Centre for
Data Analytics

Insight

# From Data to Application: Connected Health Research in Insight and ARCH Centres

**Prof Brian Caulfield & Prof Tahar Kechadi**
**University College Dublin, Ireland**

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DCU NUI Galway OÉ Gaillimh UCC UCD sfi

UCD
DUBLIN

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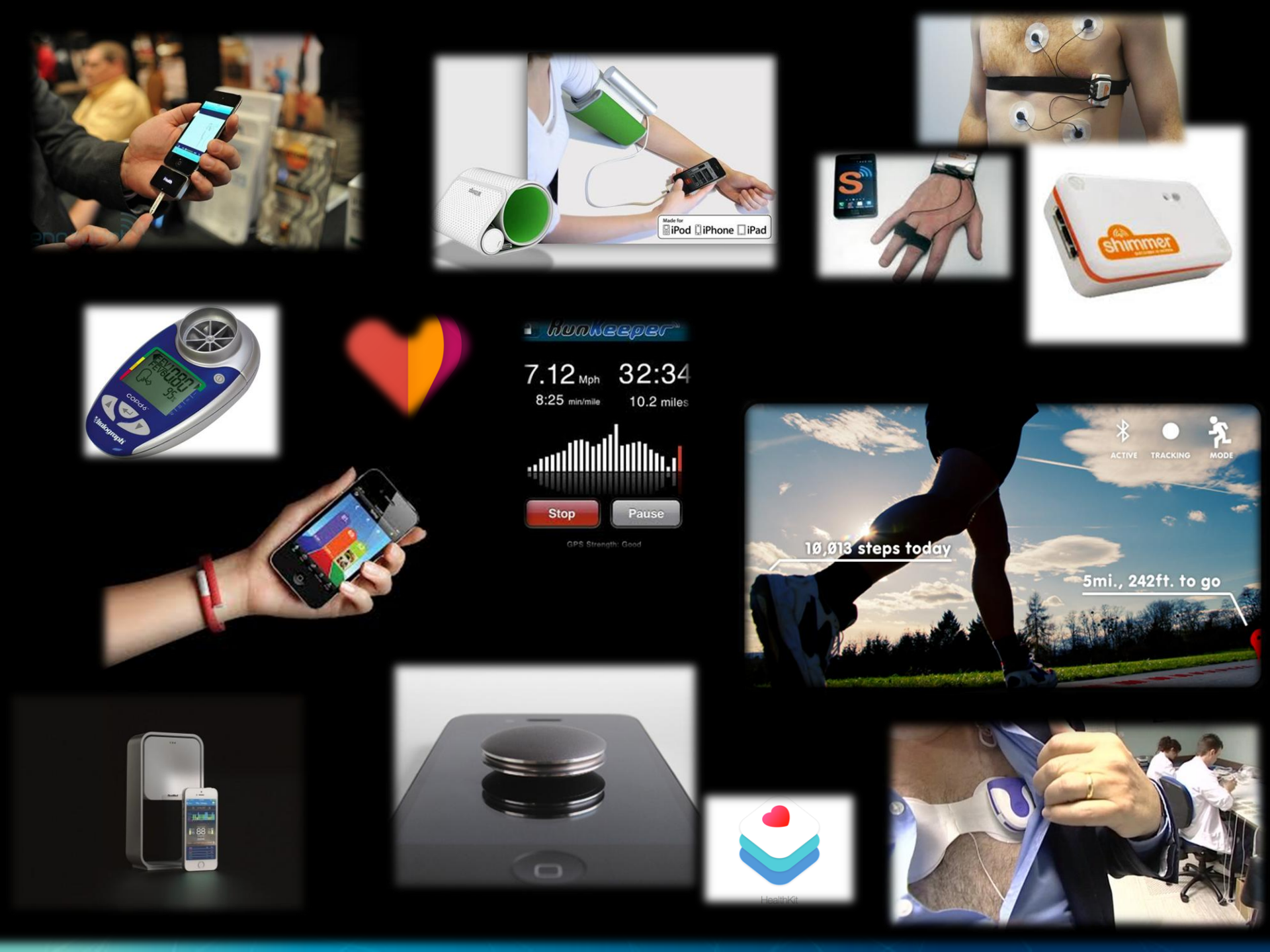
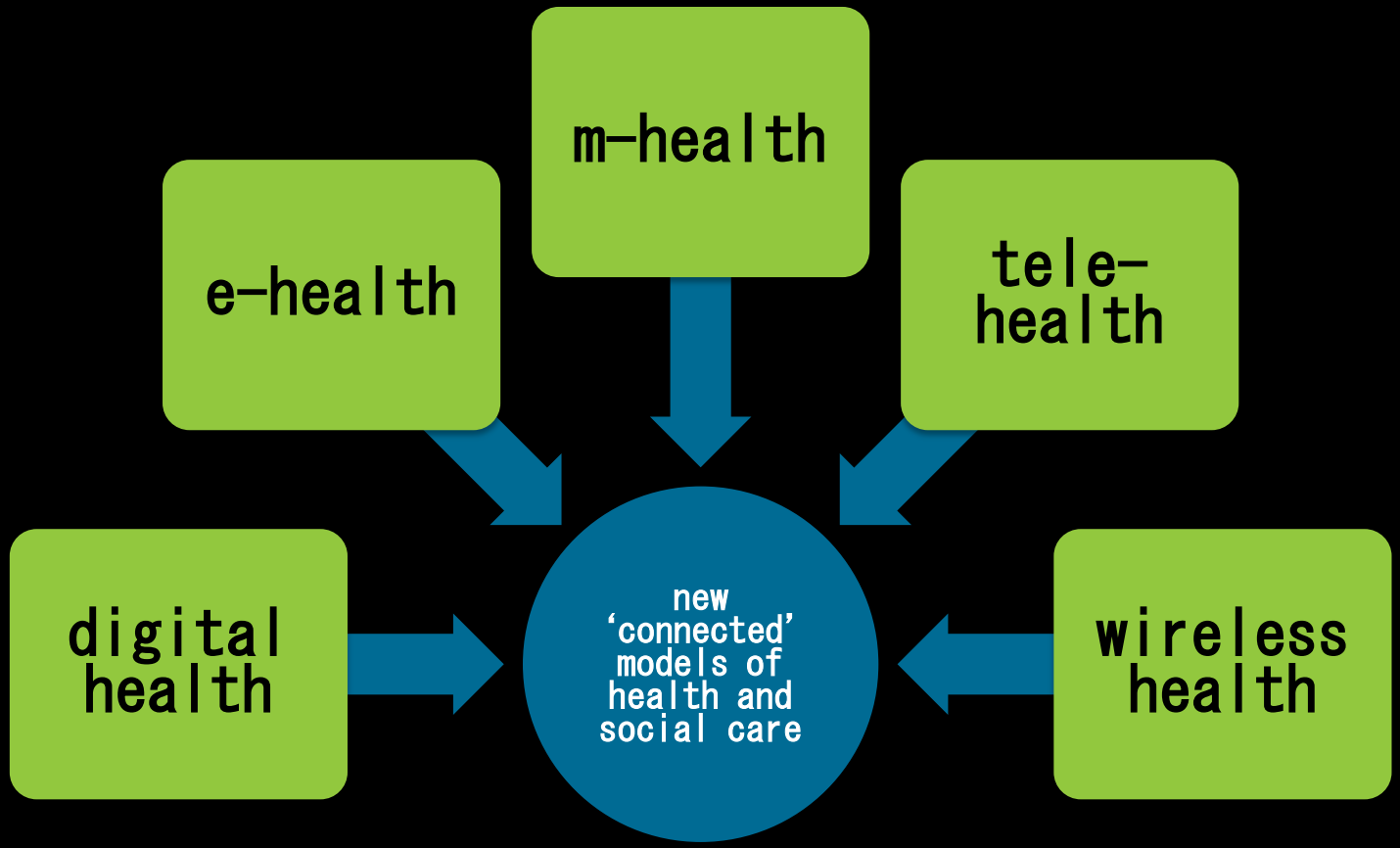
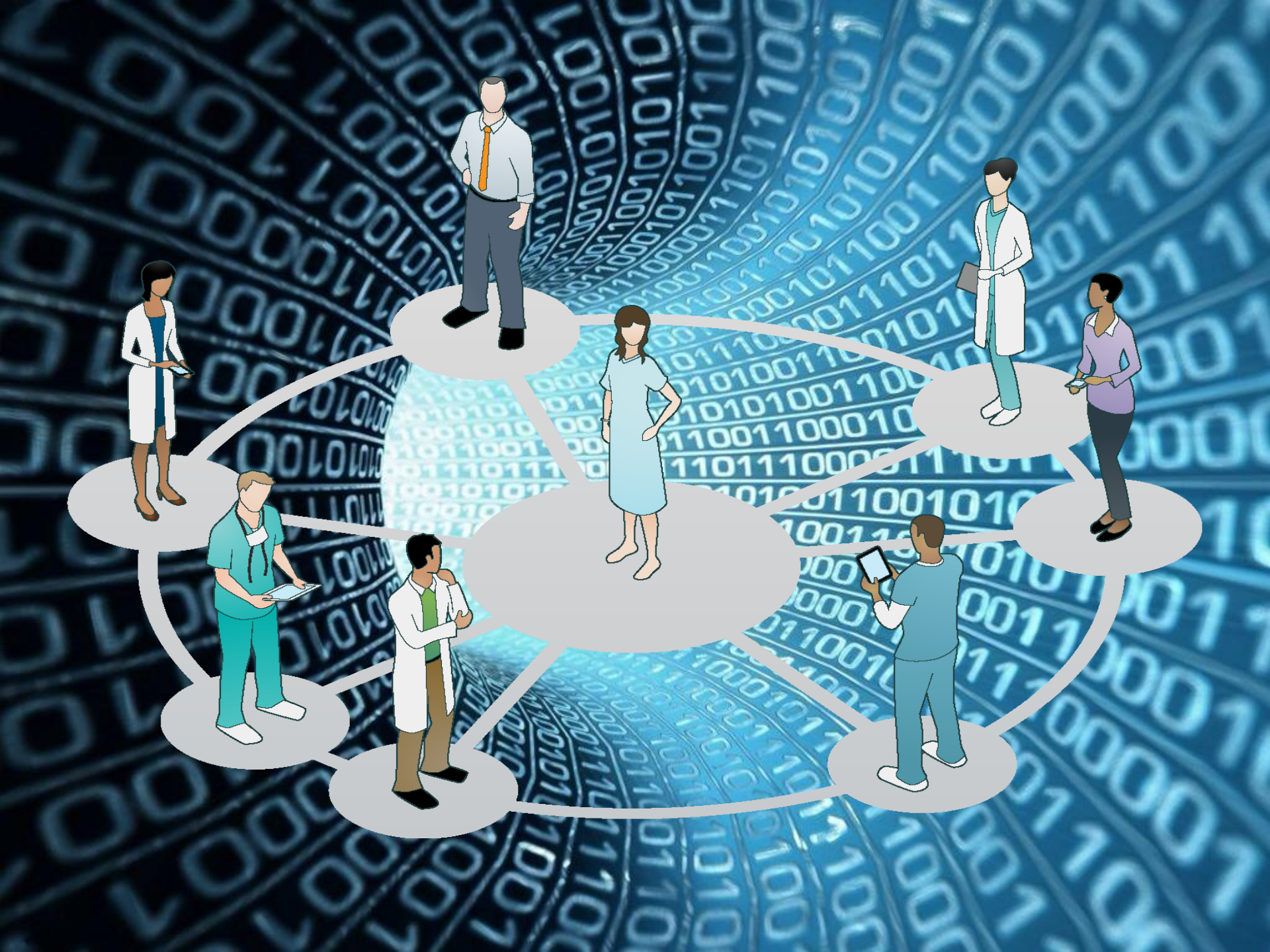
Anna Escobedo Cabral
Treasurer of the United States
100
Shutterstock

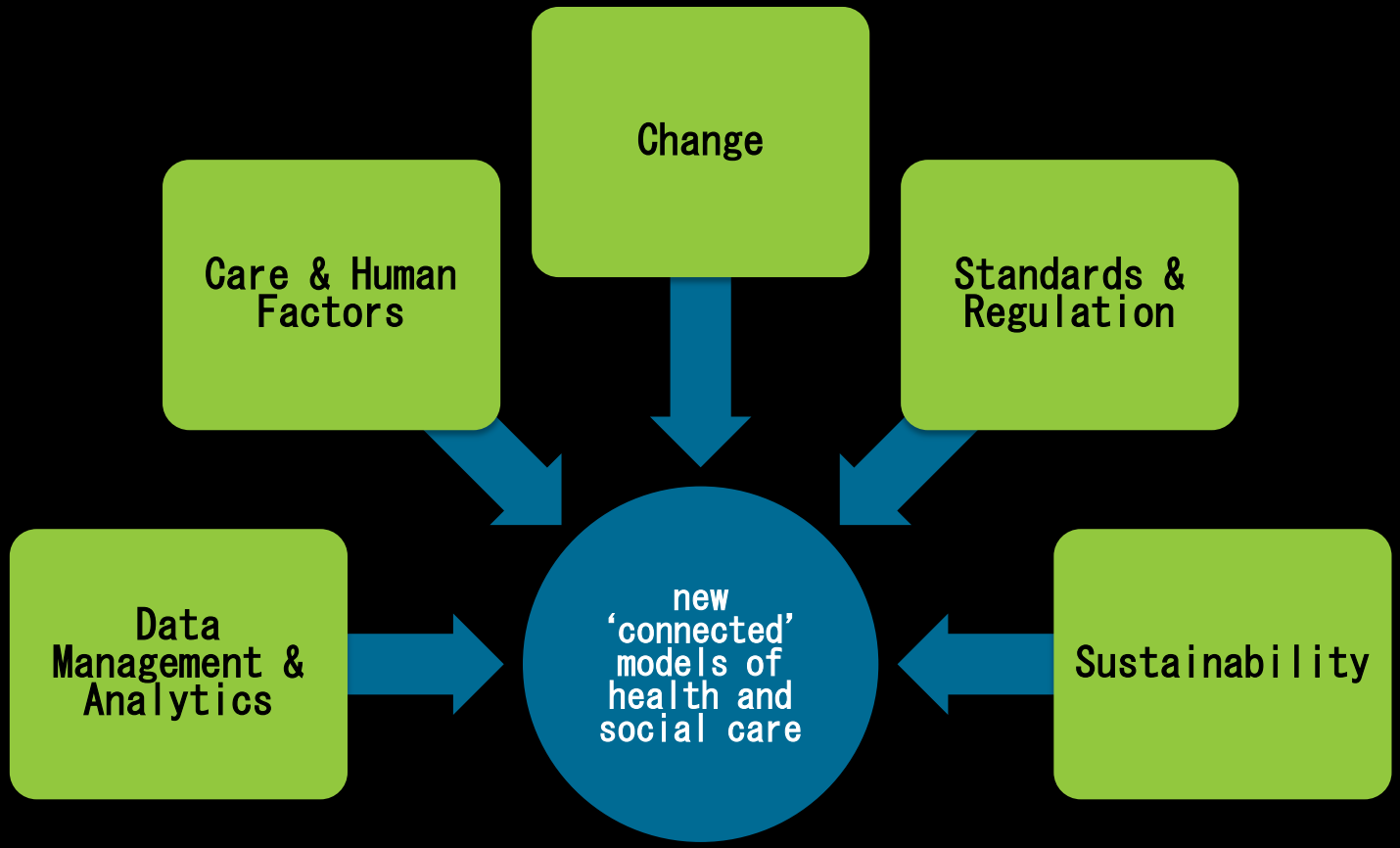

Made for iPod iPhone iPad
shimmer
hunkeeper
7.12 Mph
32:34
8:25 min/mile
10.2 miles
Stop
Pause
GPS Strength: Good
ACTIVE
TRACKING
MODE
10,013 steps today
5mi., 242ft. to go
HealthKit

TRIPLE CHECK

CARPEL TUNNEL SYNDROME
probability: 66%
BURSITIS
probability: 39%

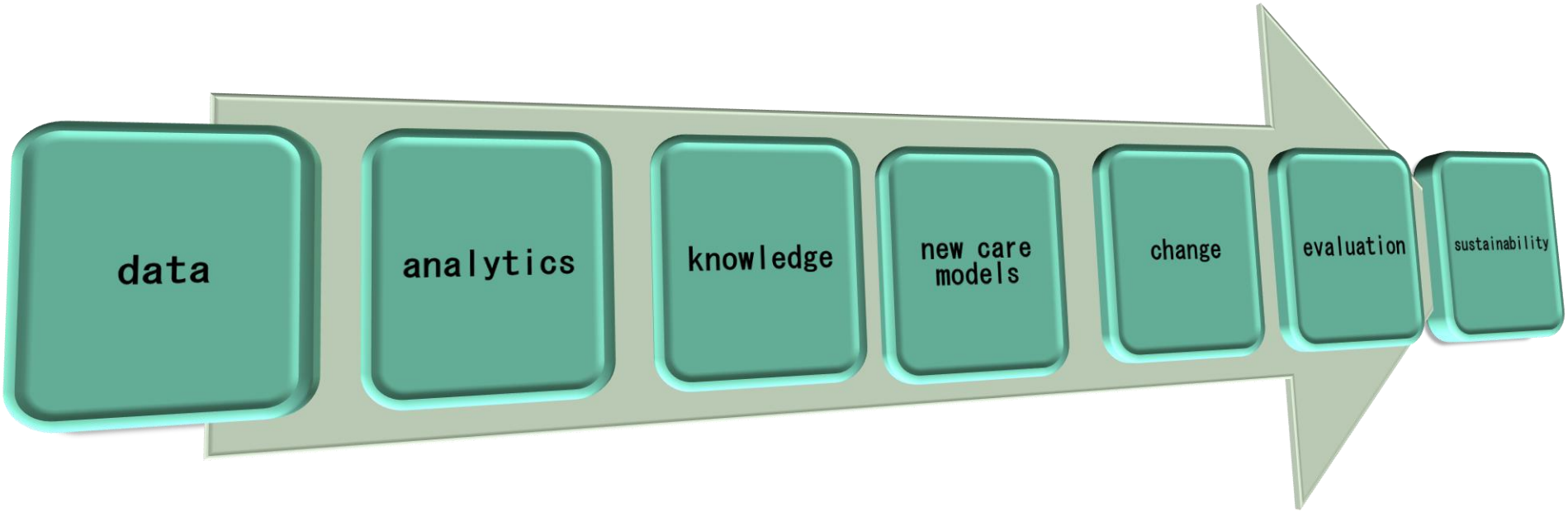

m-health
e-health
tele-
health
digital
health
new
'connected'
models of
health and
social care
wireless
health




Change
Care & Human Factors
Standards & Regulation
Data Management & Analytics
new 'connected' models of health and social care
Sustainability

# UCD Building Blocks

- personalised medicine
- devices & materials
- data science
- clinical programmes
- rehab & exercise science
- business & economics
- health systems & services research
- public health
- ethics, regulation, security

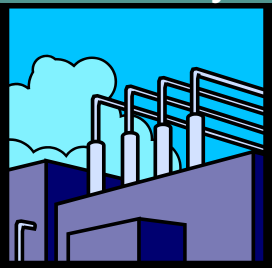



Insight

ARCH
Applied Research for Connected Health

IRELAND EAST
HOSPITAL GROUP

Industry



Academics

Insight

IEHG

ARCH
Applied Research for Connected Health

Clinicians

Patients

Project Management & Business Development
Systems Integration & Deployment
Software Engineering
Ethnographic Design
Data management infrastructure
Data Analytics Platform
Reusable technology tools
Business & Revenue Modeling
Healthcare Economics
Clinical Research Centres

# Insight

# Insight in Numbers

Insight

- Combines 5 Centres of Excellence
- 8 Institutions
- 40+ Funded Investigators
- 350+ Researchers (PD, PhD)
- 40+ Collaboration Partners
- €88m Primary Funding Base for 6 years (30% from industry)

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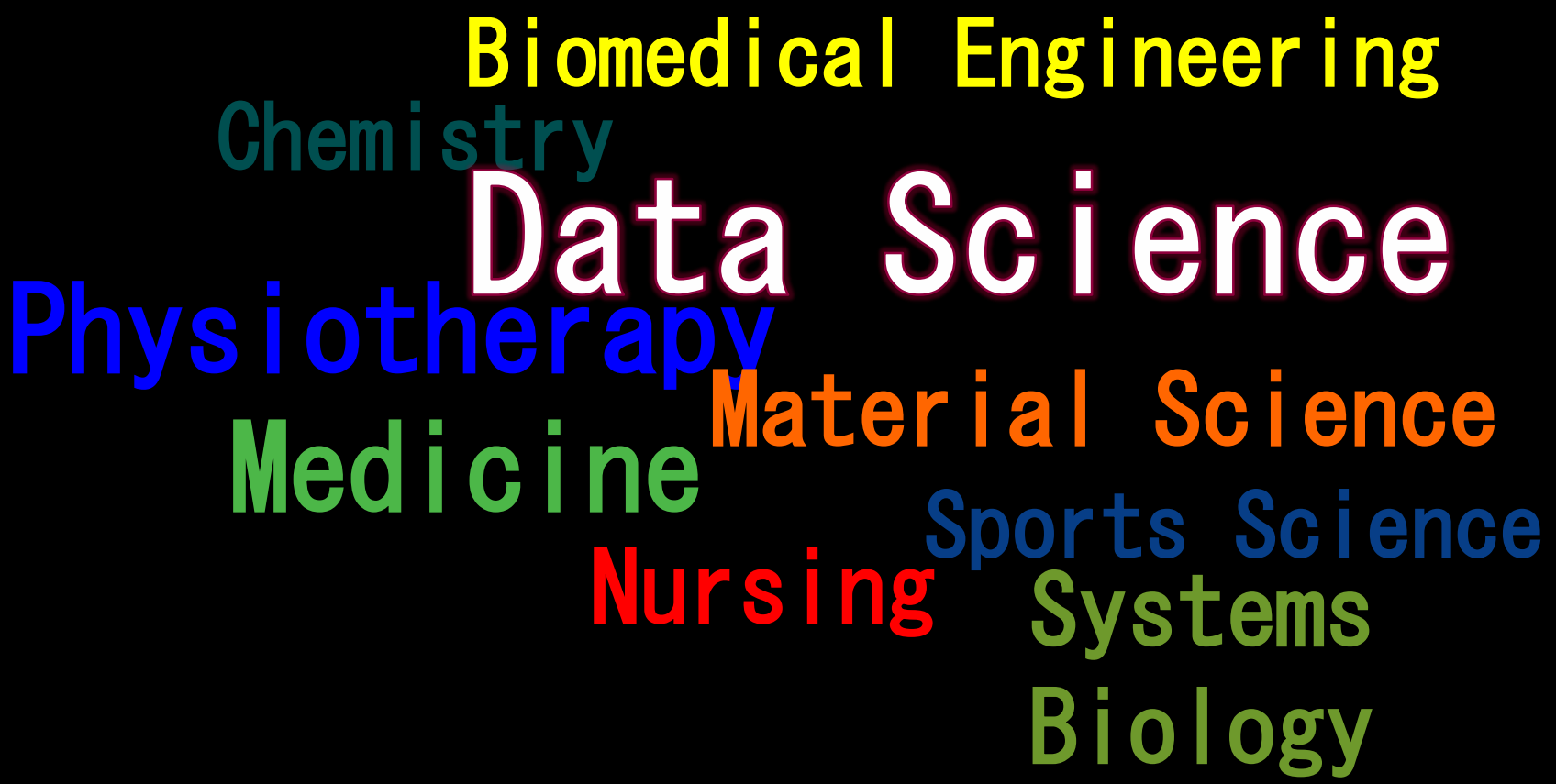
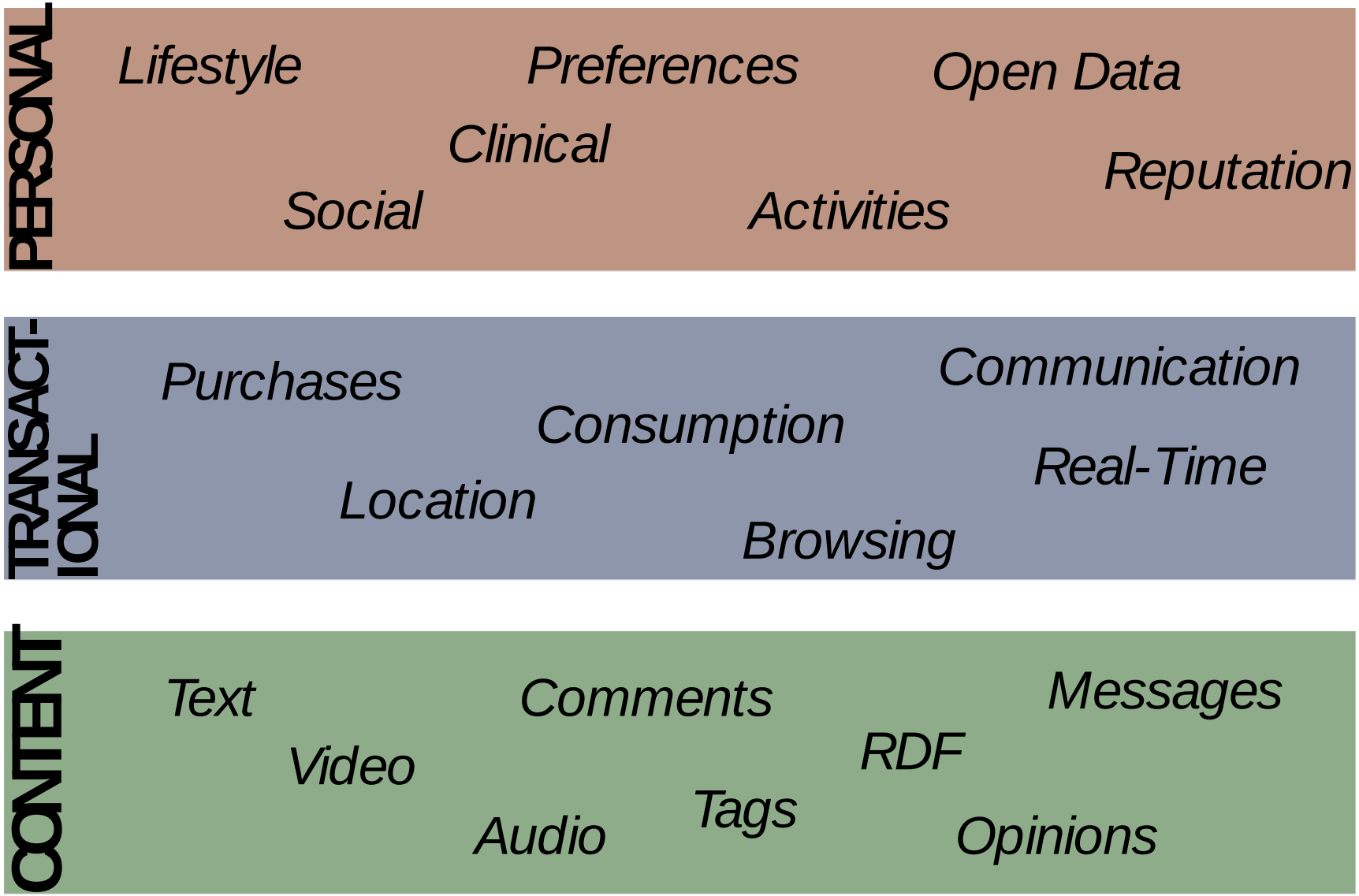
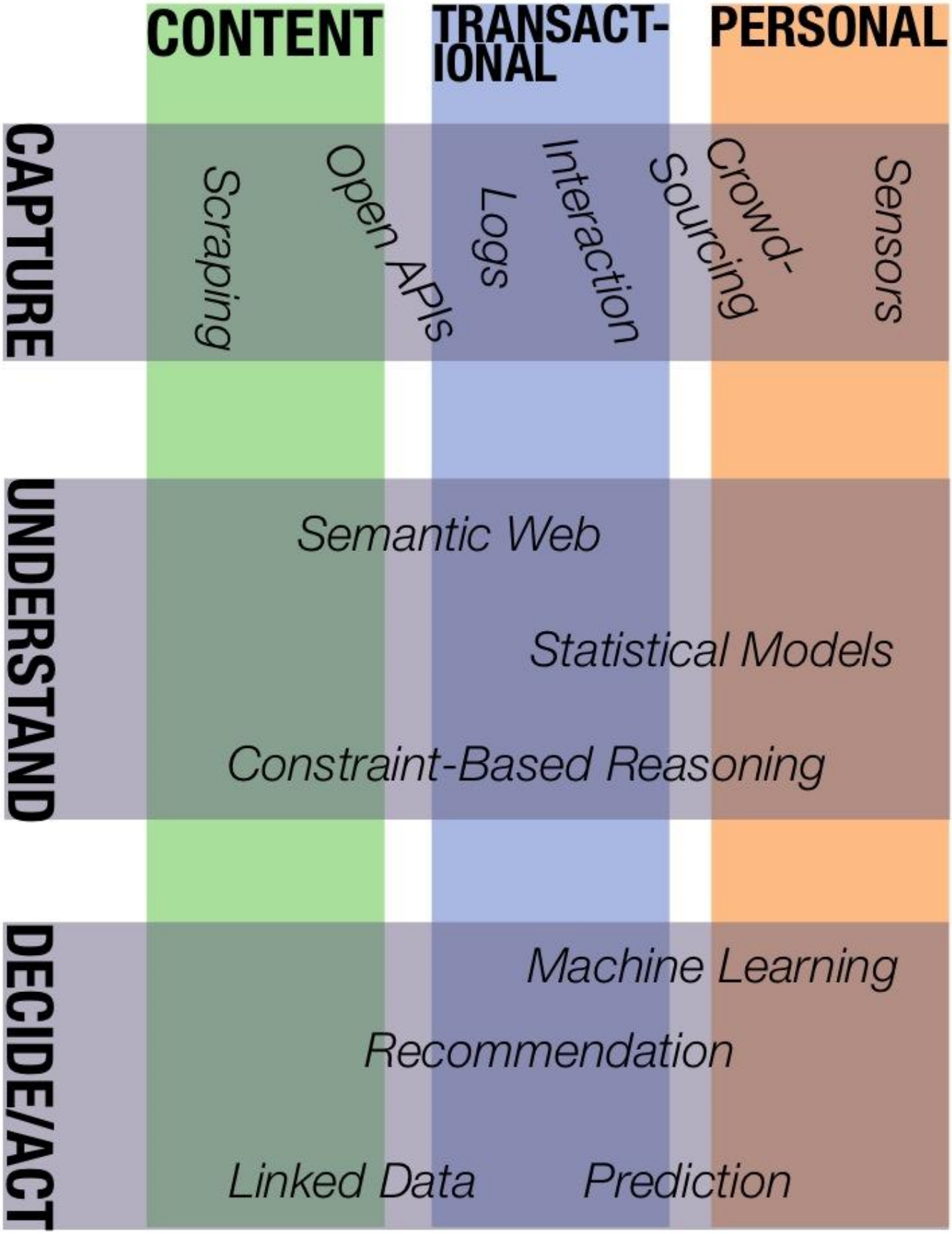
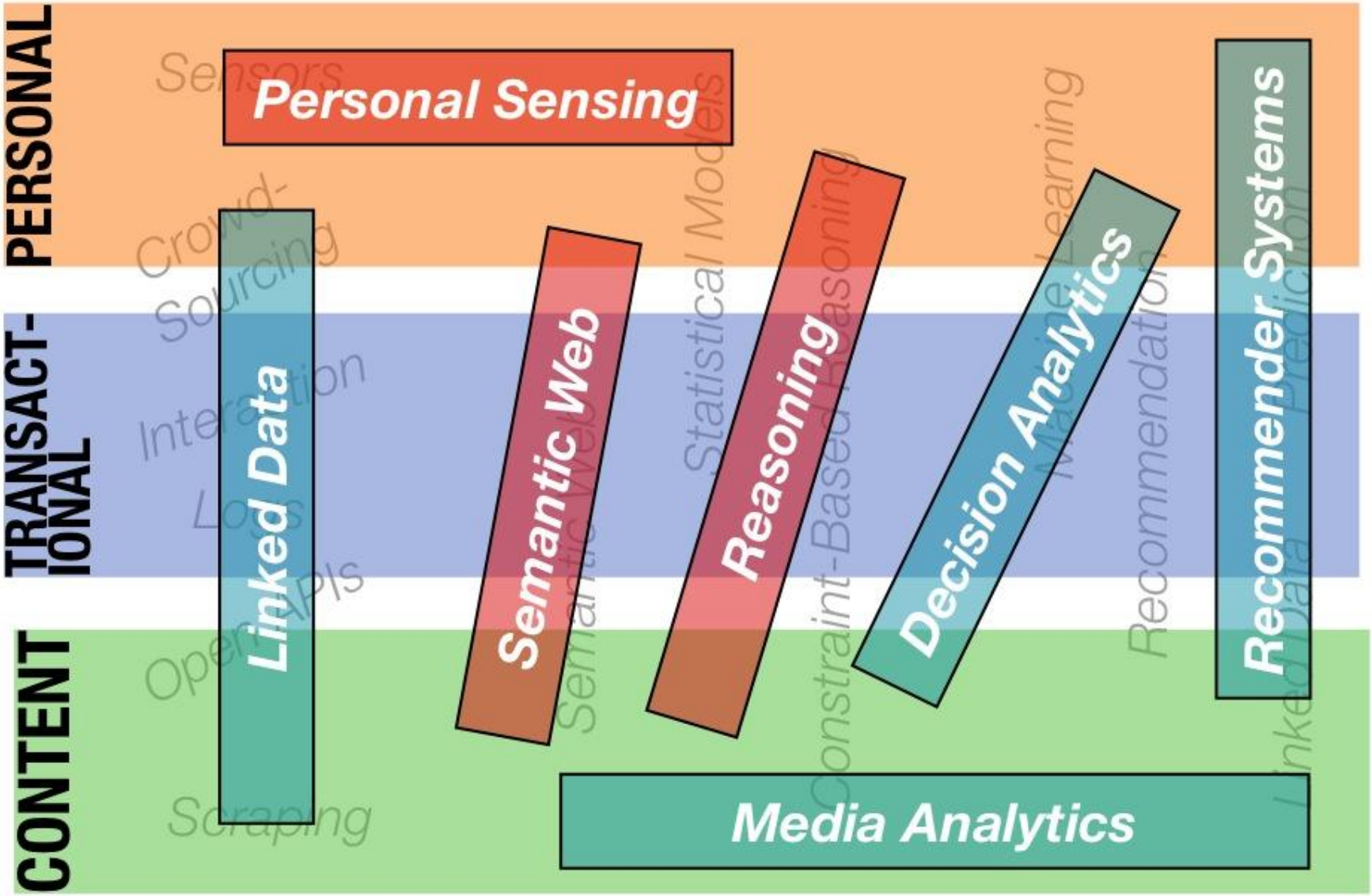
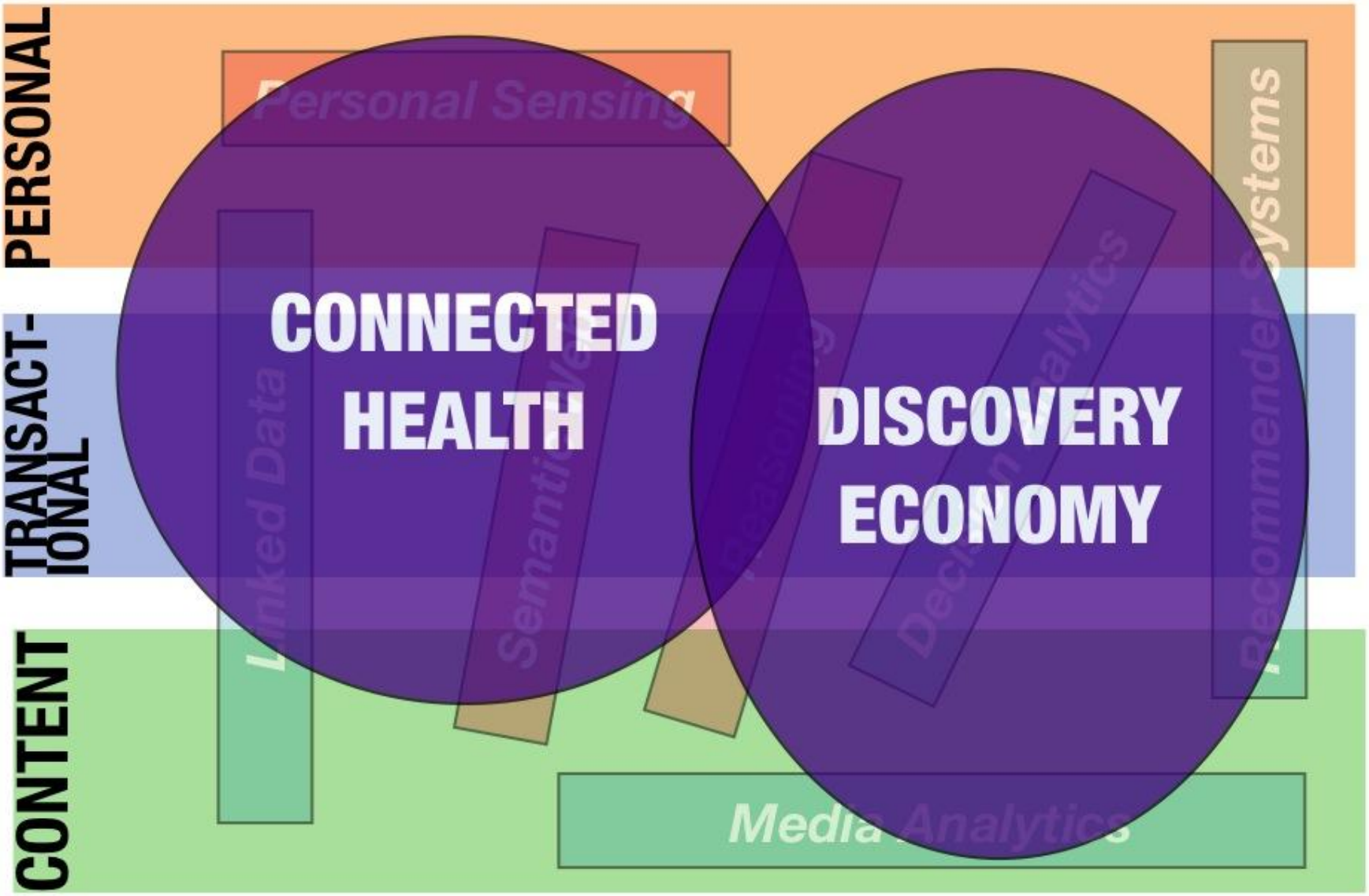

Biomedical Engineering
Chemistry
Data Science
Physiotherapy
Material Science
Medicine
Sports Science
Nursing
Systems Biology



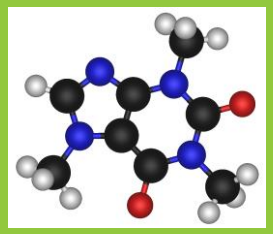

# DIVERSE DATA SOURCES


CONTENT
TRANSACT-IONAL
PERSONAL
CAPTURE
Scraping
Open APIs
Logs
Interaction
Crowd-Sourcing
Sensors
UNDERSTAND
Semantic Web
Statistical Models
Constraint-Based Reasoning
DECIDE/ACT
Machine Learning
Recommendation
Linked Data
Prediction


PERSONAL
TRANSACT-IONAL
CONTENT
Personal Sensing
Linked Data
Semantic Web
Reasoning
Decision Analytics
Recommender Systems
Media Analytics
Sensors
Crowd-Sourcing
Interaction
Logs
Open APIs
Scraping
Statistical Models
Constraint-Based Reasoning
Machine Learning
Recommendation
Prediction
CAPTURE
UNDERSTAND
DECIDE/ACT


PERSONAL
TRANSACT-
IONAL
CONTENT
Personal Sensing
Linked Data
Semantic
Decision Analytics
Recommender Systems
Media Analytics
CONNECTED
HEALTH
DISCOVERY
ECONOMY
CAPTURE
UNDERSTAND
DECISION

# Data Domains

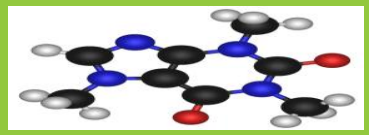


Gene/Molecule

Person

Population

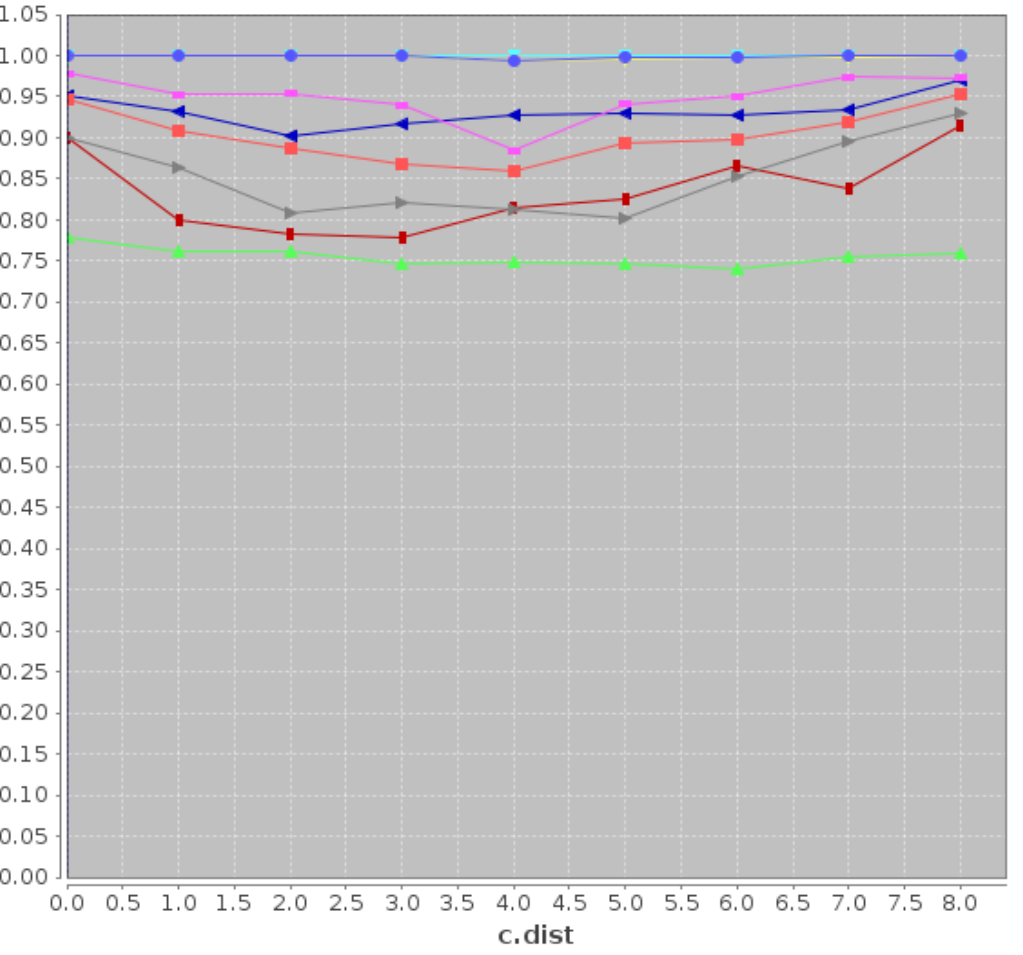
System

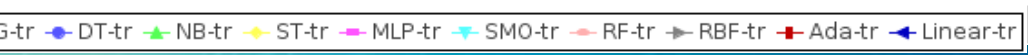


Gene/Molecule

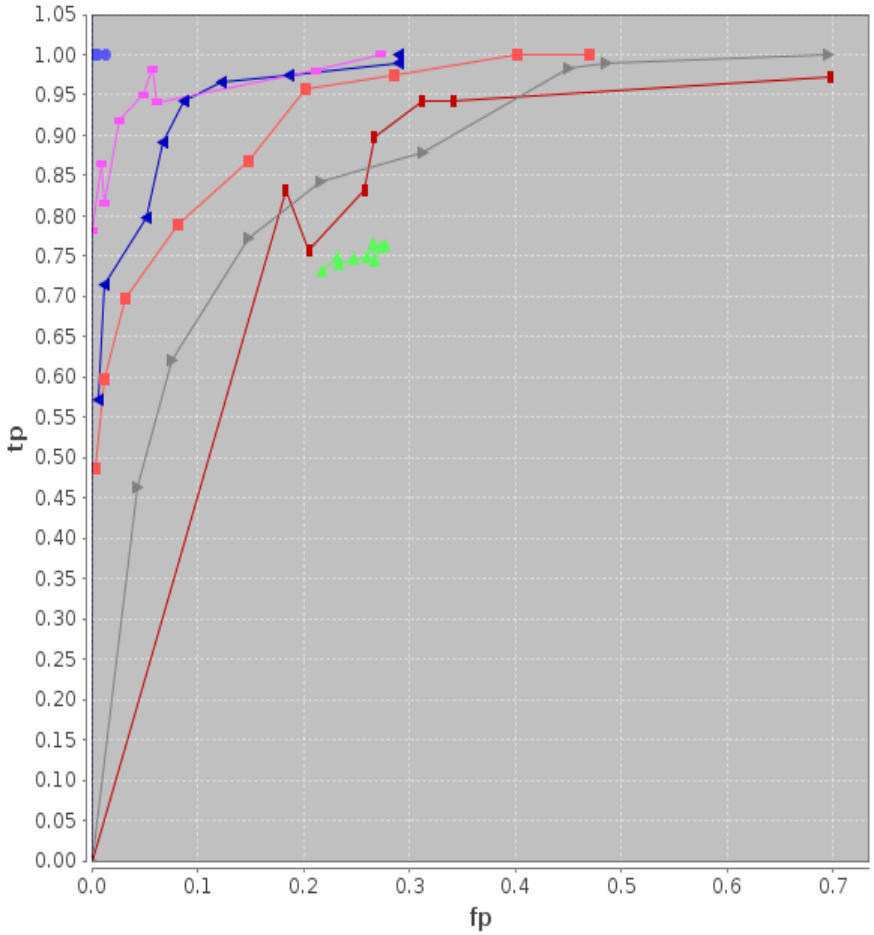
Insight

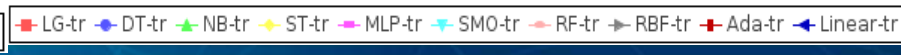
ACC




Tp-Fp

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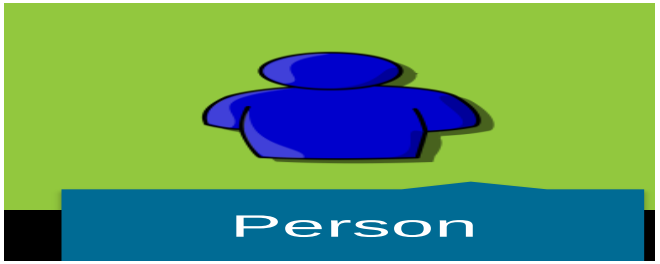
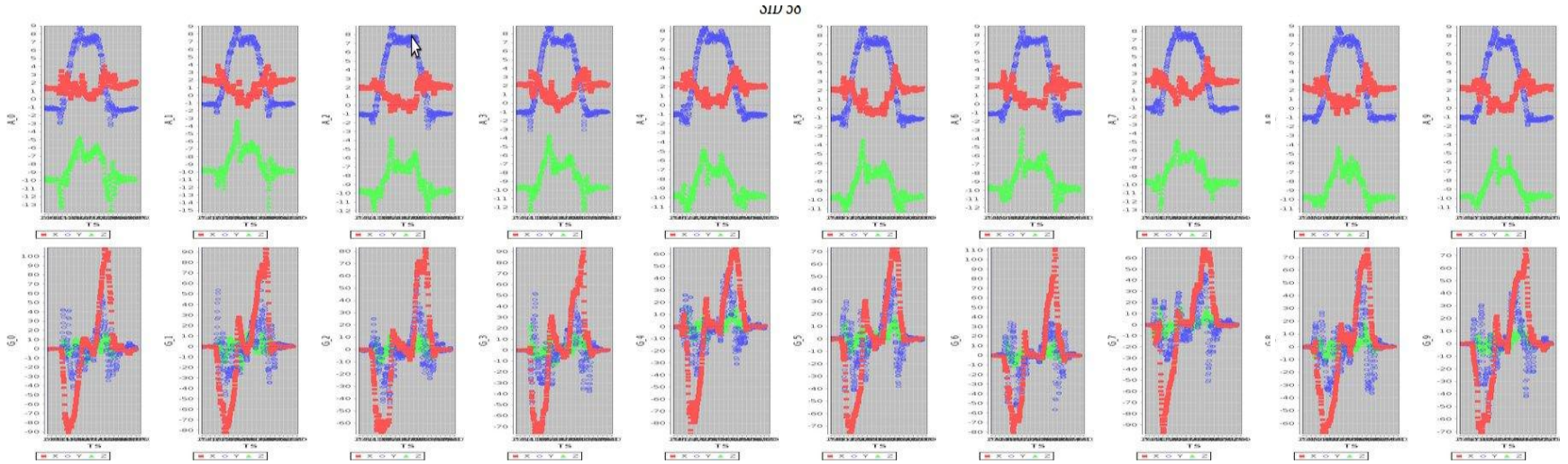
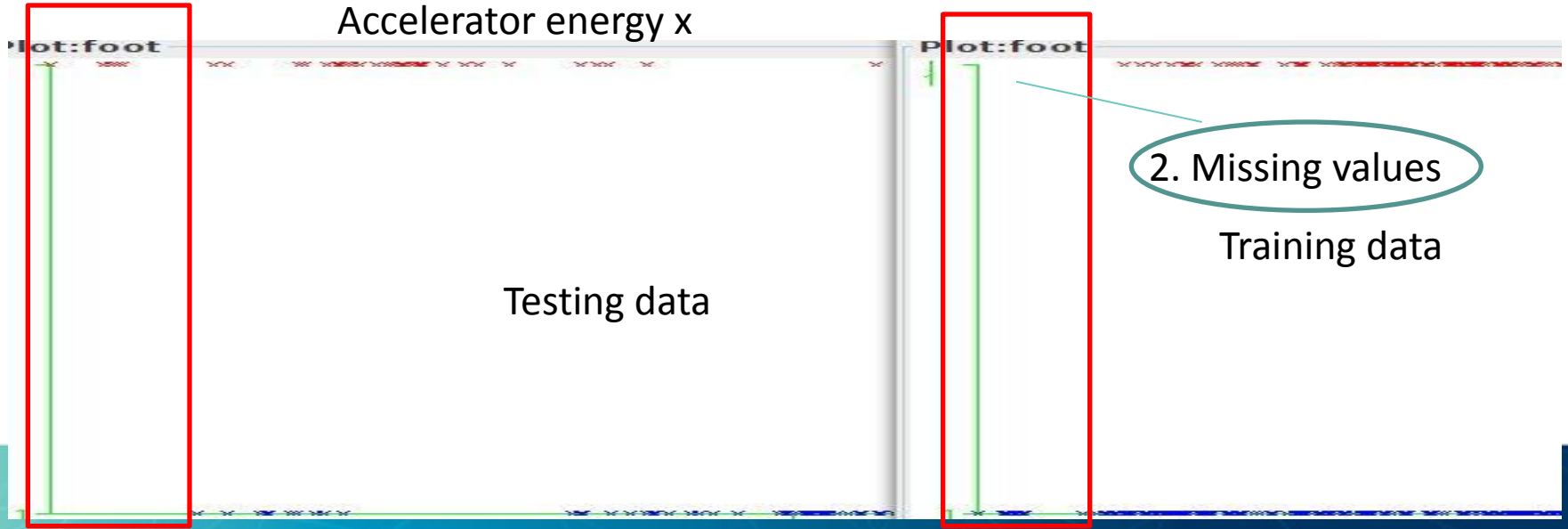



Insight

1. Some similar movements



Accelerator energy x




Testing data

2. Missing values

Training data

| | 95-99% | 95-96% | 75-80% | |
|---|---|---|---|---|
| Exercising? | Which Exercise? | Correct or Incorrect Technique? | Which Deviation? | Feedback |
| | SLR<br>Hip Ext<br>Knee Ext<br>IRQ<br>Hip Abd<br>**Knee Slide**<br>Hip Flex | Yes<br>**No** | **Ext Rot' n Hip**<br>Hip Hitch<br>Heel Lift | 'Your knee is rolling outwards. Try to move it in a straight line as you bring it towards you.' |

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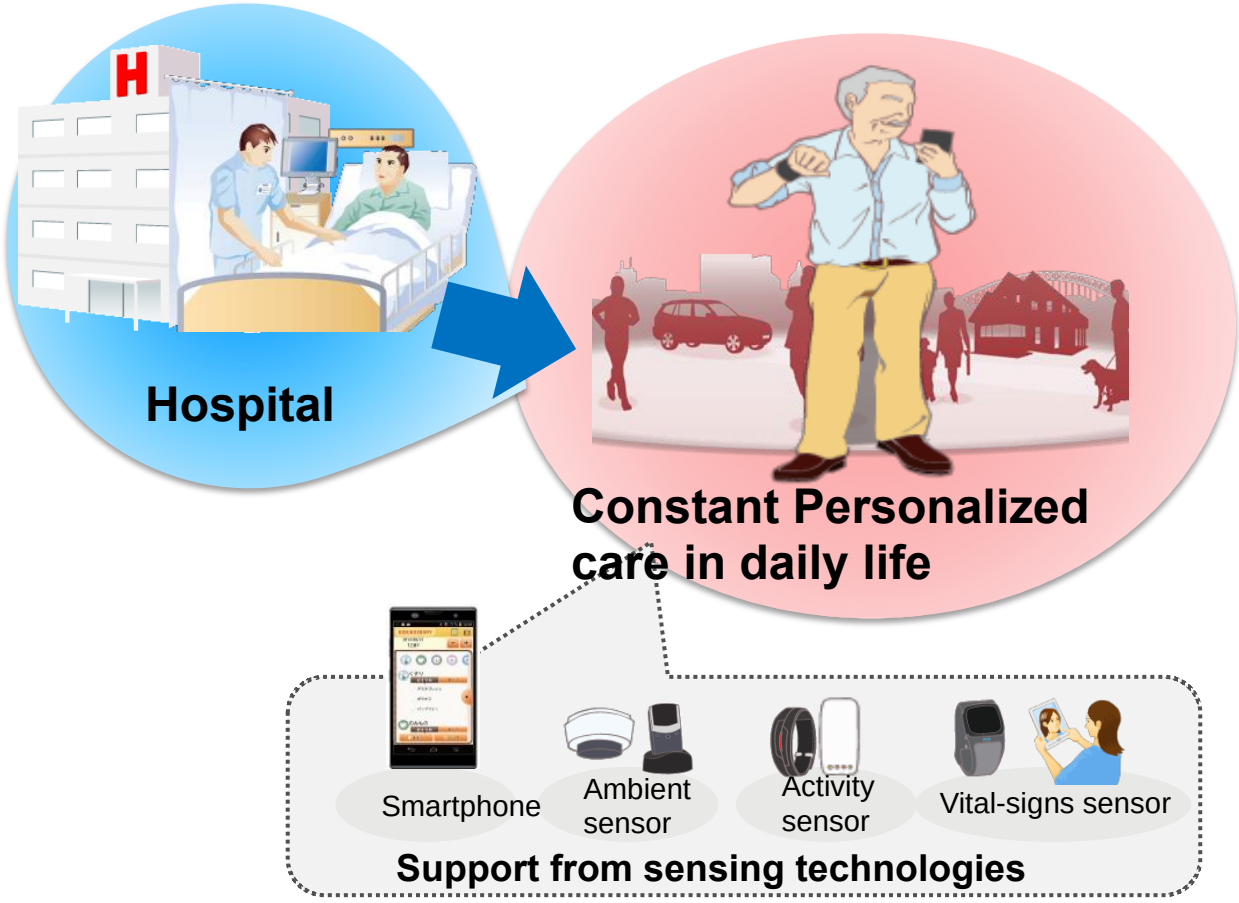
# A safer society for senior citizens and patients

FUJITSU

- Extend medical care from the hospital into a patient's daily life
- By utilizing various sensors to enable the realization of more personalized medical care that can detect illness which appears in daily life that might be hard to detect in short hospital examinations





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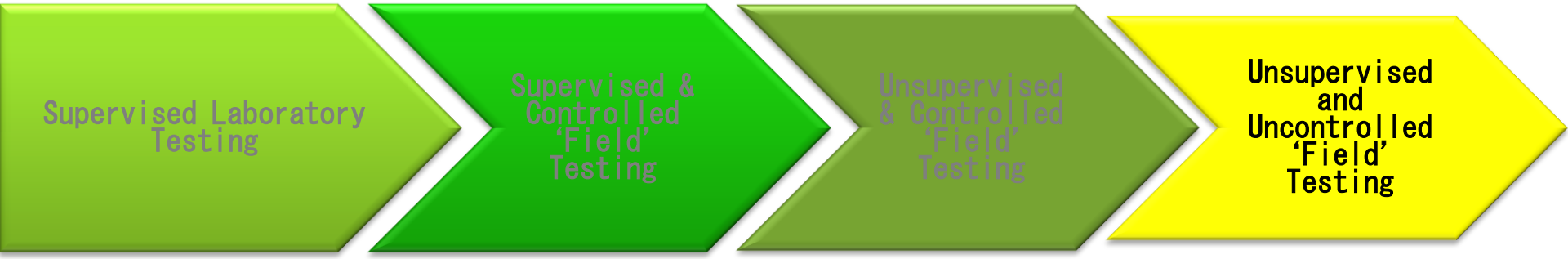
# Moving out of the Laboratory

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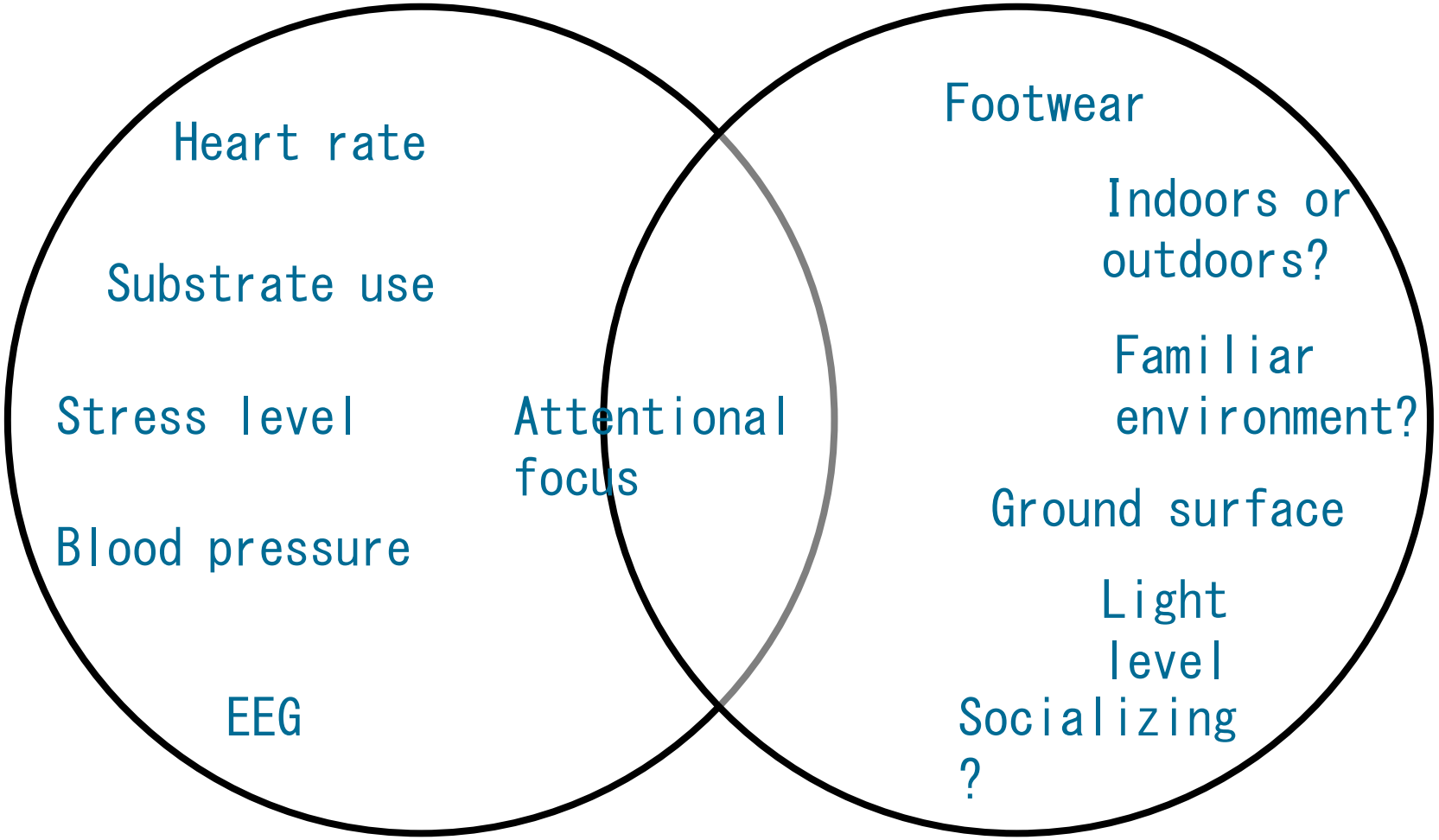
# Internal Context External Context

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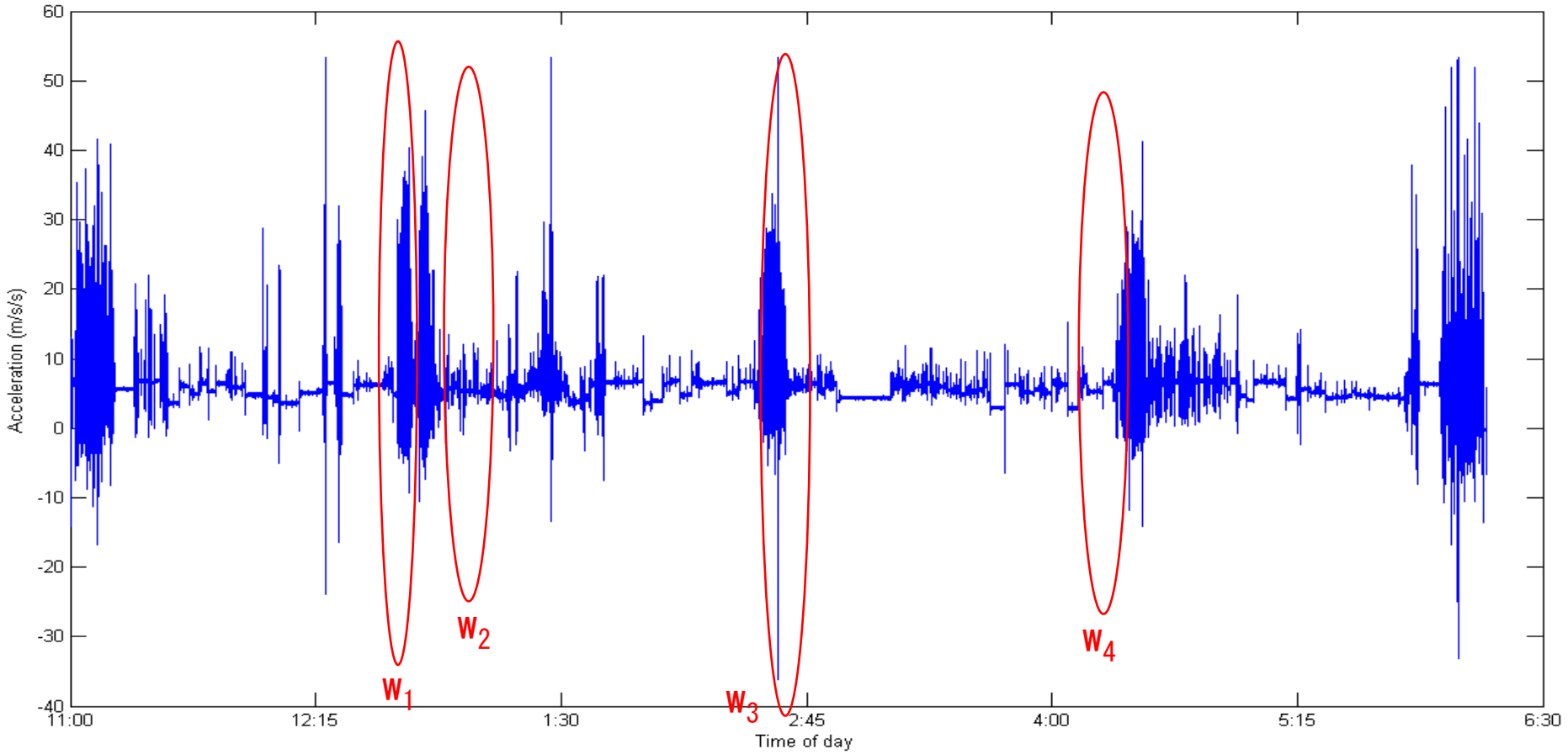
# Data Processing

- **Detect walking periods from inertial sensor data ($w_1$, $w_2$, $w_3$, $w_4$, $w_5$, … $w_n$)**

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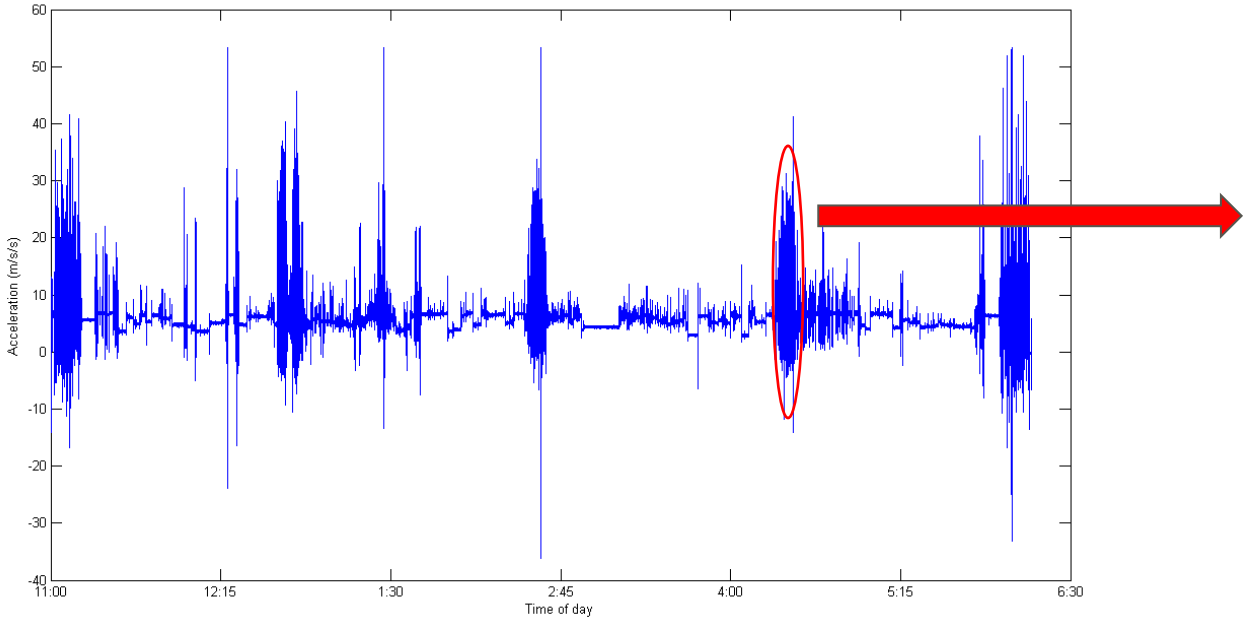
# Data Processing

- **Identify context using data from wearable camera**



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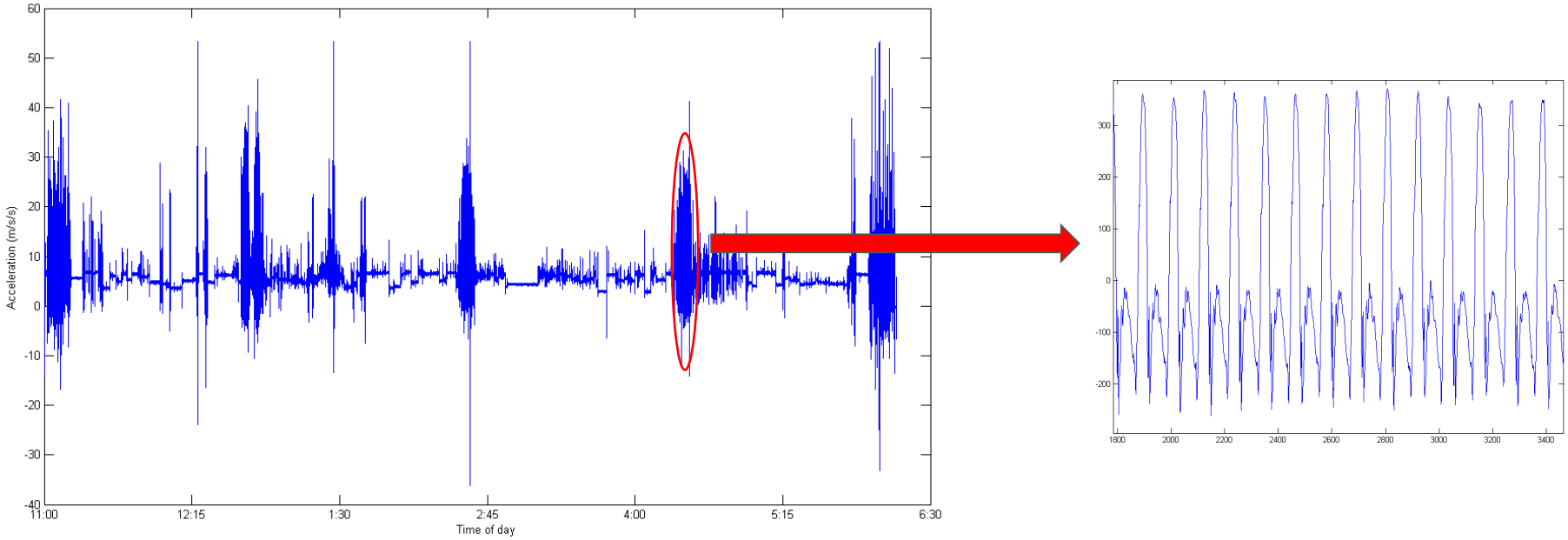
# Data Processing

- **Quantitative analysis of each individual walking period**

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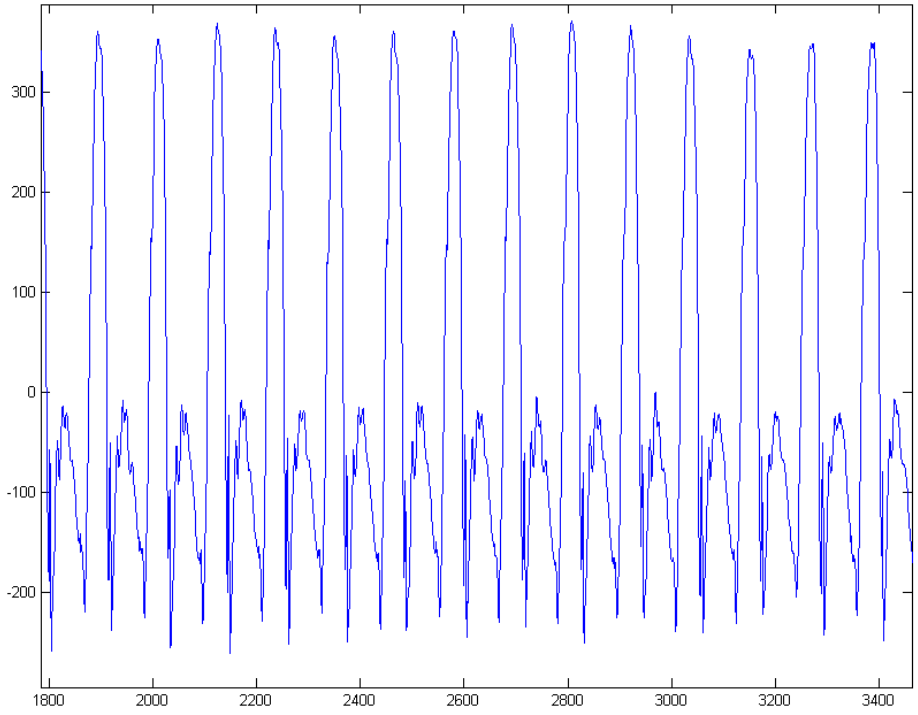
# Data Processing

- **Variables extracted for analysis**




Stride time
Stance time
Stride Time Variability
Peak shank rotation rate

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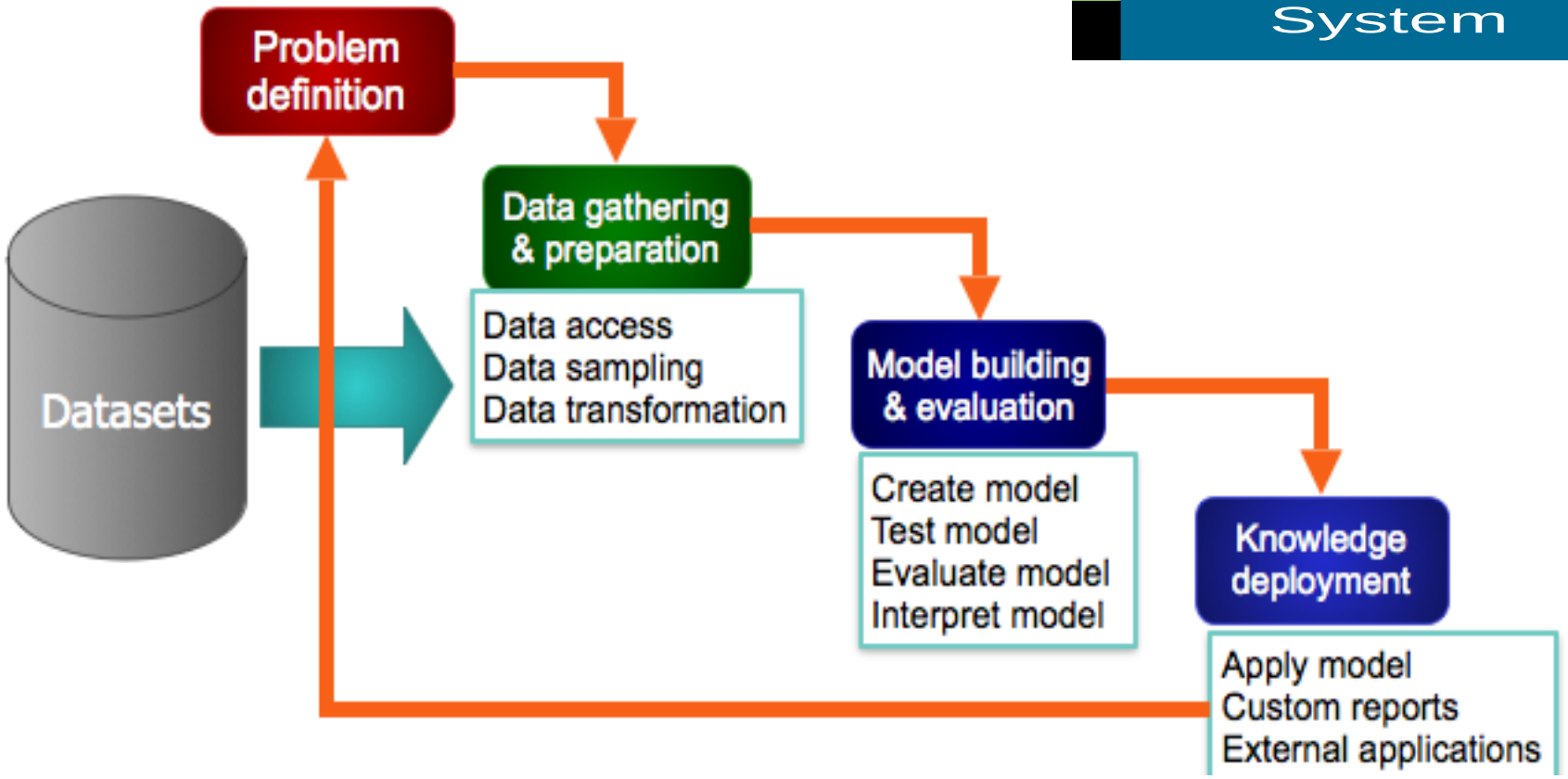
# DM Process

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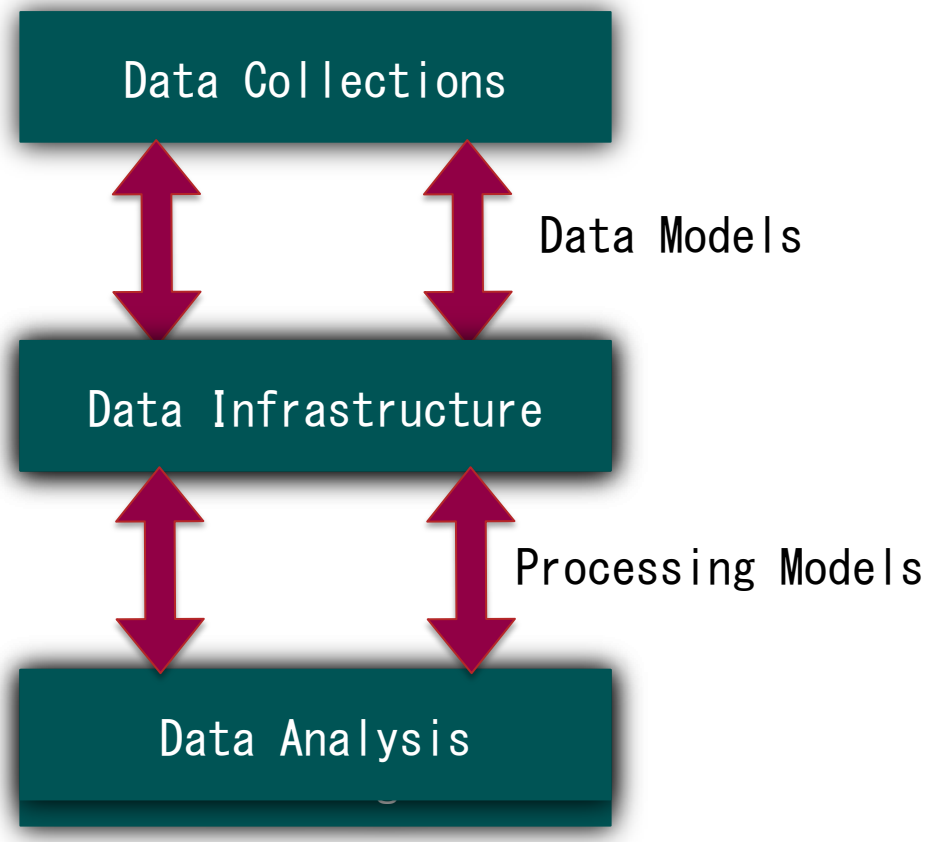
# DM Approach

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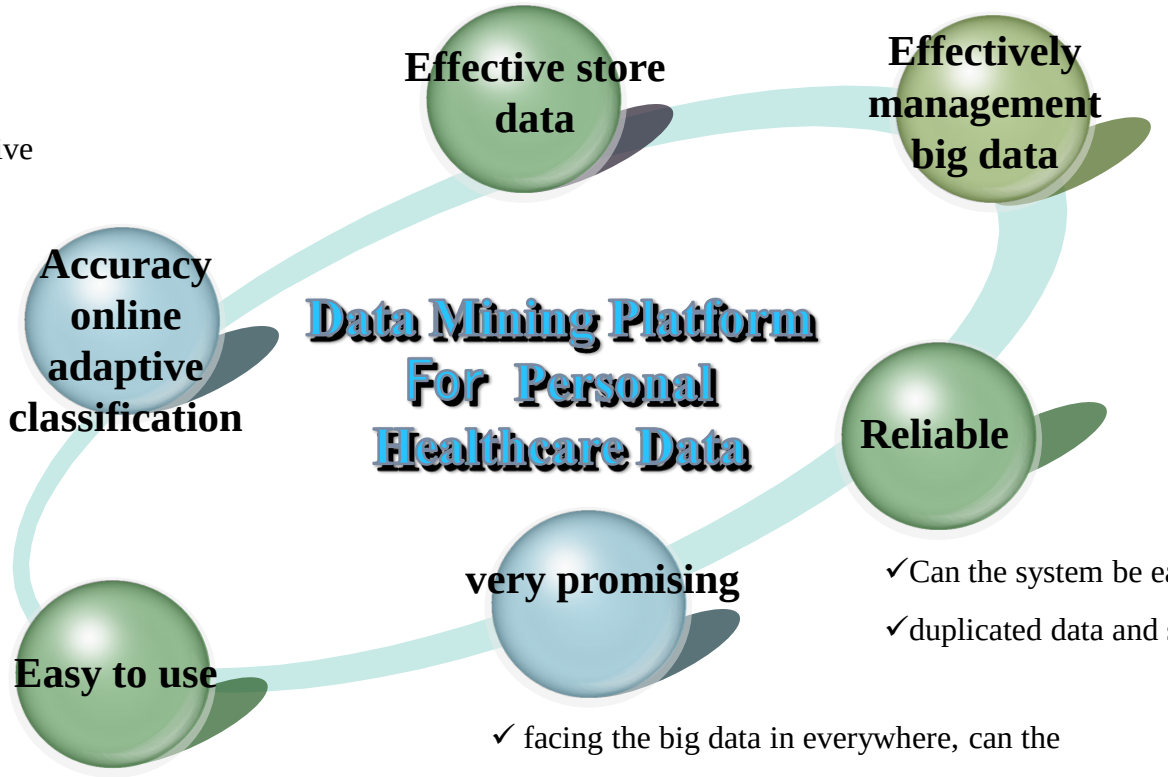
# Requirements

✓Can fast store query data from Cassandra, mongoDB, sqlit and hadoop ?

✓integration & data filtering tools




✓Online adaptive & sensitive learning algorithms

✓Friendly user Interface

✓Can the system be easy extended?

✓duplicated data and software

✓ facing the big data in everywhere, can the system be used for various datasets?

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Practitioners

Protocols

Patients

Healthcare Data

Analytics, machine learning & data mining

Legacy systems and tools

Self-management processes

DB/DW Structured/ unstructured Data

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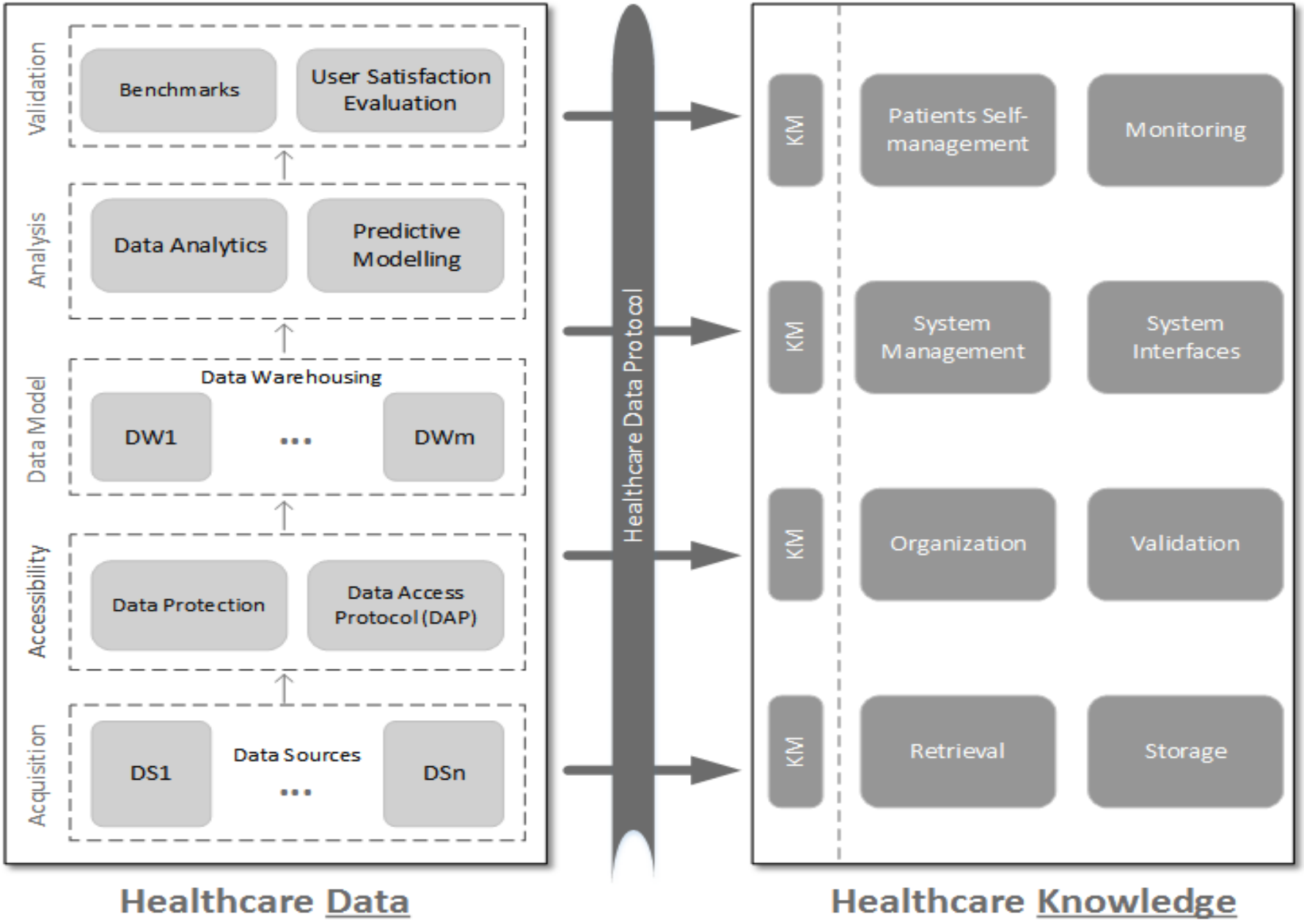


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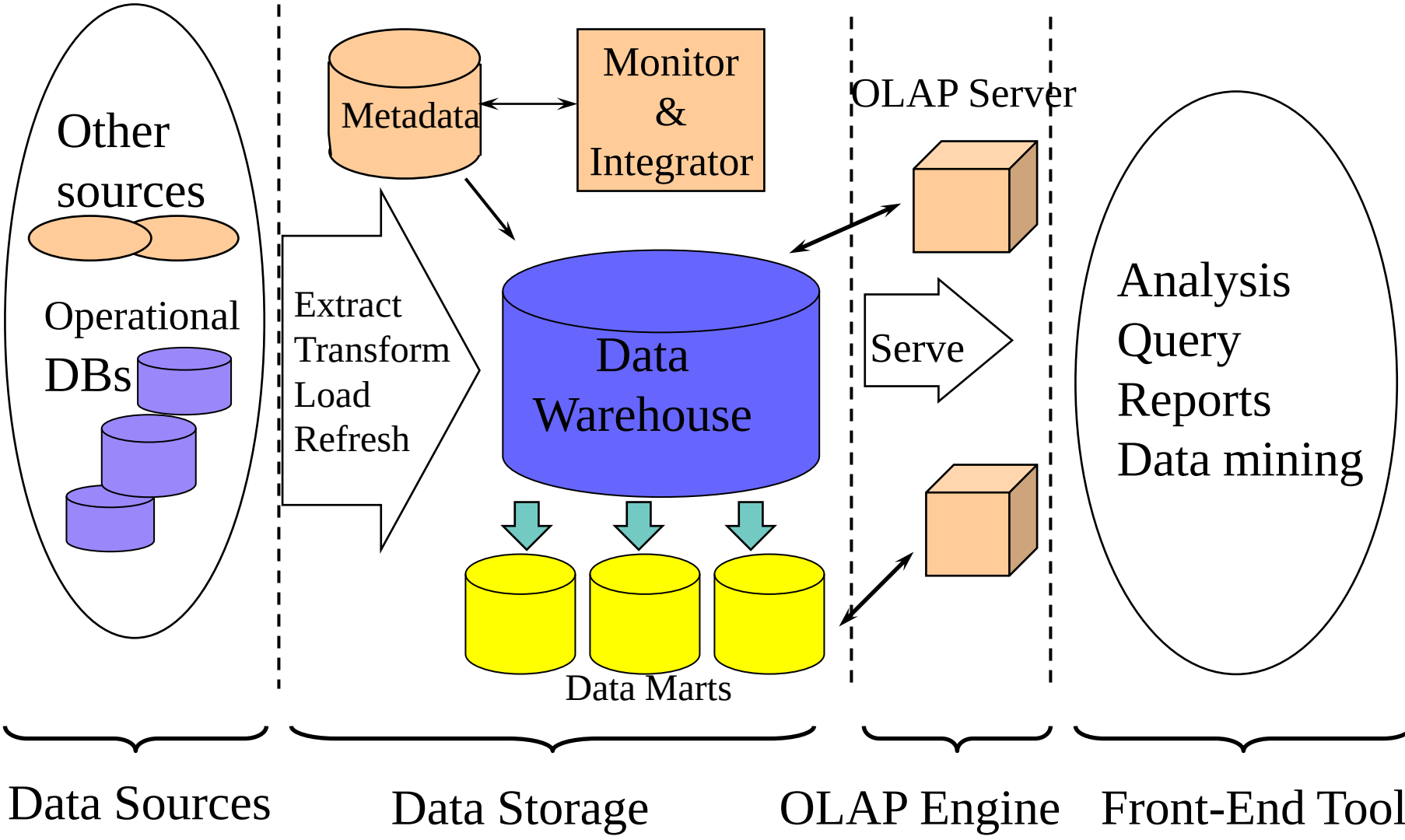
# System Architecture

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ARCH
Applied Research for Connected Health

ARCH
Applied Research for Connected Health

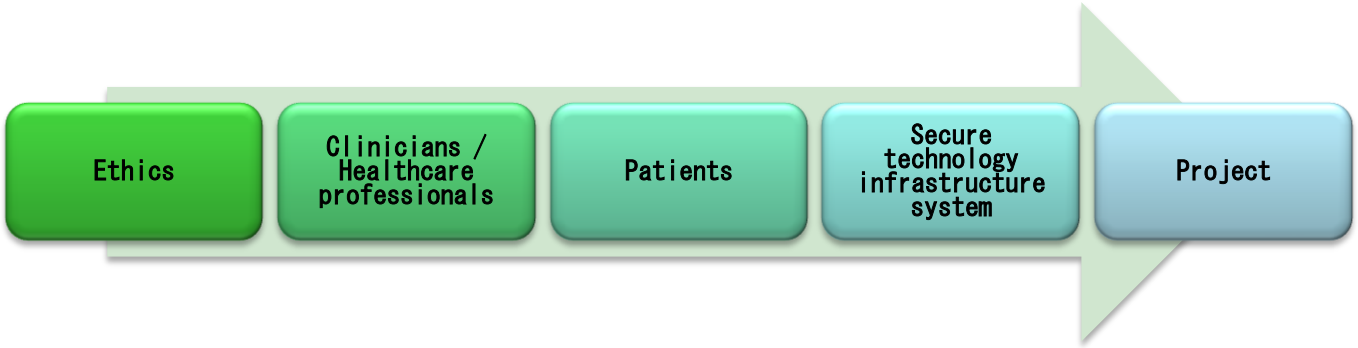
*the Irish Connected Health Technology Centre*

- **Established in Q1 2013**
- **EI / IDA Technology Centres Programme**

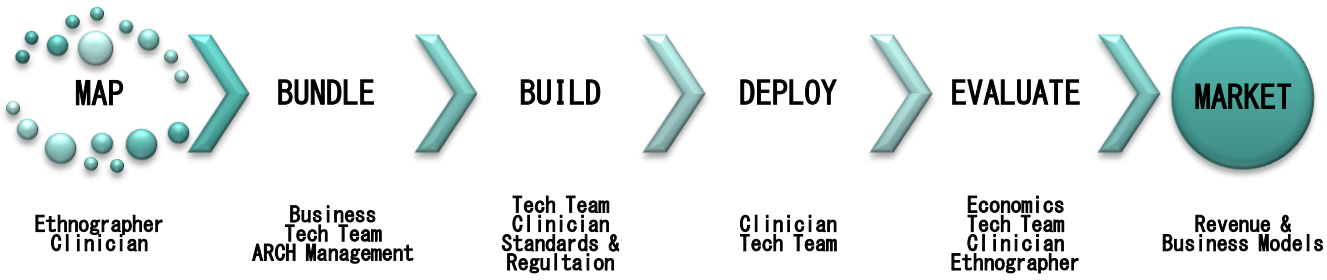
- **University based research capability designed to address common challenges associated with emerging CH sector**
- **Currently 15 industry members**
- **www.arch.ie**

ARCH
Applied Research for Connected Health

- **access to research expertise and technology infrastructure**
  - agile, cost effective research
  - de-risking innovation
- **access to a network of companies and healthcare professionals in the Connected Health value chain both nationally and internationally**
- **support in Connected Health project design**



Business Modelling
Health Psychology
Sociology and organisational culture
Clinical
Marketing
Healthcare Economics
Health informatics
Ethnography
Standards & Regulation
Engineering
ARCH
Applied Research for Connected Health


MAP
BUNDLE
BUILD
DEPLOY
EVALUATE
MARKET
Ethnographer
Clinician
Business
Tech Team
ARCH Management
Tech Team
Clinician
Standards &
Regultaion
Clinician
Tech Team
Economics
Tech Team
Clinician
Ethnographer
Revenue &
Business Models

# Research Themes

**CHANGE**
How can the barriers to the use of Connected Health technologies be overcome and maximum impact achieved?

- Adoption issues
- Behavioural change
- Ethnography
- HMI

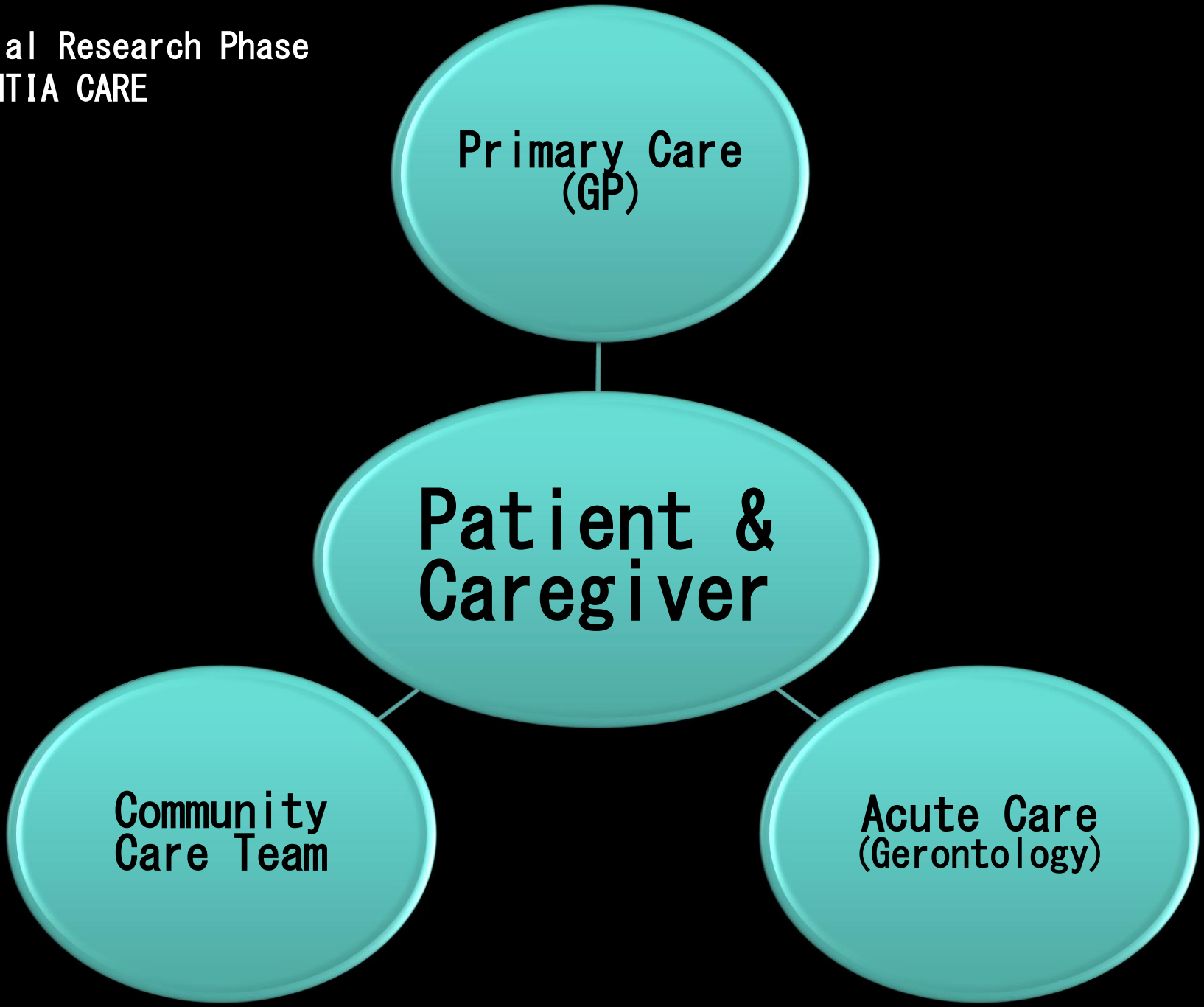
**CARE**
How care is delivered today and how might it be improved by Connected Health technologies?

- Care Pathways
- Patient journey
- Pain points in delivery of care

**DATA**
How will software, technology, data and processes be amalgamated and evaluated for use by differing stakeholders?

- Data Security
- Regulations
- Storage and analysis
- Standards & Quality

Initial Research Phase
DEMENTIA CARE



# ADST 001

| | |
|---|---|
| Address | Dublin General District 2,<br>Section 658,<br>85-93 Lower Mount Street,<br>Dublin 2<br>Ireland |
| Date of Birth | 23 September 1934 |
| Age | 79 years |

| | |
|---|---|
| Phone | 00353-38937294 |
| Next of kin | James Doe |
| GP | Popey Sailor |
| Hospital Consultant | Brutos McDonalds |
| PHN | I don't know |

## Information

View info about dementia

go to information >

## Questionnaires

You have 1 questionnaire

go to questionnaire >

## Profile

Manage your profile entries

go to profile >

## Measurements

Manage your measurements

go to measurements >

***thank you***

***@caulfieldbrian***