

Informatics for Health Care and Research

Workshop, June 5th 2018



MamaCare

Telehealth for mothers
and their babies



Presented
By:



EARLY
SIGNAL

WILLIAM FIFER
DANIELA BRUNNER
FRISO POSTMA



Research & Data Support:

Funding Support Provided by:



Cohen Veterans
Bioscience



BILL & MELINDA
GATES foundation

CTSA Clinical & Translational[®]
Science Awards

Sackler Institute at
Columbia University

Passive Continuous Monitoring

Monitoring in the Home Setting.

Research

- Expand research to new areas
- Identify predictors of serious health problems
- Predict progression and treatment response

Care

- Personalized and Connected Care
- Detect early signs of serious problems
- Enable early Intervention
- Track progression and treatment response

Platform

- Set up device and analytical pipeline to support all activities
- Maximize interoperability



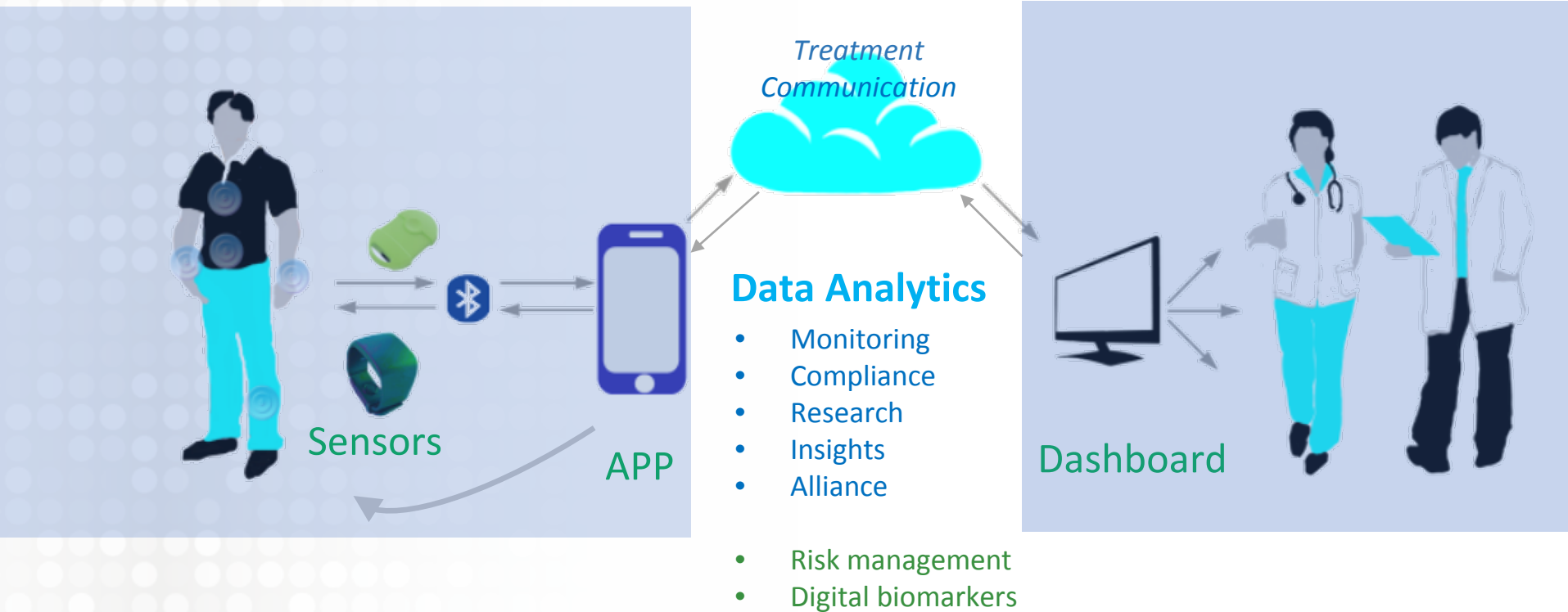
Continuous
Passive
Acquisition of
Data

Monitoring
Multidomains

Patient &
Caregiver
Focus
Closing the
Loop

The Analytics

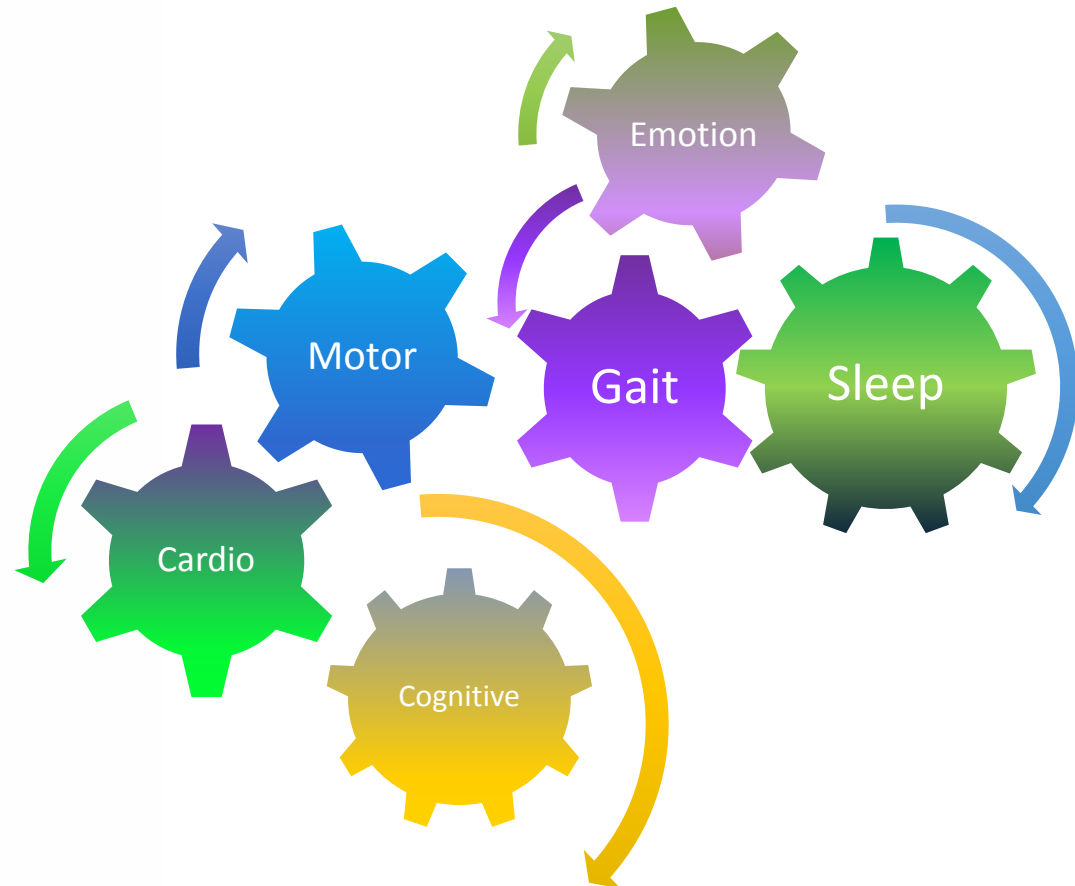
From Disconnected Data to Predictive Models



The AI Analytical platform

> A universal **intelligent, integrated** system that can

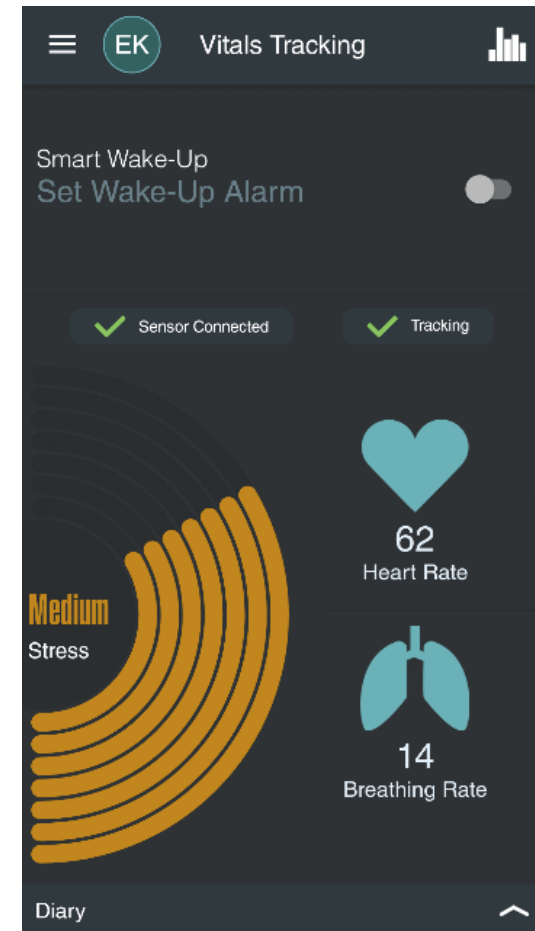
- identify disease signatures
- handle unstructured data
- be tuned to different domains
- can handle streaming data
- be a central information hub



Sensors Choice

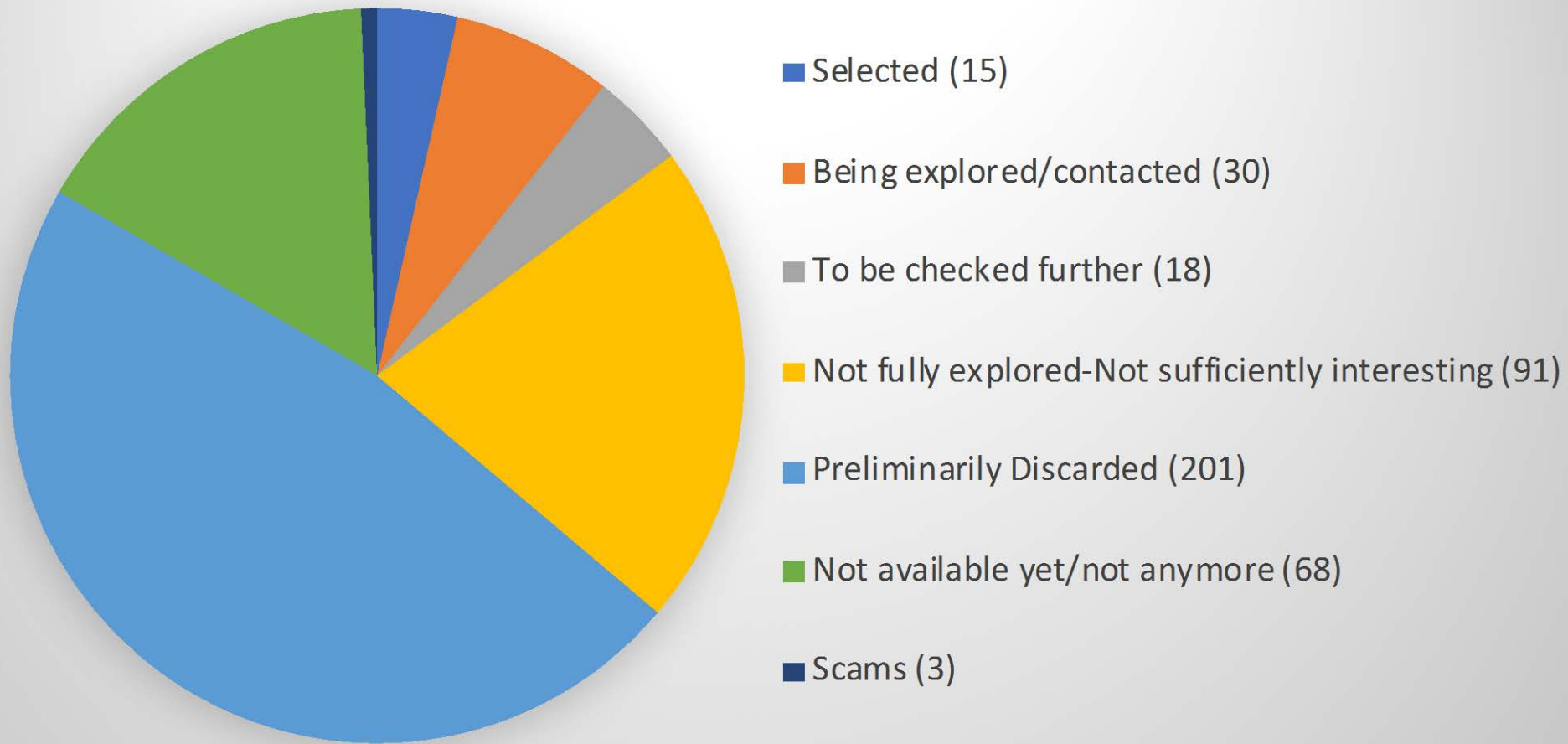
Multiple Domains - Good Quality - Affordable - Non Aggregated Data

- > Apple Watch
- > IMEC
- > Sensoria
- > EarlySense
- > Empatica
- > BioStamp
- > Proteus
- > Scanadu
- > Tobii
- > Phillips
- > Garmin
- > Fitbit
- > Emfit
- > Withings
- > Etc etc



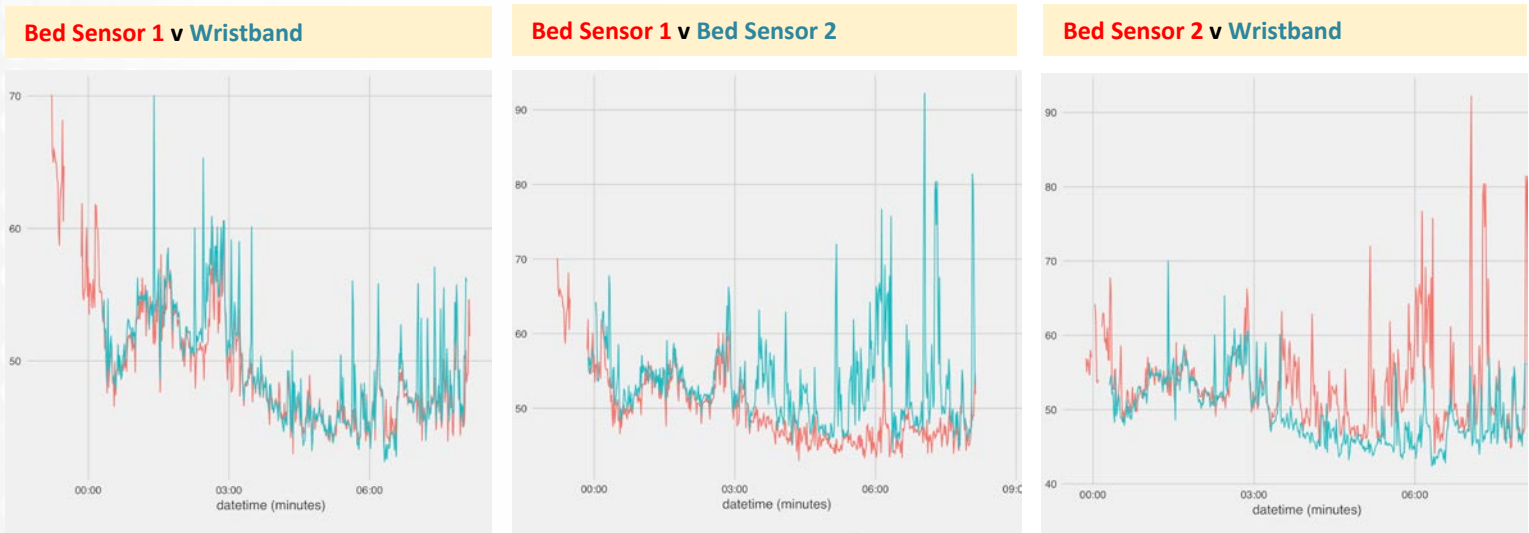
Sensors Choice

How to Choose the Best Device?



Sensor Validation

Validation of Devices in the Target Population



Comparison with Gold Standards

PSG Z-machine® Synergy*

Polar 10

*

EEG/respiratory airflow/temperature-compensated pressure transducer/pulse oximeter/thoracic respiratory inductance plethysmography belt/body position via 3D accelerometer 18.



Sensor Pipeline

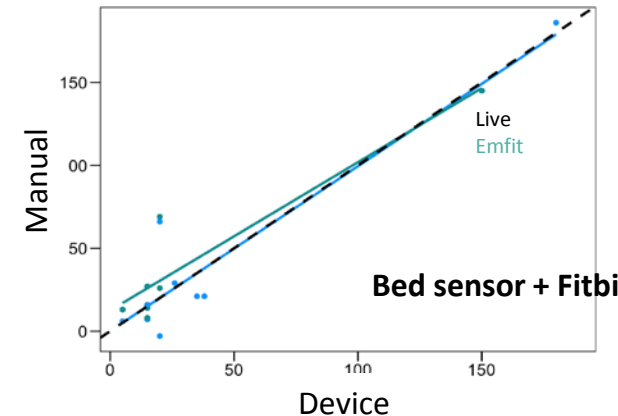
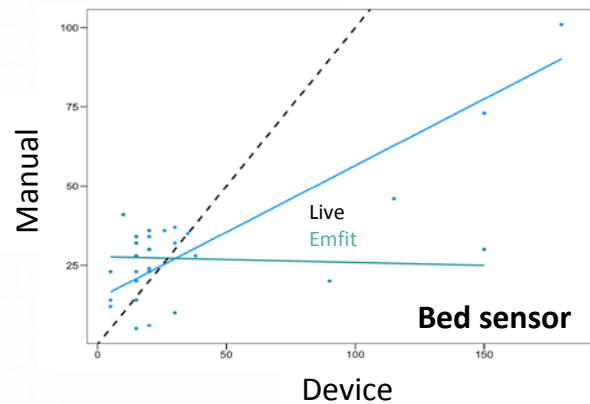
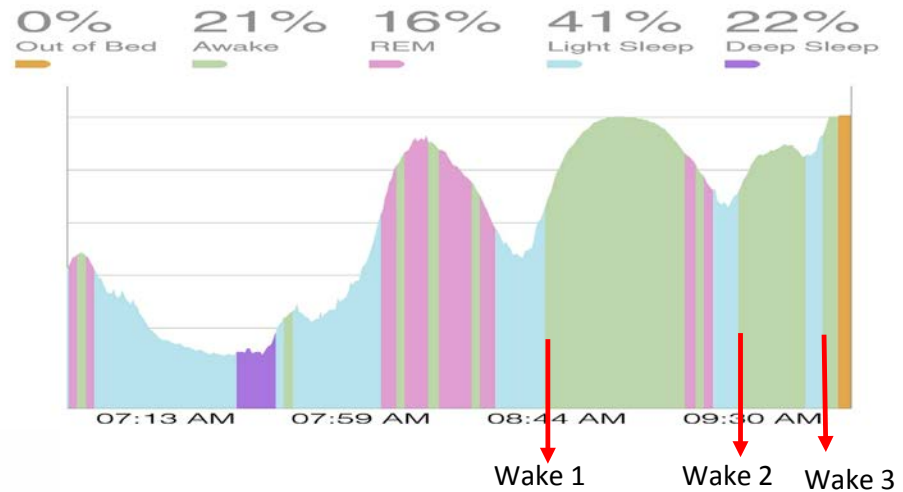
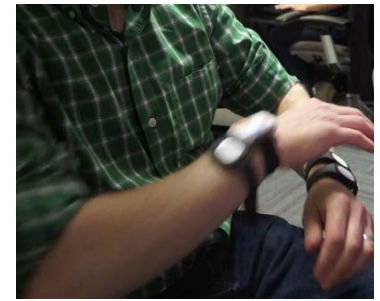
Ground truth

Verification

Interpretation

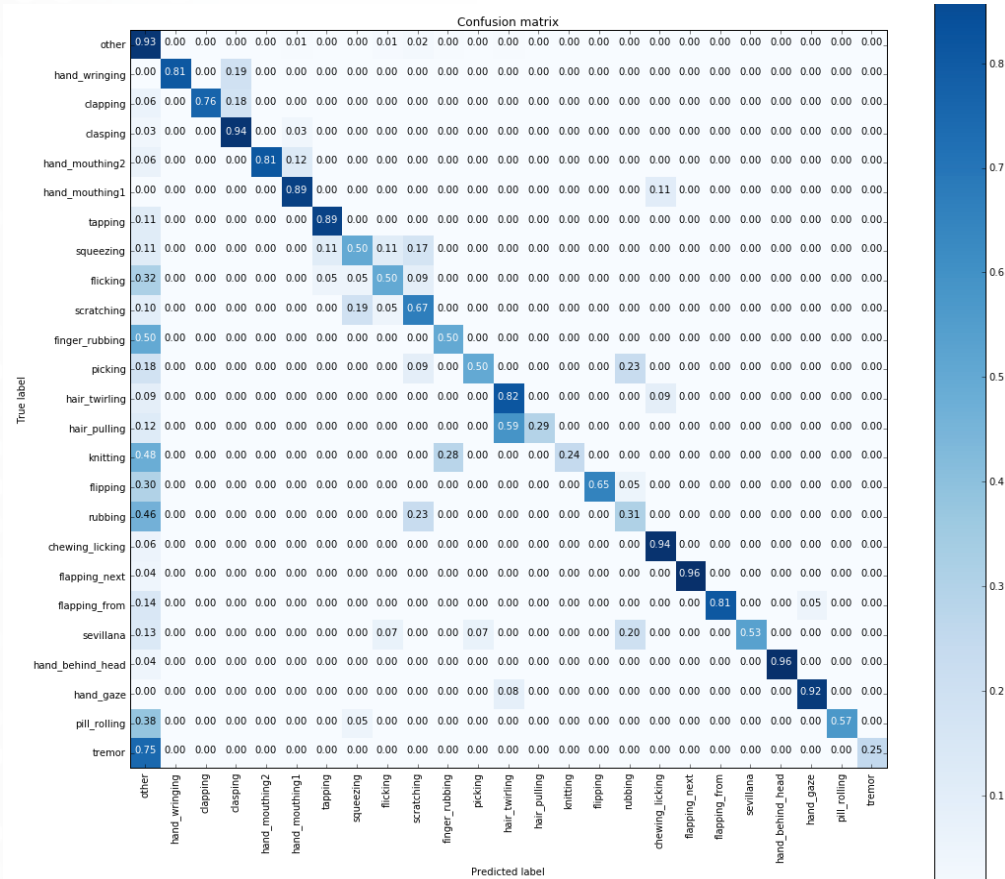
Sensor stacking

Algorithm development



Data Analytics: Motif Identification

Using AI to Identify Stereotypes as Digital Biomarkers



Confusion matrix showing the classification of 24 different gestures using raw accelerometer data

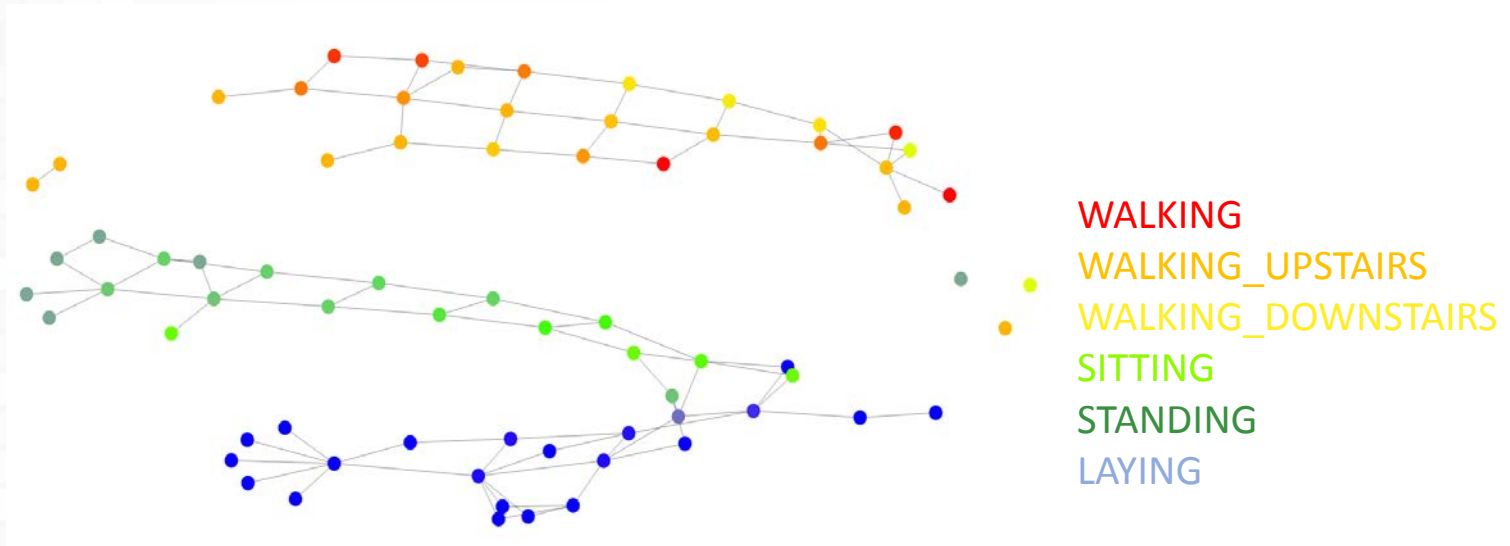


Data Analytics: Visualization

From Simple Data to Signatures

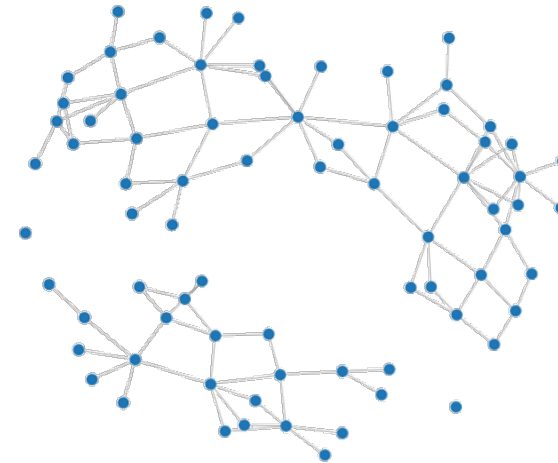


- > Premature versus on time delivery
- > Gesture & Posture Signatures
- > Sleep Apnea versus Sleep Disruption Signatures
- > Substance Impairment Signature



Data Analytics: Big Data Insights

Group patients according to **all** their data



Each point is a cluster of patients

Lines join related or “sister” clusters

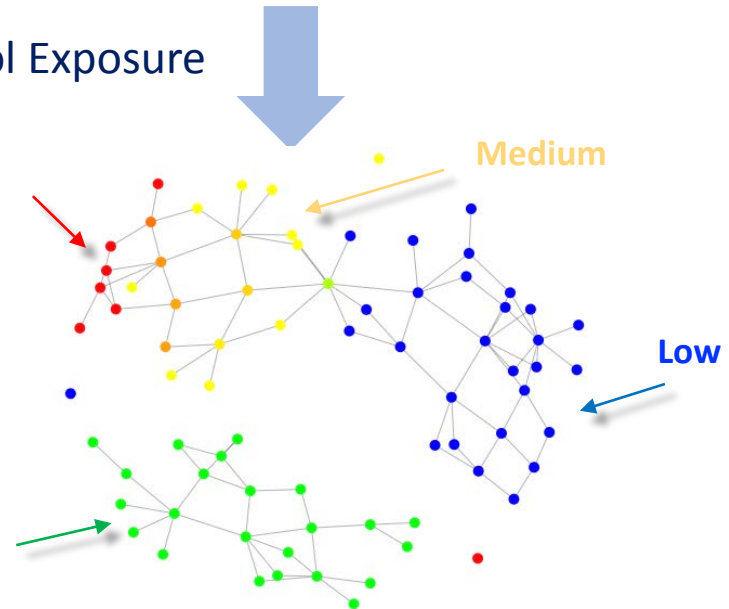
Color by Alcohol Exposure

High

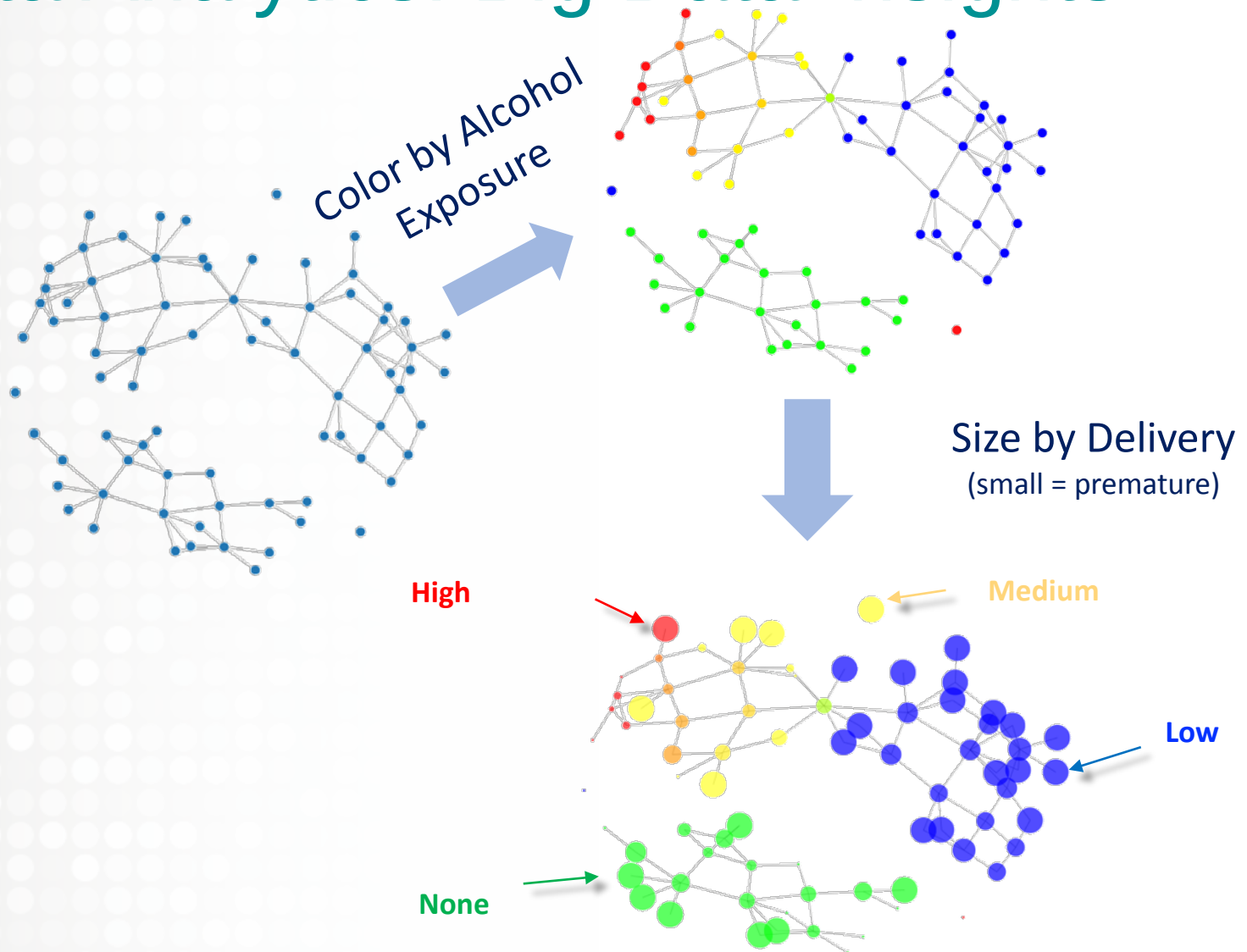
Medium

Low

None



Data Analytics: Big Data Insights

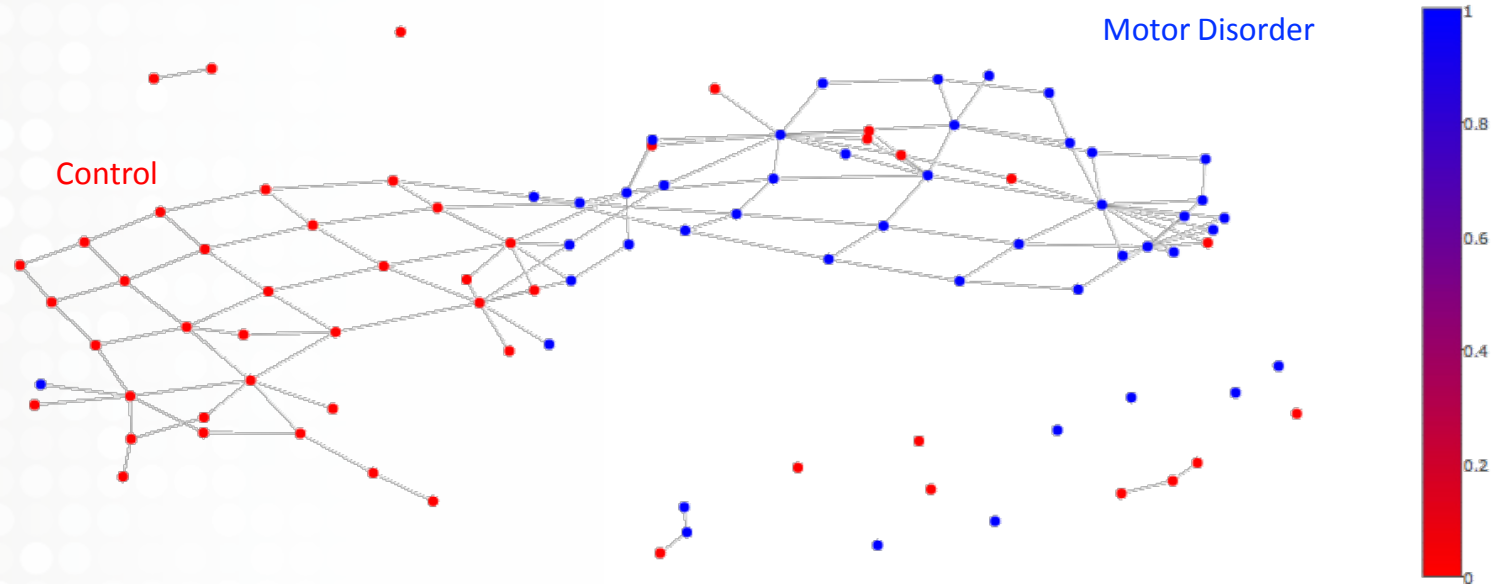


Big Data for Health Care

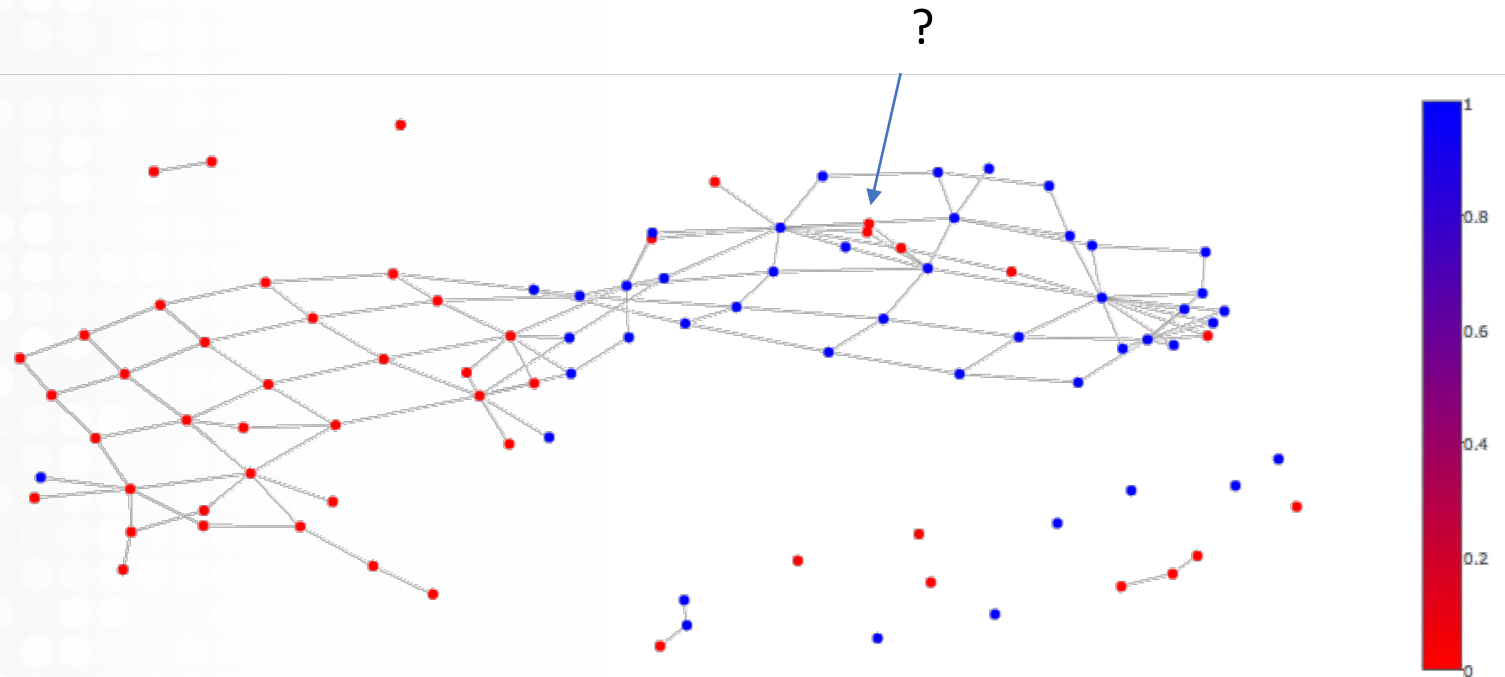
Big Data Starts with Individuals

- > Big Data at the population & group level can be used to:
 - Capture subpopulation characteristics
 - Detect comorbid patterns
 - Assess risk factors
- > Big Data can be used at the individual level to
 - Register personal idiosyncrasies
 - Increase accuracy of individual diagnosis
 - Enable preventive medicine
 - Empower the individual
- > Individualized medicine is precise medicine

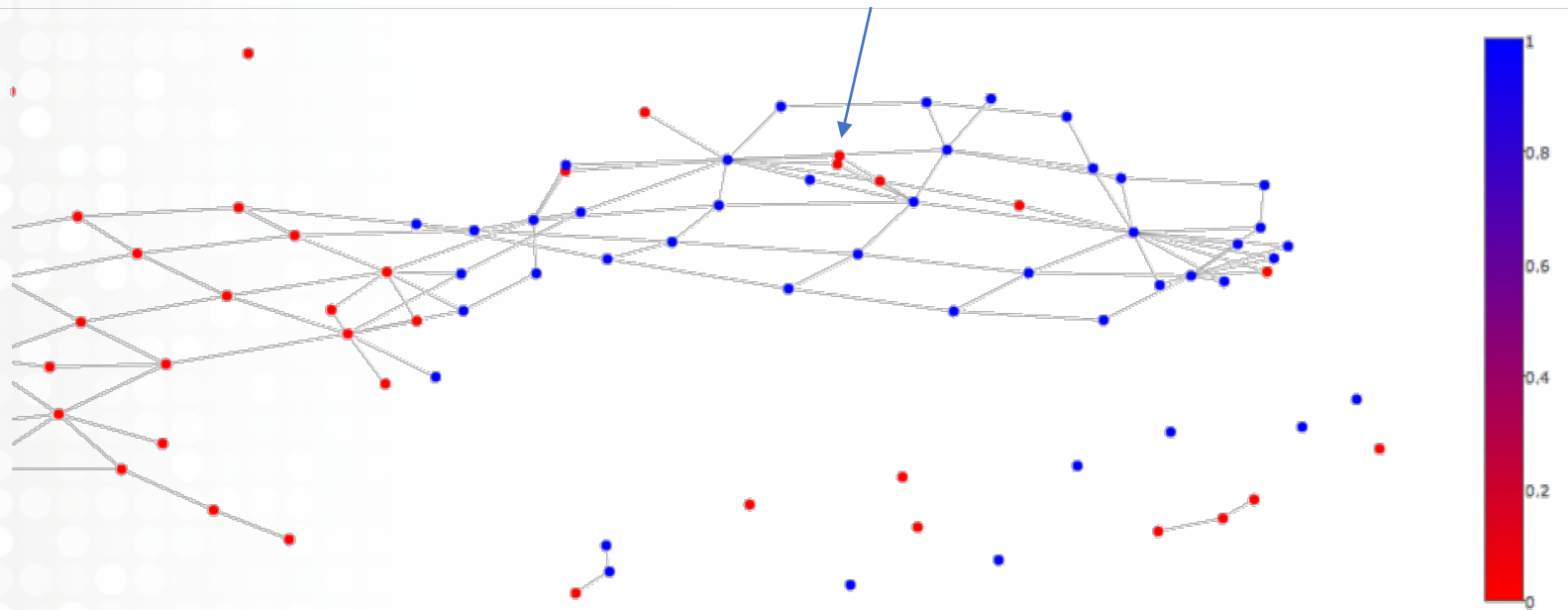
From Big Data to One



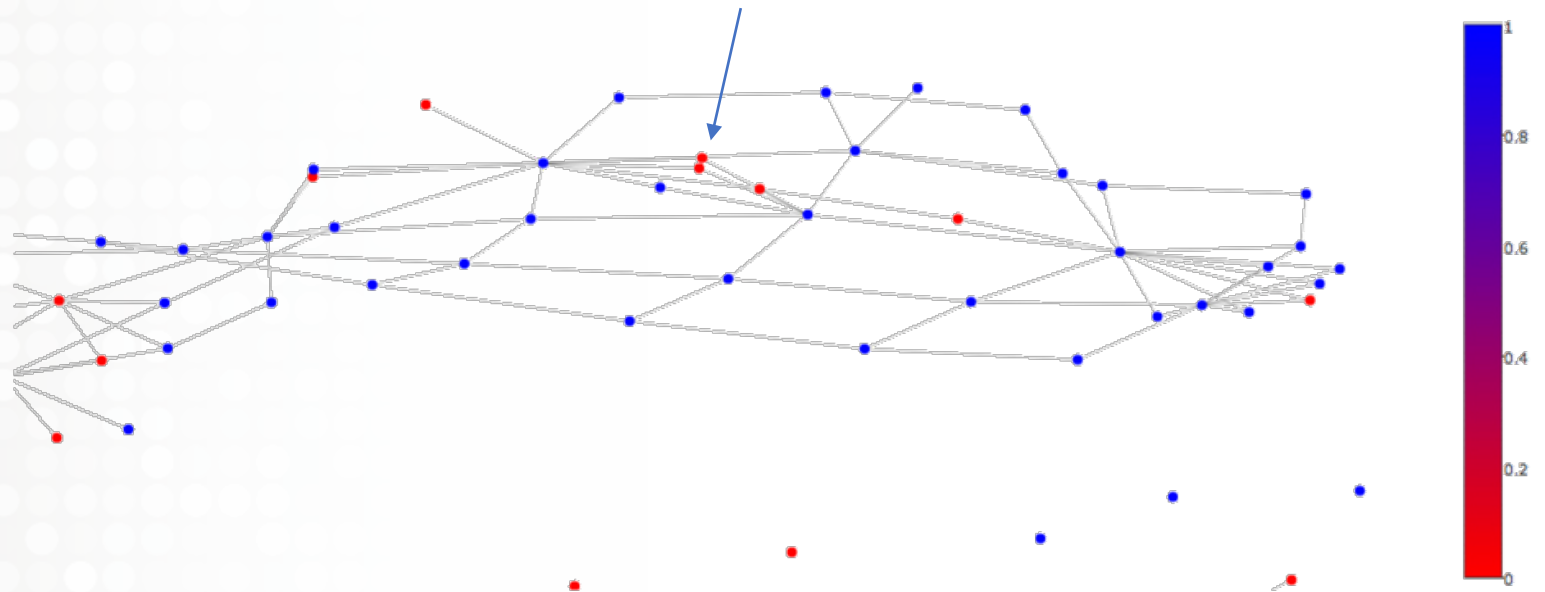
From Big Data to One



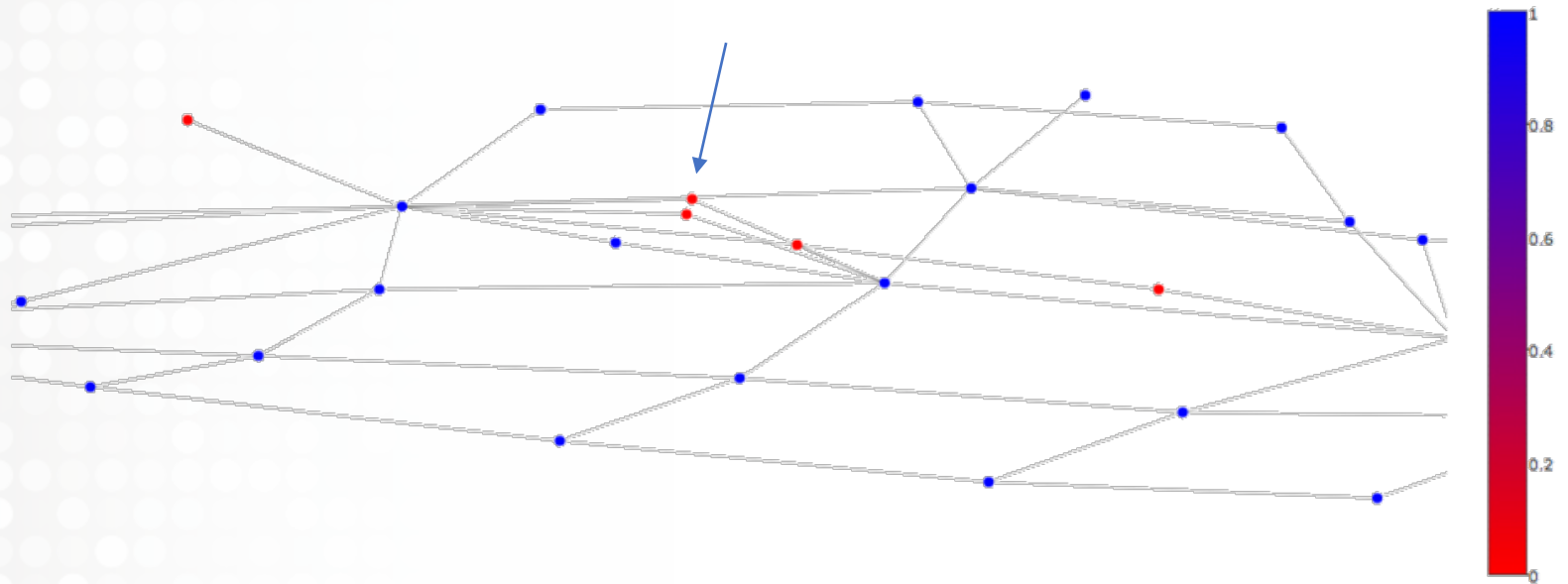
From Big Data to One



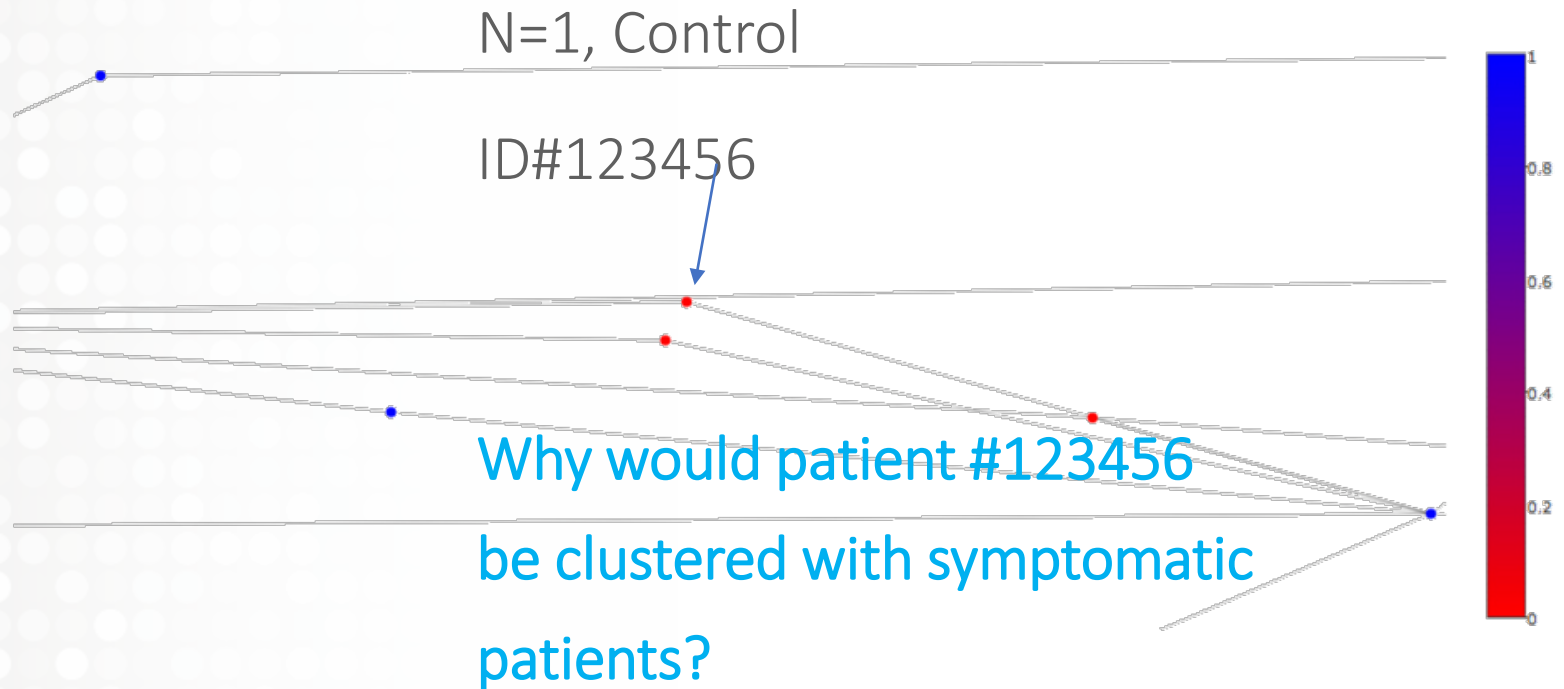
From Big Data to One



From Big Data to One

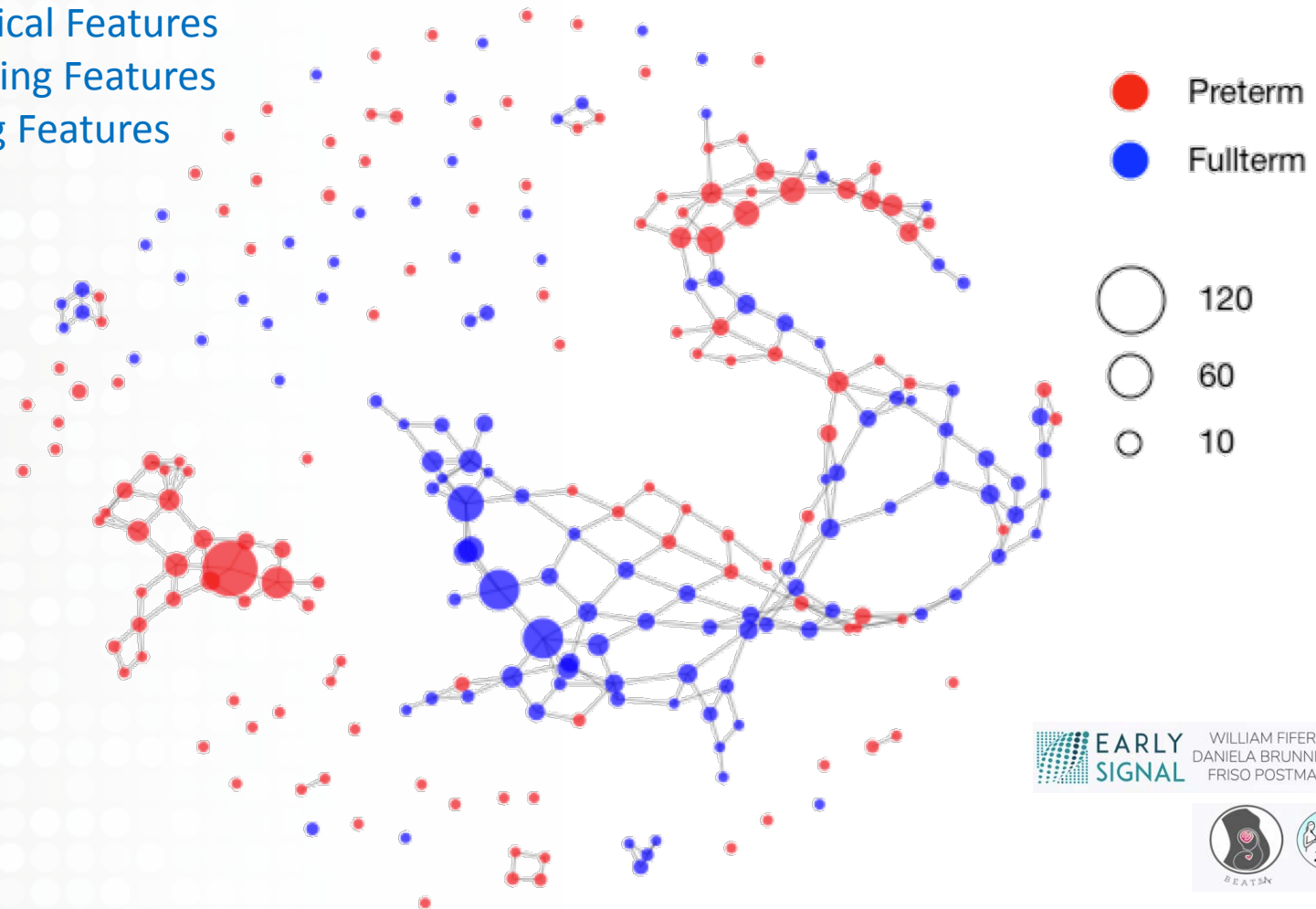


From Big Data to One



Population Analysis for Feature Identification

Standard Clinical Features
Signal Processing Features
Deep Learning Features



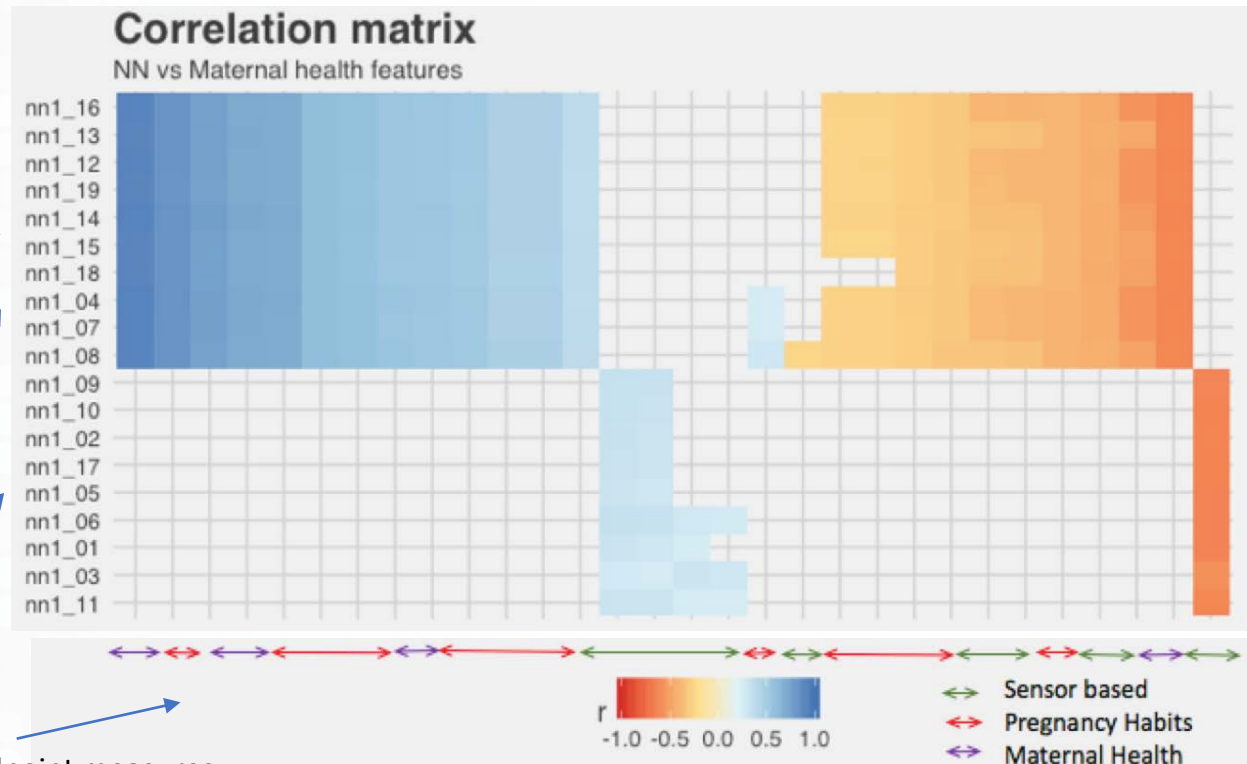
EARLY
SIGNAL

WILLIAM FIFER
DANIELA BRUNNER
FRISO POSTMA



Opening the Black Box

Repetitive
Neurons can be
trimmed for
computational
efficiency



Biometrics, endpoint measures,
and signal processing provide
interpretation a new research
windows

Essential Tensions

To Keep in Mind

- > **Research Device versus HealthCare Applications**
 - Possibly accept lower data quality and address issue with algorithms
 - Focus on BYD strategy for adoption and compliance
 - Focus on affordability for adoption
- > **Big Data versus Individual Patterns**
 - Large population studies versus focused well-control studies
- > **Signal Processing versus AI**
 - Develop more ways to interpret AI results
- > **Develop Better Models**
 - Time series analysis
 - Smart imputation
 - Sparse datasets