



# *ELECTROLYMOGRAPHY- BASED EXERGAMING IN A WHEELCHAIR*

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# Outline

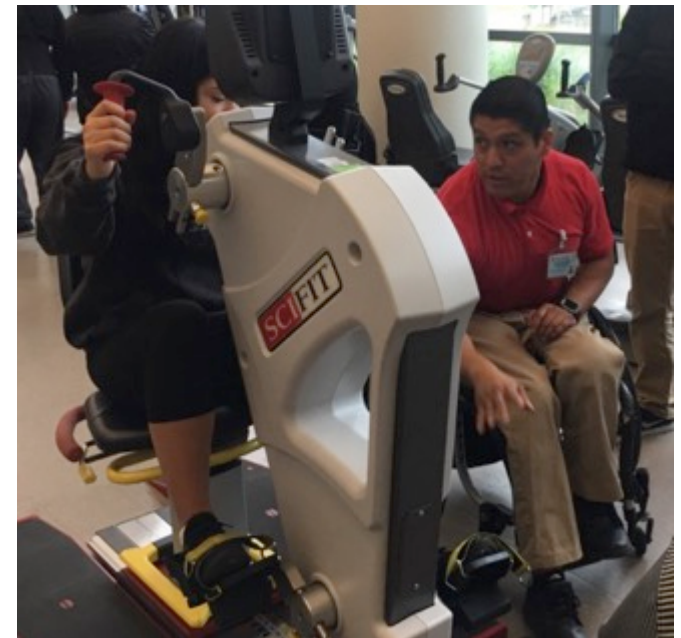
- Barriers to cardiovascular fitness for individuals in wheelchairs
- Mobile fitness system overview
- Game descriptions
- EMG-driven design
- Design challenges
  - Utilizing multiple muscles
  - Encouraging appropriate exercises
  - EMG peak detection
- Future directions

# Barriers to Cardiovascular Fitness for Individuals in Wheelchairs

- Health stats for people with spinal cord injury
  - Average life expectancy: 43 years<sup>1</sup>
  - Average lifetime health care and living expenses = \$2-5M
  - Health problems
    - Obesity
    - High blood pressure
    - Infection

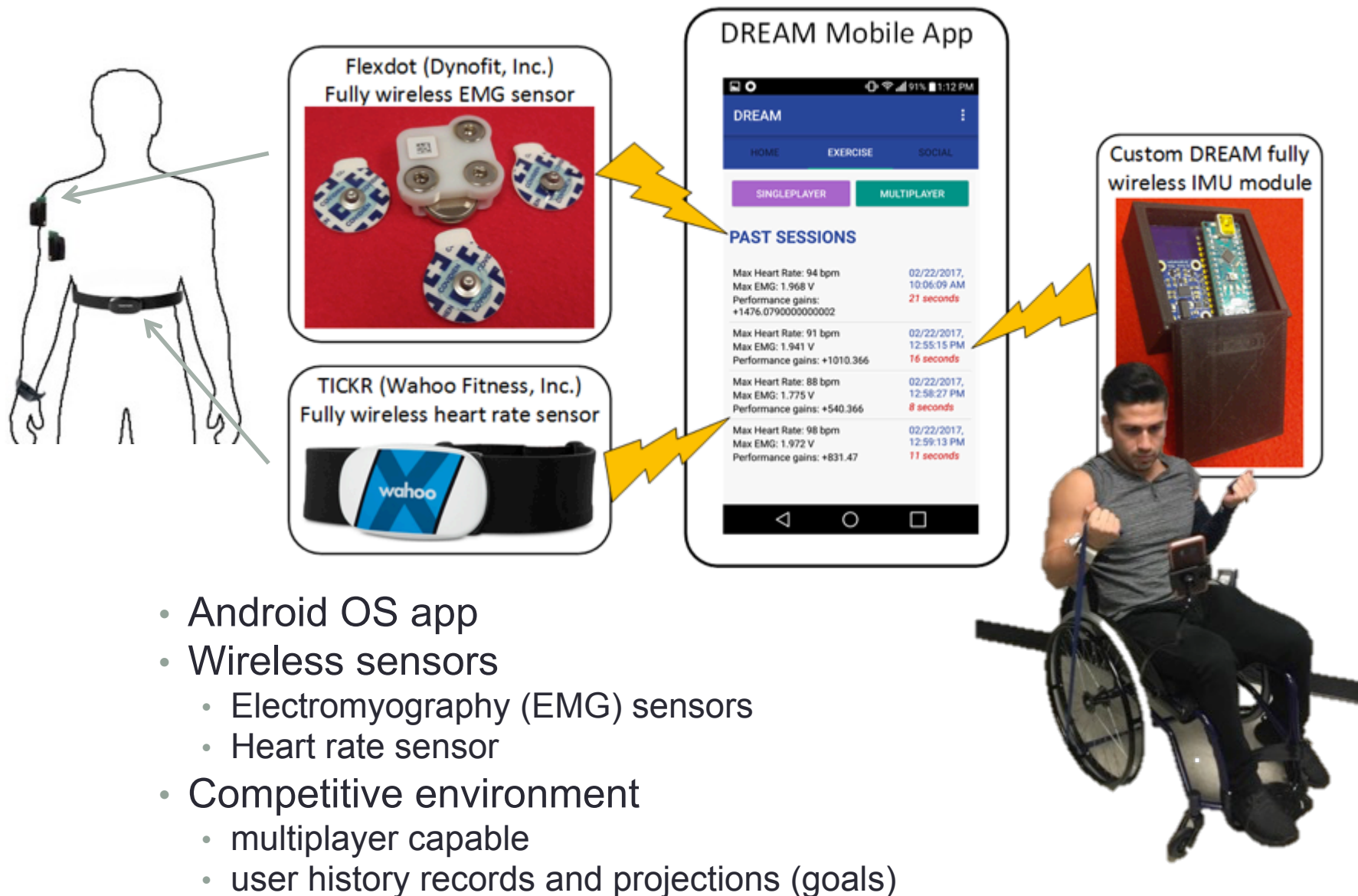
## Barriers to exercise

- transportation
- access to adapted equipment
- social stigma

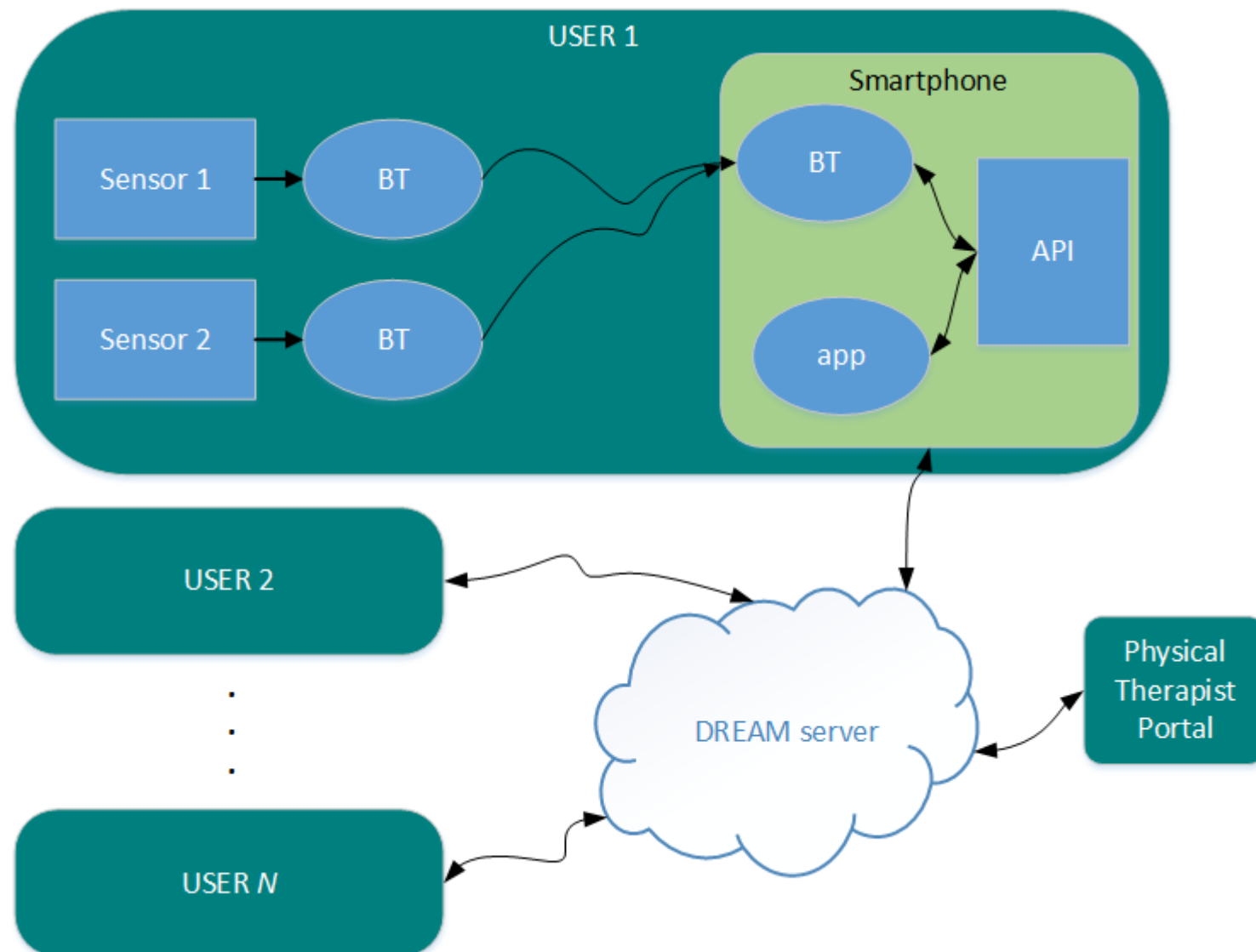


1: Krause, James S and Lee L Saunders. "Risk of Mortality and Life Expectancy After Spinal Cord Injury: The Role of Health Behaviors and Participation" Topics in spinal cord injury rehabilitation vol. 16,2 (2010): 53-60.

# Mobile fitness for individuals in wheelchairs



# Mobile Fitness Gaming Community



# 3 Games = 3 Exercises

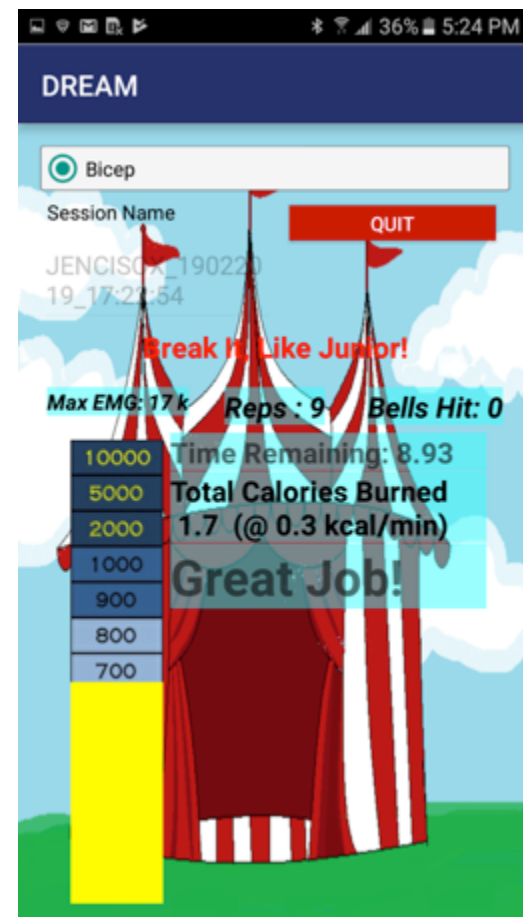
## Spinning



## Boxing



## Resistance



# Design Specifications for Exergames

	<u>Track</u>	<u>Boxing</u>	<u>Resistance</u>
Targeted Muscle Groups	Bicep Tricep Anterior Deltoid	Bicep Tricep Anterior Deltoid	Bicep Anterior Deltoid
Exercise Classification	Cardio	Aerobic	Resistance
False alarm rate	N/A	< 5%	< 5%
Missed detection rate	N/A	< 5%	< 5%
Accuracy of metric	Speed of car % error < 10%	Calories burned % error < 10%	Integrated EMG % error < 10%



# Racing Game

- Cardio-based workout
- Angular velocity of car driven by average EMG

$$x_n = a + r \cdot \epsilon \cdot \cos(\theta_n)$$

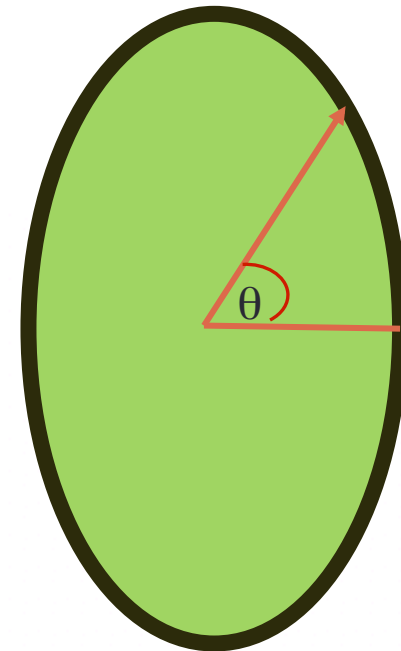
$$y_n = b + r \sin(\theta_n)$$

$$\theta_{n+1} = \theta_n + d\theta_n$$

$$d\theta_n = K \cdot s_n$$

$s_n$  = EMG sensor value at time sample n

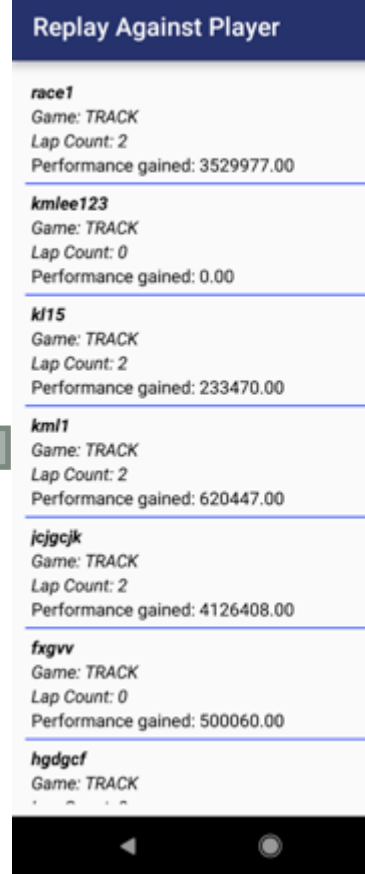
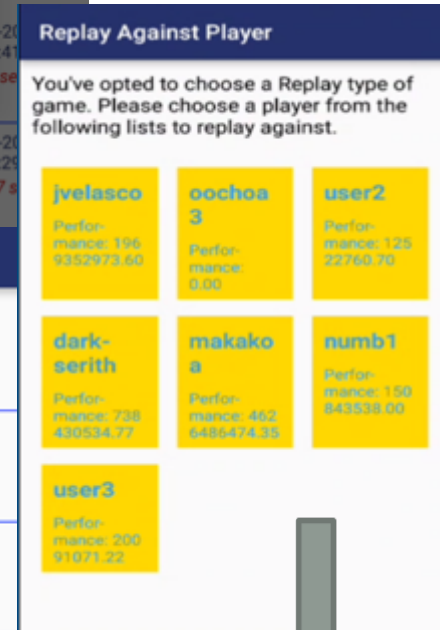
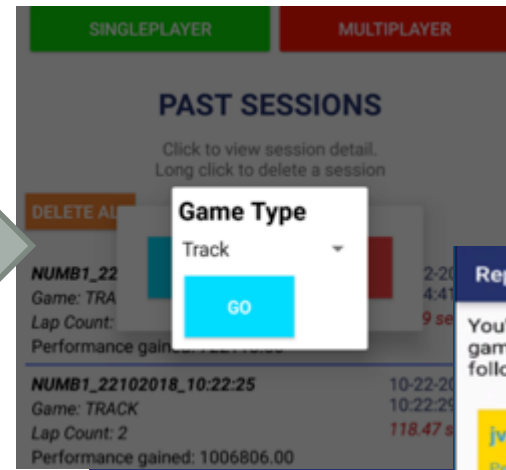
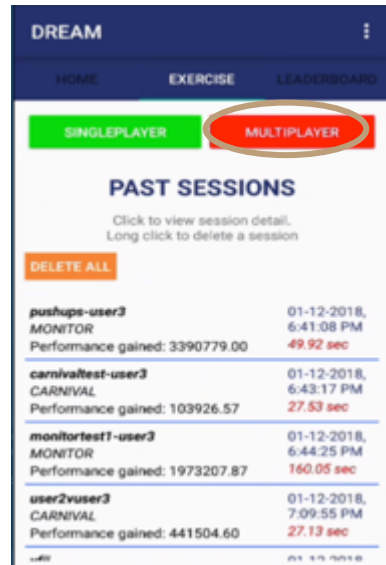
K = scaling coefficient to adjust speed as a function of EMG level





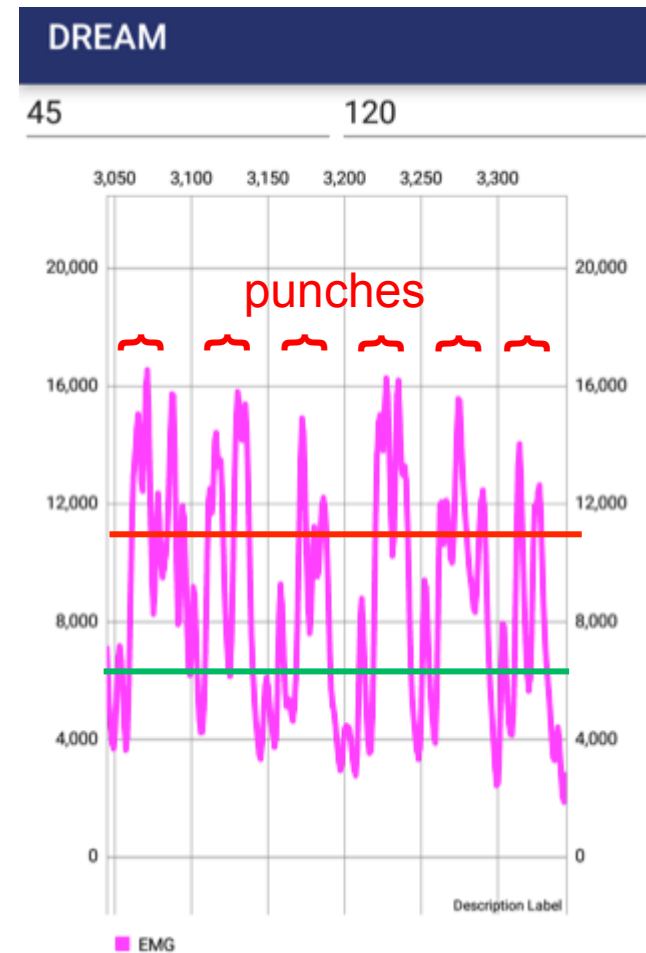
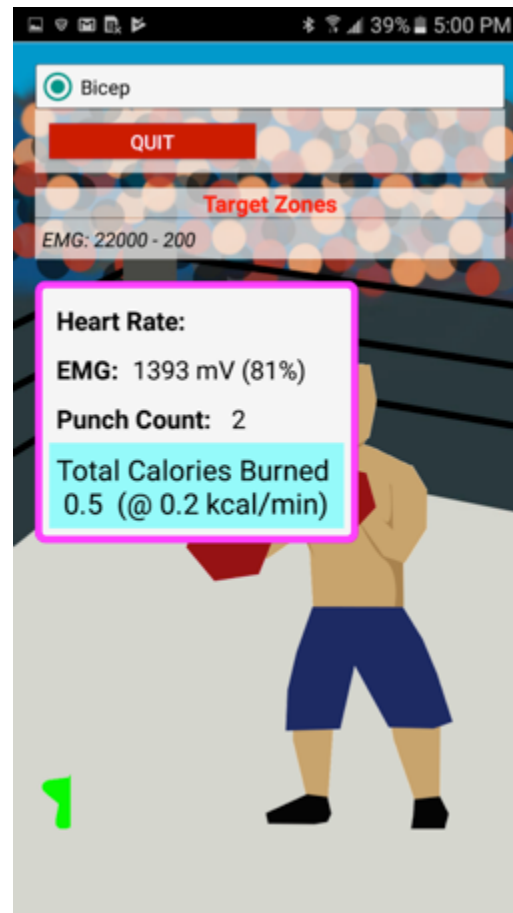
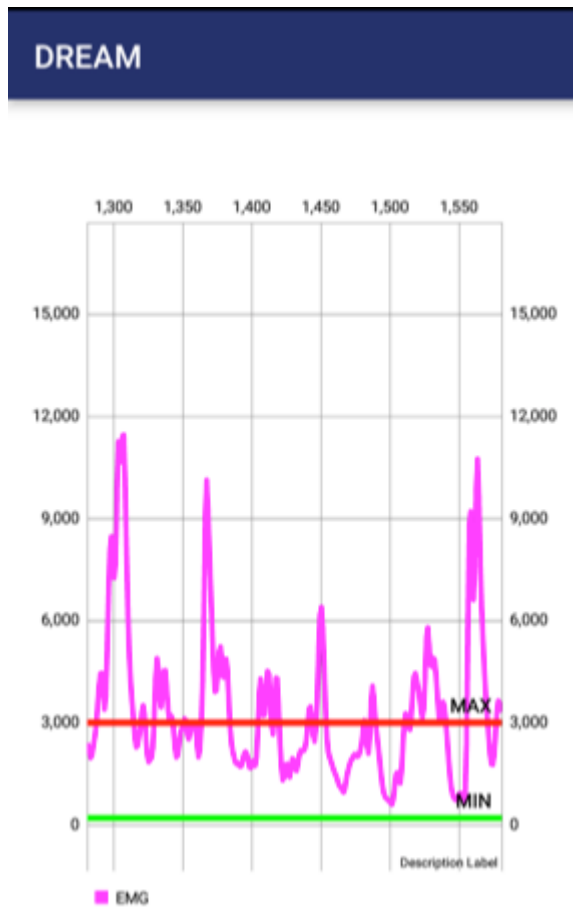
# Racing Game Demo





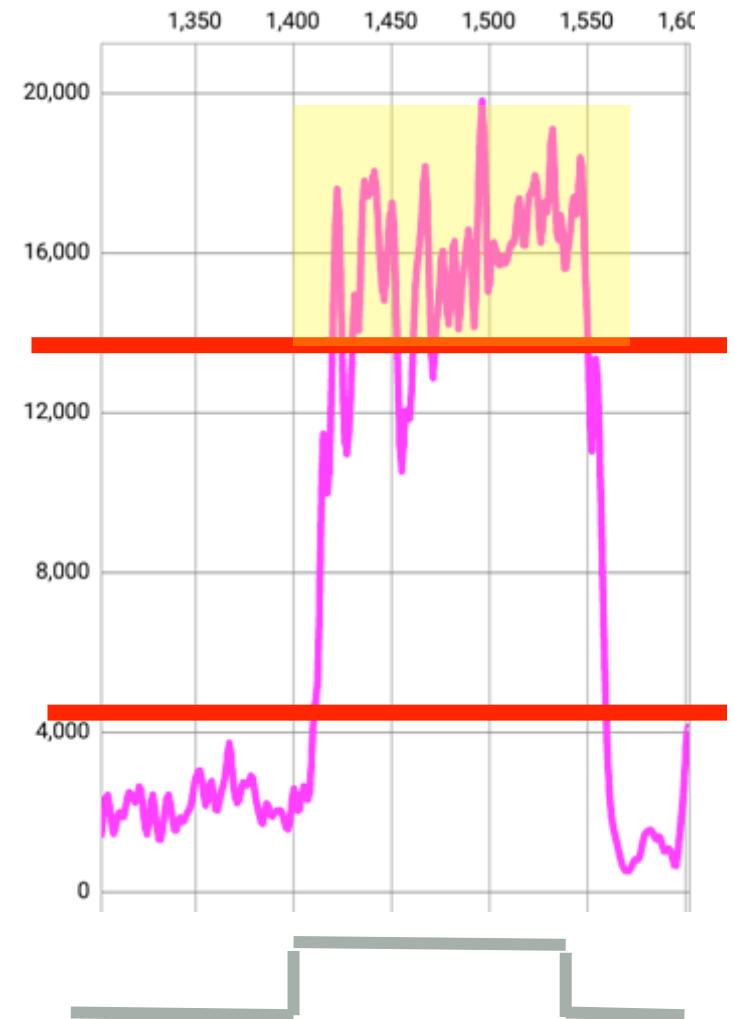
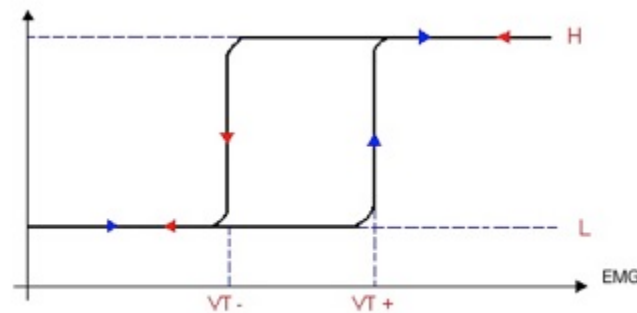
# Boxing Game

- punch count based on peak detection

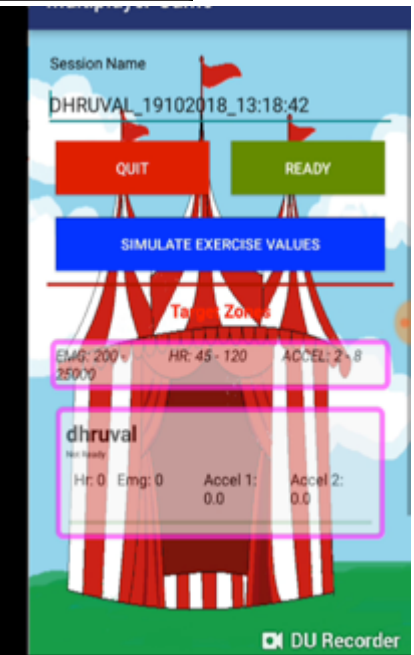
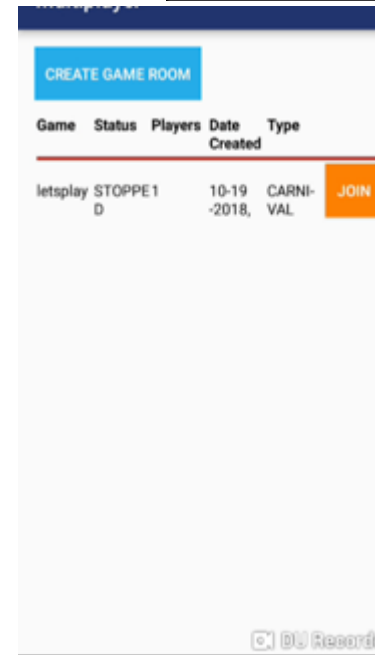
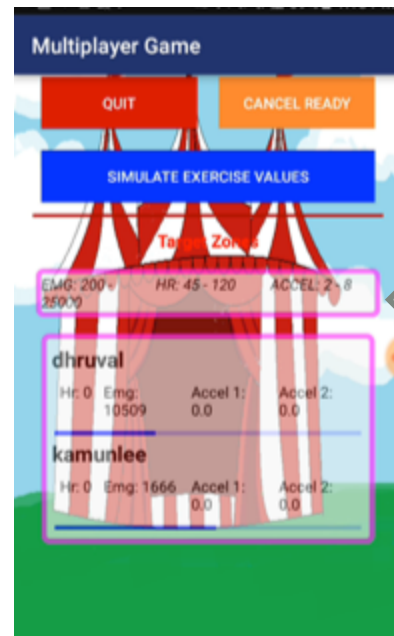
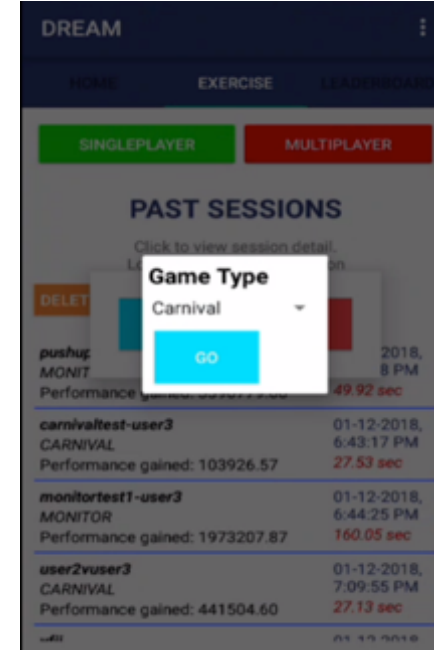
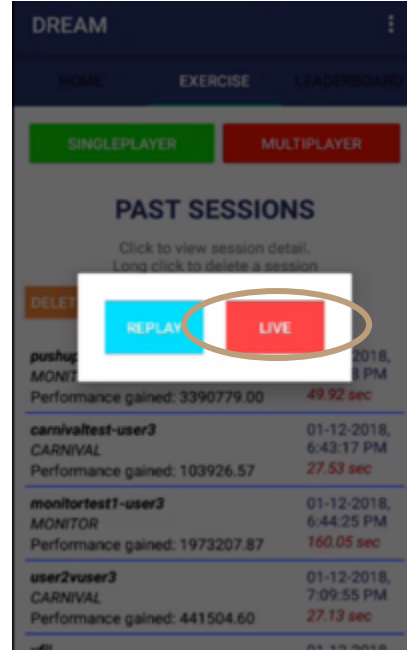
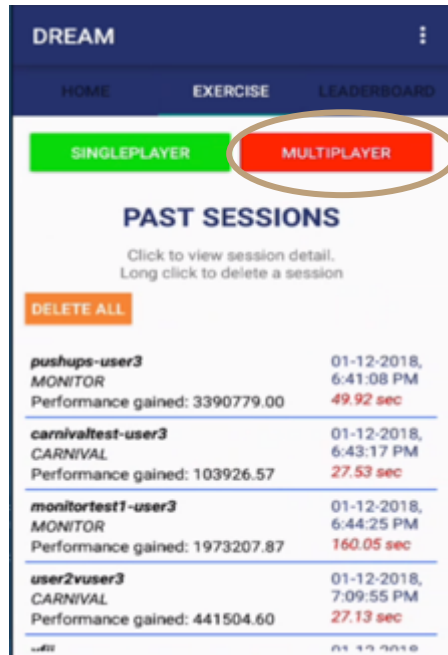


# Resistance “Carnival” Game

- Resistance-based workout



Accumulator Activation Response



# Closing Thoughts and Future Steps

- The app will improve overall quality of life
  - Ease of accessibility
  - Motivating and competitive
  - Accurate measure of fitness
- Future plans
  - Automate muscle calibration
  - Closed beta for testing and feedback
  - Deployment as a commercial product



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