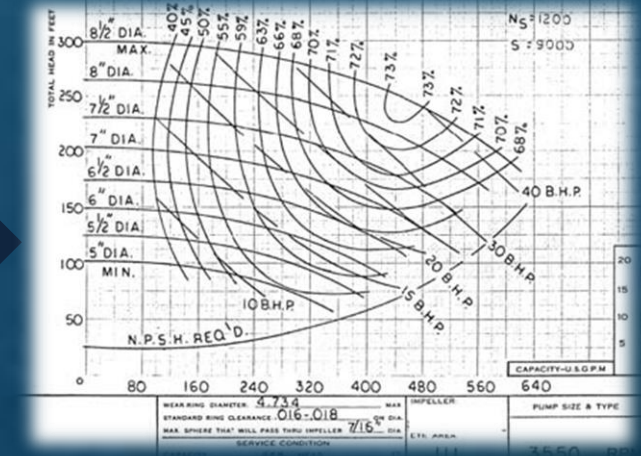Landon Evans  |  Kyle Peterson  | Steve Baek, PhD
|  Kevin Kregel  | Karim Malek, PhD
June 2018

# THE PROBLEM
## Athletics & Military



**Massive data**
- Sensors
- Subjective
- Objective
- Clinical
- Performance

- Health care providers
- Coaches
- Commanders
- Athletic Trainers
- Clinicians
- Sports scientists
- Statisticians

Tracking
Player availability
Fatigue
Mitigating injuries
Increase performance

Klipeum
PERFORMANCE THROUGH MILITARY PRECISION

# BACKGROUND

- Significant efforts in human modeling and simulation
  AI, Machine Learning, Simulation, Robotics, Biomechanics, and Physiology

- MALUM has the capability for identifying likelihood of injury risk using data that was collected by athletics for various team sports.

- Using data from the UI Athletics Department for basketball and soccer, MALUM was used to track athletes with various sensors, historical data, medical records, and performance records.

- An AI program was developed to learn from the data, identify causality of injury, and predict future injuries.

- Uniqueness: 14 years of R&D to build the virtual soldier SANTOS® with significant funding (over $50M) from the US Military and corporations such as Ford, GM, Chrysler, Caterpillar, and others.

# THE ALGORITHM



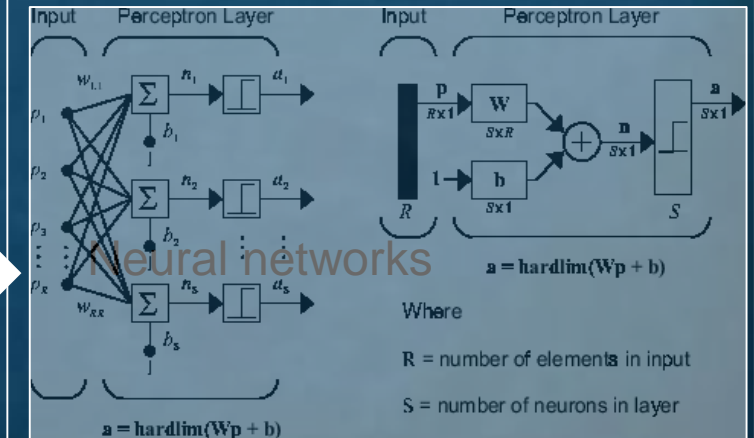Comprehensive Sets of Data

Landon Evans

Classification - AI

**Legend**
- None
- Jog
- JumpLeft
- JumpRight
- Backpedal
- Sprint
- Prep
- Walk
- WalkBack
- Jump
- Turn
- Deceleration
- Forward
- Side
- Up

Steve Baek

Santos metrics

Karim Malek

Bayesian Predictions

$a = hardlim(Wp + b)$

Where

R = number of elements in input

S = number of neurons in layer

$a = hardlim(Wp + b)$

Kyle Peterson

# COMPREHENSIVE SETS OF DATA

**training data**

**Player Profile**
- Age
- Gender
- Weight
- No of games
- …

**Body Parameters**
- Modifiable
- Physiological
- Physiological tracking and readiness
- Strength
- Non-modifiable
  Anthropometry

**Daily Measures**
- **Physiology**
- **Training Load**
Player Load ( Distance, Total IMA, Player Load/Minute, IMAs)
- **RPE Load**
- **Time dependent**
- **Wellness questionnaires**
Nutrition, Stress Academic Intensity, Sleep Quality , Sleep Duration, Fatigue

**Injuries**
- **Injury history**
- **MSK**
- **Self reported to ATC & physician**
- **Injury Data** (MSK, Type, Date, location, type, grade)

**Risk Factors /Proxies**
- **Valgus angle**
- **Past injuries**
- …

**Dynamics**
- Biomechanics metrics
- Kinetics
- Kinematics
- Energy
- Accelerations
- Peak-avg reaction forces
- Peak- avg torques at joints
- Time to completion

**Subject**
- Age, weight
- Gender
- Weight
- Strength
- Flexibility
- Physiology
- Expected Training Load
- Past injuries
- FMS
- Proxies



D A S H B O A R D

Propensity for Injury
Physiological performance
Biomechanical performance
Fatigue
Time to failure

# COMPREHENSIVE SETS OF DATA
## (Iowa)

Catapult

Omegawave

Force plates

Tensiomyography

Wellness Surveys

sRPE

Etc ...

ATHLETE
MANAGEMENT
SYSTEM
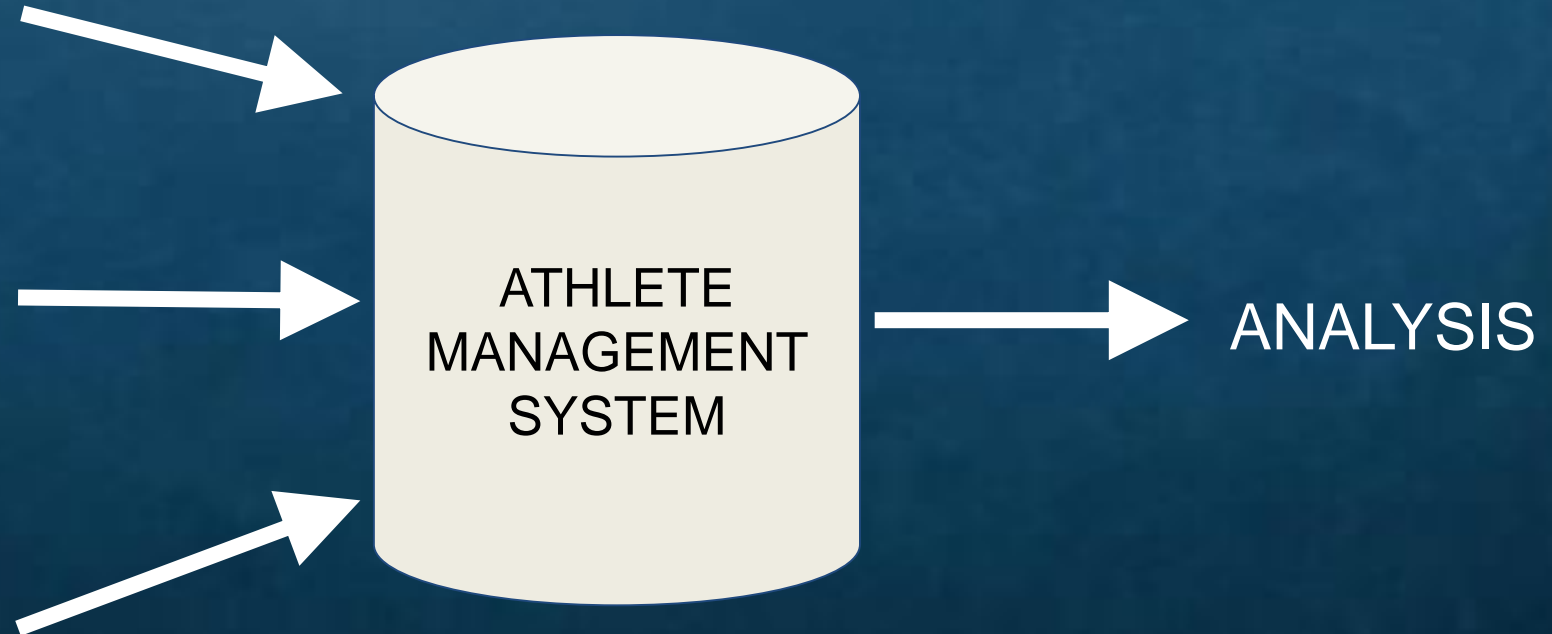
ANALYSIS

# TRACKING FROM A SINGLE CAMERA

# CLASSIFICATION & MACHINE LEARNING



Deep Neural Networks

Motion Fingerprints

"sprint"    "walk"

**Classifier**

Machine Learning Process (Offline)

Motion Identification Algorithm (Online)

Motion Identification Algorithm

Legend
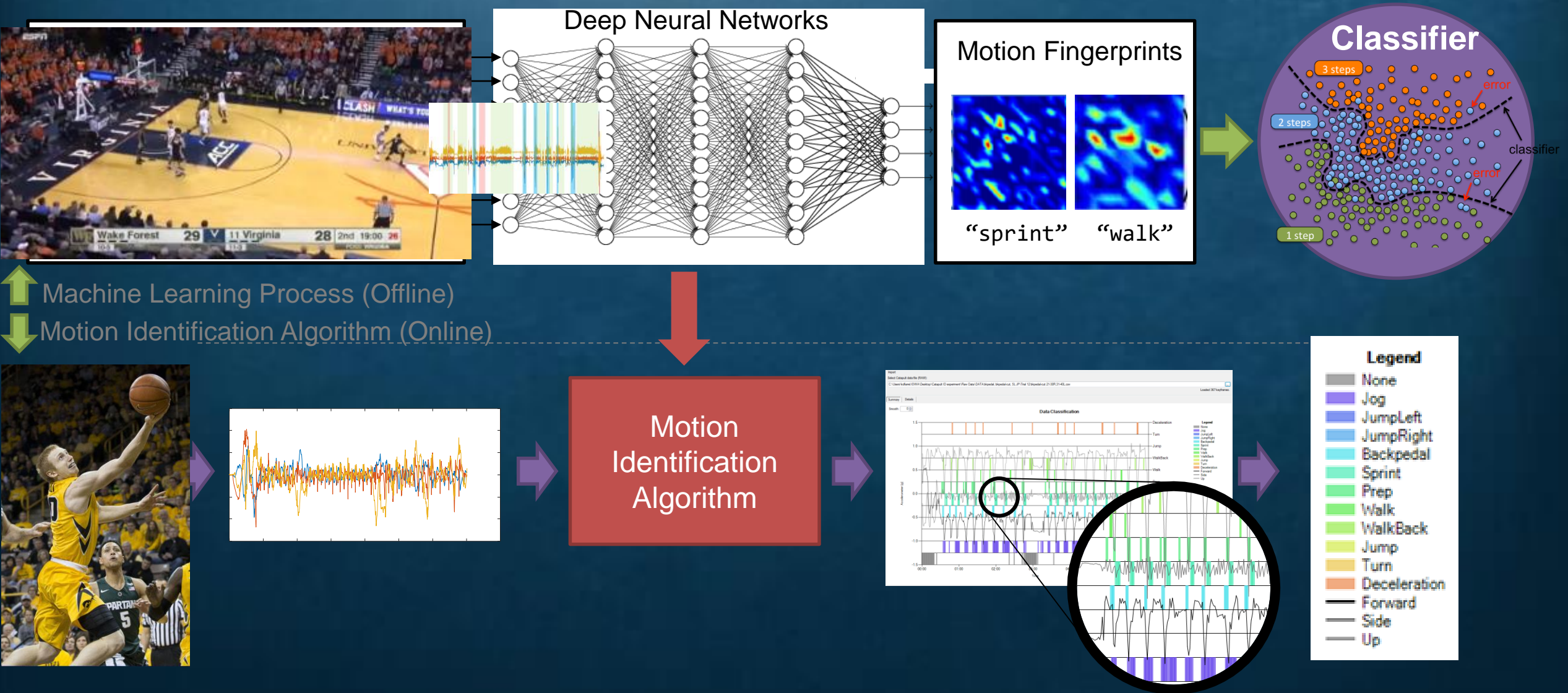
# SANTOS METRICS
## Calculating the Biomechanics Parameters

# EXAMPLE CASE



**Injury Analysis of Iowa Women's Basketball**

**Iowa Soccer Iowa Field Hockey**
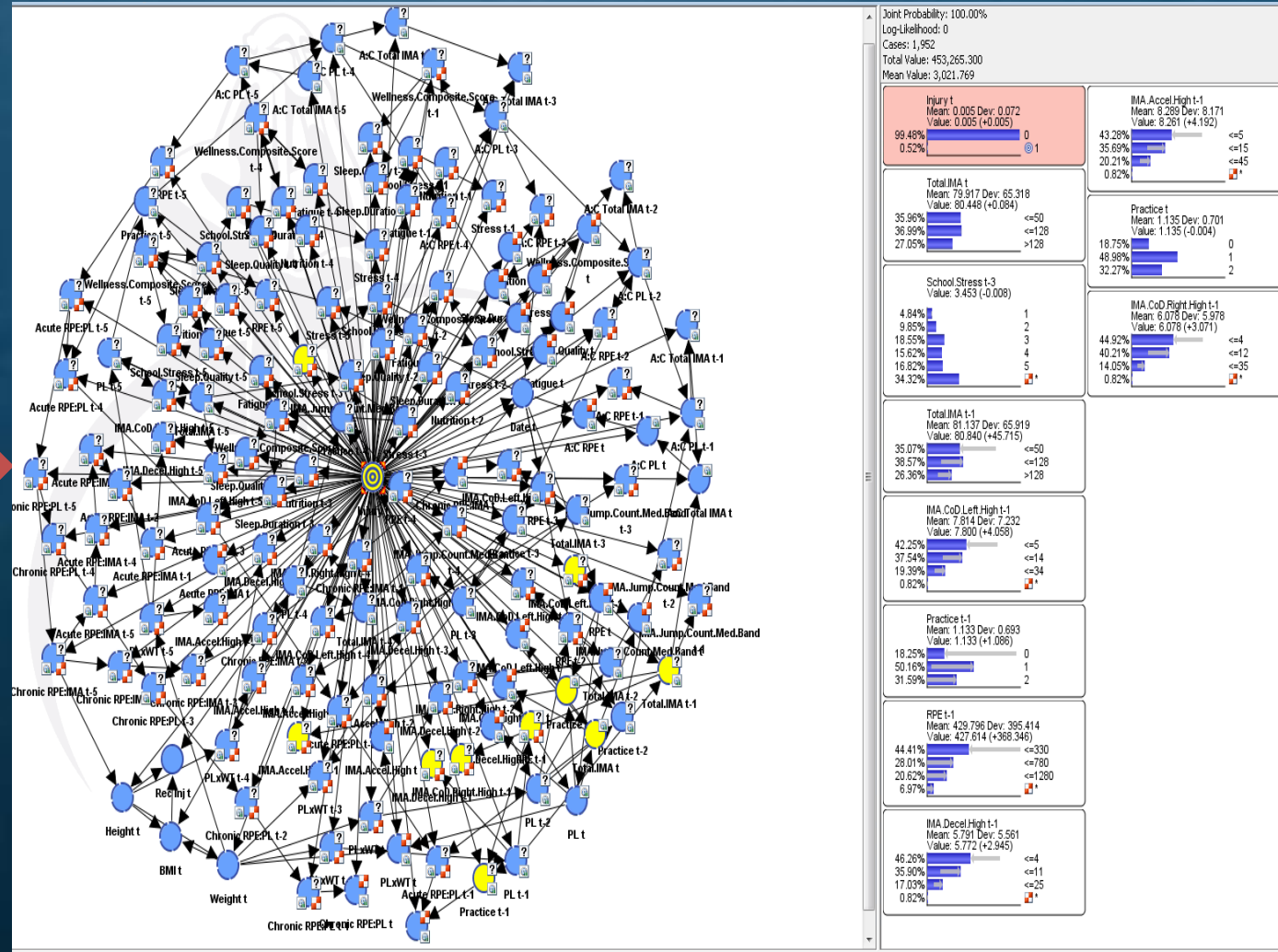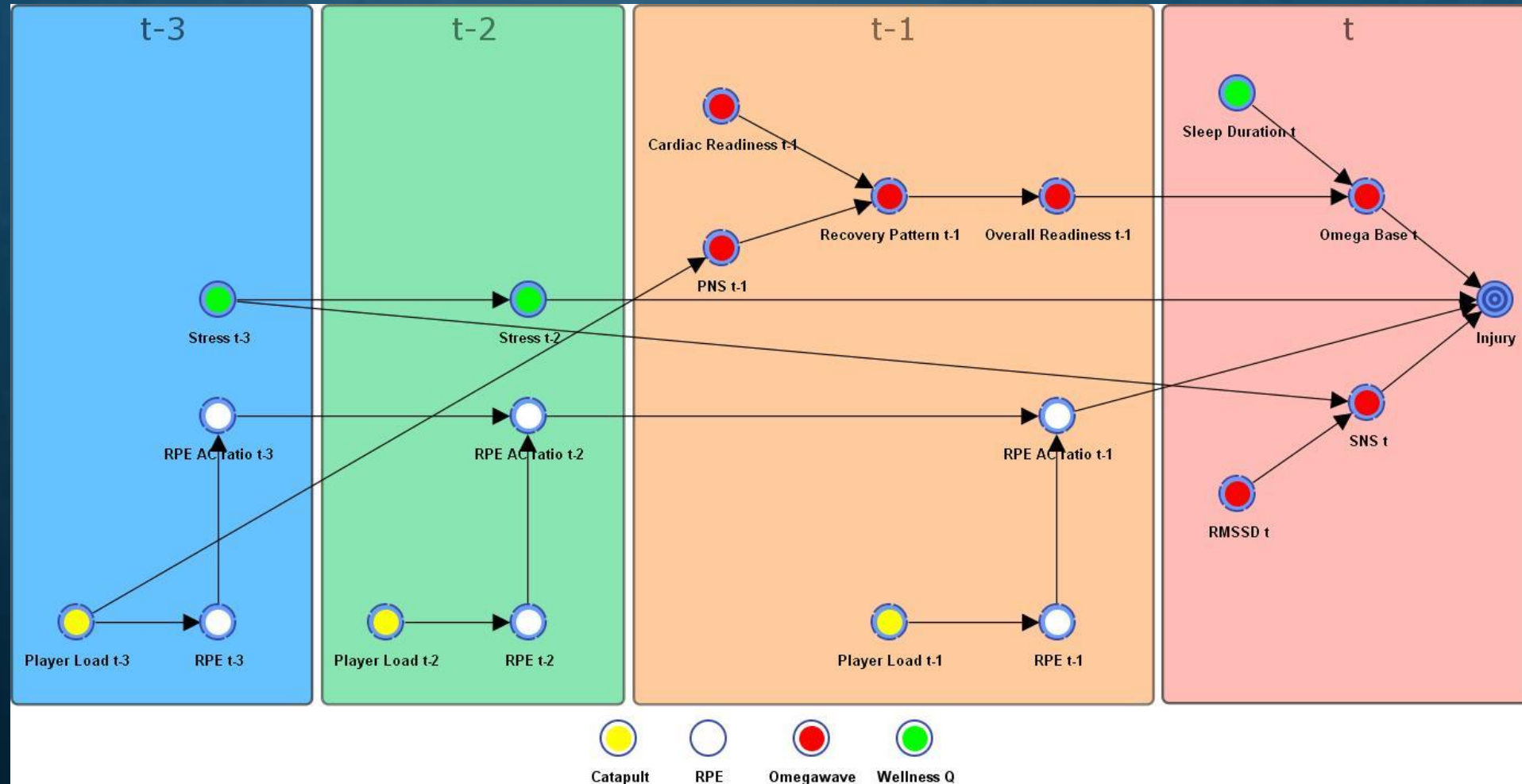
What if scenarios!

# BAYESIAN NETWORK
## Analytics and Reasoning

**PL t-1**

Mean

432

☑ Observed

**PL t-2**

Mean

665

☑ Observed

**PL t-3**

Mean

732

☑ Observed

**SNS t**

Mean

0.42

☑ Observed

**Sleep Duration t**

2
3
4
5

☑ Observed

**Stress t-2**

2
3
4
5

☑ Observed

**Injury**

0.0384

## PL t-1

Mean

824

☑ Observed

## PL t-2

Mean

857

☑ Observed

## PL t-3

Mean

670

☑ Observed

## SNS t

Mean

0.58

☑ Observed

## Sleep Duration t

2
3
4
5

☑ Observed

## Stress t-2

2
3
4
5

☑ Observed

## Injury

0.4241

# KIPLEUM AGAINST COMPETITORS

## KIPLEUM

– Comprehensive system for converting data to actionable intelligence

– Unique access to data (full seasons)

– Unique conversion of tracking to biomechanics metrics

– Unique signature extraction via Deep Learning

– Unique machine-based predictions based on belief

– Ability to conduct "What-If" scenarios

## Competitors:

– Produce sensors (hardware companies)

– Focus on physical performance

– No signature extraction using Deep Learning or AI

– Do not focus on injuries mitigation

– Already have large markets

# THANK YOU