- Provide internship opportunity for NYU graduate student
- Receive assistance at no cost

For NYU Graduate Students

- Manage and implement a meaningful project aligned with their professional and educational goals
- Hands-on experience interacting with a start-up or operational small business or organization
- Earn credit toward completion of graduate degree by conducting an unpaid Applied Project under the mentorship of an NYU-SCPS professor.

2. Project Sponsor and Student Responsibilities

- Student prepares project planning documents
- Sponsor reviews and approves student's project plan
- Student submits project plan to faculty supervisors for approval
- Student conducts project according to plan
- At predetermined milestones sponsor reviews and approves status reports submitted by student
- Status reports reviewed and evaluated by faculty supervisors to assure student effort and project meet course requirements
- Project sponsor and student participate in periodic project reviews with NYU
- At project completion project sponsor completes evaluation forms
- Student prepares final report

3. Project Selection Process

- Project Evaluation Committee reviews proposed projects
  - Projects are:
    - Relevant to MS degree course content
    - Significant to the participating organization
    - Substantial in terms of duration and scope
    - Challenging to the student
    - Capable of being measured against predetermined goals

4. The MS in Management and Systems

Concentrations in:

- Strategy and Leadership
- Systems Management
- Database Technologies
- Enterprise Risk Management

Students Study Courses in:

- Project Management
- Strategic Marketing
- Database Development
- Financial Management
- Project Management

Typical Participating Student Profile

- Students selected to participate in this program meet stringent criteria
- Have completed all required pre-requisite coursework
- High achievers with strong academic credentials
- Hold 2-10 years of business experience
- Highly motivated for success

5. Sponsor and Project Information

Type of Organization	☐For Profit ■Not for Profit				
Name of Organization	New York University School of Professional Studies				
Address	7 East 12th Street				
City	New York	**State**	NY	**Zip**	10003

Project Sponsor	**First Name**	Gary	Last Name	Rinkerman
Title	Intellectual Property Attorney			
Phone				
Email	grinkerman@gmail.com			
Type of Business	Higher Education / Academic Research			

Student Name	Roksolana Maria Sheverack
Project Title	Training Set Experiments with a Generative Pretrained Transformer

Description of Project	
New York University School of Professional Studies and the M.S. in Management and Systems Program wish to determine the effect of changing the characteristics of training sets on the nature of the generated text by a Generative Pretrained Transformers (GPT). The project will build on the work started in Fall 2020 to create a generic GPT trained on Shakespearean sonnets. We will investigate using different contemporary poets (Shakespeare, Dunn, Marlowe) as the training sets and other seed poetry to evoke responses from the GPT. We will also investigate biasing the training set to create the desired effect (the theme of the resulting poem) and techniques to create the desired outcome mood. Lastly, we will investigate the responses by varying the input seed text. The project will be done through experiments, allowing the team to develop and test hypotheses, while documenting outcomes and observations.	
Estimated Hours of Student Participation	250 Hours

Anticipated Results

The project will explore GPT text generators and analyze how altering training sets' characteristics change the generated text's nature by a GPT. The project consists of four deliverable objectives:

Deliverable Objective 1 – Research and investigate open-source GPT text generators. Select one based on designed acceptance criteria and client's approval.

Deliverable Objective 2 – Create the appropriate training data sets provided under the client's guidance. The project will consist of a collection of experiments. For each experiment, the project lead will draft an anticipated outcome hypothesis and keep inventor's notebook-style notes detailing the process, observations, outcomes, and raised questions.

Deliverable Objective 3 – Present a well-documented and organized report on the completed work: including all gathered research, the noted experiments, and project management artifacts. Prepare a presentation, providing an overview of the project, detail the work process, the outcomes, and future possibilities.

Deliverable Objective 4 – Deliver a live demonstration of the working product and a tutorial, documenting all steps in the process of setting up experiments and attaining an outcome.

Knowledge and expertise student will need to be able to complete the project

In successfully completing the required graduate course work, the student has the knowledge and expertise in the following areas to accomplish the project work:

Project Management – apply project planning skills and methodology to communicate with the project's stakeholders. Develop well-documented reports, implement a change request process (if/when required), create a work breakdown structure, and manage the project's progress.
Data Analysis – gain a deep understating of GPT text generators, apply the understanding of data types, utilize research strategies of selecting appropriate datasets, further develop presentation and public speaking skills in presenting the business benefits of the completed work.

Programing Language – Python

Will the project sponsor be available for periodic meetings with NYU to review progress, address questions and concerns with the professor supervising the program?	☑ Yes ☐ No

Describe the form and frequency of supervision of the student by the Project Sponsor.

The student will meet with the Project Sponsor weekly via a zoom meeting.
The meetings will last approximately one hour, and the student will provide updates on the progression of the project work and discuss updates, changes, and concerns.

6. Sponsor Agreement

Students are interns, not professional consultants. NYU is not responsible for the outcomes of projects undertaken by students. Work is on a best-efforts basis; no guarantees or warranties are expressed or implied. Organization is responsible for evaluating work presented, determining its value and whether to use it or not. Some projects may require on-going management or even re-work by the Organization after the student completes their Applied Project.

Please note that in order to post an unpaid position, the internship must encompass all 6 components below:

1. The internship, even though it includes actual operation of the facilities of the employer, is similar to training which would be given in an educational environment.
2. The internship experience is for the benefit of the intern.
3. The intern does not displace regular employees, but works under close supervision of existing staff.
4. The employer that provides the training derives no immediate advantage from the activities of the intern; and on occasion its operations may actually be impeded.
5. The intern is not necessarily entitled to a job at the conclusion of the internship.
6. The employer and the intern understand that the intern is not entitled to wages for the time spent in the internship.

I have read and agree with the information shown in the Terms and Conditions for employers contained on the following web page(s): http://www.nyu.edu/life/resources-and-services/career-development/employers/post-a-job/terms-and-conditions.html

Please complete and sign this form in the space provided below and return to the course professor via the student who will upload the document to the course drop-box. For any questions, please email the professor: Prof. Andres Fortino agf249@nyu.edu.

I agree to all of the above

Participating Organization: nyu **Date:** 3/10/21

By (Signature): Andres Fortino
Project Sponsor

Printed Name: Andres Fortino

Title: Clinical Associate Professor

7. Student Agreement

Students who are planning to conduct an unpaid Applied Project must read and agree to the "Important Considerations Before Accepting a Job or Internship" contained on the following web page(s): http://www.nyu.edu/life/resources-and-services/career-development/find-a-job-or-internship/important-considerations-before-accepting-a-job-or-internship.html.

Students do not register their Applied Project with the Wasserman Center.

I agree to all of the above

Student Name (Print): Roksolana Maria Sheverack **Date:** 3/10/2021

Signature: Roksolana Sheverack

Appendix C

Project Charter

Project Manager: Roksolana Maria Sheverack
Sponsor: Mr. Gary Rinkerman
Prepared by: Roksolana Maria Sheverack

Name and Location of Client Organization: New York University's School of Professional Studies (NYUSPS) and the M.S. in Management and Systems Program (MASY), New York, NY

Revision History

Revision Date	Revised by	Approved by	Description of Change

Project Goal

The project's goal is to train an available industry open-source GPT text generator with various training data sets to determine the nature of the data sets. By exploring this field, we will allow the New York University School of Professional Studies (NYUSPS) and M.S. in Management and Systems Program (MASY) to lead conversations on the opportunities of GPT within various industries and the future of technology.

Problem/Opportunity Definition

Generative Pre-Trained Transformers show modern technology's incredible progression; the project will allow NYUSPS and MASY to explore this new and exciting technology trend. The project will enable us to gain an in-depth knowledge of GPT and the progression of artificial intelligence in producing human-like poetry with a desired theme or writing style. Moreover, it will examine the legal and ethical standpoint of a GPT text generator. As Mr. Gary Rinkerman is an intellectual property attorney, the client may use the following work to further explore whether the produced work may hinder the original authors' work ownership rights and how it may impact the present-day publishing industry.

Proposed Project Description

NYUSPS and MASY wish to determine the effect of changing the characteristics of training sets on the nature of the generated text by a GPT. The project will build on the work started in Fall 2020 to create a generic GPT model trained on Shakespearean sonnets. We will investigate using different contemporary poets (Shakespeare and Donne) as the training sets and other seed poetry to evoke responses from the GPT. We will also investigate biasing the training set to create the desired effect (the theme of the resulting poem) and techniques to create the desired outcome mood. Lastly, we will investigate the responses by varying the input seed text. The project will be done through experiments, allowing the project team to develop and test hypotheses while documenting outcomes and observations.

Project Sponsor

- Name and Title: Mr. Gary Rinkerman, Esq., Intellectual Property Attorney
- Role within the Organization: Mr. Gary Rinkerman publishes research on technological advancements of machine learning and the legal implications within ownership rights.
- Role on the Project: Review the gathered research; and provide feedback and input on the direction the project's experiments should advance.

Objectives

Technical Objectives

- **Objective #1:** Research and investigate open-source GPT text generators. Select one based on designed acceptance criteria and client's approval.

- **Objective #2:** Create the appropriate training data sets provided under the client's guidance. The project will consist of a collection of experiments. For each experiment, the project lead will keep inventor notebook-style notes detailing the process, observations, outcomes, and raised questions.

- **Objective #3:** Present a well-documented and organized report on the completed work: including all gathered research, the noted experiments, and project management artifacts. Prepare a presentation, providing an overview of the project, detail the work processes, the outcomes, and future research.

- **Objective #4:** Deliver a live demonstration of the working product and a tutorial, documenting all steps in the process of setting up experiments and attaining an outcome.

Timing Objectives

- Complete the project work by May 5th, 2021

Resource Objectives

- Utilize open-source and student accessible resources to minimize the project's cost and complete the required work within the agreed-upon timeline.

Budget Objectives

- The total cost of the project may not exceed the set budget.

Costs	Planned	Actual
Consultant Salary	$32,500.00	$32,500.00
Total	**$32,500.00**	**$32,500.00**

Scope Objectives

- Develop and execute experiments to examine the nature of the GPT-2 language model.

Project Selection & Ranking Criteria

Project Benefit Category:

❑ Compliance/Regulatory ❑ Efficiency/Cost reduction ❑ Revenue increase

Portfolio Fit and Interdependencies: Future research may rely on the present experiments as a foundation for further work.

Project Urgency: High

Cost/Benefit Analysis

Tangible Benefits

Benefit:

- No Indefinable Revenue

Value & Probability: N/A

Assumptions Driving Value: N/A

Intangible Benefits

Benefit:

- Further Improve Competitive Position
- Spearhead Future Research in the Field

Value & Probability: N/A

Assumptions Driving Value: N/A

Cost Categories	**Amount**
Internal Labor Hours	250 Hours
External Costs:	
Labor (consultants, contract labor)	**$ 32,500.00**
Equipment, hardware, or software	N/A
List other costs such as travel & training	N/A

Financial Return: No Indefinable Revenue

Other Business Benefits

Explore the development of artificial intelligence and spearhead the conversation about the role of machine learning in the fine arts and publishing industry. Examine the potential benefits in ways language models may be utilized to improve initiatives, produce future revenue.

Assumptions

1. All the required software is open-source and may be utilized free of cost.
2. The project lead has the technical knowledge to utilize the required software and programming languages.
3. The completed project work will act as a foundation for future research and experiments.

Scope

Quality

- Present the experiments' documented process and outcomes, illustrating the pathway in receiving the gathered results

Time

- Complete and deliver the finalized product to the sponsor by 4/28/2021
- Submit the finalized report by 05/05/2021

Resource Allocation

- Utilize the open-source software for the execution of the project work.
- Utilize gathered research for reference and further understanding of the mechanisms within a GPT-2 language model.

Out of Scope Activities

- N/A

Constraints

1. Limited Research Availability – Research on the GPT-2 language model's capabilities is currently being developed by many scholars and requires further work.
2. Time – The project's duration is limited to three months.

Risks and Mitigation Strategies

Please see Project Risk Management Plan in Appendix F.

Communications Plan

1. Frequency – The project lead will meet with the project sponsor every week.
2. Method – The meetings will be held remotely via zoom video conference.
3. Content – The weekly meetings will follow a Daily Scrum format in providing project updates based on three questions:
    a. What did you do?
    b. What will you do?
    c. Are there any impediments in your way?

Schedule Overview

Project Start Date: 2/3/2021
Estimated Project Completion Date: 5/5/2021

Major Milestones
Project Kick-Off: Project State and Definition of Key Objectives – 2/3/2021
Milestone One: Download and Set-up GPT-2 Language Model – 3/18/2021
Milestone Two: Set up and Document a Set of Performed Experiments – 4/15/2021
Deliverable: Final Report and Presentation of the Experiments – 5/05/2021

External Milestones Affecting the Project
Ensure open-source accessibility of all required software.
Impact of Late Delivery
May render the gathered research and experiments obsolete.

Resources Required

Role	Responsibilities	Duration	Required Qualifications
Project Manager	Organize and develop the required project documentation and artifacts.	100 Hours	Experience in drafting project planning documents; completed Project Management in the Information Age course.
Project Team	Complete the required project work, experiments, reports.	150 Hours	Experience in working with Python, developing and documenting experiments.

Facilities, Software, Hardware, and other Resources

Resources required to complete the project will call for access to a computer and a stable internet connection. The project lead will utilize open-source software for performing the required experiments, including open-source Google Colaboratory notebook, OpenAI's GPT-2 model, and collected datasets. Any additional guides, research, and references will be accessed through NYU Library Article Databases and LinkedIn Learning.

Procedures and Methodology

Work Breakdown Task Definition and Schedule

Level	WBS	Element Name	Definition	Due Date
1	1	Training Set Experiments with a Generative Pretrained Transformer.	Project work in setting up an experiment in training a GPT-2 model.	
2	**1.1**	**Initiation**	Initiation of the project.	
3	1.1.1	Meet and Greet with Project's Sponsor	Meet with the sponsor of the project.	02/04/2021
	1.1.2	Evaluation of the Business Opportunity and Recommendations	Evaluate current artificial intelligence and language-model trends.	02/10/2021
	1.1.3	Create Project Proposal	Create a proposal of the project, including the deliverables, goals, and outline of the project.	02/10/2021
	1.1.4	Develop Sponsor Agreement	Draft a Sponsor Agreement on agreed-upon terms of the project.	03/08/2021
		1.1.4.1 Submit Documents to the Sponsor for Review	The Project Agreement is delivered to the project sponsor.	03/08/2021

		1.1.4.3 Documents are Signed and Approved	Formal acceptance and signing of the Project Agreement by the sponsor.	03/10/2021
	1.1.5	Develop **a** Project Charter	Draft Project Charter to move forward with the project.	03/17/2021
2	**1.2**	**Planning**	The planning process for the project.	
3	1.2.1	Literature Review and Reference List	Gather available research and industry reports.	02/24/2021
	1.2.2	Develop a Situational Analysis and Cost-Benefit Analysis	Evaluate the industry and cost benefits of the project.	03/03/2021
	1.2.3	Develop a Schedule Plan and Work Breakdown Structure	Develop a schedule plan to complete the project tasks.	03/03/2021
	1.2.4	Develop a Change Management Plan	Develop a plan to introduce changes as required.	03/31/2021
	1.2.5	Develop a Risk Management Plan	Develop a plan to address unforeseen risks and ways to mitigate risk impact.	04/14/2021
	1.2.6	Develop a Communication Management Plan	Develop a plan to draft status reports on the project's progression for the sponsor and establish meeting times.	03/11/2021
2	**1.3**	**Execution**	Work involved to execute the project.	
3	1.3.1	Project Kickoff Meeting	Formal kick off meeting with the project team, key project stakeholders, and project sponsor.	02/04/2021
	1.3.2	Validate Acceptance Criteria Requirements	The original user requirements are reviewed by the team and validated by the sponsor.	03/11/2021
	1.3.3	Acquire Software and Open-Source GPT-2 Model	Ensure open-source access for the required software tools and model code.	03/11/2021
	1.3.4	Install and Set-up Tools and GPT-2 Model	Install the required software and code.	03/14/2021
	1.3.5	Experimental Phase	Detail the set-up of experiments: the outcomes, needed adjustments, etc.	04/20/2021
		1.3.5.1 Project Status - Report A	Detail the progression of the work.	03/31/2021
		1.3.5.2 Project Status - Report B	Detail the progression of the work.	04/14/2021
	1.3.6	Develop User Tutorial		05/05/2021
	1.3.7	Presentation to the Sponsor	Present the completed work to the sponsor.	05/07/2021
	1.3.8	Produce the Final Product to the Sponsor	Deliver the working application to the sponsor.	05/07/2021
2	**1.4**	**Control**	The control process of the project.	
3	1.4.1	Monitor Project Work and Schedule Deadlines	Overall management for the project, ensure the work is progressing and set deadlines are being met.	05/05/2021
	1.4.2	Monitor and Record Changes	Document changes as they arise.	05/05/2021
	1.4.3	Monitor Risk and Document Issues	Refer to risk management efforts as defined in the Risk Management Plan.	05/05/2021
	1.4.4	Monitor Communications	Ensure ample communication and reporting is provided to the sponsor.	05/05/2021
2	**1.5**	**Closeout**	The work to close-out the project.	
3	1.5.1	Document Lessons Learned	Document the lessons learned during the project for future reference.	04/28/2021
	1.5.2	Update Files and Records	Update all files and records to reflect necessary changes, re-drafts, etc.	05/03/2021

	1.5.3	Draft Project Report	Draft the final report detailing the project lead's work and project outcomes.	04/28/2021
		1.5.3.1 Final Project Report	Deliver the finalized project report.	05/05/2021
	1.5.4	Gain Formal Acceptance	Upon product delivery, the project sponsor will formally accept the project by signing the acceptance document.	04/28/2021
	1.5.5	Archive Files and Documents	All project files and documents are formally shared with the sponsor via a GitHub repository.	05/05/2021

Project Evaluation

1. **Project Schedule** – Ensure the project work is progressing and meeting the set deadlines.
2. **Project Weekly Status Report** – During the weekly status meetings, provide updates on the progression of the project work.
3. **Project Communication Plan, Issues Log, Risk Register** – Ensure adherence to the set communication plan and scheduled status meetings. Maintain and update all required project artifacts and reports. Note and review all issues, changes, and risks encountered during the project.
4. **Project Monthly Status Report** – Draft two comprehensive status reports detailing the progression of the project's work.

Appendix D

Project Plan

Project Tasks Outline

1. Training Set Experiments with a Generative Pre-trained Transformer

1.1 Initiation

- 1.1.1 Meet and Greet with the Project Sponsor
- 1.1.2 Evaluation of the Business Opportunity and Present Recommendations
- 1.1.3 Create Project Proposal
- 1.1.4 Develop Sponsor Agreement and Project Acceptance Documents
  - 1.1.4.1 Submit Documents to the Sponsor for Review
  - 1.1.4.2 Sponsor Agreement and Project Acceptance Signed and Approved
- 1.1.5 Develop a Project Charter

1.2 Planning

- 1.2.1 Literature Review and Reference List
- 1.2.2 Develop a Situational Analysis and Cost-Benefit Analysis
- 1.2.3 Develop a Schedule Plan and Work Breakdown Structure
- 1.2.4 Develop a Change Management Plan
- 1.2.5 Develop a Risk Management Plan
- 1.2.6 Develop a Communication Management Plan

1.3 Execution

- 1.3.1 Project Kickoff Meeting
- 1.3.2 Validate Acceptance Criteria Requirements
- 1.3.3 Acquire Software and Open-Source GPT-2 Model
- 1.3.4 Install and Set-up Tools and GPT-2 Model
- 1.3.5 Experimental Phase
  - 1.3.5.1 Deliver Project Status - Report A
  - 1.3.5.2 Deliver Project Status - Report B
- 1.3.6 Develop User Tutorial
- 1.3.7 Presentation to the Sponsor
- 1.3.8 Produce the Final Product to the Sponsor

1.4 Control

- 1.4.1 Monitor Communications
- 1.4.2 Monitor Project Work and Schedule Deadlines
- 1.4.3 Monitor and Record Changes
- 1.4.4 Monitor Risk and Document Issues

1.5 Closeout

- 1.5.1 Document Lessons Learned
- 1.5.2 Update Files and Records

1.5.3 Draft Project Report
1.5.3.1 Final Project Report
1.5.4 Gain Formal Acceptance
1.5.5 Archive Files and Records

Work Breakdown Task Definition and Schedule

Level	WBS	Element Name	Definition	Due Date
1	1	Training Set Experiments with a Generative Pre-trained Transformer.	Project work in setting up an experiment in training a GPT-2 model.	
2	**1.1**	**Initiation**	Initiation of the project.	
3	1.1.1	Meet and Greet with Project's Sponsor	Meet with the sponsor of the project.	02/04/2021
	1.1.2	Evaluation of the Business Opportunity and Recommendations	Evaluate current artificial intelligence and language-model trends.	02/10/2021
	1.1.3	Create Project Proposal	Create a proposal of the project, including the deliverables, goals, and outline of the project.	02/10/2021
	1.1.4	Develop Sponsor Agreement	Draft a Sponsor Agreement on agreed-upon terms of the project.	03/08/2021
		1.1.4.1 Submit Documents to the Sponsor for Review	The Project Agreement is delivered to the project sponsor.	03/08/2021
		1.1.4.3 Documents are Signed and Approved	Formal acceptance and signing of the Project Agreement by the sponsor.	03/10/2021
	1.1.5	Develop a Project Charter	Draft Project Charter to move forward with the project.	03/17/2021
2	**1.2**	**Planning**	The planning process for the project.	
3	1.2.1	Literature Review and Reference List	Gather available research and industry reports.	02/24/2021
	1.2.2	Develop a Situational Analysis and Cost-Benefit Analysis	Evaluate the industry and cost benefits of the project.	03/03/2021
	1.2.3	Develop a Schedule Plan and Work Breakdown Structure	Develop a schedule plan to complete the project tasks.	03/03/2021
	1.2.4	Develop a Change Management Plan	Develop a plan to introduce changes as required.	03/31/2021
	1.2.5	Develop a Risk Management Plan	Develop a plan to address unforeseen risks and ways to mitigate risk impact.	04/14/2021
	1.2.6	Develop a Communication Management Plan	Develop a plan to draft status reports on the project's progression for the sponsor and establish meeting times.	03/11/2021
2	**1.3**	**Execution**	Work involved to execute the project.	
3	1.3.1	Project Kickoff Meeting	Formal kick off meeting with the project team, key project stakeholders, and project sponsor.	02/04/2021
	1.3.2	Validate Acceptance Criteria Requirements	The original user requirements are reviewed by the team and validated by the sponsor.	03/11/2021
	1.3.3	Acquire Software and Open-Source GPT-2 Model	Ensure open-source access for the required software tools and model code.	03/11/2021
	1.3.4	Install and Set-up Tools and GPT-2 Model	Install the required software and code.	03/14/2021

	1.3.5	Experimental Phase	Detail the set-up of experiments: the outcomes, needed adjustments, etc.	04/20/2021
		1.3.5.1 Project Status - Report A	Detail the progression of the work.	03/31/2021
		1.3.5.2 Project Status - Report B	Detail the progression of the work.	04/14/2021
	1.3.6	Develop User Tutorial		05/05/2021
	1.3.7	Presentation to the Sponsor	Present the completed work to the sponsor.	05/07/2021
	1.3.8	Produce the Final Product to the Sponsor	Deliver the working application to the sponsor.	05/07/2021
2	**1.4**	**Control**	The control process of the project.	
3	1.4.1	Monitor Project Work and Schedule Deadlines	Overall management for the project, ensure the work is progressing and set deadlines are being met.	05/05/2021
	1.4.2	Monitor and Record Changes	Document changes as they arise.	05/05/2021
	1.4.3	Monitor Risk and Document Issues	Refer to risk management efforts as defined in the Risk Management Plan.	05/05/2021
	1.4.4	Monitor Communications	Ensure ample communication and reporting is provided to the sponsor.	05/05/2021
2	**1.5**	**Closeout**	The work to close-out the project.	
3	1.5.1	Document Lessons Learned	Document the lessons learned during the project for future reference.	04/28/2021
	1.5.2	Update Files and Records	Update all files and records to reflect necessary changes, re-drafts, etc.	05/03/2021
	1.5.3	Draft Project Report	Draft the final report detailing the project lead's work and project outcomes.	04/28/2021
		1.5.3.1 Final Project Report	Deliver the finalized project report.	05/05/2021
	1.5.4	Gain Formal Acceptance	Upon product delivery, the project sponsor will formally accept the project by signing the acceptance document.	04/28/2021
	1.5.5	Archive Files and Documents	All project files and documents are formally shared with the sponsor.	05/05/2021

Appendix E

Situational Analysis

Generative Pre-trained Transformers (GPT) is a form of artificial intelligence that can create human-like text. Working and gaining a more in-depth understanding of GPT language models is currently being explored by many researchers and businesses; therefore, the subject area holds many unanswered questions. As New York University School of Professional Studies (NYUSPS) prides itself on championing innovation, the project will allow the University to explore the rise of the new technology trend — leading the conversation on the opportunities of GPT across industries and the future of technology. Moreover, as New York University is one of the leading research universities in the nation, the following project will uphold the esteem reputation within scholarly research and higher education. In doing so, the University will hold the opportunity to be recognized as a leader and innovator in exploring emerging research trends. The project's outcome can invite recognition from industry leaders, research grants, and expansion of program offerings.

From a conceptual standpoint, the project will examine the legal and ethical implications of a GPT text generator. As Mr. Gary Rinkerman is an intellectual property attorney, he may use the following work to explore whether the produced work may hinder the original authors' work ownership rights. Therefore, spearheading the conversation on how language models may impact the publishing and entertainment industry — allowing Mr. Gary Rinkerman to strengthen his position on the emerging trend of artificial intelligence from a legal standpoint. Moreover, the project's outcome may also present the opportunity for Mr. Gary Rinkerman to explore ways transformer language models may be leveraged and employed by industries to their advantage.

The proposed project adheres to the set guidelines and requirements of a graduate capstone. Therefore, at the present moment, the project is not set to yield monetary value. However, I am hopeful the completion of the project and produced product will lay the foundation for the possibility of a profitable line of research within the coming years. Moreover, the yielded project results may be published or presented at scholarly conferences to advance further New York University's esteemed reputation as a research institution.

The project tasks and deadlines are detailed in a subsequent document, the Work Breakdown Structure and Schedule. In reviewing the project requirements and remaining work, the project lead is confident the final product will be met by the deadline.

Industry Analysis

To further gain insight into the project's goals, it is vital to examine the industry environment and recognize critical competitors. The analysis will employ Porter's Five Forces:

Porter's Five Forces				
Supplier Power	Buyer Power	Competitive Rivalry	Threat of Substitution	Threat of New Entry

In higher education, leading universities work towards developing research and educational advancement opportunities through scholarship. New York University is a private research university that provides a rigorous education to more than 50,000 students and undertakes nearly $1 billion in research annually (About NYU). The University prides itself in fostering and preserving new ideas, insights, and knowledge. The research activities promote and nurture scientific progress, develop artistic and creative expression, and sustain an informed democratic society (Research NYU). In being recognized as the nation's premier leader of higher education and academic research across all fields of study, New York University is also partnered with several globally respected research grant programs, including Fulbright and

Goddard Fellowships. Moreover, New York University is accredited by the Middle States Commission on Higher Education, certifying confidence in its mission and goals, performance, and resources.

Supplier Power – Within the Training Set Experiments with a Generative Pre-trained Transformer project, the two leading supplies include:

OpenAI: a research and development company that released an open-source model of GPT-2.

Google Workplace: matriculated students have full access to utilize the available applications to save, share, and communicate on the progress of their work.

The following two suppliers hold limited power, as the open-source model and software environment meet the project's needs and do not pose any financial implications.

Buyer Power – The project holds little to no buyer power, as the acquired tools are open-sourced and free to use. The project will utilize GPT-2 model for educational research purposes; therefore, there are no plans to build a separate language model.

Competitors

New York City is home to leading universities and companies, equipping young professionals with the opportunity to work towards their aspirations and goals. New York University holds a firm position of revolutionizing higher education in innovation, research, and graduate success. The high interest to attend New York University is especially exhibited through admissions, as 2021 marks the 14th year streak of receiving a record high of 100,000 applications for first-year admission, representing nearly every state and over 100 countries (About NYU). However, it is essential to acknowledge that the University also holds competitors.

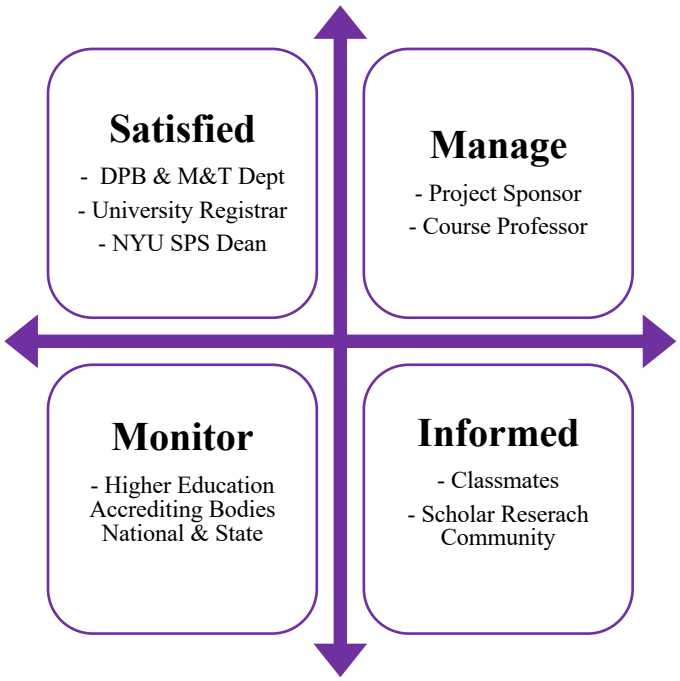
Competitive Rivalry – It is valuable to recognize that other higher education institutions that hold similar stature may offer similar degree options. Considering New York City's location, universities that may be held in comparison to New York University include Columbia University in the City of New York, Stevens Institute of Technology, and Rutgers University.

Threat of Substitution – living in the information age holds the great benefit of learning new subjects is easily accessible. While online certificate-based platforms such as LinkedIn Learning, edX, and Coursera are a great resource in developing new technical skills, it does not negate industry leaders' requirement of professional degree credentials. Therefore, holding minimal threat to the industry demand for highly skilled and educated professionals.

Threat of New Entry –The creation and reputational establishment of an educational institution requires time to gain donors and funding, qualify for required state and national accreditations, and recruit students. Therefore, the threat of new entry or the establishment of a new university is distinctly low. However, it must be recognized that well-established institutions are always looking to expand academic program offerings. For instance, half a decade ago, degree programs in data analytics were scarce and were reserved for engineering and technical programs. Fast-forward a few years, degree programs related to data now exist within businesses, public policy, and health sciences. As the field of artificial intelligence is growing in recognition, educational institutions will seek to develop academic programs that meet the demand of industry trends, therefore, making the threat of new program entry plausible.

Stakeholder Analysis

No.	Stakeholder	External Internal	Project Involvement	Role
1.	**Project Sponsor:** Gary Rinkerman	**Internal**	**Leading**	Key stakeholder within the project, requires the project work for further research.
2.	**Course Professor:** Dr. Andres Fortino	**Internal**	**Leading**	Key stakeholder within the project, requires the project work for further research.
3.	**Project Team Member:** Dr. Roy Lowrance	**Internal**	**Leading**	Key stakeholder within the project, requires the project work for further research.
4.	DPB Dean: Dr. Ihrig M&T Academic Director: Dr. Bass	External	Supportive	Oversees successful completion of capstone coursework and degree requirements.
5.	University Registrar: Elizabeth Kienle-Granzo	External	Supportive	Oversees the successful completion of courses required to confer graduate degrees.
6.	NYUSPS Dean: Dr. Greenbaum	External	Supportive	Oversees the successful completion of courses for awarding of a graduate degree.
7.	National and State Higher Education Accrediting Bodies	External	Unaware	Oversees the quality of education and courses, ensuring the university offers scholarship work to attain a degree.
8.	Capstone Course Classmates	External	Neutral	View the completed product presentation.
9.	Scholar Research Community	External	Supportive	May utilize the project work for future research.



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Appendix F

Risk Management Plan

Project Name

Modern-Day Shakespeare: Training Set Experiments with a Generative Pre-trained Transformer

Project Description

New York University's School Professional Studies (NYUSPS) and the Master of Science in Management and Systems Program (MASY) wish to determine the effect of changing the characteristics of training sets on the nature of the generated text by a generative pre-trained transformer (GPT). The team will investigate using different contemporary poets (Shakespeare, Dunn, Marlowe) as training sets and other seed poetry to evoke responses from the GPT model. Furthermore, the project will investigate biasing the training set to create the desired effect (the theme of the resulting poem) and the responses by varying the input seed text. The project will be done through defined experiments, allowing the project team to document the training process and produced outcomes.

Identified Risks

No.	Risk	Probability Score (1,2 or 3)	Impact Score (1,2 or 3)
1	Ensuring the open-source GPT-2 model and necessary software will remain free and available throughout the project period.	1	2
2	The client may decide to cancel the project.	1	3
3	OpenAI's GPT-2 model is not sufficient to be trained without additional finetuning.	**2**	**3**
4	The user license of the GPT-2 model may change, and OpenAI may try to claim ownership rights to the produced output.	1	1
5	The project calls for advanced knowledge of Python.	**3**	**3**

Risk Matrix

		Risk (Exposure)		
Probability		1.Slight	2. Moderate	3. High
	1. Very Unlikely	4	1	2
	2. Possible			3
	3. Expected			5

Contingency Plan

Risk	Description	Probability (1-3)	Exposure (1-3)	Contingency Plan
1	Ensuring the open-source GPT-2 model and necessary software will remain free and available throughout the project period.	1	2	
2	The client may decide to cancel the project.	1	3	
3	OpenAI's GPT-2 model is not sufficient to be trained without additional finetuning.	2	3	There are two open-source GPT-2 finetuned models available, which may be employed to perform the experiments.
4	The user license of the GPT-2 model may change, and OpenAI may try to claim ownership rights to the produced output.	1	1	
5	The project calls for advanced knowledge of Python.	3	3	Reference tutorials and available resources to resolve coding issues. Refer to Roy Lowrance for further guidance.

Appendix G

Change Management Plan

Project Name:	**Training Set Experiments with a Generative Pre-Trained Transformer**
Prepared by:	**Roksolana Sheverack, Project Manager**
Date:	**03/31/2021**

1. Purpose

The purpose of this Change Management Plan is to:

- Ensure that all changes to the project are reviewed and approved in advance.
- All changes are coordinated across the entire project.
- All stakeholders are notified of approved changes to the project.
- All changes are well documents and archived for future reference.

To request a change to be done within the project, the team is required to complete and submit a Change Request Form attached for formal review:	Project Change Request Form
The Project Change Request Log notes all changes requests made by the team, attached for review:	Project Change Request Log

2. Goals

The goals of this Change Management Plan are to:

- Carefully consider all requests for change
- Identify, define, evaluate, approve, and track changes through to completion
- Modify and document Project Plans to reflect the impact of the requested changes
- Bring the appropriate parties into the discussion, negotiate changes, and communicate them with all key stakeholders and affected parties.

3. Responsibilities

Responsible for Change Management	Their Responsibilities
Project Manager	Develop the Change Management Plan.
Project Manager	Facilitate the change management process, oversee updates to the scope, schedule, budget, and quality plans.
Project Team	Maintain a log of all change request and their resolutions.
Project Manager	Conduct review of all change management activities with the project sponsor periodically.

4. Process

The Change Management process for reviewing requests:

The Change Management process occurs in six steps:

1. Submit a written Change Request (CR)
2. Review Change Request and approve or reject for further analysis
3. If approved, perform analysis, and develop a recommendation
4. Accept or reject the recommendation
5. If accepted, update project documents and re-plan
6. Notify all stakeholders of the change.

The following describes the change control process in detail:

1. **Any stakeholder can request or identify a change. He/she will use the *Change Request Form* to document the nature of the change request.**
2. **The completed form is sent to a designated member of the Project Team who enters the CR into the *Project Change Request Log*.** Project Change Request Log

3. Change Requests are reviewed by the PM and will be assigned one four possible outcomes:

Reject:	a) Notice is sent to the submitter b) Submitter may appeal (sends the matter to the Project Team) c) Project Team reviews the CR at its next meeting.
Defer to a Later Date:	a) Project Team is scheduled to consider the CR on a given date b) Notice is sent to the submitter c) Submitter may appeal (sends the matter to the Project Team) d) Project Team reviews the CR at their meeting.
Accepted for Analysis Immediately:	a) An analyst is assigned, and impact analysis begins b) Project Team is notified.
Accepted for Consideration by the Project Team:	a) Project Team reviews the CR at its next meeting.

4. All new pending CRs are reviewed at the Project Team meeting. Possible outcomes:

Reject:	b) Notice is sent to the submitter c) Submitter may appeal (which sends the matter to the Project Sponsor) d) The Project Team discusses and makes a final ruling.
Defer to a Later Date:	a) Project Team is scheduled to consider the CR on a given date b) Notice is sent to the submitter.

4. Process	
Accepted for Analysis:	a) An analyst is assigned, and impact analysis begins b) Notice is sent to the submitter.
5. Once the analysis is complete; the Project Team reviews the results.[1] Possible outcomes:	
Reject:	a) Notice is sent to the submitter b) Submitter may appeal, which sends the matter to the Project Sponsor c) The Project Team discusses and makes a final ruling.
Accept:	a) Project Team accepts the analyst's recommendation b) Notice is sent to Project Sponsor as follows: Low Impact CR: Information only, no action required Medium Impact CR: Sponsor review requested; no other action required High Impact CR: Sponsor approval required.
Return for Further Analysis:	a) Project Team has questions or suggestions that are sent back to the analyst for further consideration.
6. Accepted CRs are forwarded to the Project Sponsor for review of recommendations. Possible outcomes:	
Reject*:*	b) Notice is sent to the submitter c) Submitter may appeal to the Project Team d) The Project Team discusses and makes a final ruling.
Accept*:*	a) Notice is sent to the submitter b) Project Team updates relevant project documents c) Project Team re-plans d) Project Team acts on the new plan.
Return for Further Analysis:	a) The Sponsor has questions or suggestions that are sent back to the analyst for further consideration b) Notice is sent to the submitter c) Analyst's recommendations are reviewed by Project Team (return to *Step 5*).

[1] Note: Sponsor participates in this review if the analysis was done at Sponsor's request.

5. Notes on the Change Control Process

1. A Change Request is:

- Included in the project only when both Sponsor and Project Team agree on a recommended action.

2. The Change Request may be:

- **Low Impact:** Has no material effect on cost or schedule. Quality is not impaired.
- **Medium Impact:** Moderate impact on cost or schedule, or no impact on cost or schedule, but the quality is impaired. If the impact is negative, Project Sponsor's review and approval is required.
- **High Impact:** Significant impact on cost, schedule, or quality. If the impact is negative, Project Sponsor and Project Team's review and approval is required.

3. For this project:

- **Moderate Impact:** Fewer than **five**-days change in schedule; no change to the budget; one or more major use cases materially degraded
- **High Impact:** More than **ten**-days change in schedule; no change to the budget; one or more major use cases lost.

4. All project changes will require some degree of updates to project documents:

- **Low Impact:** Changes likely require update only to requirements and specifications documents.
- **Moderate or High Impact:** Depending on the type of change, the following documents (at a minimum) must be reviewed and may require update:

Type of Change:	Documents to Review and Update:
Scope	• Scope Statement and Work Breakdown Schedule • Budget • Project Schedule • Resource Plan • Risk Response Plan • Requirements and Specifications
Schedule	• Project Schedule and Work Breakdown Schedule • Budget and Cost • Resource Plan • Risk Response Plan
Budget	• Budget and Cost • Resource Plan • Risk Response Plan

5. Notes on the Change Control Process

Quality	• Resource Plan (Software) • Risk Response Plan • Quality Plan • Requirements and Specifications

5. Project Documents:

Whenever changes are made to project documents, the version history is updated on the document, and prior versions are maintained in an archive. Edit access to project documents is limited to the Project Manager and designated individuals on the Project Team.

- For this project, all electronic documents are kept in:

[ ] Version Control System:

[x] Shared Storage Folder Available to the Project Team:	The documents include: Project Plan, Project Charter, WBS, Cost and Benefit Analysis, Project Agreement and Acceptance, Gathered Research
[x] Project File Maintained by the Project Manager:	All project-related documents: Project Plan, Project Charter, WBS, Cost and Benefit Analysis, Project Agreement and Acceptance, Gathered Research
[x] Other: The following individual(s) have edit access to project documents:	Dr. Andres Fortino

Role	Documents
• Project Manager	• Review and update all project documents
• Project Manager	• Archive project documents
• Project Lead/Team	• Assist PM in updating project documents

6. Project Change Management Plan / Signatures

Project Name:	Training Set Experiments with a Generative Pre-Trained Transformer
Project Manager:	Roksolana Sheverack

I have reviewed the information contained in this Project Change Management Plan and agree:

Name	Role	Signature	Date
Roksolana Sheverack	Project Lead and PM	Roksolana Sheverack	3/31/2021

The signatures above indicate an understanding of the purpose and content of this document by those signing it. By signing this document, they agree to this as the formal Project Change Management Plan.

Appendix H

Status Reports

Training Set Experiments with a Generative Pretrained Transformer

Status Report – April 2021

To:	Gary Rinkerman	**cc:**	Dr. Andres Fortino
From:	Roksolana Maria Sheverack		
Date:	April 1, 2021		

YOUR ANTICIPATED COMPLETION DATE: April 29, 2021

COMPLETION SEMESTER: Spring 2021

Project Status Areas	Execution Week 4		
	Green	Yellow	Red
1. Overall Project Status	Progressing on Target		
2. Project Schedule	Progressing on Target		
3. Project Deliverables	Progressing on Target		
4. Issues	No Issues		
5. Project Risks		Monitoring Closely	
6. Resources & Collaboration	Progressing on Target		
7. Change Status	Progressing on Target		

1 – Overall Project Status
• The project is progressing well and is on track to meet the deliverables by the set deadlines.

2 – Project Schedule	
Tasks that are not on schedule per work plan	Impact
At the moment, the project work is progressing. We must be vigilant in ensuring the required work is completed on time and meets the set deadlines.	The project may not be delayed beyond April 30, 2021.

3 – Project Deliverables
COMPLETED DELIVERABLES: Installation and set-up of GPT-2 language model. Performed a validation test of the GPT-2 pre-trained language model and generated three text samples. **UPCOMING DELIVERABLES:** Training GTP-2 with a dataset of unbiased Shakespeare sonnets. Once the training is complete, test the trained language model by attempting to evoke a response.

4 – Issues
Technical issues encountered during installation were resolved. At the present moment, no additional issues have been encountered.

5 – Project Risks	
Potential Risks	**Possible Mitigation**
There is a possibility we will encounter technical issues while training the language model with the selected datasets.	Resources documenting solutions on training GPT-2 with a dataset are available and may be utilized as a guide. In the event of technical issues or the need for further support of working with Python, resources are readily available. We may also seek additional guidance from Roy Lowrance.

6– Resources and Collaboration
Software Resources Utilized: • Software (Anaconda – Jupyter) is open-source and free to utilize. • Generative Pretrained Transformer (GPT-2) is an open-source model made available by OpenAI.

7 – Change Status	
Scope Changes	**Status** (Requested | Approved | Completed)
OpenAI's GPT-2 model works with Python; we had to switch the initial plan of utilizing R to employ Python in setting up and training the model. The change did not impact the schedule's timeline; however, it did impede one of the discussed deliverables. Creating an application interface is not attainable with Python and may require further exploration/skill set. In discussing the change, the Project Team and the Project Sponsor agreed to detailed documentation of the set experiments and a possible demonstration of receiving an output from the model in place of the application counterpart.	Completed

Comments/Actions

8 – Sponsor Signoff	
The sponsor indicates agreement with the above status report.	
Andres Fortino Gary Rinkerman	4/20/21

Assessment Guidelines

The assessment is designated by one of the three "Traffic Light" colors utilizing the following guidelines:

Each project should establish the appropriate project slippage metrics for yellow vs red status

Executive Summary:	Assessment		
	Green	Yellow	Red
Overall Project and Most Status Areas	No major issues, minimal risk to project, on target with expected outcomes, project on schedule, everyone satisfied with progress.	Some major issues, moderate risk to project, must monitor closely, some internal or/and external dissatisfaction with progress. Project plan slipping by 2+ days.	Significant issues, serious risks to project, significant intervention must occur to achieve success, potential for stoppage of project activity. Project slipping by 5+ days, and resources uncommitted to meet deliverables.

Training Set Experiments with a Generative Pretrained Transformer

Status Report – April 2021

To:	Gary Rinkerman	**cc:**	Dr. Andres Fortino
From:	Roksolana Maria Sheverack		
Date:	April 15, 2021		

YOUR ANTICIPATED COMPLETION DATE: **April 29, 2021**

COMPLETION SEMESTER: **Spring 2021**

Project Status Areas	Execution Week 4		
	Green	Yellow	Red
1. Overall Project Status	Progressing on Target		
2. Project Schedule	Progressing on Target		
3. Project Deliverables	Monitoring Closely		
4. Issues	Monitoring Closely		
5. Project Risks	Monitoring Closely		
6. Resources & Collaboration	Progressing on Target		
7. Change Status	Progressing on Target		

1 – Overall Project Status
• The project is progressing well and is on track to meet the deliverables by the set deadlines.

2 – Project Schedule	
Tasks that are not on schedule per work plan	Impact
At the moment, the project work is progressing. We must be vigilant in ensuring the required work is completed on time and meets the set deadlines.	The project may not be delayed beyond April 30, 2021.

3 – Project Deliverables
COMPLETED DELIVERABLES: Installation and set-up of GPT-2 language model. Performed a validation test of the GPT-2 pre-trained language model and generated three text samples. Prepared and encoded the datasets to train GPT-2 language model. **UPCOMING DELIVERABLES:** Training GTP-2 with a dataset of unbiased Shakespeare sonnets. We are currently working to resolve a code error message to proceed towards training the language model.

4 – Issues
At the present moment, the project team is working to resolve a code error issue in training the model.

5 – Project Risks	
Potential Risks	**Possible Mitigation**
We encountered a technical issue while attempting to train the language model.	Refer to shared resources documenting solutions on training GPT-2 with a select dataset.

6– Resources and Collaboration
Software Resources Utilized: • Software (Anaconda – Python) is open-source and free to utilize. • Generative Pretrained Transformer (GPT-2) is an open-source model made available by OpenAI.

7 – Change Status	
Scope Changes	**Status** (Requested | Approved | Completed)
No scope changes requested.	

Comments/Actions

8 – Sponsor Signoff	
The sponsor indicates agreement with the above status report.	
Andres Fortino Gary Rinkerman	4/20/21

Assessment Guidelines

The assessment is designated by one of the three "Traffic Light" colors utilizing the following guidelines:

Each project should establish the appropriate project slippage metrics for yellow vs red status

Executive Summary:	Assessment		
	Green	Yellow	Red
Overall Project and Most Status Areas	No major issues, minimal risk to project, on target with expected outcomes, project on schedule, everyone satisfied with progress.	Some major issues, moderate risk to project, must monitor closely, some internal or/and external dissatisfaction with progress. Project plan slipping by 2+ days.	Significant issues, serious risks to project, significant intervention must occur to achieve success, potential for stoppage of project activity. Project slipping by 5+ days, and resources uncommitted to meet deliverables.

Appendix I

Annotated Bibliography

1. Bena, B., & Kalita, J. (2020). *Introducing aspects of creativity in automatic poetry generation.* arXiv. https://arxiv.org/abs/2002.02511

   Poetry Generation involves teaching systems to automatically generate text that resembles poetic work. A deep learning system can learn to generate poetry on its own by training on a corpus of poems and modeling the particular style of language. In this paper, we propose taking an approach that fine-tunes GPT- 2, a pre-trained language model, to our downstream task of poetry generation. We extend prior work on poetry generation by introducing creative elements. Specifically, we generate poems that express emotion and elicit the same in readers, and poems that use the language of dreams—called dream poetry. We are able to produce poems that correctly elicit the emotions of sadness and joy 87.5 and 85 percent, respectively, of the time. We produce dreamlike poetry by training on a corpus of texts that describe dreams. Poems from this model are shown to capture elements of dream poetry with scores of no less than 3.2 on the Likert scale. We perform crowdsourced human-evaluation for all our poems. We also make use of the Coh-Metrix tool, outlining metrics we use to gauge the quality of text generated.

Bena and Kalita's research examines the techniques in training a deep learning system to generate a work of poetry from a dataset of poems and modeling the corpus to adhere to a particular style. The research paper mainly focuses on fine-tuning GPT- 2 to produce poetry in a dream-poem style. Bena and Kalita's experiment holds similarities to the experimental work my project seeks to accomplish, which may act as a resource guide in comparing Bena and Kalita's approach to setting my experiments.

2. Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021, March 3 - 10). *On the dangers of stochastic parrots: Can language models be too big?* [Paper presentation]. Association for Computing Machinery 2021 Conference on Fairness, Accountability, and Transparency, Virtual Event, Canada.

   The past 3 years of work in NLP have been characterized by the development and deployment of ever larger language models, especially for English. BERT, its variants, GPT-2/3, and others, most recently Switch-C, have pushed the boundaries of the possible both through architectural innovations and through sheer size. Using these pretrained models and the methodology of fine-tuning them for specific tasks, researchers have extended the state of the art on a wide array of tasks as measured by leaderboards on specific benchmarks for English. In this paper, we take a step back and ask: How big is too big? What are the possible risks associated with this technology and what paths are available for mitigating those risks? We provide recommendations including weighing the environmental and financial costs first, investing resources into curating and carefully documenting datasets rather than ingesting everything on the web, carrying out pre-development exercises evaluating how the planned approach fits into research and

development goals and supports stakeholder values, and encouraging research directions beyond ever larger language models.

The following paper examines the risks associated with large natural language processors (NLP), such as GPT-2 and GPT-3, which are pre-trained on significantly sized datasets. The authors weigh the financial impacts over the models' accuracy while noting that "size does not guarantee diversity," raising the concern for machine bias. In presenting several risks, the research lists recommendations to mitigate risk. I intend to utilize the authors' research to support my discussion of the ethical standpoint from the presented risks in the misuse of a language model.

3. Das, A., & Verma, R. M. (2020). Can machines tell stories? A comparative study of deep neural language models and metrics. *IEEE Access,* 8, 181258–181292. https://doi.org/10.1109/ACCESS.2020.3023421

   Massive textual content has enabled rapid advances in natural language modeling. The use of pre-trained deep neural language models has significantly improved natural language understanding tasks. However, the extent to which these systems can be applied to content generation is unclear. While a few informal studies have claimed that these models can generate 'high quality' readable content, there is no prior study on analyzing the generated content from these models based on sampling and fine-tuning hyperparameters. We conduct an in-depth comparison of several language models for open-ended story generation from given prompts. Using a diverse set of automated metrics, we compare the performance of transformer-based generative models – OpenAI's GPT2 (pre-trained and fine-tuned) and Google's pre-trained Transformer-XL and XLNet to human-written textual references. Studying inter-metric correlation along with metric ranking reveals interesting insights – the high correlation between the readability scores and word usage in the text. A study of the statistical significance and empirical evaluations between the scores (human and machine-generated) at higher sampling hyperparameter combinations ($t=\{0.75, 1.0\}$, $k=\{100, 150, 250\}$) reveal that the top pre-trained and fine-tuned models generated samples condition well on the prompt with an increased occurrence of unique and difficult words. The GPT2-medium model fine-tuned on the 1024 Byte-pair Encoding (BPE) tokenized version of the dataset along with pre-trained Transformer-XL models generated samples close to human written content on three metrics: prompt-based overlap, coherence, and variation in sentence length. A study of overall model stability and performance shows that fine-tuned GPT2 language models have the least deviation in metric scores from human performance.

Das and Verma's research examines an in-depth comparison of multiple language models for open-ended story generation. The gathered research provides an in-depth analysis of GPT-2 in comparing performance to other pre-trained transformers. The study explores the notion of deep learning and the growing popularity of the end-to-end learning approach. The following research paper is highly technical in discussing model fine-tuning, setting up experiments, and providing measurement metrics to quantify their findings. The

following paper may be a reference for measurement metrics and visualization of experiment trials.

4. Gillioz, A., Casas, J., Mugellini, E., & Abou Khaled, O. (2020, September 6-9). *Overview of the transformer-based models for NLP tasks* [Paper Presentation]. 15th Federated Conference Computer Science and Information Systems, Sofia, Bulgaria. http://dx.doi.org/10.15439/2020F20

    In 2017, Vaswani et al. proposed a new neural network architecture named Transformer. That modern architecture quickly revolutionized the natural language processing world. Models like GPT and BERT relying on this Transformer architecture have fully outperformed the previous state-of-the art networks. It surpassed the earlier approaches by such a wide margin that all the recent cutting-edge models seem to rely on these Transformer-based architectures. In this paper, we provide an overview and explanations of the latest models. We cover the auto-regressive models such as GPT, GPT-2 and XLNET, as well as the auto-encoder architecture such as BERT and a lot of post-BERT models like RoBERTa, ALBERT, ERNIE 1.0/2.0.

The following research draws from Vaswani, Shazeer, Parmar, Uszkoreit, Jones, Gomez, Kaiser, and Polosukhin (2017) in examining transformer-based models, GPT and BERT in performing natural language processing tasks. The article concludes that the Transformer-based networks have pushed the reasoning skills to human-level abilities and can go beyond results obtained with RNNs inconsistency and time. This article will help better understand a transformer-based model, GPT-2, while connecting to another important research article that laid the foundation for understanding the Transformer and the attention mechanisms.

5. Klein, T., & Nabi, M. (2019). *Learning to answer by learning to ask: Getting the best of GPT-2 and BERT worlds.* arXiv. https://arxiv.org/abs/1911.02365

    Automatic question generation aims at the generation of questions from a context, with the corresponding answers being sub-spans of the given passage. Whereas, most of the methods mostly rely on heuristic rules to generate questions, more recently also neural network approaches have been proposed. In this work, we propose a variant of the self-attention Transformer network architectures model to generate meaningful and diverse questions. To this end, we propose an easy-to-use model consisting of the conjunction of the Transformer decoder GPT-2 model with Transformer encoder BERT the downstream task for question answering. The model is trained in an end-to-end fashion, where the language model is trained to produce a question-answer-aware input representation that facilitates to generate an answer focused question. Our result of neural question generation from text on the SQuAD 1.1 dataset suggests that our method can produce semantically correct and diverse questions. Additionally, we assessed the performance of our proposed method for the downstream task of question answering. The analysis shows that our proposed generation & answering collaboration framework relatively improves both tasks and is particularly powerful in the semi-supervised setup. The results further

suggest a robust and comparably lean pipeline facilitating question generation in the small-data regime.

Klein and Nabi's research examines two leading transformer-based language models, GPT2- and BERT in question generation, by tying together the two language models in end-to-end trainable fashion facilitation of semi-supervised learning. The gathered research may be utilized to refer to training a dataset to achieve the desired outcome.

6. Köbis, N., & Mossink, L. D. (2021). Artificial intelligence versus Maya Angelou: Experimental evidence that people cannot differentiate AI-generated from human-written poetry. *Computers in Human Behavior*, *114*, Article 106553. https://doi.org/10.1016/j.chb.2020.106553

   The release of openly available, robust natural language generation algorithms (NLG) has spurred much public attention and debate. One reason lies in the algorithms' purported ability to generate humanlike text across various domains. Empirical evidence using incentivized tasks to assess whether people (a) can distinguish and (b) prefer algorithm-generated versus human-written text is lacking. We conducted two experiments assessing behavioral reactions to the state-of-the-art Natural Language Generation algorithm GPT-2 (Ntotal = 830). Using the identical starting lines of human poems, GPT-2 produced samples of poems. From these samples, either a random poem was chosen (Human-out-of-the loop) or the best one was selected (Human-in-the-loop) and in turn matched with a human-written poem. In a new incentivized version of the Turing Test, participants failed to reliably detect the algorithmically generated poems in the Human-in-the-loop treatment, yet succeeded in the Human-out-of-the-loop treatment. Further, people reveal a slight aversion to algorithm-generated poetry, independent on whether participants were informed about the algorithmic origin of the poem (Transparency) or not (Opacity). We discuss what these results convey about the performance of NLG algorithms to produce human-like text and propose methodologies to study such learning algorithms in human-agent experimental settings.

Köbis and Mossink's research discusses the power of algorithms to generate human-like text. The paper adopts a behavioral science approach to examine creative artificial intelligence and survey individuals on whether participants can distinguish between man and machine-developed poetry. I found this article particularly interesting as it explores the advancement of GPT-2 in creating human-like text that is hard to distinguish from original works of literature.

7. Peng, X., Li, S., Frazier, S., & Riedl, M. (2020, December). *Reducing non-normative text generation from language models* [Paper presentation]. The Association for Computational Linguistics13th International Conference on Natural Language Generation, Dublin, Ireland.

   Large-scale, transformer-based language models such as GPT-2 are pretrained on diverse corpora scraped from the internet. Consequently, they are prone to generating non-normative text (i.e. in violation of social norms). We introduce a technique for fine-tuning GPT-2, using a policy gradient reinforcement learning technique and a normative

text classifier to produce reward and punishment values. We evaluate our technique on five data sets using automated and human participant experiments. The normative text classifier is 81-90% accurate when compared to gold-standard human judgements of normative and non-normative generated text. Our normative fine-tuning technique is able to reduce non-normative text by 27-61%, depending on the data set.

The research article examines the process of training and fine-tuning a language model, illustrating how models, GPT-2 or BERT, can be trained to a specific domain of interest. The authors conduct three experiments to demonstrate how large-scale transformer-based language models can be trained to generate text with fewer descriptions or variations, decreasing the risk of inappropriate language. I intend to reference the conducted experiments to set up a hypothesis during my project's experiments.

8. Radford, A., Wu, J., Amodei, D., Amodei, D., Clark, J., Brundage, M., & Sutskever, I. (2019, February 14). Better language models and their implications. *OpenAI*. https://openai.com/blog/better-language-models/

   We've trained a large-scale unsupervised language model which generates coherent paragraphs of text, achieves state-of-the-art performance on many language modeling benchmarks, and performs rudimentary reading comprehension, machine translation, question answering, and summarization—all without task-specific training.

OpenAI maintains the following blog to publish gathered research and release updates for the GPT-2 model. The authors also provide GPT-2 generated text samples to illustrate how the model can adapt the conditioned text's style and content. OpenAI's blog is a rich resource to learn more about the GPT-2 model, access the GitHub repository, and reference further research on the field of natural language processing.

9. Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2019). Language models are unsupervised multitask learners. *OpenAI*. https://cdn.openai.com/better-language-models/language_models_are_unsupervised_multitask_learners.pdf

   Natural language processing tasks, such as question answering, machine translation, reading comprehension, and summarization, are typically approached with supervised learning on task specific datasets. We demonstrate that language models begin to learn these tasks without any explicit supervision when trained on a new dataset of millions of webpages called WebText. When conditioned on a document plus questions, the answers generated by the language model reach 55 F1 on the CoQA dataset - matching or exceeding the performance of 3 out of 4 baseline systems without using the 127,000+ training examples. The capacity of the language model is essential to the success of zero-shot task transfer and increasing it improves performance in a log-linear fashion across tasks. Our largest model, GPT-2, is a 1.5B parameter Transformer that achieves state of the art results on 7 out of 8 tested language modeling datasets in a zero-shot setting but still underfits WebText. Samples from the model reflect these improvements and contain coherent paragraphs of text. These findings suggest a promising path towards building

language processing systems which learn to perform tasks from their naturally occurring demonstrations.

OpenAI put together the following technical document in releasing a smaller model of GTP-2 for researchers to experiment within 2019. The authors provide an overview of machine learning, the utilized training dataset, and a summary of experiments to illustrate the performance of GPT-2. I will use the technical paper to reference the gathered research and gain more insight into the architecture of GTP-2.

10. Simić, D., & Bačanin Džakula, N. (2019). *The ethics of machine learning* [Paper presentation]. Sinteza 2019 International Scientific Conference on Information Technology and Data Related Research, Belgrade, Serbia. https://doi.org/10.15308/Sinteza-2019-478-484

    Data science and machine learning are advancing at a fast pace, which is why tech industry needs to keep up with their latest trends. This paper illustrates how artificial intelligence and automation in particular can be used to enhance our lives, by improving our productivity and assisting us at our work. However, wrong comprehension and use of the aforementioned techniques could have catastrophic consequences. The paper will introduce readers to the terms of artificial intelligence, data science and machine learning and review one of the most recent language models developed by non-profit organization OpenAI. The review highlights both pros and cons of the language model, predicting measures humanity can take to present artificial intelligence and automatization as models of the future.

Simić and Bačanin Džakula explore artificial intelligence opportunities in illustrating ways machine learning algorithms and automation may be unitized to improve business practices, medical research, and overall user experience. The paper takes a look at weighing the positive and negative implications of OpenAI's GPT-2, a transformer-based language model to be employed within the corporate and scientific industries. The following overview of artificial intelligence and GPT-2 will act as a foundation to support my further analysis on the role of ethics and arising risks within today's technological advances.

11. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, L., & Polosukhin, I. (2017, December). *Attention is all you need* [Paper presentation]. 31st Conference on Neural Information Processing Systems, Long Beach, CA, United States. https://dl.acm.org/doi/10.5555/3295222.3295349

    The dominant sequence transduction models are based on complex recurrent or convolutional neural networks that include an encoder and a decoder. The best performing models also connect the encoder and decoder through an attention mechanism. We propose a new simple network architecture, the Transformer, based solely on attention mechanisms, dispensing with recurrence and convolutions entirely. Experiments on two machine translation tasks show these models to be superior in quality while being more parallelizable and requiring significantly less time to train. Our

model achieves 28.4 BLEU on the WMT 2014 English to- German translation task, improving over the existing best results, including ensembles, by over 2 BLEU. On the WMT 2014 English-to-French translation task, our model establishes a new single-model state-of-the-art BLEU score of 41.8 after training for 3.5 days on eight GPUs, a small fraction of the training costs of the best models from the literature. We show that the Transformer generalizes well to other tasks by applying it successfully to English constituency parsing both with large and limited training data.

The following research paper provides an in-depth understating of the Transformer, founded on the attention mechanisms. The authors provide an experiment on translation tasks, illustrating that the model can be re-trained significantly faster than architectures based on recurrent or convolutional layers and output quality results. The presented findings provide further context on understanding the mechanisms of the GPT-2 model.

12. Vig, J. (2019). *Visualizing attention in transformer-based language representation models.* arXiv. https://arxiv.org/abs/1904.02679

    We present an open-source tool for visualizing multi-head self-attention in Transformer-based language representation models. The tool extends earlier work by visualizing attention at three levels of granularity: the attention-head level, the model level, and the neuron level. We describe how each of these views can help to interpret the model, and we demonstrate the tool on the BERT model and the OpenAI GPT-2 model. We also present three use cases for analyzing GPT-2: detecting model bias, identifying recurring patterns, and linking neurons to model behavior.

Vig introduces a visualization tool for attention in a transformer-based language model, GPT-2. The research presents three use cases for GPT-2, illustrating how the visualization tool may be utilized to gain insight in adjusting or seeking ways to improve the GPT-2 model in different instances. The gathered research and visualization tool will help me better understand the inner workings of transformer-based language models.

13. Vig, J., & Belinkov, Y. (2019, August). *Analyzing the structure of attention in a transformer language model* [Paper presentation]. Association for Computational Linguistics 2019 Workshop BlackboxNLP: Analyzing and Interpreting Neural Networks for NLP, Florence, Italy. https://doi.org/10.18653/v1/W19-4808

    The Transformer is a fully attention-based alternative to recurrent networks that has achieved state-of-the-art results across a range of NLP tasks. In this paper, we analyze the structure of attention in a Transformer language model, the GPT-2 small pretrained model. We visualize attention for individual instances and analyze the interaction between attention and syntax over a large corpus. We find that attention targets different parts of speech at different layer depths within the model, and that attention aligns with dependency relations most strongly in the middle layers. We also find that the deepest layers of the model capture the most distant relationships. Finally, we extract exemplar sentences that reveal highly specific patterns targeted by particular attention heads.

In the following research report, Vig and Belinkov further examine the structure of attention in a transformer-based language model, particularly GPT-2. The research builds on Vig's previous research detailing the architectural design of attention in a GPT-2 transformer language model. The gathered research and presented tools will provide me with a detailed understanding of a transformer language model.

14. Wang, C., Li, M., & Smola, A. J. (2019). *Language models with transformers.* arXiv. https://arxiv.org/abs/1904.09408

    The Transformer architecture is superior to RNN-based models in computational efficiency. Recently, GPT and BERT demonstrate the efficacy of Transformer models on various NLP tasks using pre-trained language models on large-scale corpora. Surprisingly, these Transformer architectures are suboptimal for language model itself. Neither self-attention nor the positional encoding in the Transformer is able to efficiently incorporate the word-level sequential context crucial to language modeling. In this paper, we explore effective Transformer architectures for language model, including adding additional LSTM layers to better capture the sequential context while still keeping the computation efficient. We propose Coordinate Architecture Search (CAS) to find an effective architecture through iterative refinement of the model. Experimental results on the PTB, WikiText-2, and WikiText-103 show that CAS achieves perplexities between 20:42 and 34:11 on all problems, i.e. on average an improvement of 12.0 perplexity units compared to state-of-the-art LSTMs.

The architecture of Transformer-based language models, such as GPT and BERT, is recognized as more powerful and superior to RNN- based language models in computation efficacy. However, there is debate on GPT and BERT's effectiveness to achieve state-of-the-art performance in language modeling, particularly in predicting the next word given the previous context. The research illustrates the need to fine-tune a subset of paraments to improve responses from the pre-trained Transformer models and introduce long short-term memory (LSTM) layers. This article is vital in further understanding the complexities of Transformer-based language models. Moreover, the conducted experiments can be utilized for reference to best interpret my project's experiment outcomes.

15. Worsham, J., & Kalita, J. (2020). Multi-task learning for natural language processing in the 2020s: Where are we going? *Pattern Recognition Letters*, 136, 120–126. https://doi.org/10.1016/j.patrec.2020.05.031

    Multi-task learning (MTL) significantly pre-dates the deep learning era, and it has seen a resurgence in the past few years as researchers have been applying MTL to deep learning solutions for natural language tasks. While steady MTL research has always been present, there is a growing interest driven by the im- pressive successes published in the related fields of transfer learning and pre-training, such as BERT, and the release of new challenge problems, such as GLUE and the NLP Decathlon (decaNLP). These efforts place more focus on how weights are shared across networks, evaluate the re-usability of network components and identify use cases where MTL can significantly outperform single-task solutions. This paper strives to provide a comprehensive survey of

the numerous recent MTL contributions to the field of natural language processing and provide a forum to focus efforts on the hardest unsolved problems in the next decade. While novel models that improve performance on NLP benchmarks are continually produced, lasting MTL challenges remain unsolved which could hold the key to better language under- standing, knowledge discovery and natural language interfaces.

Worsham and Kalita examine the potential future of natural language processing and provide an overview of machine learning techniques by illustrating the relationships between transfer learning and multi-task learning. The article focuses on a qualitative analysis of the challenges and opportunities within multi-task learning from an academic standpoint. The following article is an excellent resource for understanding machine learning and deep learning techniques and their inner relationships.