Working Draft:

Project Summary:

The domain of motion classification has found numerous applications across healthcare, sports analytics, security, and human-computer interaction. Traditional methods have shown certain limitations in terms of accuracy and real-time applicability. Deep Learning, with its ability to learn complex patterns, presents a promising avenue for advancements in motion classification. The objective of this project is to experiment with deep learning technologies, initially focusing on primitive motion classes from skeleton based datasets. This initiative stems from a motivation to harness deep learning on temporal and spatial data. This exploratory venture is geared towards demonstrating the foundational capabilities of deep learning techniques in classifying motions, thereby potentially laying groundwork for more sophisticated applications in the future.

What You Will Do (Approach):

A substantial portion of the project will be dedicated to the exploration of publicly available datasets requiring minimal pre-processing, to ensure a smooth transition into the model training phase. Current research uses low dimension skeleton representations of human actions to reduce the complexity of features. The methodology will involve selecting appropriate deep learning architectures such as Convolutional Neural Networks (CNN) or Recurrent Neural Networks (RNN), or possibly a hybrid approach since our problem involves both temporal and spatial dimensions. The chosen models will be trained on the selected dataset, followed by a rigorous validation and testing phase to evaluate the model's performance. Besides, the project will venture into optimization, where tuning the hyperparameters for optimal performance and comparing different models to select the best one will be paramount. It's crucial to go beyond just running existing code on a dataset; a thorough implementation, analysis, and understanding of the underlying theory are imperative to ensure the project's success.

Resources / Related Work & Papers:

The state-of-the-art in motion classification is rapidly evolving with many projects leveraging deep learning techniques. Recent advances have shown the efficacy of deep learning in handling high-dimensional data and complex patterns inherent in motion data. This project will exclusively utilize Python and PyTorch for development, training,

and evaluation of the deep learning models, aligning with contemporary projects and papers in the field. While this project may implement existing approaches, the emphasis will be on understanding, experimenting, and possibly enhancing the existing methodologies to suit the specific goal of classifying primitive motion classes initially. A comprehensive review of existing literature and similar projects will be conducted to gather insights and ensure a well-informed approach.

Datasets:

Current state of the art models are trained on skeletal renderings of the input video animation. We will need to find a skeleton dataset that is also considered a benchmark dataset for motion classification. Listed are some potential datasets we will consider.

We're needing the following sections:

- Team Name
- Project Title
- List your Group members.

Goal:

Ideally our proposal will look like the one the TA provided as a reference. Need to change the Resources and Datasets sections to have actual references that we are considering using (see below)

Homework:

- **Each member finds two unique references for motion classification (papers, walkthrough, explainer, etc.)**
- **Each member finds one unique dataset for us to consider using**

NIKO

- Dataset - http://jhmdb.is.tue.mpg.de/dataset

- Research Articles/Walkthroughs
    1. **On human motion prediction using recurrent neural networks (Paper + Github)** -
        - https://arxiv.org/pdf/1705.02445.pdf
        - https://github.com/una-dinosauria/human-motion-prediction
    2. **Human Motion Prediction Using Adaptable Recurrent Neural Networks and Inverse Kinematics**
        - https://ieeexplore.ieee.org/abstract/document/9281312

Clay

- Dataset: mmskeleton/doc/SKELETON_DATA.md at master · open-mmlab/mmskeleton · GitHub
- Research Articles/Walkthroughs
    1. Entropy | Free Full-Text | A Spatio-Temporal Motion Network for Action Recognition Based on Spatial Attention (mdpi.com)
    2. [2008.07404] Skeleton-based Action Recognition via Spatial and Temporal Transformer Networks (arxiv.org)

Andrew

- Dataset: https://www.deepmind.com/open-source/kinetics
- Research:
    - **Deep Representation Learning for Human Motion Prediction and Classification**: This work proposes a deep learning framework specifically aimed at human motion capture data. The model learns a generic representation from a substantial corpus of motion capture data and is able to generalize well to new, unseen motions. source[1].
    - **Human Motion Modeling with Deep Learning: A Survey**: This paper provides a comprehensive overview of recent methodologies in human motion modeling using deep learning. It summarizes various approaches to help computers understand and mimic human motion across different scenarios. source[2].
    - **Human Activity Classification using Deep Learning Based on 3D Motion Feature**: This paper discusses a method for classifying human activity using deep learning, based on 3D motion features. It might provide insights into the application of deep learning for human motion classification in three dimensions. source[3].
    - **Evaluation of Deep Learning Models in Contactless Human Motion**: This paper focuses on improving the performance of deep learning models in a

contactless human motion scenario through techniques like structure modification and dimension reduction of the original data. source[4].

- **Deep Learning for Human Motion Analysis**: In this work, several deep neural models are proposed for supervised classification and semi-supervised feature learning, as well as modeling of temporal dependencies. This could be particularly useful if you are looking into analyzing temporal aspects of human motion. source[5].

Sample proposal:

Team: Next Move

Project Title: Motion Prediction

Project Summary:

The ability to forecast human motion is useful for a myriad of applications including robotics, self-driving cars, and animation. Typically we consider this a generative modeling task, where given a seed motion sequence, a network learns to generate/synthesize a sequence of plausible human poses. This task has seen much progress for shorter horizon forecasting through traditional sequence modeling techniques; however, longer horizons suffer from pose collapse. This project aims to explore recent approaches that can better capture long-term dependencies and generate longer horizon sequences.

Approach:

Based on our preliminary research, there are multiple approaches to address the 3D Motion Prediction problem. We want to start by collecting and analyzing varying approaches; e.g. Encoder-Recurrent-Decoder (ERD), GCN, and Spatio-Temporal Transformer. We expect to reproduce [1] and baseline other approaches.

As a stretch goal, we want to explore possible directions to improve these papers. One avenue is to augment the data to provide multiple views of the same motion and ensure prediction consistency.

Another stretch goal is to come up with a new metric and loss terms (e.g. incorporating physical constraints) to improve benchmarks.

Resources/Related Work:

[1] "A Spatio-temporal Transformer for 3D HumanMotion Prediction", Aksan et al.
[2] "Recurrent Network Models for Human Dynamics", Fragkiadaki et al.
[3] "Learning Dynamic Relationships for 3D Human Motion Prediction", Cui et al.
[4] "Convolutional Sequence to Sequence Model for Human Dynamics", Zhang et al
[5] "Attention is all you need", Vaswani et al.
[6] "On human motion prediction using recurrent neural networks", Martinez et al.
[7] "Structured Prediction Helps 3D Human Motion Modelling", Aksan et al.
[8] "Learning Trajectory Dependencies for Human Motion Prediction", Mao et al.
[9] "AMASS: Archive of Motion Capture as Surface Shapes", Mahmood et al.

Datasets:

AMASS https://amass.is.tue.mpg.de/

Team Members:

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