

## Key Outcomes:

- Confirmed machine learning with wearable devices is an effective strategy to understand and predict medical conditions
- Confirmed a machine learning algorithm can accurately predict ankle sprains
- Devised an actionable plan for future data collection

**Mission Statement:** Predict ankle sprain on simple and definable external factors

### Background Into Ankle Sprain

- 2 most common types of sprain are **inversion** and **eversion** [1]
- Approximately 2 million ankle sprains occur each year [2]



Figure 1: Inversion vs eversion [4]

### Current Attempts at Utilizing ML for Ankles



Figure 2: Ankle brace design using muscle stimulation [5]

- Classified sprain using random forest ML, muscle stimulation, and gyroscopic data [5]

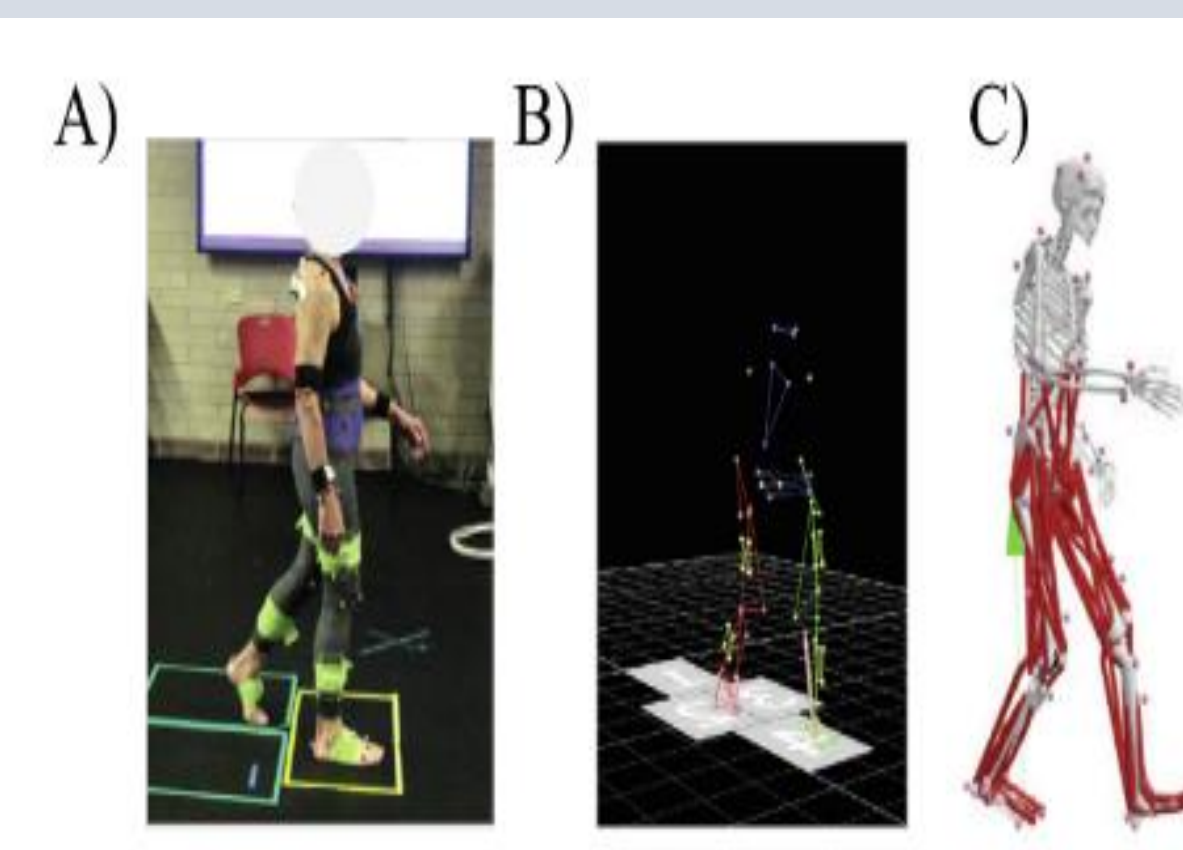


Figure 3: Motion capture to use in OpenSim [6]

- Understood normal gait during daily activities with OpenSim [6]



Figure 4: Footbed pressure sensor [7]

- Developed embedded footbed sensor to understand ankle angles during daily activities [7]

### Synthetic Data Fabrication

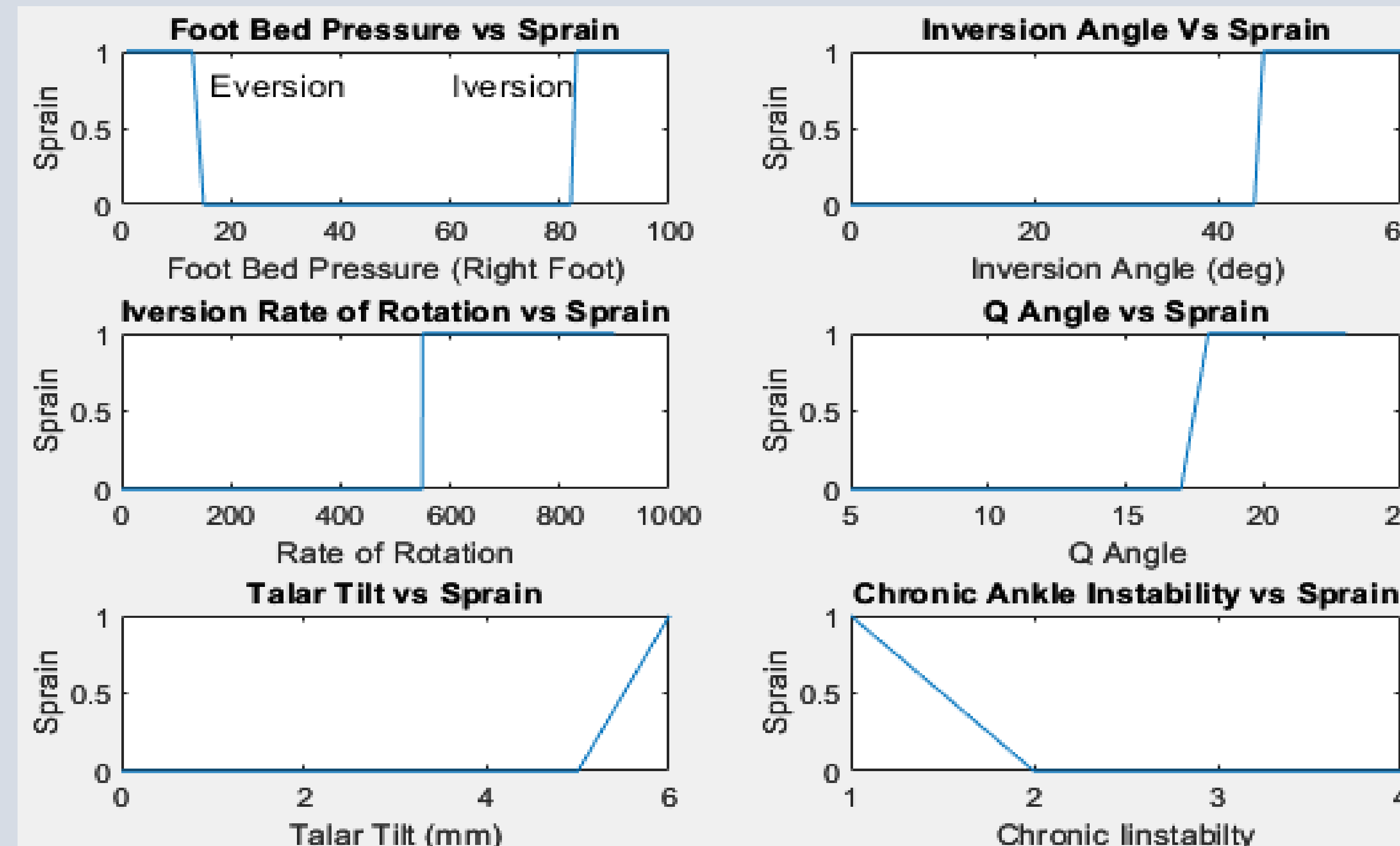


Figure 5: MATLAB Synthetically Fabricated Data

- Relative footbed pressure: 85/15 [7]
- Inversion ROR: 550 (deg/s) [8-10]
- Talar Tilt: 5 (deg) [11]
- Inversion angle: 45 (deg) [8-10]
- Q angle: 17 (deg) [12]
- CAI: Assigned to 25% of the synthetic data population [13]

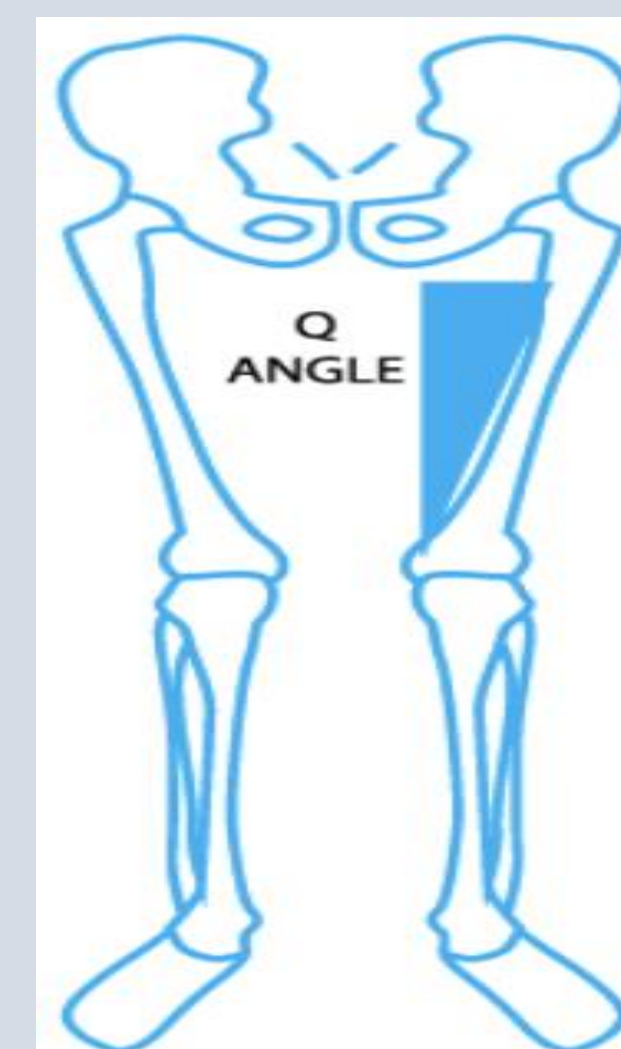


Figure 6: Q Angle [14]



Figure 7: Talar Tilt [15]

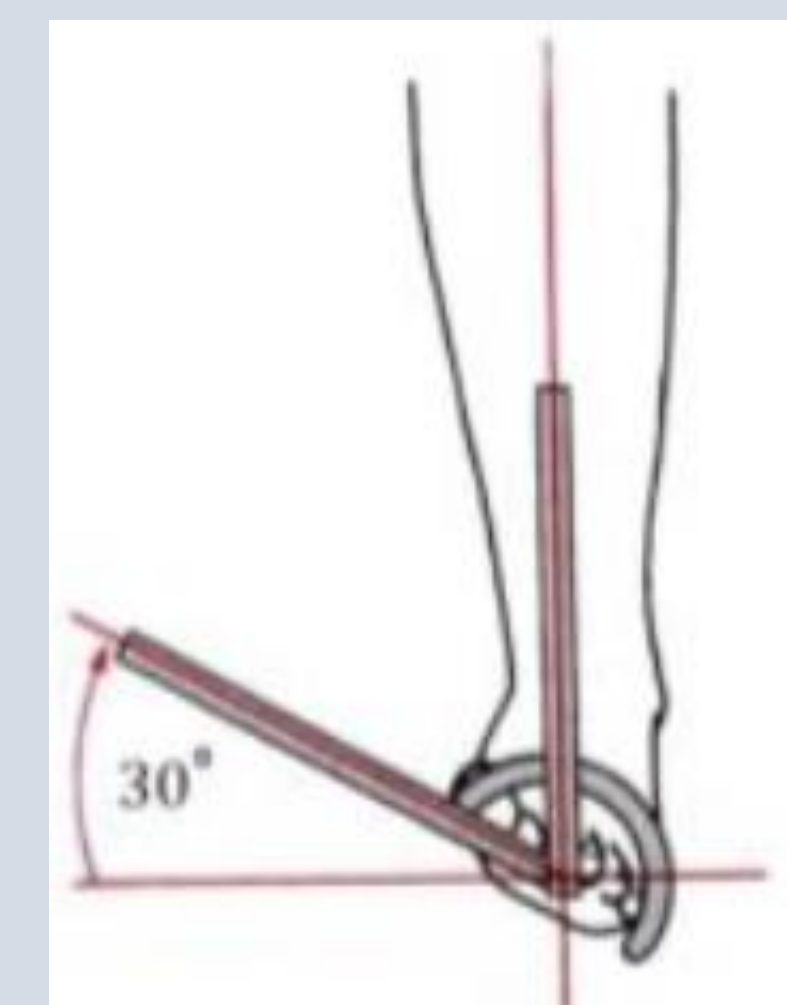


Figure 8: Inversion Angle [16]

### Machine Learning Model

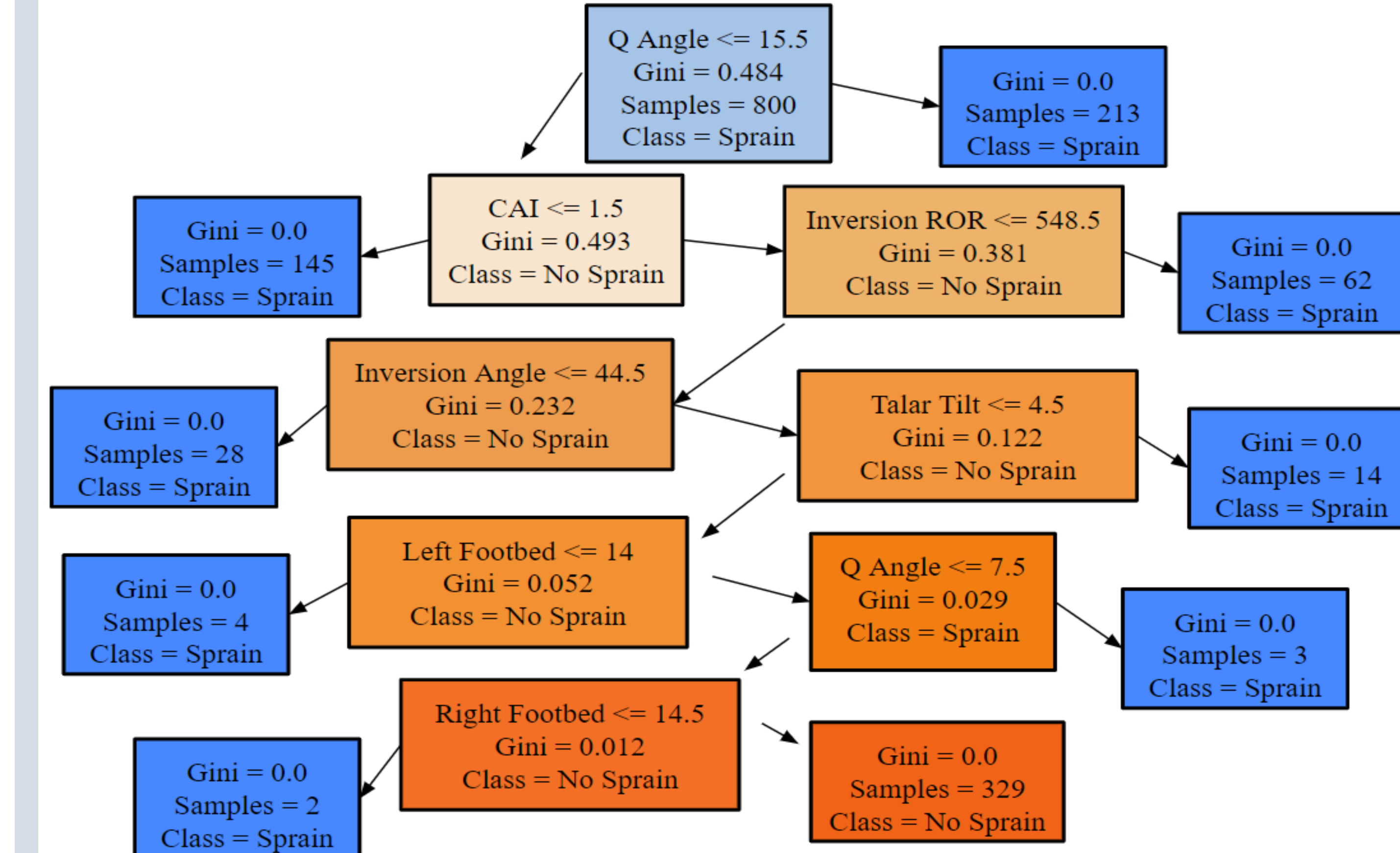


Figure 9: Random Forest Decision Tree Machine Learning Visualization

### Future Data Collection and Implementation

- 99% accuracy
- Implement wearable devices to collect movement data during normal daily activity and athletics to improve ML
- Interface ML predictions with real world brace to prevent sprain
- Create user specific algorithms to more accurately predict an individual's chance of sprain



Figure 10: IMU Based Ankle sensor

#### References:

- [1] sportsmedtexas, et al., 9/28/2022; [2] Herzog, Mackenzie, et al., 5/28/2019; [3] Massgernalbrigham, et al., Sprained Ankle; [4] Betancourt, Mikel, Ankle Sprains: Inversion vs. Eversion; [5] Turyatamba, Joseph, 2022; [6] Burton, Myers, et al., 6/23/2021; [7] Choffin, Zachary, et al., 5/30/2021; [8] Yumeng, Li, et al., 2019; [9] D. Gehring, et al., 08/16/2012; [10] Fong, et al., 2009; [11] Cox JS, et al., 1979; [12] Zamani Moghadam, et al., 2017; [13] Lin, et al., 5/28/2021; [14] H. Hillyard, et al., 2016; [15] OrthoFixar, "Talar Tilt Test," 4/2/2024; [16] Yonezawa, et al., 2014