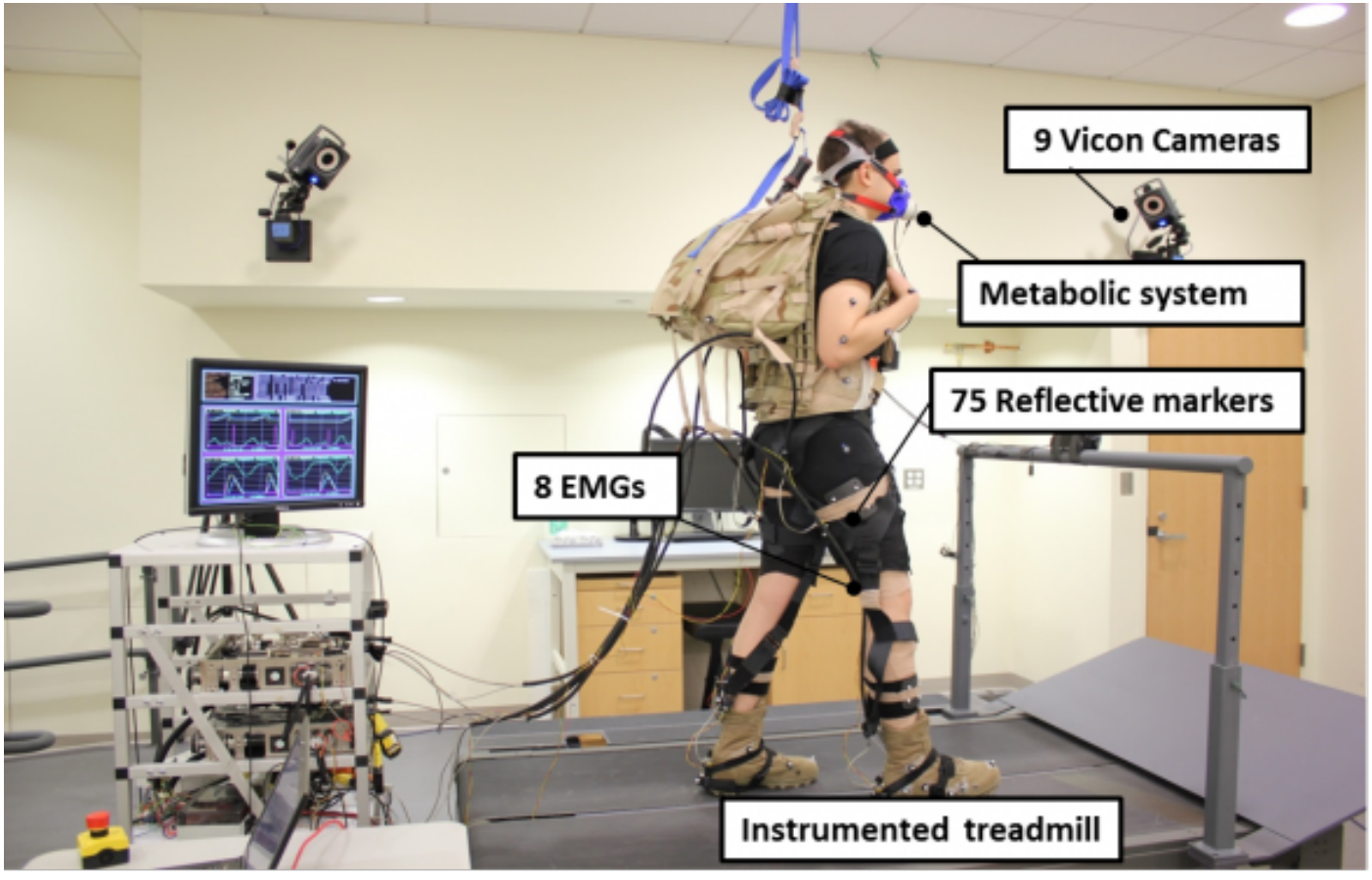
Gait Event Detection Using an LSTM Network

10-701 Project Presentation

Pablo Iturralde
Yin Zhong
Jakob Bauer

April 22, 2015

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*N reals)
  - Output: {Left, Right} $\times$ {Heel Strike, Toe Off} (4*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 quasi-periodic patterns even in presense of input noise
  - Robust and precise learning of rhythmic timing

Network architecture

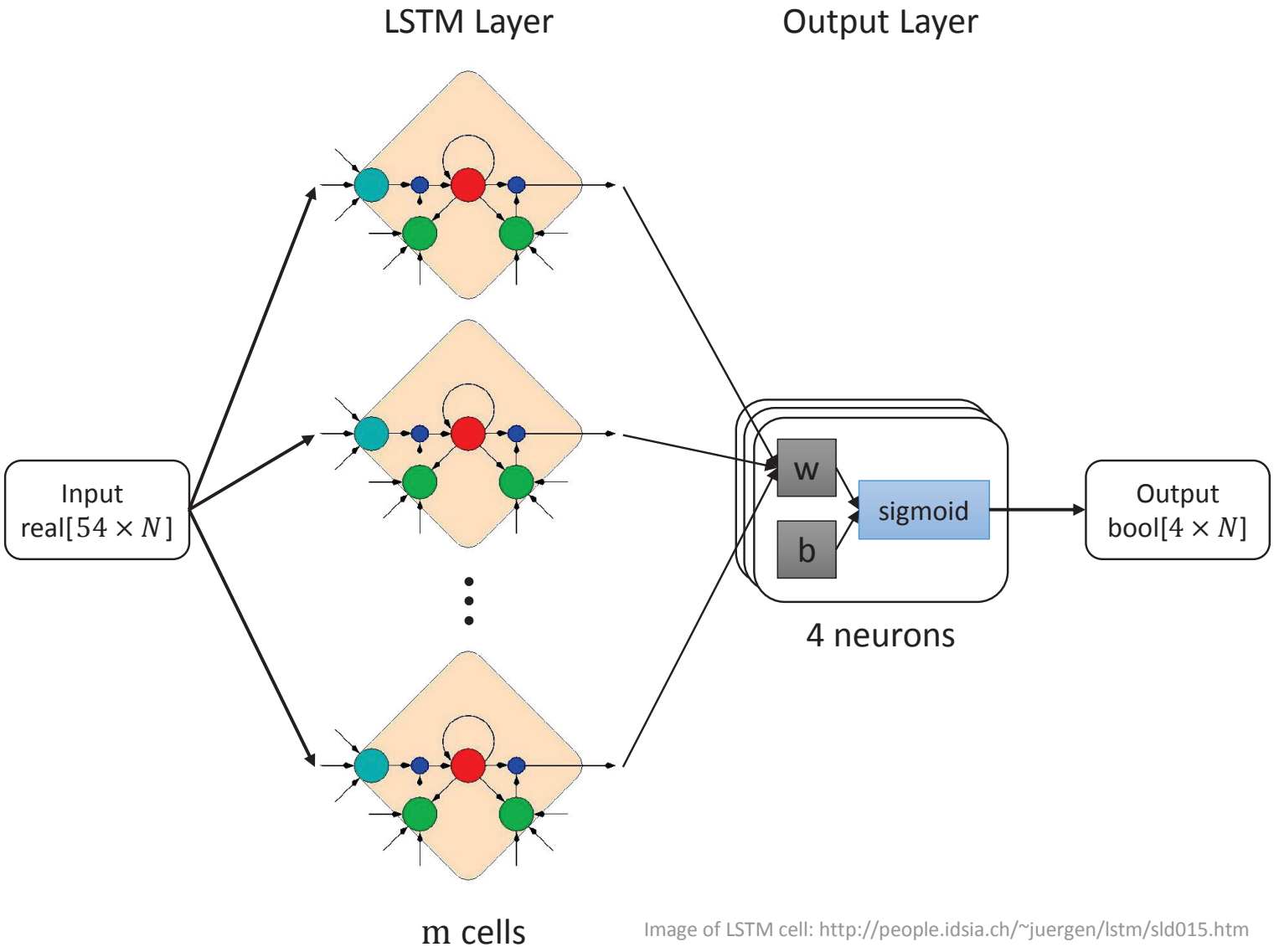


Image of LSTM cell: http://people.idsia.ch/~juergen/lstm/sld015.htm

Implementation

- Torch/Lua on AWS EC2 GPU instance (g2.2xlarge)
- Use LSTM code example by de Freitas (Oxford/Google)
  - Adapt to our input/output
  - Does not converge out of the box
  - Tweaks: Learning rate, mini-batch, regularization, etc.

Results

	deviation		mistake	
	mean	std	mean	std
Foot velocity	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
Feed-forward NN	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX
LSTM	XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX

Table 1: Comparison of results for $N = 30$ subjects, $T = 2.5\,\mathrm{s}$.

Results

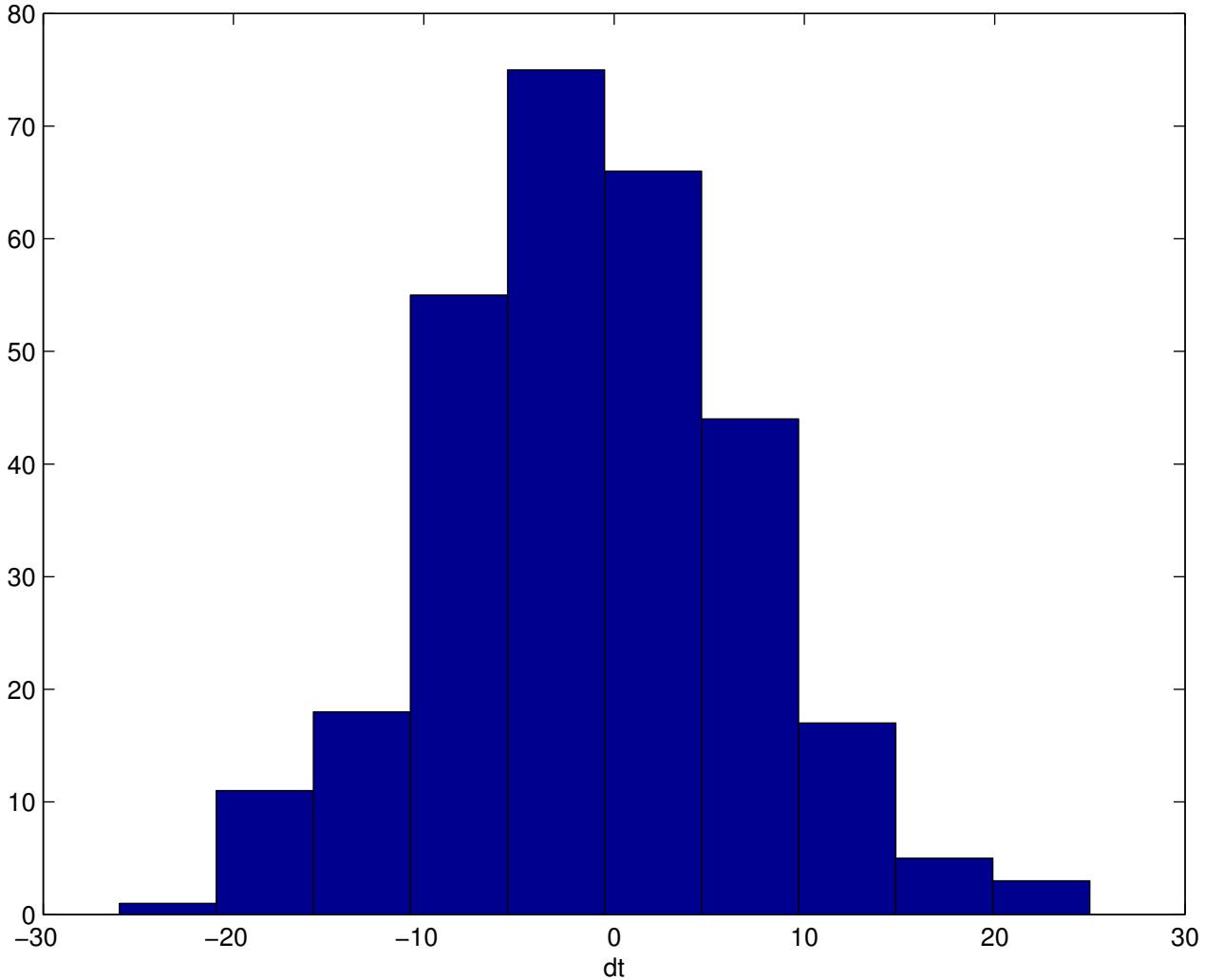


Figure 1: Histogram Miller

Q&A

Thank you for your attention!

Human Gait Cycle

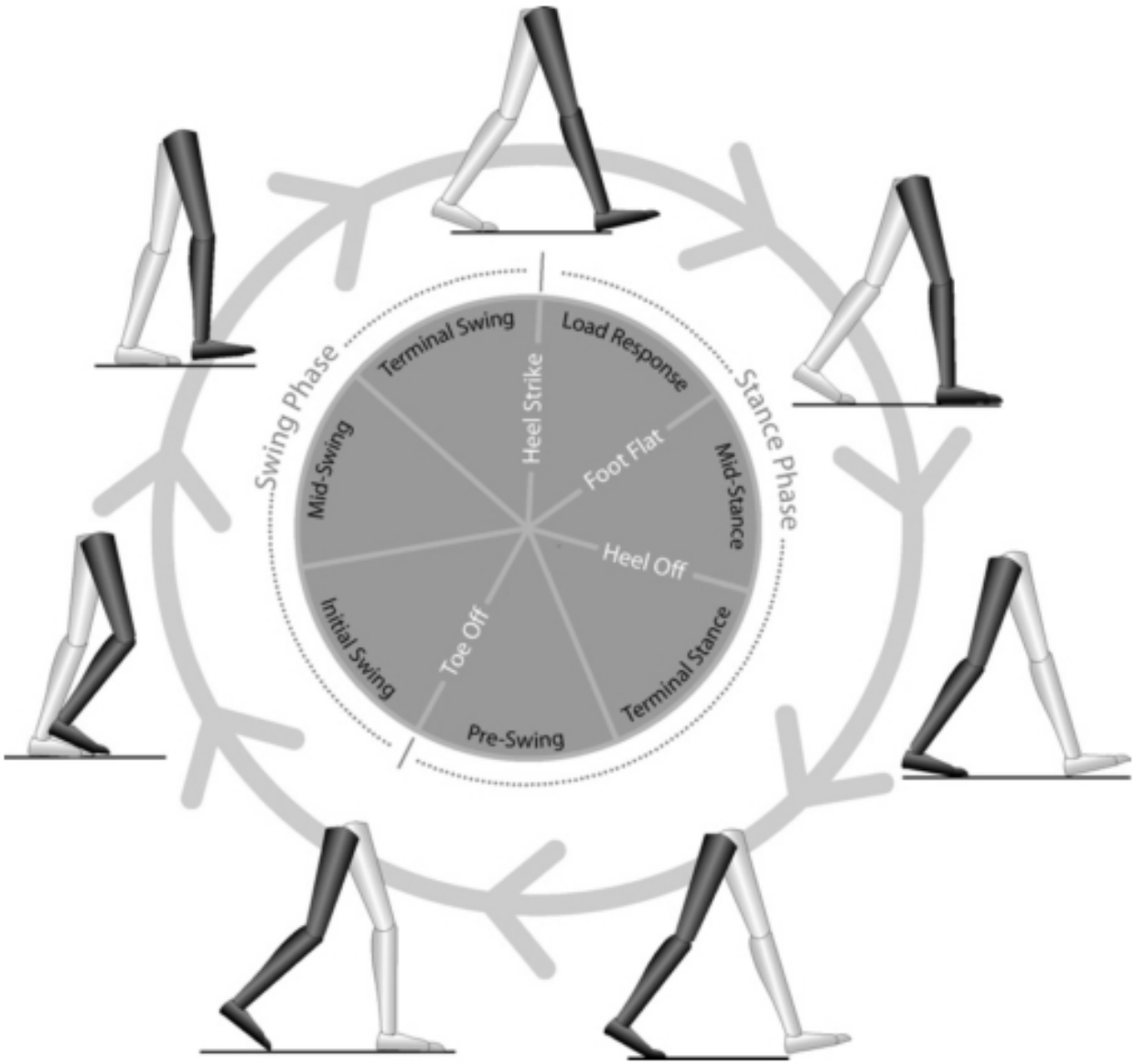


Figure 2: Gait events [Rueterbories et al., 2010]