

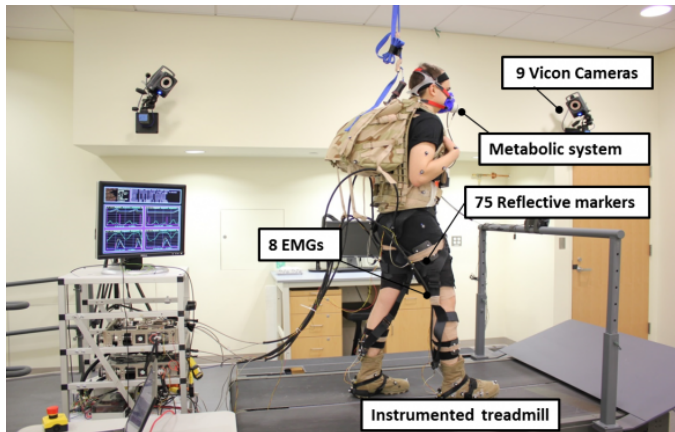
# Gait Event Detection Using an LSTM Network

## 10-701 Project Presentation

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# Introduction



from <http://biodesign.seas.harvard.edu/soft-exosuits>

**Goal:** Accurately detect gait events (heel strike, toe off) in video-based motion capture data of human walking gait

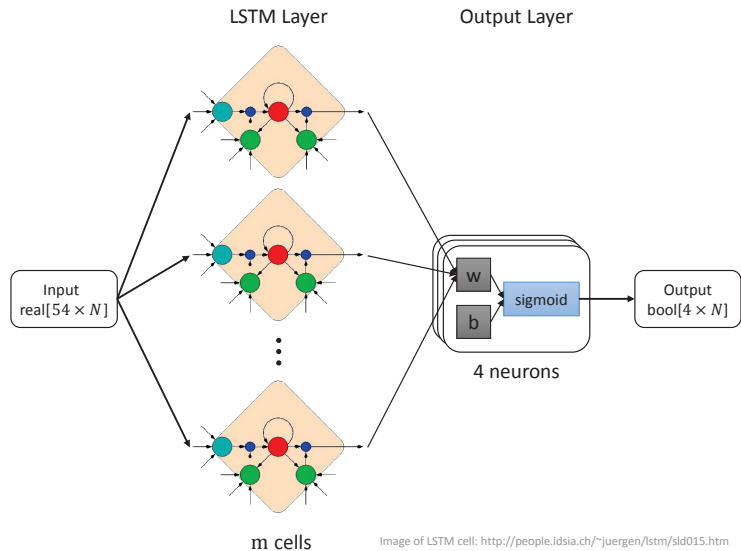
# Introduction

- ▶ **Problem:** Sequence labeling
  - ▶ Input: 3D locus of 18 motion capture markers ( $54 \times N$  reals)
  - ▶ Output:  $\{\text{Left, Right}\} \times \{\text{Heel Strike, Toe Off}\}$  ( $4 \times N$  bools)
- ▶ **Dataset:**
  - ▶ 8 subjects  $\times$  3 trials  $\times$  10 000 samples @ 100 Hz
  - ▶ Ground truth from force plates on treadmills

# Our Approach

- ▶ Objectives:
  - ▶ Empirical feature-engineering should be minimal
  - ▶ Number of manually-picked parameters (window size, threshold, filter cutoff, etc.) should be minimal
  - ▶ Dependence of one gait cycle on those preceding it should be exploited
- ▶ Proposed solution: LSTM-based RNN
  - ▶ Recognition of periodic patterns even in presence of input noise
  - ▶ Robust and precise learning of rhythmic timing

# Network architecture



# Implementation

- ▶ Torch/Lua on AWS EC2 GPU instance (g2.2xlarge)
- ▶ Start with LSTM code example by de Freitas
  - ▶ Adapt to our problem setup
  - ▶ Problem: Does not converge out of the box
  - ▶ Tweaks: Learning rate, mini-batch, regularization, etc.
- ▶ Further work:
  - ▶ Train on GPU (currently only runs on CPU cores)
  - ▶ Explore other network architectures
  - ▶ Improve time invariance

# Results

	mean	std	mistake
O'Connor	XXXXXXXX	XXXXXXXX	XXXXXXXX
Miller	XXXXXXXX	XXXXXXXX	XXXXXXXX
LSTM	XXXXXXXX	XXXXXXXX	XXXXXXXX

# Results

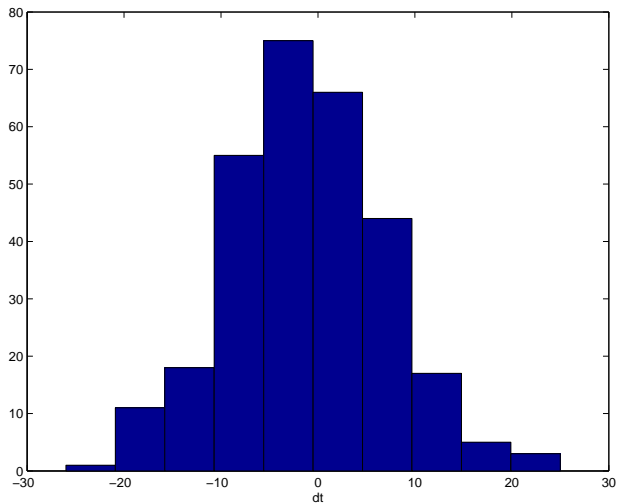


Figure 1: Histogram Miller



Thank you for your attention!

# Human Gait Cycle

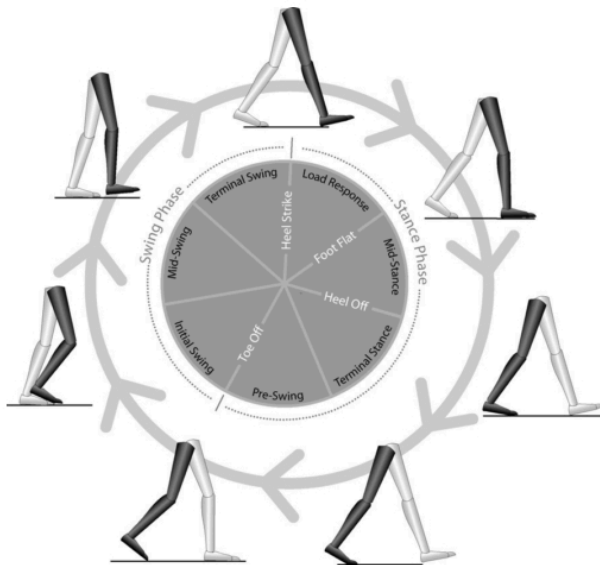


Figure 2: Gait events [Rueterbories et al., 2010]