Detection and Measurement of Lymph Nodes Using Artificial Intelligence

(Technical Paper)

AI's Effects on the Future of Work

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

With the rapid advancement of technology comes both excitement and apprehension. Artificial intelligence (AI) is an emerging technology that can automate existing workflows and allows technical systems to learn, adjust, and perform human-like tasks. The emergence of AI technologies such as ChatGPT have shown the world just how capable AI is for efficiently completing tasks and improving the quality of life for many. The medical imaging space is one of many fields that holds the potential to be revolutionized by AI.

CT and MRI scans allow for a non-invasive view into a patient's body in order to identify the causes of ailments or observe any irregularities. For cases that involve tumors, these scans are utilized by radiologists who must follow a guideline to identify potentially harmful tumors that may be cancerous. Although this method has allowed doctors to identify early stages of cancer in patients, the current clinical workflow introduces human error, leading to potentially erroneous assessments of the scans.

In order to address this issue, the technical portion of this paper will discuss an implementation of AI to improve the existing clinical workflow of tumor identification and measurement. The AI implementation will be in the form of a software tool, primarily focusing on the ability to quickly identify the presence of tumors within a CT or MRI scan and consistently measure its volume.

Although AI has potential to improve lives, many fear that AI will threaten their way of life. Many radiologists fear that their job may be taken from them as technology such as AI continues to develop. The STS portion of this paper will utilize the Technological Determinism framework to discuss major advancements of past technologies and their impacts, then compare them to AI and the current research of the topic.

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I. SPECIFIC AIMS

Identification and assessment of the change in tumor burden (size) is an important feature of the clinical evaluation of cancer therapeutics. Current methods of assessment include CT, MRI, and ultrasound (Eisenhaur et al., 2009). To calculate the change in tumor burden between images from different time points, the dimension of the select lesions, referred to as target lesions, are used. This calculation is then categorized as complete response (CR), partial response (PR), stable disease (SD), or progressive disease (PD). CR is complete disappearance of tumor (-100%), PR is a change between -100% and -30%, SD is a change between -30% and +20%, and PD is an increase of 20% or greater (Jain et al., 2012). These methods take significant time and are prone to human error, depending entirely on the radiologists experience and ability. A study by Adrian P. Brady cites a day-to-day average error rate of 3-5% as well as a retrospective error rate of 30% from radiological studies (Brady, 2017). Alexander et al states that an average scan generates over 1000 images and within a normal work day, radiologists are left with less than 1 second to read each image (Alexander et al., 2022). To this end, we propose to develop an **automated and user-friendly AI-based lymph node detection and measurement tool** (Aim 1). We will then use this AI framework in medical image analysis for CT and/or MRI images to **evaluate the safety and effectiveness of the tool in radiology** (Aim 2). The use of artificial intelligence in the field of radiology, and the general medical industry for that matter, is emerging rapidly and constantly changing, leaving questions and risks regarding the improvement of such radiologic techniques. Fear of privacy or the general public's distrust in technology is always present, however, the application of AI within radiology has the potential to revolutionize the industry. It can allow for increased diagnostic accuracy among cancer patients and a reduced workload for radiologists. The following specific aims outline our approach to this capstone project, including the AI development, execution, and evaluation.

Aim 1: Develop an AI-based lymph node detection measurement tool by:

a) Combining existing assessment methodologies into an automated python algorithm consisting of the following steps:
    i) Loading in data, installing and importing required libraries, data exploration and preprocessing, model training, and hyperparameter tuning
b) Designing a user-friendly interface for continuous research applications.
    i) Minimal required steps for implementation
    ii) Aesthetic, inuitive, consistent, and allows for user control and freedom

Aim 2: Evaluate the safety and effectiveness of the tool in radiology by:

a) Demonstrate that the above framework (Aim 1) improved upon the existing lymph node detection methodologies, as it is more efficient and provides results that are equally, if not more, accurate.
    i) Consistently achieve accuracy scores comparable to or greater than existing methodologies
b) Implementing rapid deployment of the tool within a radiologist's workflow setting.
    i) Analyze how the tool can be integrated into the existing workflow
    ii) Receive feedback from users and improve upon our tool

We will implement these aims by developing, executing, and evaluating the AI algorithm. It will integrate convoluted neural networks, filters, and pooling for complex tasks like image recognition and image segmentation. We will train the model on training data sets using appropriate optimization tools and fine-tune hyperparameters using the validation set to evaluate and achieve the best performance. Continuous analysis and deep comparison to existing lymph node detection techniques as outlined by RECIST will be utilized for the improvement of our model's performance.

Our work will produce a tool to assist the workflow for radiologists and lower the potential rates of human error. The proposed work has the potential to be integrated into any radiologist clinical workflow. In addition, this work will advance the field of radiology by: 1) Improving the efficiency of lymph node detection while matching or improving the results of current methodologies, 2) Improving the quality of life for radiologists, reducing mental fatigue and exhaustion from manual image analysis, and 3) Enhancing the existing clinical workflow and setting a new standard for medical image analysis.

II. SIGNIFICANCE

Cancer is a group of diseases caused by the uncontrolled growth and spread of irregular cells that can ultimately lead to death if not treated properly. In the United States, cancer is the second highest cause of death with heart disease being the leading cause. The American Cancer Society has estimated that in the US alone, approximately 1.9 million cancer cases are expected to be diagnosed in 2023 while over 600,000 cancer-related deaths are expected (Sigel et. al., 2023). To address this, there have been major advancements in the treatment and prevention of cancer. Identification and assessment of the change in tumor burden (size) is considered an important feature in the clinical evaluation of cancer therapeutics however there is still room for improvement. Tumor burden identification is entirely dependent on the radiologists experience and ability, leaving space for human error as shown in a study which cites a day-to-day average error rate of 3-5% as well as a retrospective error rate of 30% from radiological studies (Brady, 2017). The current process is also heavily time consuming. A study by Alexander et. al. states that an average MRI scan generates over 1000 images and within a normal work day, leaving radiologists with less than 1 second to read each image (Alexander et al., 2022).

By introducing an AI-based lymph node detection and measurement tool, individual images within scans will be analyzed by our algorithm, outputting its analysis for the radiologist to view. This will enhance the current existing workflow by decreasing the amount of manual analysis required and increasing the amount of time radiologists can analyze each set of scans, resulting in a more thorough analysis. The proposed work has the potential to be integrated into any radiologist clinical workflow. In addition, this work will advance the field of radiology by: 1) Improving the efficiency of lymph node detection while matching or improving the results of current methodologies, 2) Improving the quality of life for radiologists, reducing mental fatigue and exhaustion from manual image analysis, and 3) Enhancing the existing clinical workflow and setting a new standard for medical image analysis.

III. INNOVATION

RECIST is the current methodology to evaluate and assess changes in tumor burden. It is a guideline that provides a standard approach for solid tumor measurement and provides definitions for the assessment of tumor size changes. To calculate the change in tumor burden between images from different time points, the dimension of the select lesions, referred to as target lesions, are used. This calculation is then categorized as complete response (CR), partial response (PR), stable disease (SD), or progressive disease (PD). CR is complete disappearance of tumor (-100%), PR is a change between -100% and -30%, SD is a change between -30% and +20%, and PD is an increase of 20% or greater (Jain et al., 2012). Currently, radiologists must manually measure and analyze these changes in order to determine the tumor burden. Our proposed solution will continue to utilize the existing RECIST methodology and revolutionize its implementation in clinical workflows by utilizing an AI-based tool to automate the image analysis process. The novel AI-based lymph node detection and measurement tool will be created to uphold the existing RECIST guidelines, providing an automated process that identifies tumor burden and then consistently measures them.

IV. APPROACH

Firstly, we will begin by conducting research on the background of lymphoma disease and other cancer types with metastasis to lymph nodes. We start by getting a general understanding of the disease and its pathology, then moving onto how lymph nodes can be enlarged during lymphoma. This includes taking a look at various conventional techniques used for the measurement of lymph nodes using RECIST, as well as researching and developing background for the logistics behind these procedures. Diagnosis often involves a combination of physical examination, imaging, and biopsy of affected lymph nodes. Lymph nodes, which are part of the lymphatic system, can become enlarged due to several reasons, including infection or malignancy like lymphoma. It’s important to recognize all the various ways that the size of lymph nodes increases. Considering the unique characteristics of enlarged nodes is another step that must be taken since enlarged nodes in lymphoma can be rubbery, painless, and may feel fixed in their position. The size and location of swollen nodes can vary based on the type and stage of lymphoma. So, depending on the stage of cancer, time frame, and dimensions of the node, it can have a profound effect on the process of our diagnosis and our results. Deepening our knowledge of lymphoma's characteristics, its pathology, and the mechanisms behind the enlargement of lymph nodes will provide a solid foundation for developing machine learning models or AI-based diagnostic tools for accurate detection and understanding of this disease.

We plan to look at coding competitions on Kaggle, such as first place competition projects that have performed similar processes using RSNA Screening Mammography for breast cancer detection. Kaggle hosts a plethora of machine learning competitions, including the RSNA Screening Mammography Challenge. Analyzing and understanding winning solutions from similar competitions can offer valuable insights and methodologies for optimizing our approach. For instance, if one project submission has unique pooling components to their network model that improve the accuracy of their training and reduce the training time, we can play around with similar pooling and filtering commands for our model in the hopes of replicating the same network improvement to our design. So, experimenting around and implementing the design processes and ideas from these groups will allow our team to quickly learn more about what new elements we can implement into our own project. By experimenting with ideas and techniques employed in successful Kaggle projects, our team can expedite the learning process and potentially discover innovative elements to integrate.

Specific Aim 1: Develop an AI-based lymph node detection measurement tool.

Rationale: As stated previously, the current method of lymph node identification is manual and relies on the radiologists discretion. While this may not be an issue for reviewing one scan at a time, radiologists must view multiple scans daily. The accumulated fatigue of manually inspecting scans does not provide radiologists ample time to properly review each image and instead allows for more incorrect assessments of tumor burden. To this end, an introduction of a more automated method of scan analysis would allow the radiologists more time to review the scan as a whole, reducing fatigue and error rates. We aim to develop an algorithm that will quickly process the input scan and then output the results of the analysis, showing the numerical change in tumor burden as well as what was identified as tumors. In addition, we aim to develop a user-friendly interface for continuous research applications. The interface will require minimal steps for implementation, allowing a seamless integration of the proposed method into the radiologists existing workflow. Ideally, the interface will consist of three steps: Upload Data, Select the Process Data button, and then select the Output Data button. We also aim to have the user interface allow for corrections to the tumor burden identification. Should the algorithm incorrectly identify a lymph node, the radiologist will have the freedom and control to adjust and correct the identification.

Experimental Approach:

The algorithm will be developed through a step-by-step process. We plan to use Jupyter Notebook to compile and organize any of our coding scripts utilizing Python Programming language to write any code concerning the algorithm. First, we will load in the training/test data required to train our model and, thus, enable the algorithm to perform our specified task. In the context of image classification, this process involves presenting the model with large amounts of labeled or unlabeled data and allowing it to learn the patterns, associations, or features within the data. The collected data is cleaned, preprocessed, and formatted in a way that the machine learning model can understand and learn from it. Producing an accurate model requires a large and diverse dataset to be used for training. We will use Digital Imaging and Communications in Medicine (DICOM) software to extract image data sets for both training and testing. DICOM is a widely used format for medical imaging. Using DICOM software allows the extraction of image datasets, crucial for training and testing in the context of medical images. After the data has been imported, we will install the required libraries necessary to proceed with the next steps. Data exploration is essential for understanding what type of data will be used and will allow insight into the diversity of the set. Preprocessing is necessary to ensure that the data used for training and testing is consistent with its format and quality, allowing for proper training of the model. For the model training step, we plan on utilizing Tensorflow. The Tensorflow machine learning platform will elicit our ideologies in order to design the convoluted neural networks. TensorFlow is a powerful machine learning platform, particularly renowned for its capabilities in building neural networks. Convolutional Neural Networks, a specialized neural network architecture for image analysis, will likely be the core of our model. Typically CNNs used for the classification of images into different subgroups follow a general systemic structure (Figure 1) . From this platform, we will combine machine learning filters like image augmentation, pooling, and matrix multiplication for the design of the network modeling. These filters play pivotal roles in enhancing feature extraction, reducing overfitting, and improving the network's overall performance. Lastly, the hyperparameter tuning step allows for optimization of the model training. By adjusting parameters, the training process will be improved in order to produce a model that possesses more accuracy. To begin the development of a user-friendly interface, we will prototype a user interface and then integrate our model into the interface.

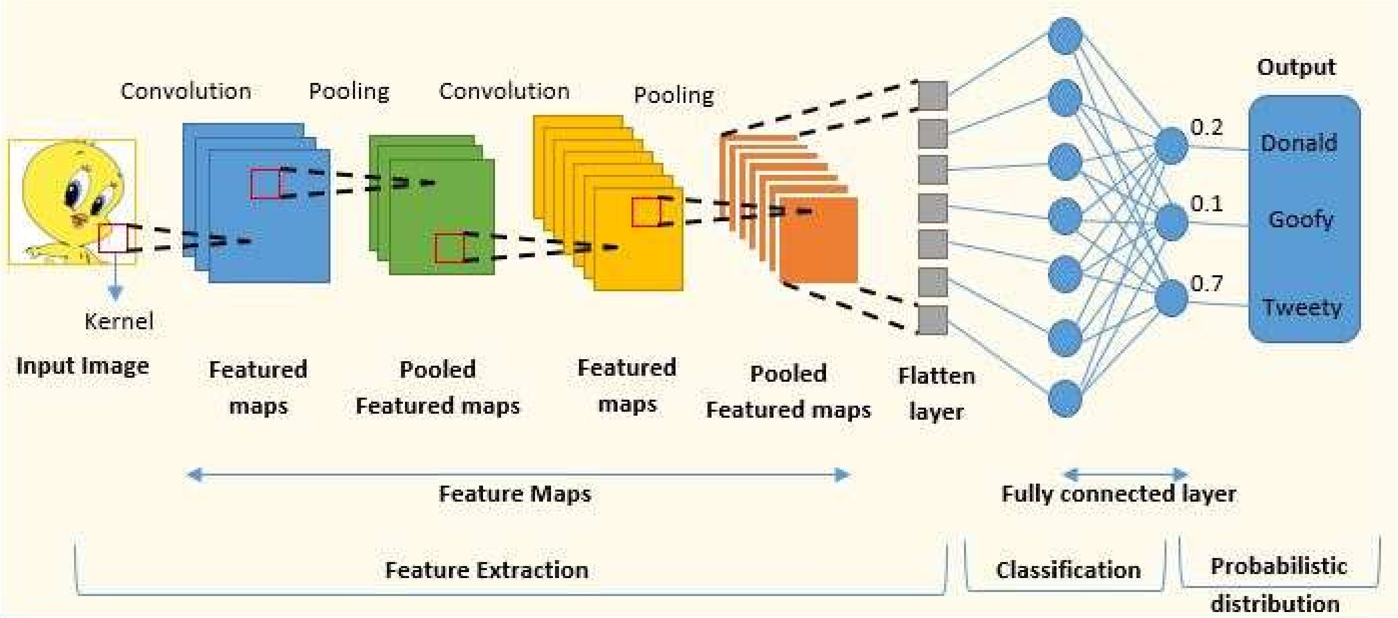


Figure 1. Traditional Convolutional Neural Network Model for Image Classification.

Expected Outcome: By following the stated process of data loading, installation/importing required libraries, data exploration/preprocessing, model training, and hyperparameter tuning, **the model will be fully trained and ready to be tested/improved through more hyperparameter tuning**. The results after the model analyzes the scan will be displayed to the user and will allow for measurement adjustment and correction of lymph node identification. The user-friendly interface will be simple and easy to use, allowing for ease of navigation.

Limitations and Alternative Approaches: Ideally, the model will be able to successfully identify lymph nodes and measure tumor burden at a high level of accuracy and display these results to the user. However, there is a possibility of underperformance of lymph node identification and measurement. This could be due to a scan that the model is not able to interpret because of improper training or oddities within the scan that the model cannot handle. This can be accounted for with proper training and user corrections as the model will continue to learn as it is being used, allowing for better performance. Improper training could be the result of a lack of both sufficient time and training images. With extensive model training, the algorithm will be exposed to more oddities and unique image scans, thus, increasing the chances of accurately interpreting the measurement of the lymph node. Alternative methods for image analysis can be that the user will be able to quickly revert back to the original method of image analysis manually as the software will allow the user to manipulate and cycle through images within the scan.

Specific Aim 2: Evaluate the safety and effectiveness of the tool in radiology.

Rationale: The primary objective of any medical tool or technology is to ensure the safety of patients. Accessing the safety of this tool is crucial to minimize potential risks, such as misdiagnosis, and to enhance the overall well-being of patients. Furthermore, evaluating the effectiveness of this new tool ensures that it improves diagnostic accuracy, which leads to better patient outcomes and reduced misdiagnosis. Additionally, many medical centers have established guidelines and standards, so it is important to ensure that the introduction of such tools meets regulatory compliance. Since radiology departments are often fast-paced, efficient environments, it is vital to determine whether the device streamlines clinical workflow and reduces waiting times. Lastly, by evaluating and ensuring the safety and effectiveness of this radiological tool, it'll lead to advanced medical knowledge and increased patient confidence.

Experimental Approach: To evaluate the safety and effectiveness of the AI tool in radiology, a retrospective study will be conducted. The hybrid design of a retrospective approach involves selecting a group of patients who have already been exposed to a radiological tool (MRI and/or CT), and whose lymph nodes have been manually detected and measured using the preexisting method (control). The results of the existing process will then be compared to those using the experimental AI tool. Data will be gathered from 2000 Johns Hopkins University and UVA patient records, including demographics, medical history, radiological images (MRI and/or CT), and treatment outcomes. The outcomes and safety measures for both the control and experimental tools will be compared, such as diagnostic accuracy, patient outcomes, or safety profiles. The null hypothesis used for this experiment will be that there is no difference between the two diagnostic techniques. Statistical analysis will then be performed to determine if there is a significant difference in analysis between the two techniques. Based on the statistical results, a cost-effectiveness analysis will be performed to evaluate the financial implication of using the experimental tool. During the process, patient privacy will be protected, and ethical guidelines will be followed. Lastly, findings may be published to contribute to the scientific body of knowledge.

Expected Outcome: The expected outcomes of this experiment include i**dentifying any safety risks associated with the AI tool, quantifying safety measures, and providing recommendations for risk mitigation for further enhancements**. For effectiveness, the experiment will result in increased diagnostic accuracy compared to the existing method, positive impact on patient outcomes, and a more efficient radiology department. Additionally, potential economic advantages will be identified, including reduced healthcare costs or improved resource utilization. The tool will meet regulatory requirements, obtain the necessary approvals, and eventually successfully integrate into healthcare practice.

Limitations and Alternative Approaches:

Possible limitations with this approach include selection bias, confounding variables, recall bias, data completeness and quality, and lack of randomization. Since the study is relying on existing data, it can introduce selection bias. The data may have not been selected with the research question in mind. 2000 patients means differences in patient characteristics, medical history, and treatments received, which may affect validity. Using existing data may make it difficult for those patients or healthcare providers to remember information accurately. The data quality and completeness can vary by source and time period, so this may limit the study's generalizability until it is utilized on current patients. An alternative method is an experimental approach. The experimental approach study design consists of either random controlled trials (RCTs) or observational studies. Participants would be selected from UVA radiology, assuming they give consent, and assigned to different groups. The AI tool would be administered to one group and the existing method to the other, which helps assess the effectiveness and safety of the new tool to the other. Data would then be collected from the two groups, including diagnostic accuracy and patient outcomes. Just like the retrospective approach, statistical analysis tests, such as t-tests, chi-squared tests, or more advanced techniques, will be performed to compare the outcomes of the two groups. The findings can then be used for continuous improvement of the new tool. Executing this approach could alleviate the selection bias since patients will be selected randomly.

Conclusion

Overall, our plan encapsulates a comprehensive approach to building a breast cancer detection model. It leverages the power of Jupyter Notebook for coding, DICOM for image data extraction, TensorFlow for building CNNs, and learning from top-performing solutions in relevant Kaggle competitions. Willingness to experiment, adapt, and innovate based on successful methodologies is key to accelerating the learning curve and developing an effective solution for lymph cancer detection.

Design Criteria and Constraints

1. Needs be able to detect individual lymph nodes
2. Needs to be able to trace the edges of lymph nodes to measure size and volume accurately
3. Needs to produce consistent results
4. Needs to run under a practical amount of time
5. Needs to be easily implemented by the user

In order to measure success for these criteria, we have created a table of acceptable values that need to be achieved (Table 1).

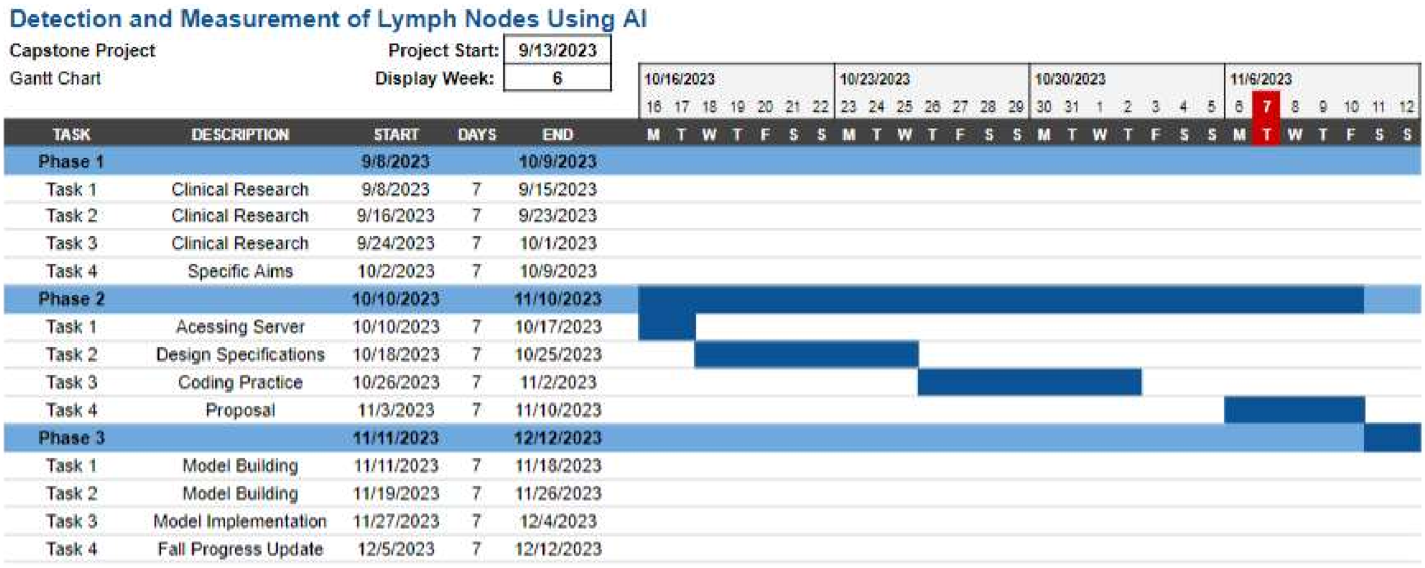
Table 1: Design constraints and specifications in accordance to the needs.

Criteria	Design Constraint / Metric	Unit of Measure	Marginal (Acceptable)	Ideal Value
1	Detection of individual lymph nodes	Accuracy (% of lymph node detections that are actually lymph nodes)	69-80%	80%
2	Ability to measure size of lymph node	Accuracy (% of lymph node measurement)	80-90%	90%
3	Replicability of results	Precision (% of expected outputs to total outputs)	85-100%	100%
4	Time to run code	Seconds	10-20	10
5	User-friendly	Steps need to implement	3-6	3

Timeline

An approximate timeline of the Capstone project for the rest of the fall semester is shown below in Table 2. It is important to note that the other weeks are not shown here, but are stored locally in an interactive excel file.

Table 2 - Gantt chart: Work completed and project milestones.



Detection and Measurement of Lymph Nodes Using AI

Capstone Project
Gantt Chart

Project Start: 9/13/2023
Display Week: 6

TASK	DESCRIPTION	START	DAYS	END
Phase 1		**9/8/2023**		**10/9/2023**
Task 1	Clinical Research	9/8/2023	7	9/15/2023
Task 2	Clinical Research	9/16/2023	7	9/23/2023
Task 3	Clinical Research	9/24/2023	7	10/1/2023
Task 4	Specific Aims	10/2/2023	7	10/9/2023
Phase 2		**10/10/2023**		**11/10/2023**
Task 1	Acessing Server	10/10/2023	7	10/17/2023
Task 2	Design Specifications	10/18/2023	7	10/25/2023
Task 3	Coding Practice	10/26/2023	7	11/2/2023
Task 4	Proposal	11/3/2023	7	11/10/2023
Phase 3		**11/11/2023**		**12/12/2023**
Task 1	Model Building	11/11/2023	7	11/18/2023
Task 2	Model Building	11/19/2023	7	11/26/2023
Task 3	Model Implementation	11/27/2023	7	12/4/2023
Task 4	Fall Progress Update	12/5/2023	7	12/12/2023

V. APPENDIX

Funding

We do not foresee any funding required for our project as our work will be based on computer coding and we do not need to purchase any supplies, materials, or equipment to complete our project. The software tools and data have been supplied by our advisor, Dr. Feng.

References

Siegel, R. L., Miller, K. D., Wagle, N. S., & Jemal, A. (2023). Cancer statistics, 2023. *CA: A Cancer Journal for Clinicians*, *73*(1), 17–48.

Alexander, Robert, et al. *Mandating Limits on Workload, Duty, and Speed in Radiology*, 14 June 2022, pubs.rsna.org/doi/10.1148/radiol.212631.

Brady, Adrian P. “Error and Discrepancy in Radiology: Inevitable or Avoidable?” *Insights into Imaging*, U.S. National Library of Medicine, Feb. 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC5265198/#CR22.

Eisenhauer, E.A., et al. *New Response Evaluation Criteria in Solid Tumours: Revised RECIST …*, 2009, ctep.cancer.gov/protocoldevelopment/docs/recist_guideline.pdf.

Jain, R. K., Lee, J. J., Ng, C., Hong, D., Gong, J., Naing, A., Wheler, J., & Kurzrock, R. (2012). Change in tumor size by RECIST correlates linearly with overall survival in phase I oncology studies. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*, *30*(21), 2684–2690. https://doi.org/10.1200/JCO.2011.36.47

STS Research Topic

Artificial Intelligence is becoming rapidly integrated into our everyday lives, from our daily use of smartphones and smart devices to the improvement of workflows in various sectors, AI is allowing us to cut costs, increase efficiency, and improve our quality of life. An analysis by PricewaterhouseCoopers reports that AI technologies could contribute up to $15.7 trillion to the global economy in 2023. Of this, $6.6 trillion is expected to come from increased productivity while the remaining $9.1 trillion is to come from consumption side-effects (PriceWaterhouseCooper, 2017). Although the benefits of developing AI technologies are clear, many view this development negatively. A study conducted to gather the public's opinion on AI garnered negative viewpoints on the effects of AI, many reflecting concerns on AI's impact on the job market (Brauner et. al., 2023). Due to the nature of new technologies, many hold misconceptions of a technologies capabilities. Whether due to its portrayal in entertainment or biased media sources, people often view AI in a cynical view, often fearing a change in their own life.

This begs the question, how will AI impact our lives? What potential changes, for better or for worse, will be introduced as AI improves and becomes more integrated into our daily life? This paper will explore the history of major technological advancements and its resulting societal changes. Technological Determinism is the idea that technology has important impacts on our lives and is the main cause of major social and historical changes. Using the theory of Technological Determinism, the gathered research will highlight past technological advancements and the resulting changes. Afterwards, the potential changes that may come with the advancement of AI will be discussed.

The Assembly Line

One past advancement to explore is the introduction of the assembly line. In the early 1900s, automobiles were owned by the wealthy elite. The process of producing an automobile was costly and time consuming, requiring the craftsmen to move from vehicle to vehicle. Then, in 1913, Henry Ford successfully introduced the first automobile assembly line containing a series of workers and machinery in a formative order that assembled parts in an efficient manner (Swamidass, 2000). The increased efficiency and production of automobiles allowed Ford to supply his vehicles at a reduced price, increasing the availability of automobiles to the general public. To this day, the assembly line has been improved and is still utilized in manufacturing around the world.

Despite its positive outcomes, the assembly line faced many criticisms by the public. Similar to the public's current view of AI, many saw the waves of unemployment in a negative light. Quoted from David Nye by Boozer, "Workers… worried about the loss of freedom on the shop floor, about endless repetition of the same movements for eight hours, and about jobs that deadened the soul" (Boozer, 2020). Yet according to Bonciu, the assembly line contributed to the new abundance of jobs with decreased physical labor (Bonciu, 2017). The creation of the assembly line improved manufacturing practices and created a large pool of jobs. This technological advancement can be used to draw parallels to the current advent of AI technology being integrated into society.

The Personal Computer

The personal computer is another technological innovation that has greatly impacted society. With its advent, people now have access to nearly endless amounts of data and are able to produce, process and store large amounts of data. Complex calculations can be completed in seconds and the computer has become so integrated into our daily lives, it is now an essential part of learning. A 1997 study stated that since 1970, there was an observed 30-50% growth in the demand for highly skilled workers that can use a computer (Autor et. al. 1997). Nowadays, we have digital based softwares with numerous applications in various fields such as business, science, engineering, healthcare, and more.

The advent of the personal computer and its advancement have also been met with negative responses and have also negatively impacted our lives. In 1987, an analysis conducted by Larry Rosen stated that of 1,256 randomly selected adults, 71% felt that computer technology would threaten jobs and over half felt that computers were a threat to privacy (Rosen et. al. 1987). In addition, it is widely known that prolonged periods of computer use can lead to multiple injuries. Carpal tunnel syndrome, joint pain, eye strain, and more can be caused by prolonged computer use. The advent of the personal computer has also led to extended time periods of inactivity, contributing to obesity and a less healthy lifestyle. Despite the negative response and risks of a lifestyle centered around a computer, it is clear that the personal computer has shaped our way of life. More jobs have been created, various fields have been improved, and our sources of entertainment have even changed. This advancement may also be used to draw parallels to AI technology and AI's potential impact on society.

Conclusion

Artificial Intelligence is a technology that is still being developed and integrated into our daily lives. The technical topic will utilize AI to develop a lymph node detection and measurement tool that will be integrated into the existing clinical workflow used by radiologists. Meanwhile, the STS research paper will delve into the history of revolutionizing technologies and analyze the impacts. The paper will then draw parallels between previous revolutionary technologies and AI technology, discussing its potential effects on society. While the technical topic will utilize AI technology, the STS paper will highlight the potential effects of AI technology by drawing from the effects of previous technologies. To conclude, the exploration of the technical topic will highlight the capability of AI in a healthcare application and the STS topics will highlight the potential impacts of AI.

References

Brauner, P., Hick, A., Philipsen, R., & Ziefle, M. (2023). What does the public think about artificial intelligence?—A criticality map to understand bias in the public perception of AI. Frontiers in Computer Science, 5. https://doi.org/10.3389/fcomp.2023.1113903

PriceWaterhouseCooper. (2017). Sizing the prize: What's the real value of AI for your business and how ... https://www.pwc.com.au/government/pwc-ai-analysis-sizing-the-prize-report.pdf

Swamidass, P. (2000). MOVING ASSEMBLY LINE. Encyclopedia of Production and Manufacturing Management, 465–466. https://doi.org/10.1007/1-4020-0612-8_596

Boozer, K. (2020). The Assembly Line. Pressbooks.pub. https://pressbooks.pub/anne1/chapter/assembly-line/

Bonciu, F. (2017). Evaluation Of The Impact Of The 4th Industrial Revolution On The Labor Market. Romanian Economic Business Review, 12(2), 7–16. https://ideas.repec.org/a/rau/journl/v12y2017i2p7-16.html

Rosen, L. D., Sears, D. C., & Weil, M. M. (1987). Computerphobia. *Behavior Research Methods, Instruments, & Computers*, *19*(2), 167–179. https://doi.org/10.3758/bf03203781

Autor, D., Katz, L., & Krueger, A. (1997). Computing Inequality: Have Computers Changed the Labor Market? https://doi.org/10.3386/w5956