Capstone Status Report for Week 1

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1 Team Members

My team includes the following members:

1. Sasha Lawson
2. Alana Matheny
3. Sam Donaldson
4. Noah Buchanan

2 Goals from Previous Week

The following goals were set in the previous weekly report:

1. **Task 1**: Perform research on the "Related Work" section for our project proposal; use this knowledge to write our "Related Work" section.
2. **Task 2**: Perform research on best database technology to utilize for our back-end and add it to the "Technology" section.
3. **Task 3**: Write our objective statement on how we plan to address the problems stated in the "problem statement" section of our project proposal.
4. **Task 4**: Perform research into convolutional neural networks to understand the underlying mechanics; use this knowledge to make a mid-level explanation in our background.

3 Completion of Tasks Planned

The following work has been accomplished with respect to my previously set goals:

Task 1: Related Work

All work was completed as expected, proofread, and approved by the team. I found one project and one research paper that I felt were similar to what we are trying to perform.

2.3 Related Work

Push-up Counter

(Nguyen, 2021) Viet-Anh Nguyen has made a push-up counter app using OpenCV and Deep learning. Our project will be similar to theirs, but we will add new features. Their architecture involves using key point detection for signal processing to determine whether the user is pushing up or down, and involves a model solely for push-up recognition. Their project has a GUI application, and our project in addition will propose to implement advanced data analytics on the users' exercises as well as implementing a web based interface for this purpose. In addition to the desktop application that will perform the actual exercise recognition and counting, we also intend to pick up where their project left off. They stated that they believed that they could have achieved better counting results with more key points and leveraging those key points to correct wrong push-ups. The latter is something we will certainly implement as that was one of our key problems we set out to solve in our objective. We intend to also implement these features for multiple exercises and not just for pushups.

Recognizing Exercises and Counting Repetitions in Real Time

(Alatiah & Chen, 2020) The model uses OpenPose to extract 3D human body key points. These key points are used to determine the exercise being performed between one of the following: push-ups, pull-ups, and squats. The actual model that counts exercises uses the last 10 frames and the following formula to predict the exercise being performed:

$$\text{performed exercise}(f) = most\_common(y(f-9), y(f-8), ..., y(f))$$

This equates to aggregating the classification of the last 10 frames and using the most occurring classification of exercise. We will use something similar to this in our classification, however they used pre-selected parameters in their research. We will have our features determined from the interaction of key points through a convolutional neural network.

Task 2: Research on Database Technology

All work was completed as expected and approved by the team. I found one resource where I simply compared its raw performance in comparison to other relation database management systems. I then validated it by looking at the advantages of MySQL in the second resource listed. In the third resource I looked into which big companies were using MySQL to determine its reputation.

- **Link 1: https://www.g2.com/categories/relational-databases**
- **Link 2: https://www.datamation.com/storage/8-major-advantages-of-using-mysql/**
- **Link 3: https://www.mysql.com/**

Task 3: Objective Statement

All work was completed as expected, proofread, and approved by the team.

1.2 Objective

Our project sets out to solve three problems that modern fitness applications typically have. Firstly, our application will make fitness insightful. We will keep a variety of statistics for each user to provide invaluable information about their fitness goals and their rate of progression. This makes each user's fitness journey highly personalized.

The second problem we are attempting to solve is the matter of consistency required for physical fitness. Making it to the gym multiple times a week is a daunting task for busy individuals. This is where our application comes in. With our application you can exercise from any location that you have a computer and a webcam.

The last problem for most is that exercising is difficult. Our application aims to make it easier through two key innovations. First, our application will monitor your exercises and make sure you are performing them correctly. Additionally, our application will track your live progress and rest times throughout a workout. Both of these combined can make fitness magnitudes easier for those that find fitness difficult.

Task 4: CNN Research

All work was completed as expected and approved by the team. I used multiple resources to understand convolutional neural networks and found some graphics to help explain better from **https://anhreynolds.com/blogs/cnn.html/**.

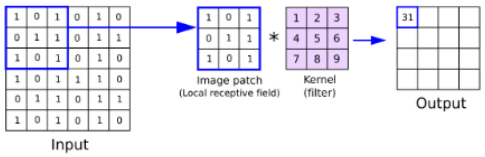
Convolutional Neural Network

Convolutional neural networks (CNN) do three specific things to make classification practical:

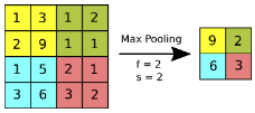
1. Reduce the number of input nodes.
2. Tolerate small shifts in where the pixels are in the image.
3. Take advantage of the correlation between features.

The first thing a CNN does is apply a filter to the input image. Filters are sometimes also called kernels. For this explanation the former will be used. A filter is a smaller matrix of pixels typically around the size of 3×3. The intensity of each pixel in the filter is determined by back propagation. To begin with the pixel values in the filter are randomized.

The filter is overlaid onto the image and the dot product of the image and the filter is calculated to get a value that we add a bias to and then put into a feature map.



We can say that the filter is "convolved" with the input after performing this which is what gives CNNs their name. The filter is then moved over one pixel or possibly more, this is up to the users discretion, and does that process over again. Once the feature map is finished we run it through an activation function, typically ReLU. Once the map has been run through ReLU we max pool the feature map to further minimize the size, max pooling meaning that the filter does not overlap itself, so for a 2×2 filter it would move 2 pixels. Max pooling selects the spots where the filter did the best job matching the input image; mean pool alternatively could be used where the mean of the filter is taken rather than the maximum value.



Now we convert the pooled layer into an $n \times 1$ input layer. These input nodes are then plugged into a normal neural network.

4 Additional Work Completed

In addition to the goals set for the previous project, I also completed the following work:

1. Helped proofread others sections for errors and spelling checks.
2. Aided Sam in fixing our .bib file references so that we could put proper citation.

5 Overall Group Dynamics

We used both class sessions this week to meet and work as a team. In addition, we also scheduled an additional meeting on Sunday at 1:30, Monday at 4, and Tuesday at 4. All members were in attendance. We are all making excellent progress.

6 Goals for This Week

The following goals and tasks are planned to be completed by our next status report:

1. **Task 1**: Review and make changes as needed to any of my sections before presentation
2. **Task 2**: Run through practice presentation with team members to prepare for presentation
3. **Task 3**: Start looking into how to construct our different models we will be using.