WPI

Human Context Recognition:
A Controllable GAN Approach

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Last Week Summary

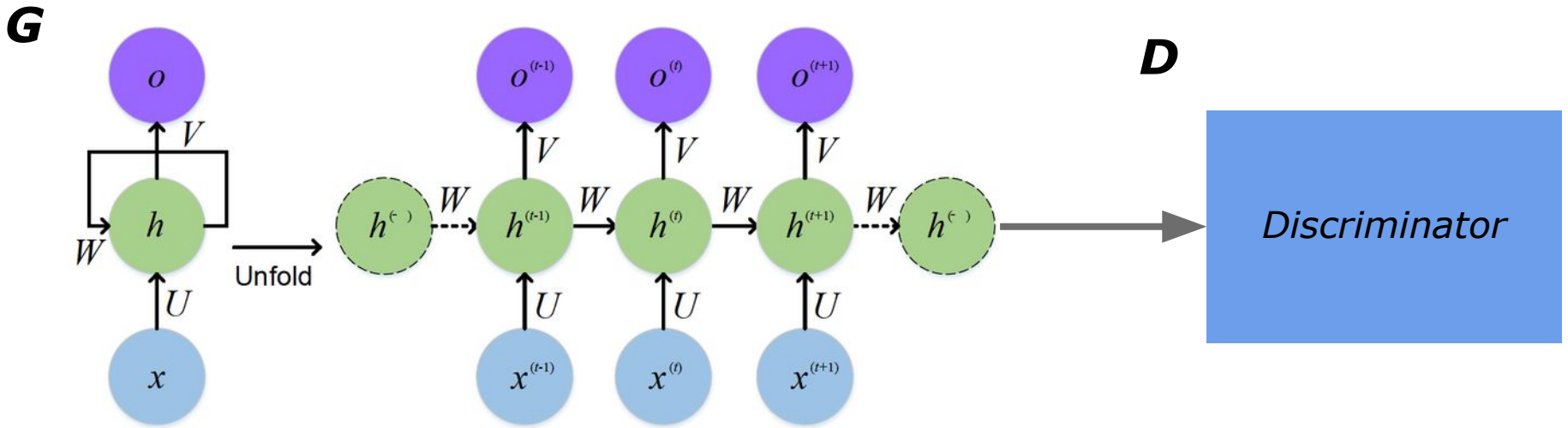
1. Developed a basic understanding of the standard ML libraries and tools we'll use throughout our research.

2. Read and analyzed the strengths and weaknesses of different GAN-based architectures rooted in image-based domains.

3. Began looking into how to apply these related works into the time-series-based domain of mobile sensor data.

GANs for Sequential Data

Generators with recurrent architectures allow for developing realistic time-series data for an iteration t by using previous iterations for generation (t-1, t-2, t-3, … t-n)



Feng et. al. (2017). Audio visual speech recognition with multimodal recurrent neural networks. 681-688. 10.1109/IJCNN.2017.7965918.

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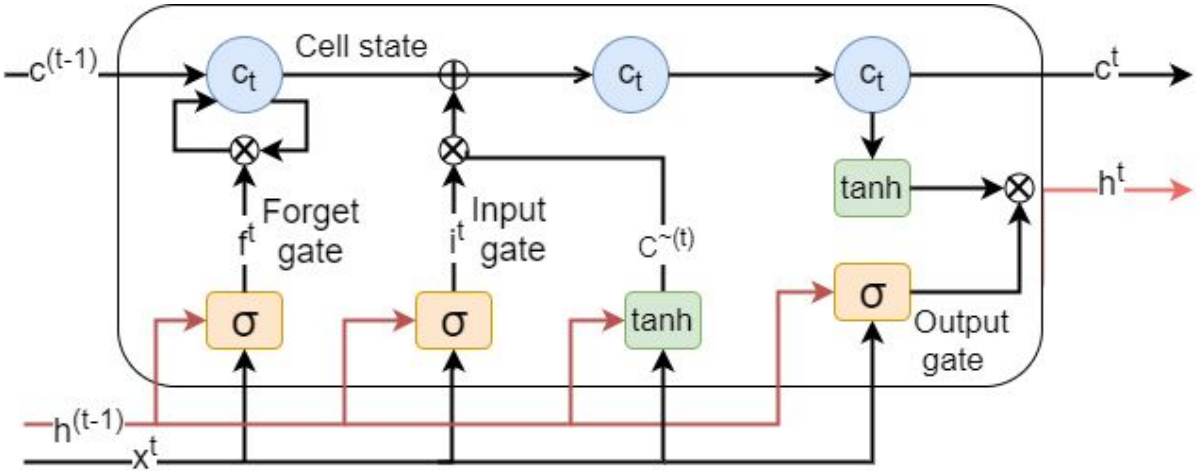


Jenkins et. al. (2018). Accident Scenario Generation with Recurrent Neural Networks. 3340-3345. 10.1109/ITSC.2018.8569661.

wGANs for Mobile Sensor Data

- Use Wasserstein distance to increase stability of learning and decrease mode collapse
- Used 2 models with different generators
  - CNN and LSTM
- CNN showed improvement

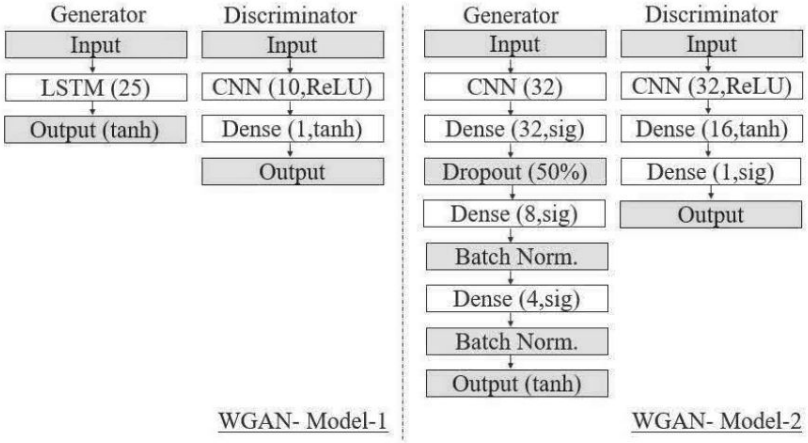


Figure 2. WGAN MODEL-1 (left) AND MODEL-2 (right)

F. Alharbi, L. Ouarbya and J. A. Ward, "Synthetic Sensor Data for Human Activity Recognition," *2020 International Joint Conference on Neural Networks (IJCNN)*, 2020, pp. 1-9, doi: 10.1109/IJCNN48605.2020.9206624.

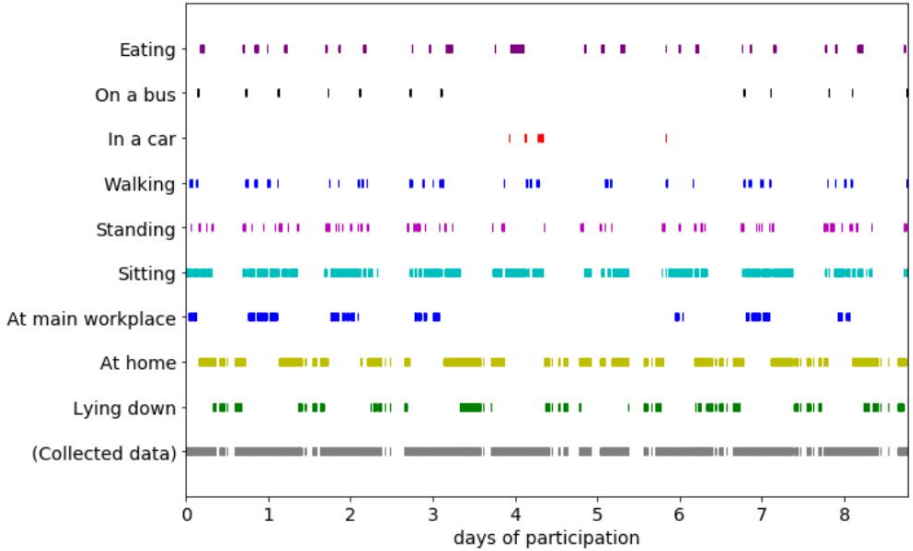
ExtraSensory

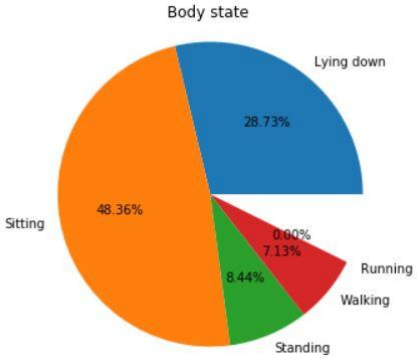
- 60 Participants
- 300k+ data points
- 15 different devices
- 10 unique sensors
- 183 features
- 41 discrete device attributes
- 51 labels (not all mutually exclusive)

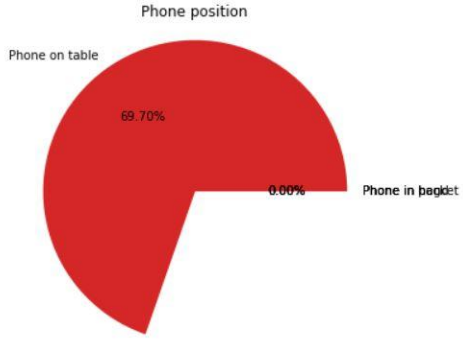
Accessible at: http://extrasensory.ucsd.edu/

Exploring the Dataset

- Aperiodic time records
- Inconsistent use of sensors among users
- Significant class imbalance







Simple PyTorch NN for Classification

Using featurized accelerometer data without temporal context from ExtraSensory, can we classify when users are sitting?

Model:

- 27 accelerometer features
- 4 ReLu layers (40 neurons each)
- 20% dropout
- 1 sigmoid layer to 1 neuron
  - Probability user was sitting

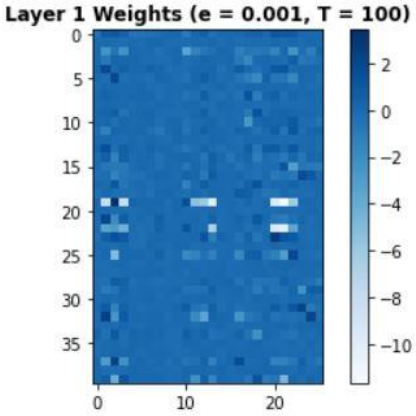
Training:

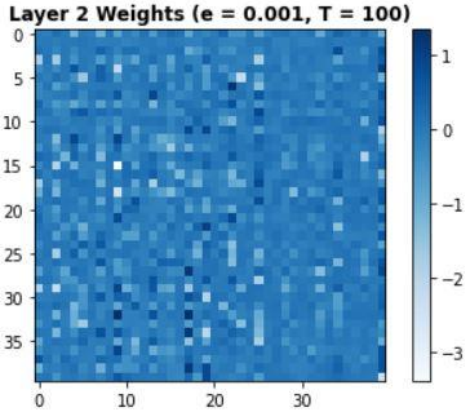
- e = 0.001
- Epochs = 120
- Training Loss: MSE
- Batch Size = 10,000 datum
- Volume = 264,142 datum

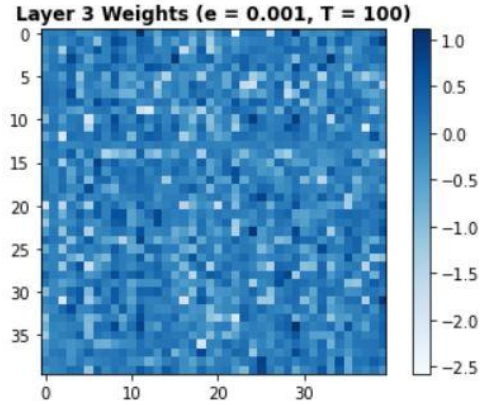
Results:

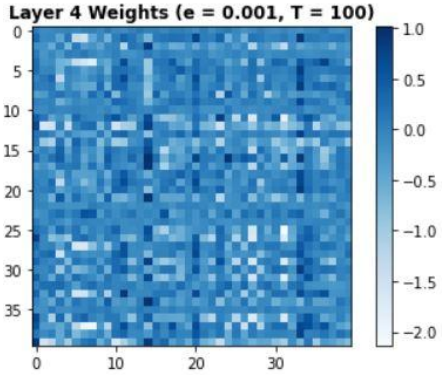
Test loss (MSE): 0.1882
NN Accuracy: 70.72%

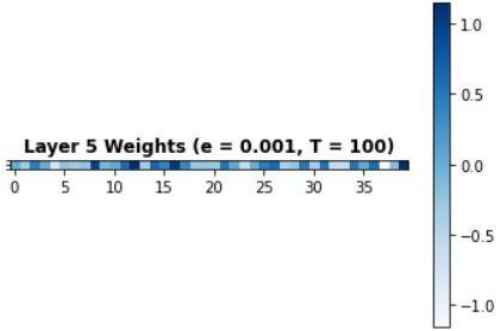
Weight Visualization









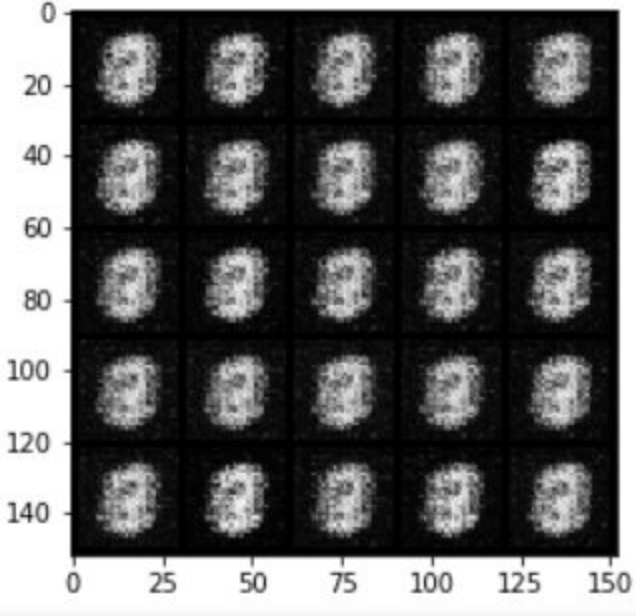


PyTorch GAN for Digit Image Generation

Generator:
- Linear Layers
- 1D Batch Normalization
- ReLU Layers
- Sigmoid Output Layer

Discriminator:
- Linear Layers
- Leaky ReLU Layers
- Linear Output Layer

Epoch 1



Epoch 185