Livestock Well-being Identification

DESIGN DOCUMENT

Team Number:
sdmay23-05

Client/Advisor:
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Team Members:
Asad Abdalla — Dev Ops Manager
Meet Patel — Advisor Interaction
Mohammed Elbermawy — Client Interaction
Yannick Fumukani — Frontend Manager
Rashed Alyammahi — Backend Manager
Richard Gonzalez — Scrum Master / Team Organizer
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Executive Summary

Development Standards & Practices Used

- IEEE 7000: Use value-based engineering to prioritize user values in system design, evaluate technological risks and ethical considerations in AI
- IEEE 7010: Use AI to positively impact human well-being
- IEEE Computer Society Code of Ethics: Work professionally and ethically to further the software engineering profession
- Agile project management
- GitLab code sharing and version control

Summary of Requirements

- AI model must be trained on sound files of healthy and sick farm animals.
- AI model should encode sound files as spectrograms (images) before training.
- AI model should be scalable and should be able to train on datasets of varying size.
- After training, AI model should be able to analyze an animal's sound and determine if it is sick or healthy with high accuracy.
- The accuracy of the AI model should improve with each iteration of training.
- The accuracy of the AI model should be at a level that is satisfactory to the client.
- AI model should have no direct economic cost to develop.

Applicable Courses from Iowa State University Curriculum

- COM S 309 - Software Development Practices
- COM S 319 - Construction of User Interfaces

New Skills/Knowledge acquired that was not taught in courses

- Python
- Keras
- TensorFlow

Table of Contents

Team

1.1 Team Members

Asad Abdalla
Meet Patel
Mohammed Elbermawy
Yannick Fumukani
Rashed Alyammahi
Richard Gonzalez
Lucas Onwuchekwa
Adam Sweiger

1.2 Required Skill Sets For Your Project

(if feasible – tie them to the requirements)

- AI development
- GitLab
- Keras
- TensorFlow

1.3 Skill Sets Covered By The Team

(for each skill, state which team member(s) cover it)

All members cover all skills because they are all a necessary part of developing our solution. Everyone must understand how AI works and be able to use GitLab, Keras, and TensorFlow to create a machine learning model.

1.4 Project Management Style Adopted By The Team

We will use the Agile project management style so that we can develop iterations of the AI model that each bring us closer to meeting the client's requirements.

1.5 Initial Project Management Roles

(Enumerate which team member plays what role)

Asad Abdalla — Dev Ops Manager
Meet Patel — Advisor Interaction
Mohammed Elbermawy — Client Interaction
Yannick Fumukani — Frontend Manager
Rashed Alyammahi — Backend Manager
Richard Gonzalez — Scrum Master / Team Organizer
Lucas Onwuchekwa — QA
Adam Sweiger — Status Reporter

Introduction

2.1 Problem Statement

Livestock Well-being Identification aims to develop a machine-learning system that can accurately identify sick farm animals by analyzing sound patterns. This system must differentiate between healthy and unhealthy animals by recognizing the acoustic signals emitted by their vocalizations or other sounds in their environment. The model should be trained on data from data that has been collected already here at Iowa State University. This is to detect subtle changes in sound, such as coughing, sneezing, or labored breathing, which may also indicate an animal's health status. The training datasets should include a diverse range of healthy and diseased animals from various data sets. By utilizing these datasets, the model should be able to effectively distinguish between healthy and sick animals. Ultimately, this system will enable farmers to better monitor their livestock health and quickly identify any potential illnesses before they become severe and spread. By identifying these illnesses as early as possible, farmers can better provide treatment and prevent financial losses in real time.

2.2 Intended Users And Uses

1. Team Member
   Key Characteristics:-Farmers with livestock in herds
   Need:- Identification of sick animals in a herd.
2. Third Party User
   Key Characteristics:-Wildlife conservations
   Need:-Identification of sick animals within a range.

2.3 Requirements & Constraints

Functional requirements

- AI model must be trained on sound files of healthy and sick farm animals.
- AI model should encode sound files as spectrograms (images) before training.
- AI model should be scalable and should be able to train on datasets of varying size.
- After training, AI model should be able to analyze an animal's sound and determine if it is sick or healthy with high accuracy.
- The accuracy of the AI model should improve with each iteration of training.
- The accuracy of the AI model should be at a level that is satisfactory to the client.

Economic requirements

The AI model should have no direct economic cost to develop.

Resource requirements

1. Linux Ubuntu
2. High Power GPU

3. Virtual Machine
4. Laptop with Internet connection

2.4 Engineering Standards

1. IEEE 1003.1-2008 - This standard is simultaneously ISO/IEC 9945, IEEE Std 1003.1, and forms the core of the Single Unix.
2. IEEE 1680.1-2009 - This standard ensures the consistent environmental performance for the resources used.

Project Plan

3.1 Project Management/Tracking Procedures

We are adopting the agile methodology. The Agile methodology will allow us to make corrections or adjustments in the development process. We will also regularly meet and discuss how we are doing in the project, and how we can improve.

We used Discord to communicate with our team members. We used Discord and Zoom to conduct the weekly meetings where we shared updates with each other. This project has been done in the virtual machine and we used to provide the team updates in the weekly meeting. We also held weekly meetings with the advisor to share the status of our progress. Next semester, we plan to use GitLab to track progress on developing the AI model.

3.2 Task Decomposition

Sprints for the entire project.

- Learn and understand Keras framework
  - Gain access to VM and GPU
  - Download software on VM
  - Practice tutorials for developing with Keras
- Research AI applications
  - Image classification
  - Speech cognition
  - Future additional topics
- Train AI models
  - Pick a model of choice from the research (image or speech or both)
  - Train model using training data
- Test trained models
  - Test models using testing data with aim of getting a high accuracy

3.3 Project Proposed Milestones, Metrics, And Evaluation Criteria

The pattern recognition logic on FPGA will recognize a pattern every 1 ms (at 1K patterns/sec throughput). ML accuracy target might go up to 90% from 80%.
In an agile development process, these milestones can be refined with successive iterations/sprints (perhaps a subset of your requirements applicable to those sprint).

- ●Training the model with a larger dataset (> 1000) for better training accuracy
- ●Testing the model and having a high accuracy, TBD by the client
- ●For each research area, build and train one applicable AI model in order to understand how it works.

3.4 Project Timeline/Schedule

Phase 1

- Set up a project plan and any necessary software or external applications
- Identify potential data sources for animal sound recordings, both online and offline
- Research relevant literature to gain insights into industry standards and benchmarks for animal well-being identification using sound.
- Create a technology stack that will enable the AI model to autonomously capture, process, and classify sounds for animal well-being identification

Phase 2

- Begin the data collection process by creating a dataset of raw sound recordings of animals exhibiting signs of health and illness across various breeds, age, and environments
- Train machine learning models with the collected dataset to identify patterns in the sound recordings which correspond to healthy or sick animals
- Validate results with experts in the field to ensure the accuracy of results

Phase 3

- Refine machine learning models based on expert feedback from phase 2
- Gather additional datasets from different sources if needed to further improve the accuracy of model predictions

Phase 4

- Perform A/B testing of ML models between different datasets using real-world scenarios and conditions to determine the best performance, accuracy, and reliability of prediction results.

Phase 5

- Finalize design, architecture, and code for AI model implementation within a production environment.

Phases that are out of the scope for this project

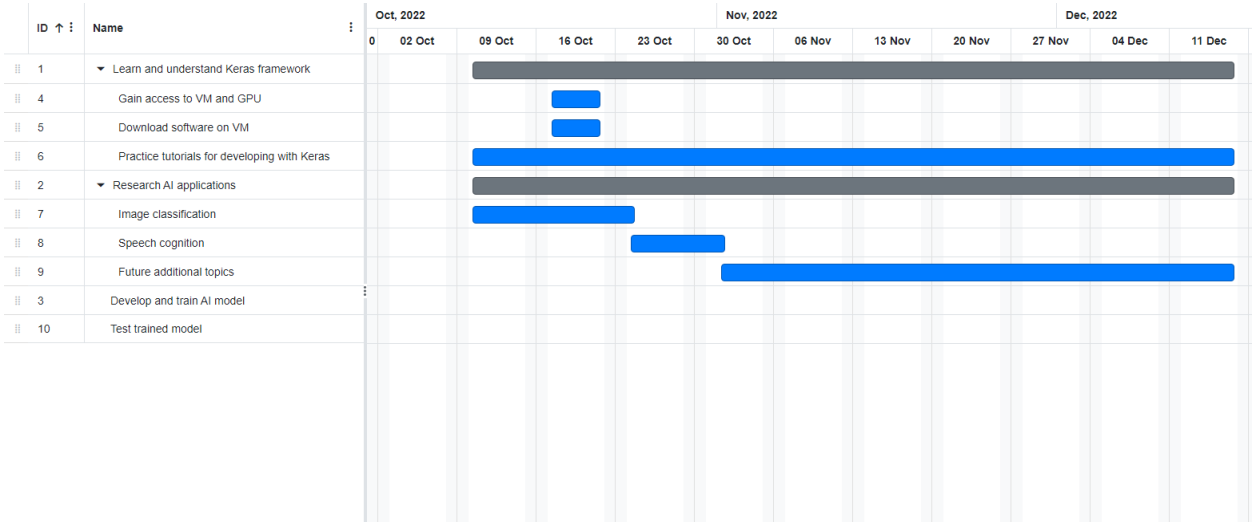
Phase 6

- Perform final validation tests before fully deploying the Model solution as a product in the marketplace

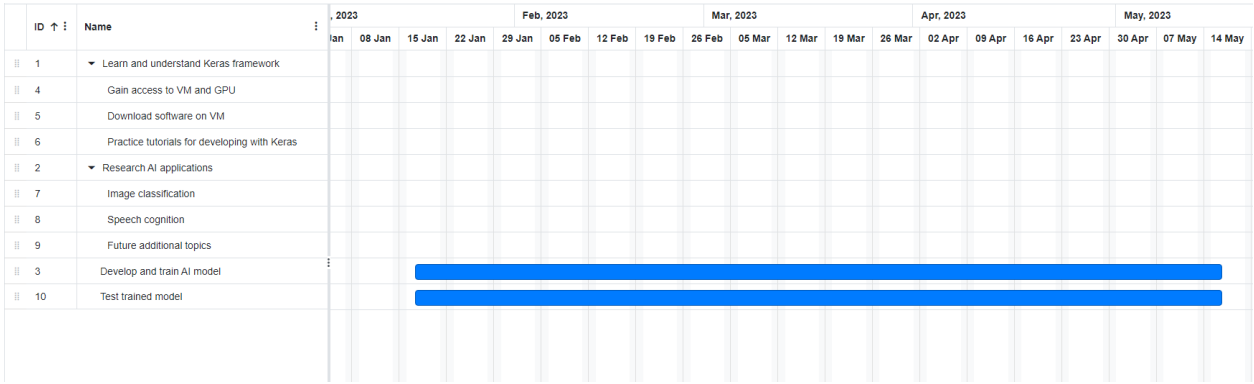
Phase 7

- Deploy the final version of the Model solution with necessary documentation such as user manual, technical specs, demo videos, etc., ensuring a smooth transition from the development phase to the product usage phase

Gantt Chart for Fall Semester



Gantt Chart for Spring Semester



List of Tasks

ID	Name	Start Date	End Date	Duration
1	Learn and understand Keras framework	Oct 10, 2022	Dec 16, 2022	50 days
4	Gain access to VM and GPU	Oct 17, 2022	Oct 21, 2022	5 days
5	Download software on VM	Oct 17, 2022	Oct 21, 2022	5 days
6	Practice tutorials for developing with Keras	Oct 10, 2022	Dec 16, 2022	50 days
2	Research AI applications	Oct 10, 2022	Dec 16, 2022	50 days
7	Image classification	Oct 10, 2022	Oct 24, 2022	11 days
8	Speech cognition	Oct 24, 2022	Nov 01, 2022	7 days
9	Future additional topics	Nov 01, 2022	Dec 16, 2022	34 days
3	Develop and train AI model	Jan 17, 2023	May 16, 2023	86 days
10	Test trained model	Jan 17, 2023	May 16, 2023	86 days

The first semester 491 is dedicated to learning and research for Keras and AI models, while the second semester is dedicated to training and testing of the AI model for our solution.

3.5 Risks And Risk Management/Mitigation

- Learn and understand Keras framework
    - Gain access to VM and GPU
        - Risk: The school refuses to give access or the ETG does not have a GPU strong enough to power our models >0.5
        - Mitigation plan: We pitch in and buy a GPU for the project, or try to use HPC for computing needs
    - Download software on VM
        - Software is incompatible with our operating system (<0.5 very low risk because TensorFlow can be installed on any OS with PIP
    - Practice tutorials for developing with Keras
        - Risk: No available tutorials on Keras.io (<0.5 very low risk because we researched before choosing this framework and found multiple tutorials)
- Research AI applications
        - All of these topics have the same risk: lack of sufficient materials to learn about them. This has a low risk of < 0.5 because they are common AI applications with plenty of research.
    - Image classification
    - Speech cognition
    - Future additional topics
- Train AI models
        - Risk: Not enough training data to get the expected training accuracy (> 0.5)
        - Mitigation plan: Choose a different model to train
    - Pick a model of choice from the research (image or speech or both)
    - Train model using training data
- Test trained models

- Test models using testing data with aim of getting a high accuracy
  - Risk: Model is not developed well enough to achieve high accuracy (risk > 0.5).
  - Mitigation plan: Try to improve code for the model, seek technical help from advisor

3.6 Personnel Effort Requirements

Task	Number of person-hours required
Learn and understand Keras framework	44
Gain access to VM and GPU	2
Download software on VM	2
Practice tutorials for developing with Keras	40 (5 per person)
Research AI applications	32
Image classification	16 (2 per person)
Speech cognition	16 (2 per person)
Future additional topics	TBD
Develop and train AI model	16
Develop AI model to analyze animal sounds	16 (2 per person)
Train model using training data	TBD
Test trained model	TBD
Test model using testing data with aim of getting a high accuracy	TBD

The last three tasks have TBD for the number of person-hours required because it will vary greatly depending on factors such as our implementation of the model, the dataset provided by the client, our GPU resources, and our client's requirements.

3.7 Other Resource Requirements

Identify the other resources aside from financial (such as parts and materials) required to complete the project.

- GPU (Graphics Processing Unit)
- VM (Virtual Machine)
- Training data (large collection of animal sound files)
- Test data (large collection of animal sound files)
- PCs (for personal use and computation)
- Tutorial videos (for learning)
- GitLab (for version control and code sharing)

Design

4.1 Design Context

4.1.1 Broader Context

Area	Description	Examples
Public health, safety, and welfare	The model can help improve public health by identifying illnesses in farm animals. This will also improve the health of humans.	Reducing illness of farm animals will make food such as beef safer for humans to eat.
Global, Cultural, and social	The model could be used by farms around the world.	The animals would sound the same in various areas around the world.
Environmental	The model can have a positive environmental impact by improving the health of farm animals.	If farmers save money because their animals are healthier, they can invest in farming practices that are more environmentally friendly.
Economic	The economic impact of this project could be significant, as it could prevent large financial losses for farmers.	Farmers will save money because they will be able to treat animal illness early before it becomes severe and reduce animal deaths.

4.1.2 Prior Work/Solutions

1. Viz.ai: In healthcare, delays can mean the difference between life and death, so Viz.ai helps care teams react faster with AI-powered healthcare solutions. The company's AI

products can detect issues and notify care teams quickly, enabling providers to discuss options, provide faster treatment decisions, thus saving lives.

2. PathAI : PathAI develops machine learning technology to assist pathologists in making more accurate diagnoses. The company's current goals include reducing error in cancer diagnosis and developing methods for individualized medical treatment.
   PathAI worked with drug developers like Bristol-Myers Squibb and organizations like the Bill & Melinda Gates Foundation to expand its AI technology into other healthcare industries.
3. Enlitic : Enlitic develops deep learning medical tools to streamline radiology diagnoses. The company's deep learning platform analyzes unstructured medical data – radiology images, blood tests, EKGs, genomics, patient medical history – to give doctors better insight into a patient's real-time needs.
4. Iterative: Iterative Scopes applies AI to gastroenterology to improve disease diagnosis and treatment. The company's AI Recruitment service uses computational algorithms to automate the process of identifying patients who are eligible to be potential candidates for inflammatory bowel disease clinical trials.

Iterative Scopes also submitted the first clinical trial of its SKOUT device, a tool that uses AI to help doctors identify potentially cancerous polyps, for review by the FDA.

Since we have decided to use Keras as our AI development framework, we have researched previous implementations of image classification and speech recognition using Keras. One example we looked at trains a neural network to classify images of clothing ("Basic Classification…"). Once trained, the model is able to predict what type of clothing an image contains. Another application we researched trains an automatic speech recognition (ASR) model to detect one of ten different words in a WAV file ("Simple Audio Recognition…"). In this example, the dataset's waveforms are converted to spectrograms, which can be represented as 2D images. This way, the neural network can process the data for training.

4.1.3 Technical Complexity

The design of our AI model for the Image and Sound Classification project consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles. The subsystems include:

- A convolutional neural network (CNN) for image classification.
- A deep neural network (DNN) for sound classification.
- A support vector machine (SVM) for post-processing.

The problem scope also contains multiple challenging requirements that match or exceed current solutions or industry standards. For example, the images in our dataset are 300x300 pixels, which is much larger than the typical image size used in other image recognition projects. Furthermore, the dataset contains images and sounds, a unique feature that has not been explored in previous projects.

4.2 Design Exploration

4.2.1 Design Decisions

1. Gathering the data for sound classification algorithm to use is important for the success of this project. We need to find an algorithm that can accurately classify images and sounds.

2. Deciding on the efficiency of the data that we are working on. For our project, we need to make sure that our algorithm gives precise information with high accuracy

3. Deciding on the physical layout of the project is important. We must ensure everything is placed in a way that allows for the most accurate results.

4.2.2 Ideation

For at least one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). Describe at least five options that you considered.

For our computing needs, we considered the following options:
1. VM
2. High Performance Computing (HPC)
3. AWS
4. Our Own CPU
5. Our Own GPU

We are using VM since the storage and RAM have been allocated by the University. They allocated us the new linux kernel where it used GPU for the research project work. This was apparent to us the best option to us to take advantage of the high storage and allocated memory for the project.

We found it difficult to use AWS due to budget constraints. The budget didn't allowed us to use AWS and our team members were not familiar with AWS.

Only two team members had their own CPU and GPU built on their local machines. So, we decided to drop this idea since other team members didn't had the CPU or GPU built on their local machines.
HPC was very difficult to use compared to VM.
So, at the end, we decided to stay with VM option.

4.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish you include a weighted decision matrix or other relevant tool.
Describe the option you chose and why you chose it.

The option we chose was a support vector machine (SVM) with a Gaussian kernel. There are many reasons why we chose this option:

1. SVMs are very versatile and can be used for a variety of different tasks, including image and sound classification.
2. They are able to learn complex patterns and are relatively fast to train.
3. They tend to have high accuracy rates.

4.3 Proposed Design

4.3.1 Overview

The model will be designed to detect sick animals by identifying patterns in their sounds indicative of illness. It would require data from healthy animals to learn the patterns of normal sounds and then be able to compare new data against this baseline to identify abnormalities. The model also could be used to predict which animals are most likely to become ill so that preventative measures can be taken or help diagnose and treat sick animals. The model will use a deep neural network to input and analyze data collected from animals' sounds. The deep neural network is composed of several layers, each designed to recognize different features in the data. This allows the model to learn and distinguish between healthy and sick animal sounds with greater accuracy. The key components that contribute to the overall design are the input layer, which takes in sound data, and the deep neural network, which analyzes and recognizes features in the data.

4.3.2 Detailed Design and Visual(s)

The model will comprise of preprocessing, feature extraction, classification, and output subsystems

Preprocessing: The preprocessing subsystem will include the steps of noise reduction, feature extraction, and feature normalization. Noise reduction will be achieved using a combination of a noise gate and a low-pass filter. The feature extraction step will extract features from the audio data that are indicative of sickness in animals. These features will be normalized to ensure that they are on the same scale.

Feature extraction: The feature extraction subsystem will extract features from the audio data that are indicative of sickness in animals. These features will be normalized to ensure that they are on the same scale. The features that will be extracted include -

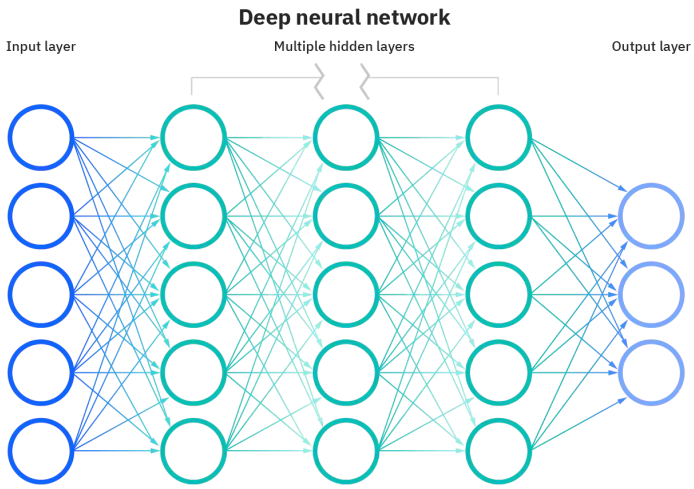
Frequency content: the frequency content of the audio signal can be used to indicate the health of an animal. Sick animals tend to produce sound with high-frequency content than healthy animals

Duration: the duration of the sound can also be used to indicate the health of an animal. Sick animals tend to produce sound for a longer duration than healthy animals

Amplitude: the amplitude of the sound can also be used to indicate the health of an animal. Sick animals tend to produce sound with higher amplitude than healthy animals.

Classification: the classification subsystem will use a neural network to classify audio as being from a healthy or sick animal. The deep neural network is composed of several layers, each designed to recognize different features in the data. This allows the model to learn and distinguish between healthy and sick animal sounds with greater accuracy. The key components that contribute to the overall design are the input layer, which takes in sound data, and the deep neural network, which analyzes and recognizes features in the data.

Output: During training, the model will output information about the current training iteration including time spent training, accuracy, etc. Once the model has been trained and we are using it to predict the health of an animal from its sound, the output will be the result of the prediction, either healthy or sick, as well as the confidence in this prediction as a percentage. It may display the result as a list or table, or it may generate a graphical representation of the prediction depending on our future needs.



4.3.3 Functionality

There are going to be devices with the ability to constantly listen to each group of farm animals, so the sound will serve as input for our trained model. The model will constantly process the captured sound in order to detect whether the animals are fine or not, in case,

the model detects a sick animal sound, it will notify the user in charge by sending the precise location of the concerned group of animals, so the user can take appropriate actions as soon as possible.

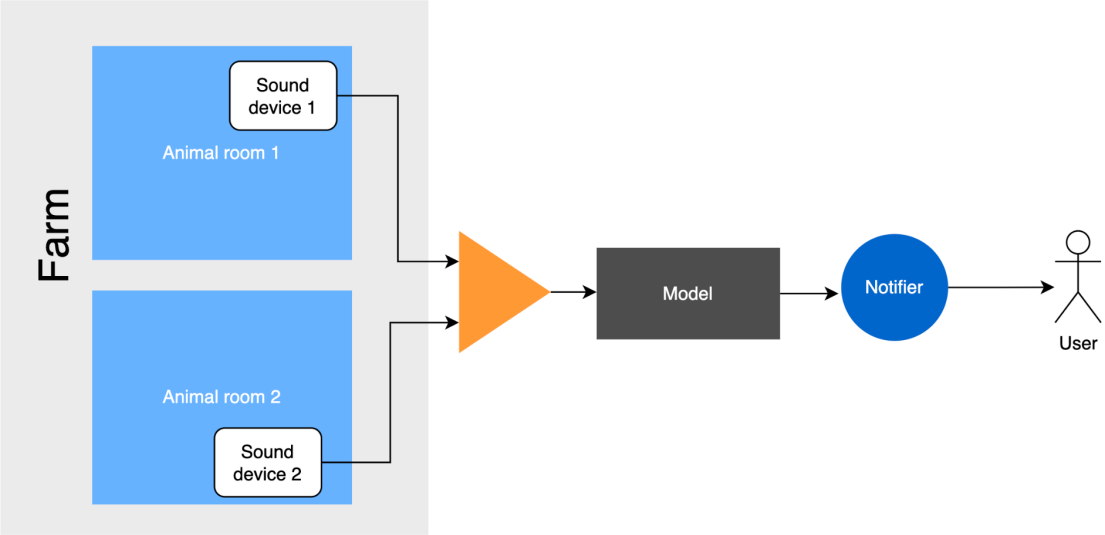


Figure demonstrating the process of an animal outputting a sound, followed by the sound being analyzed by the model, and finally, the user is notified that one of their animals is believed to be sick. For the scope of our project, we are developing the AI model. This is just showing how we believe our model would be used in a real-world application.

4.3.4 Areas of Concern and Development

The current design satisfies requirements and meets user needs very well. If implemented correctly, our design will enable our users to track the health of sickness so that they can act when they become sick. Our main concern is to learn the Keras as a development framework. However, we have been learning about how AI works and how to use Keras. We are also concerned about how we will be acquiring sound data for animals, but we will continue to discuss this with our client. The client has helped us to grow as a team. He has addressed our concerns and provided us with various tutorials for using Keras to develop AI. We have been successfully able to learn and grow in this field. The team will continue to practice using Keras so that we can learn everything we need in order to implement our design. Now, our main concern will be to train AI Models to recognize the sound patterns of sick animals. However, the client has promised us to help us with our concerns and we believe he will help us.

4.4 Technology Considerations

We will be using the following technologies:-

1. Linux Ubuntu Virtual Machine for GPU
2. GPU for running Python program for AI Model
3. Keras Library for development framework
4. Anaconda for managing development environments on VM
5. Jupyter Notebook as IDE for writing and running the code
6. GitLab for code sharing and version control

Strengths with the available technologies:-

1. The team is familiar with Linux VMs, Jupyter Notebook, and GitLab so we will be comfortable using them.
2. Keras is a simple library built on top of TensorFlow that takes care of a lot of the low-level specifics of the AI model for us.
3. Python has some modules, such as matplotlib, that are useful for creating and storing visual representations of data.

Weaknesses with the available technologies:-

1. The team lacks experience and knowledge in using Keras as a development framework so a lot of learning is required to use it effectively.
2. The Virtual Machine has a small amount of available memory so we are limited in what we can store on it.

Trade-offs made in technology available:-

1. The Virtual Machine is customized to have a powerful GPU for running the AI model but it is limited in available memory.

a. Keras has the advantage of being a simple, high-level AI library but it doesn't have all of the features that a lower-level library has.

4.5 Design Analysis

The team has set up the environment needed to run the AI model. We have been experiencing build issues during the beginning of the starting phase. However, our team kept learning and kept training the AI model. As part of our learning process, we have successfully trained other AI models that analyze sound patterns. In the future, we will continue training practice models. Our client will provide us with sound data for our model. After writing the code for the model, we will train it in several iterations with the goal of increasing its accuracy until it is at a satisfactory level. As we train, we will analyze the results to determine if we need to adjust the model in any way. Once we successfully train the model, we will be able to use it to analyze new animal sounds and predict whether that animal is sick or healthy.

Testing

5.1 Explanation Of Exclusion Of Traditional Testing

For this project, we will not be conducting the traditional types of testing, such as unit, interface, integration, and system testing, because we will be developing an AI model that will test itself during training. In order for a model to know that it is learning correctly, it must evaluate itself during each iteration of its training. We will divide our dataset into a training set, used for teaching the model about sound patterns, and a validation set (testing), used for evaluating the ability of the model to detect the desired sound patterns. As the model tests itself, it determines its own accuracy and adjusts its parameters in order to improve its learning ability. As a result, the accuracy of the model should improve with each iteration.

5.2 Materials Needed for Testing

In order to develop and test our AI model, we will need the following materials:

- Linux Ubuntu Virtual Machine for hosting GPU
- GPU for running Python program for AI model
- Keras library as development framework
- Anaconda for managing development environments on VM
- Jupyter Notebook as IDE for writing and running code
- Animal sound files to be used as training and testing data

5.3 Our Testing Plan

Each iteration in the training process, we will record the data that produced that result and the produced result. We will then take each iteration data and check the efficiency. As stated above the accuracy of the model should improve with each iteration. That being said, we want to record each iteration and be able to show a diagram of our accuracy improving over iterations. This will give a full picture of the overall accuracy of our models during testing. Additionally, we want to track how well our models are converging on the global minimum. To do this, we will need to save the best validation error achieved thus far and plot it on a graph over iterations. We would ensure that the result is highly accurate at the end.

5.4 Results

Our testing process aims to ensure that our AI model can accurately identify sick and healthy animals. We have designed our process to comply with the client's requirements. Our testing process includes both a validation and verification step. In the validation step, we will test our AI model with a set of known data. We will use this data to verify that our model accurately

identifies sick and healthy animals. In the verification step, we will test our AI model on a new set of data to ensure that it is still accurate. This new data will not be used to train our model, so that it will be a true test of its accuracy. We will also analyze the results of both steps to ensure that our AI model meets the requirements set by the client.

Implementation

An implementation plan for next semester can be found in section 3.4. We will need to receive the animal sound data from our client and develop and train the AI model. Then, we will train the model using the sound data and adjust the model until it meets our client's requirements.

Professional Responsibility

7.1 Areas Of Responsibility

one of IEEE, ACM, or SE code of ethics. Add a column to Table 1 from the paper corresponding to the society-specific code of ethics selected above. State how it addresses each of the areas of seven professional responsibilities in the table. Briefly describe each entry added to the table in your own words. How does the IEEE, ACM, or SE code of ethics differ from the NSPE version for each area?

Area of responsibility	IEEE Computer Society / ACM Code of Ethics for Software Engineers Canon
Work Competence	Only work in areas of competence, be honest about any experience or education they're lacking in. Strive for high quality, acceptable cost, and a reasonable schedule. Ensure that they're qualified for projects based on education, training, and experience.
Financial Responsibility	Strive for product to have an acceptable cost. Do not engage in unethical financial practices. Managers should offer fair pay. Do not promote their own interest at the expense of the profession, client, or employer.
Communication Honesty	Be honest in all statements about software, methods, and tools, especially to the public.

Health, Safety, Well-Being	Only approve software that is believed to be safe and does not diminish quality of life.
Property Ownership	Develop software that respects the privacy of everyone who will be affected by it. Maintain data integrity.
Sustainability	Only approve software if it does not harm the environment. Report environmental dangers of software to appropriate parties or authorities.
Social Responsibility	Moderate interests of the software engineer, the client, and users with the public good. Use professional skills for good causes and help educate the public about the profession.

7.2 Project Specific Professional Responsibility Areas

For each of the professional responsibility area in Table 1, discuss whether it applies in your project's professional context. Why yes or why not? How well is your team performing (High, Medium, Low,N/A) in each of the seven areas of professional responsibility, again in the context of your project.
Justify.

Area of responsibility	Importance and justification	Level of performance and justification
Work Competence	**High**: Coming into this project, all of us were up front about our lack of experience and knowledge in AI development. This is very important because it means we need to learn about AI and our development frameworks in order to meet our requirements and complete the project.	**Medium**: Ideally, we would have had some previous experience or knowledge with the topic of our project, but we have done a good job learning about AI development and the Keras API. We have been completing Keras and TensorFlow tutorials related to AI applications such as image classification and speech recognition.

Financial Responsibility	**N/A**: This project has no financial costs associated with it and no money is at stake for anyone involved	**N/A**: As previously stated, this area doesn't apply to our project due to there being no financial stakes for anyone involved.
Communication Honesty	**High**: With a team of 8 people, things can get disorganized and chaotic very quickly without frequent and honest communication. Communication honesty amongst the team increases our efficiency. It's important for our interactions with our advisor as well because he needs to understand our progress in order to help us complete the project.	**High**: Members of the team have always been honest in their interactions with each other. For example, no one has tried to be deceptive about their contributions. We have also communicated honestly with our advisor/client about our lack of previous knowledge and experience in AI.
Health, Safety, Well-Being	**High**: Our model would be used to diagnose illnesses in farm animals so it would have a large impact on the health, safety, and well-being of animals.	**Medium:** We have done research into how animal illnesses impact the sounds they make but will need to learn more to implement our solution.
Property Ownership	**Low**: Data used to train AI models is typically very insensitive so I don't anticipate this being much of an issue. It might be something to keep in mind depending on what type of models we end up developing.	**N/A**: This area could become relevant later depending on the data we work with when developing our AI models, but up to this point, we have not dealt with any sensitive data or property.
Sustainability	**Low**: AI training uses up a lot of computing power which could theoretically have adverse effects on the environment but it is unlikely to be an issue at the scale we are working at.	**High**: We haven't considered it very deeply, but with the AI tutorials we're doing, we aren't posing a threat to the environment.
Social Responsibility	**Medium**: Not a super high priority for our project but could be a demonstration of how AI can be used to benefit the public. It's also an opportunity to promote the software engineering profession.	**Medium**: At this point, we are considering this area because we want to use our AI models for something that will benefit the public, but we aren't sure how yet. This area will likely become more relevant later in the project.

7.3 Most Applicable Professional Responsibility Area

The most applicable professional responsibility area for a Livestock Well-being Identification AI model is the ethical and legal implications of using artificial intelligence (AI) in animal welfare. This professional responsibility area focuses on how AI can be used responsibly and ethically regarding livestock well-being, particularly when recognizing and addressing potential problems related to animal health. As AI technology advances and becomes more sophisticated, it is increasingly important to consider ethical considerations when implementing such technologies.

In the context of livestock well-being identification, this means considering both the ethical and legal implications of deploying an AI system designed to identify sick animals. For example, suppose a machine learning algorithm is trained on a dataset that contains sensitive personal information about sick animals. In that case, appropriate safeguards should be in place to ensure this data remains secure and private. Additionally, those responsible for managing this type of system should consider various other ethical issues, such as ensuring there are no unintended consequences regarding animal welfare or human suffering due to the AI system's decisions. Furthermore, animal welfare laws and regulations must also be adhered to when using AI technology in this domain.

Finally, those responsible for using such systems should keep up with the latest research developments to stay informed on any technological advancements that could potentially impact animal welfare or any related considerations from an ethical standpoint. In conclusion, professional responsibility within the Livestock Well-being Identification AI models requires a deep understanding of ethical considerations and relevant laws and regulations to ensure that these technologies are deployed responsibly and effectively concerning animal welfare standards.

Closing Material

8.1 Discussion

The Livestock Well-Being Identification project aimsto develop a system for identifying sick farm animals by analyzing sound patterns. The goal is to reduce the costs associated with traditional sickness identification methods, which require manual identification of symptoms from animal samples collected from farms. The project uses machine learning and audio analysis to identify and classify animal sounds based on acoustic features.

The models we searched, learned, and tested as part of this project were positive overall. It was found that machine learning could be used effectively to identify and classify sick animals based on their sound patterns. The system's accuracy ranged from 80-90%, depending on the species studied and the audio sample type. Furthermore, it was discovered that different techniques, such

as feature extraction and time domain analysis, could be used to further improve the accuracy and speed of the system over traditional methods.

In addition, it was found that certain features such as frequency, intensity, duration, and pitch can be used to distinguish between healthy and ill animals more accurately than in manual identification processes. This research is important because it can provide farmers with an early warning system for potential diseases before they manifest in physical symptoms. As a result, farmers can take decisive action earlier for their livestock to remain healthy.

The model trained during this project will prove that machine learning is an effective tool for identifying sick animals through their acoustic signatures alone. Using these tools and feature extraction techniques, we can create systems capable of identifying sickness with greater accuracy and speed than traditional methods like manual sampling or observation. With further development, these systems have the potential to revolutionize how farmers monitor their livestock's health daily in order to keep them healthy longer while improving overall yields at a fraction of the cost compared to traditional methods.

8.2 Conclusion

Our work on the Livestock Well-being Identification project has revolved around analyzing sound patterns to identify sick farm animals. Our overall goal is to create a model that can accurately recognize the sounds made by sick or ill livestock so that farmers and ranchers can quickly take action to ensure the well-being of their animals. To achieve this goal, We have researched existing models that utilize sound recognition technology and exploring ways to improve these models. So far, machine learning algorithms such as Convolutional Neural Networks (CNNs) would be the best way forward because they can learn from data and recognize patterns in sound. We have also looked into collecting more reliable datasets for training this model to ensure its accuracy.

The main constraints we have encountered with this project include limited data collection and processing resources and a need for more general knowledge about machine learning models in this context. In order to overcome these challenges, one possibility is for us to reach out for help from various stakeholders, such as veterinarians and animal welfare experts who have experience working with sick animals, to gain access to better datasets. Similarly, we could look into other open-source datasets available online, which may provide additional insight into what different types of diseases sound like when spoken by an animal. Furthermore, increasing our knowledge of machine learning tools would also be beneficial in developing more sophisticated models capable of providing higher accuracy results related to livestock health diagnostics.

In conclusion, moving forward with this project will require continued research on available datasets and exploring ways to build a reliable model using machine learning algorithms. With further collaboration between stakeholders across different fields, it should be possible to achieve our goals of creating an accurate diagnostic tool that can detect when an animal is sick and provide quick, actionable insights so farmers can take the initiative in protecting their livestock’s well-being earlier than before.

8.3 References

[1]Basic classification: Classify images of clothing, “Basic classification: Classify images of clothing | TensorFlow Core,” *TensorFlow*, 2017. https://www.tensorflow.org/tutorials/keras/classification

[1]“Simple audio recognition: Recognizing keywords | TensorFlow Core,” *TensorFlow*. https://www.tensorflow.org/tutorials/audio/simple_audio

[1]IBM Cloud Education, “What are Neural Networks?,” *www.ibm.com*, Aug. 17, 2020. https://www.ibm.com/cloud/learn/neural-networks

8.4 Team Contract

Team Name P-Solvers (sdmay23-05)

Team Members:

1) Asad Abdalla
2) Richard Gonzalez
3) Lucas Onwuchekwa
4) Rashed Alyammahi
5) Adam Sweiger
6) Meet Patel
7) Yannick Fumukani
8) Mohammed Elbermawy

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team meetings: Face-to-face meeting every Thursday at 5:00 PM, usually about 1 hour in length
2. Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face): Discord, face-to-face
3. Decision-making policy (e.g., consensus, majority vote): Majority Vote
4. Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived): Recap of each meeting posted in discord and pinned for easy reference

Participation Expectations

1. Expected individual attendance, punctuality, and participation at all team meetings:
   Every member is expected to attend and participate in weekly meetings. Ideally, everyone should also participate in meetings with the faculty advisor, but we don’t expect every member to attend every meeting with the advisor.
2. The expected level of responsibility for fulfilling team assignments, timelines, and deadlines: Each member will be equally responsible for completing team assignments and meeting deadlines. If a team member is struggling, they should seek help from the team.
3. The expected level of communication with other team members:

The team is expected to communicate in the case of issues, concerns, and stand-ups through Discord or face-to-face meetings.

4. The expected level of commitment to team decisions and tasks:
   Team members are expected to be committed to assigned/agreed to tasks. If a team member struggles with a task, they should ask other team members or the advisor for assistance.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):
   a. Meet Patel: Advisor Interaction
   b. Richard Gonzalez: Scrum Master/ Team Organizer
   c. Mohammed Elbermawy: Client Interaction
   d. Asad Abdalla: DevOps Manager
   e. Yannick Fumukani: Frontend Manager
   f. Rashed Alyammahi: Backend Manager
   g. Lucas Onwuchekwa: QA - Act as a client and test the product on each dev release before prod release (QA testing)
   h. Adam Sweiger: Meeting and Status Reporter - Record minutes for weekly minutes and complete weekly status reports

   <u>In Rotation</u>

   Team Manager - Ensure that each member stays on top of assigned tasks and meets deadlines.

   Project Manager - Manage the design progress of the project and ensure that team is achieving design goals.

2. Strategies for supporting and guiding the work of all team members:
   Being cognizant of everyone's tasks at a minimum level. Being open to helping other team members, and team members are to inform each other when stuck or in need of help.
3. Strategies for recognizing the contributions of all team members:
   a. Sprint planning:- Where each team member is expected to finish their task within the due date of the sprint
   b. Weekly Meeting:- Each team member is expected to tell what they did within this week for the project
   c. Weekly Commits:- Each team member is expected to commit progress to GitLab each week

Collaboration and Inclusion

1. Describe the skills, expertise, and unique perspectives each team member brings to the team.

a. **Meet Patel** - I know Java, Javascript, HTML, and CSS. I have experience with frontend. I have experience with both android studio and web development. I am comfortable with any text editor. I can bring to develop the frontend and design the pages for android studio or website. I also have experience with testing. I can bring up the testing component and test if the components pass or not. I am also a TA for SE317, i.e., Introduction to Testing class. I have experience with mock testing, unit testing, and GUI Testing. I can also help with C or C++ if the project demands it.

b. **Richard Gonzalez** - Java, Javascript, HTML, Bootstrap, SQL, Spring MVC, Full Stack

c. **Asad Abdalla** - Fullstack, I've worked with many technologies, including ReactJs, Spring Framework, NodeJS, and some DevOps technologies

d. **Mohammed Elbermawy** - Java, Javascript, and Python

e. **Yannick Fumukani** - I am specialized in the following technologies: Html, CSS, Javascript/Typescript, Java, Swift, Dart, Python, C#, C/C++, SQL, MongoDB, Node.js, SwiftUI, Tailwind, AWS, ReactJS, React Native, Spring Boot

f. **Lucas Onwucheckwa** - Full Stack development and technologies specializing in Frontend design and implementation using frameworks like ReactJS and ReactBoostrap. High-level expertise in Java and any database management system (relational and non-relational) excluding graph SQL, but low-level in Python, C/C++, etc.

g. **Rashed Alyammahi** - Java, database, C/C++, Node.JS.

h. **Adam Sweiger** - My expertise is in backend/database development, but I can also contribute to the frontend if necessary. Significant experience in Java, Spring Boot, Node.js, SQL, C, and C++, as well as some experience in JavaScript and React.js. Knowledge of JUnit and Mockito testing.

2. Strategies for encouraging and supporting contributions and ideas from all team members:
    - Being respectful of everyone's ideas
    - Taking votes on major decisions
    - Discussing and debating ideas without disparaging team members

3. Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment is obstructing their opportunity or ability to contribute?)
    - Team discussions on the issue
    - Inform the Team Manager who will attempt to resolve the issue

- Voting to decide when we have multiple opinions
- Provide constructive reasons for your opinion.

Goal-Setting, Planning, and Execution

1. Team goals for this semester:
    a. Complete the project successfully
    b. Achieve the project goals with the given constraints
    c. Ensure customer satisfaction
    d. Productivity for the project
    e. Learn and grow
2. Strategies for planning and assigning individual and teamwork:
    a. Individual work will be assigned as per individual consent
    b. Individual work will be assigned with the individual's skills
    c. Teamwork should be collaborative and productive
    d. Productivity is needed
    e. If a team member gets stuck or gets errors, other team members need to stand for that team member and help him.
    f. It's important to attend the weekly team meeting and update the project status.
3. Strategies for keeping on task:
    Git Board has all our tasks and shows who is working on what. Weekly stand-ups/ meetings for the entire team.

Consequences for Not Adhering to Team Contract:

1. The team will make a meeting with team member(s) not adhering to the contract
2. If multiple infractions continue, a team meeting will be made with the professor
3. Meeting with professor or advisor to discuss possible removal of student

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a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*
b) *I understand that I am obligated to abide by these terms and conditions.*
c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*

1) Asad Abdalla DATE 12/01/2022
2) Meet Patel DATE 12/01/2022
3) Lucas Onwuchekwa DATE 12/01/2022
4) Rashed Alyammahi DATE 12/01/2022
5) Adam Sweiger DATE 12/01/2022
6) Mohammed Elbermawy DATE 12/01/2022
7) Yannick Fumukani DATE 12/01/2022
8) Richard Gonzalez DATE 12/01/2022