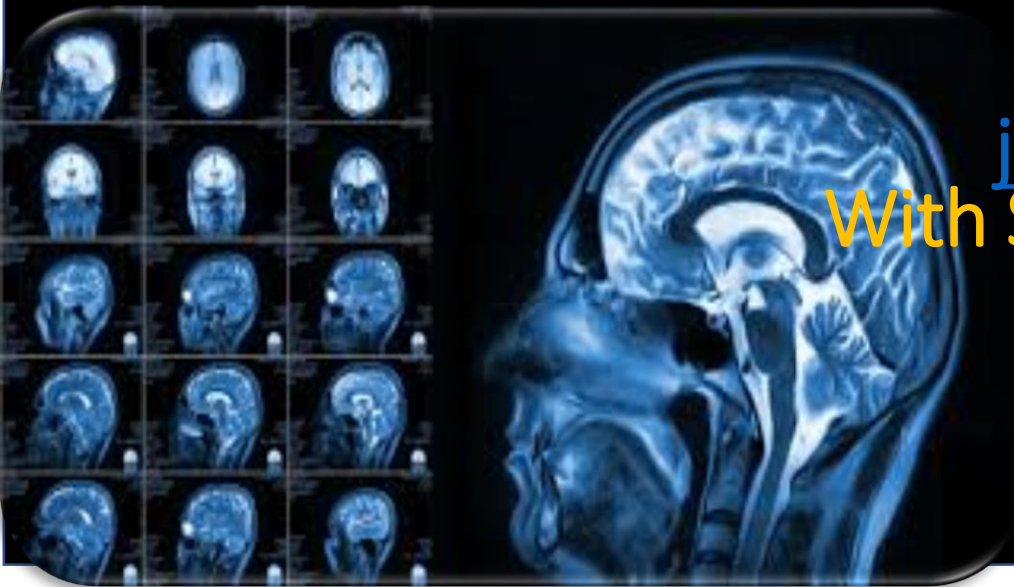
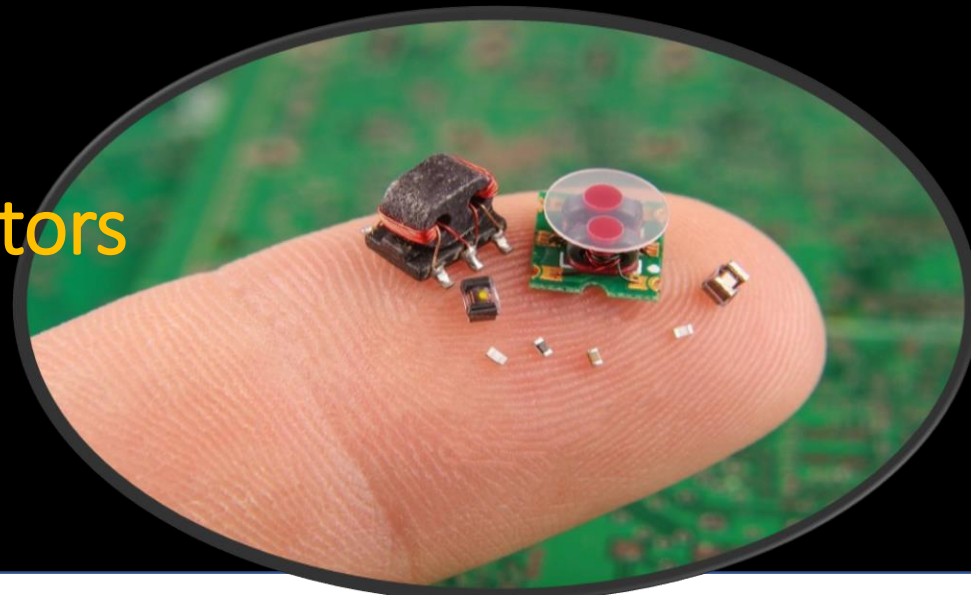


# Health Surveillance



Ramesh Jain  
[jain@ics.uci.edu](mailto:jain@ics.uci.edu)  
With Several Collaborators

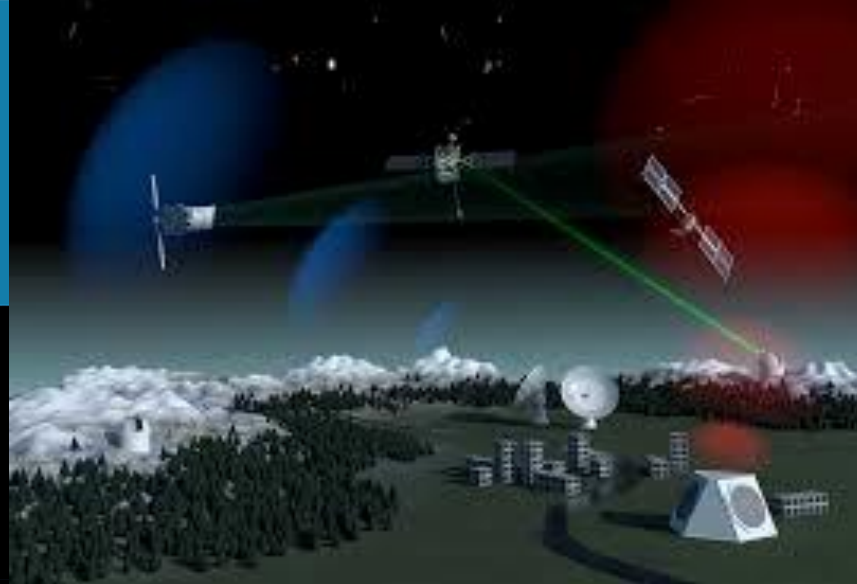


# Themes for Discussion

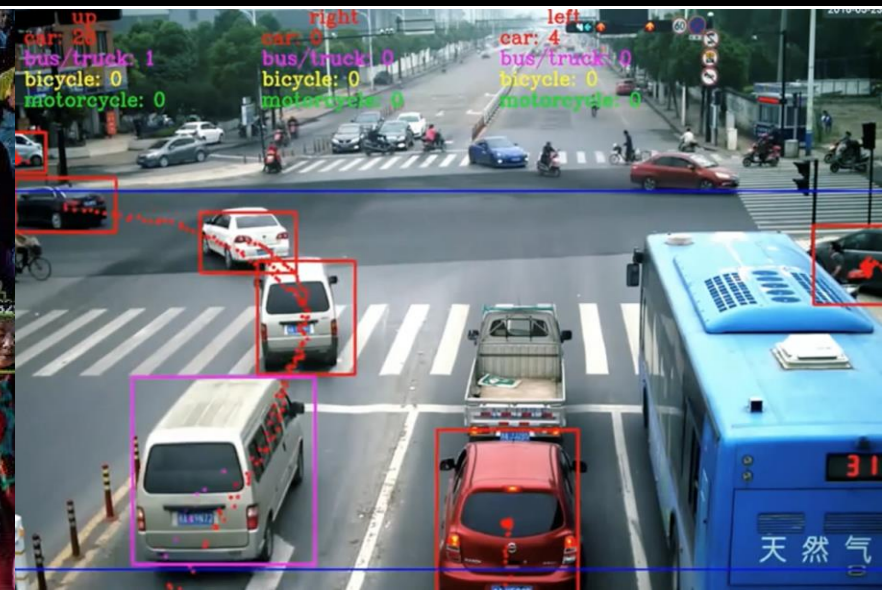
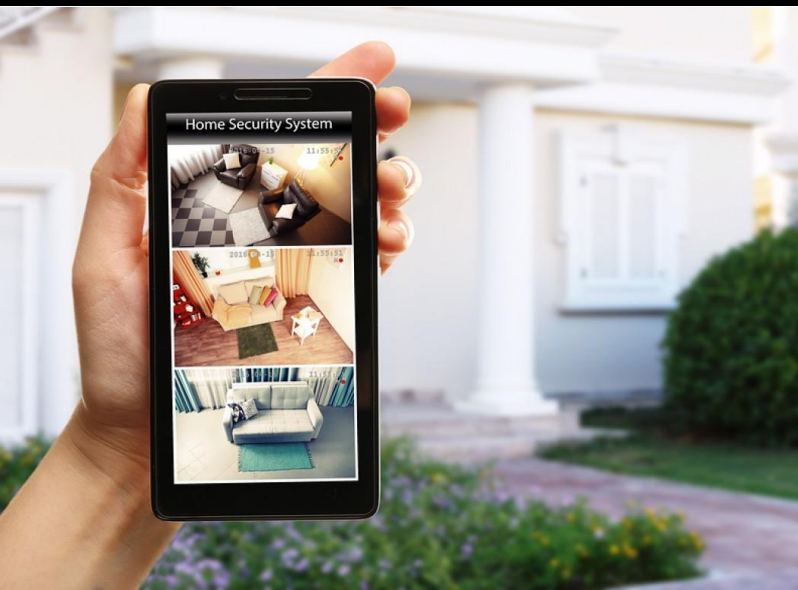
- **Surveillance Systems:** Computer Vision/AI/Multimedia
- **Empowering Health:** Current Trends and Future directions
- **Surveillance for Health:** New Frontier for Research
  
- **Potential Projects**

**See: A Navigational Approach to Health, IEEE Computer, Cover article, April 2019.**





Surveillance is essential for human life!



# Surveillance

**Surveillance (/sər'veɪ.əns/ or /sər'veɪləns/) is the monitoring of behavior, activities, or other changing information for the purpose of influencing, managing, directing, or protecting people.**



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[HTML] Mental health surveillance among children--United States, 2005-2011
S Aveneoli, J Baio, RH Bitsko, SJ Blumberg, DJ Brody... - 2013 - stacks.cdc.gov
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[BOOK] The invention of the passport: Surveillance, citizenship and the state
JC Torpey - 2018 - books.google.com
... David Lyon, probably the most distinguished analyst of modern surveillance techniques, has made this point in a ... I would be delighted if this study were to stimulate studies of systems of document ... to make sense of the processes that spawned the world-girdling system of passport ...

Abnormal behavior recognition for intelligent video surveillance systems: A review
AB Mabrouk, E Zagrouba - Expert Systems with Applications, 2018 - Elsevier
With the increasing number of surveillance cameras in both indoor and outdoor locations, there is a grown demand for an intelligent system that detects abnormal events. Although human action recognition is a highly reached topic in computer vision, abnormal behavior ...

Prevalence of spina bifida at birth—United States, 1983–1990: a comparison of two surveillance systems
JM Lary, LD Edmonds - ... MORTALITY WEEKLY REPORT: CDC Surveillance ... , 1996 - JSTOR
... This content downloaded from 66.249.79.86 on Thu, 14 Jun 2018 21:39:03 ... of spina bifida reported from 16 state-based birth defects surveillance systems and the ... Surveillance system Northeast New Jersey New York Total North Central Illinois Iowa Missouri Nebraska Total ...

Related searches

- video surveillance systems surveillance systems updated guidelines
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[HTML] Prevalence and characteristics of autism spectrum disorder among children aged 8 years—autism and developmental disabilities monitoring network, 11 sites ...
DL Christensen, KVN Braun, J Baio... - MMWR Surveillance ... , 2018 - ncbi.nlm.nih.gov
... and Developmental Disabilities Monitoring (ADDM) Network is an active surveillance system that provides ... Estimated prevalence was higher in surveillance sites where education records and health ... and health records suggests the role of special education systems in providing ...

Towards a genomics-informed, real-time, global pathogen surveillance system
JL Gardy, NJ Loman - Nature Reviews Genetics, 2018 - nature.com
Abstract The recent Ebola and Zika epidemics demonstrate the need for the continuous surveillance, rapid diagnosis and real-time tracking of emerging infectious diseases. Fast, affordable sequencing of pathogen genomes—now a staple of the public health ...

[HTML] Prevalence of autism spectrum disorder among children aged 8 years- autism and developmental disabilities monitoring network, 11 sites, United States, 2010
J Baio - 2014 - stacks.cdc.gov
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VS Chernyak - 2018 - taylorfrancis.com
... JORN Jindalee over-the-horizon SSR secondary surveillance radar operational radar network TDOA ... definition of MSRSs which covers both Multistatic Radars and Multiradar (Netted Radar) Systems. We define a MSRS as a radar system including several spatially separated ...

[BOOK] Veterinary epidemiology
M Thrusfield, R Christley - 2018 - books.google.com
... part of this publication may be reproduced, stored in a retrieval system, or transmitted ... of participatory epidemiology 481 402 0003337191.3D 14 25/1/2018 6:04 ... surveillance 485 Aquatic-animal surveillance 485 Assessing the performance of surveillance systems 486 ...

[BOOK] Global tuberculosis report 2018
World Health Organization - 2018 - apps.who.int
... Geneva: World Health Organization; 2018 ... TB RT-qPCR reverse transcriptase quantitative PCR SDG Sustainable Development Goal SHA System of Health ... and hundreds of people working for national TB programmes or within national surveillance systems who contributed to ...

Detecting influenza epidemics using search engine query data
J Ginsberg, MH Mohebbi, RS Patel, L Brammer... - Nature, 2009 - nature.com
... Polgreen, PM, Chen, Y., Pennock, DM & Forrest, ND Using internet searches for influenza surveillance. Clin. Infect. Dis. 47, 1443–1448 (2008) ... Author Contributions JG and MHM conceived, designed and implemented the system ... Information Systems Frontiers (2019) ...

Vehicle surveillance system, vehicle surveillance method, and program
T OKAZAKI, T FUKASE - US Patent App. 10/157,541, 2018 - Google Patents
A vehicle surveillance system includes: a photographing unit configured to photograph a target vehicle; a positional information acquisition unit configured to acquire positional information indicating a position of the photographing unit; a surveillance information ...

Digital disease detection—harnessing the Web for public health surveillance
JS Brownstein, CC Freifeld... - New England Journal of ... , 2009 - Mass Medical Soc
Perspective from The New England Journal of Medicine — Digital Disease Detection — Harnessing the Web for Public Health Surveillance.

The reporting sensitivities of two passive surveillance systems for vaccine adverse events.
S Rosenthal, R Chen - American Journal of Public Health, 1995 - ajph.aphapublications.org
... admin- istered during the periods covered by the monitoring and reporting systems were estimated (1 ... public sector funds from January 1985 through October 1990 (the monitoring system) and from ... local recipients of grant funds; and (2) from CDC Biologics Surveillance of doses ...

[BOOK] Video-based surveillance systems: computer vision and distributed processing
P Remagnino, GA Jones, N Paragios, CS Regazzoni - 2002 - Springer
... PDF. Intelligence Distribution of a Third Generation People Counting System Transmitting Information ... The latest generation of surveillance systems has eagerly adopted re cent technological ... The resultant surveillance products are highly-flexihle, capahle of generating forensic ...

[BOOK] Implanting strategic management
HI Ansoff, D Kiple, AO Lewis, R Helm-Stevens... - 2018 - books.google.com
... strategy Diversity of product-technology strategy Diversity of production system Examples of

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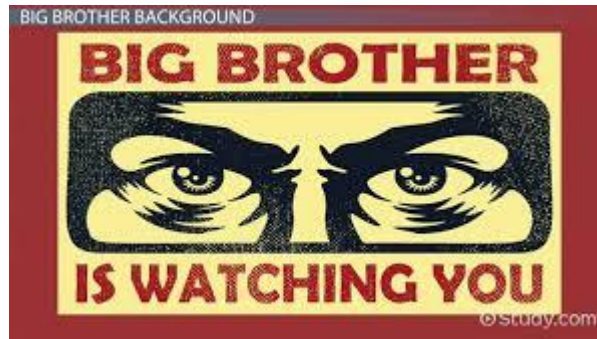
[HTML] nih.gov UC-eLinks

[PDF] aphapublications.org Full View

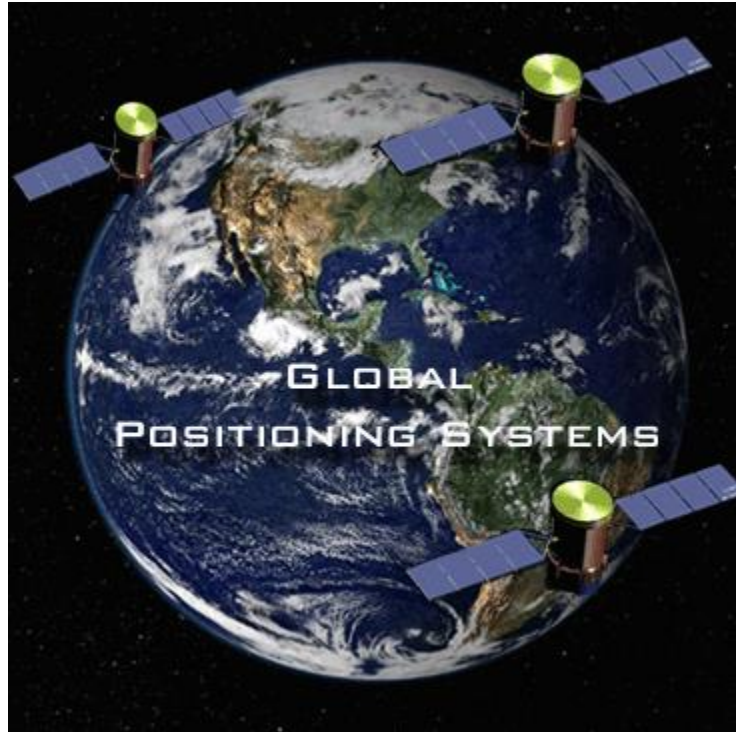
# Surveillance Society



Panopticon



# Self Surveillance



# *Video Surveillance*

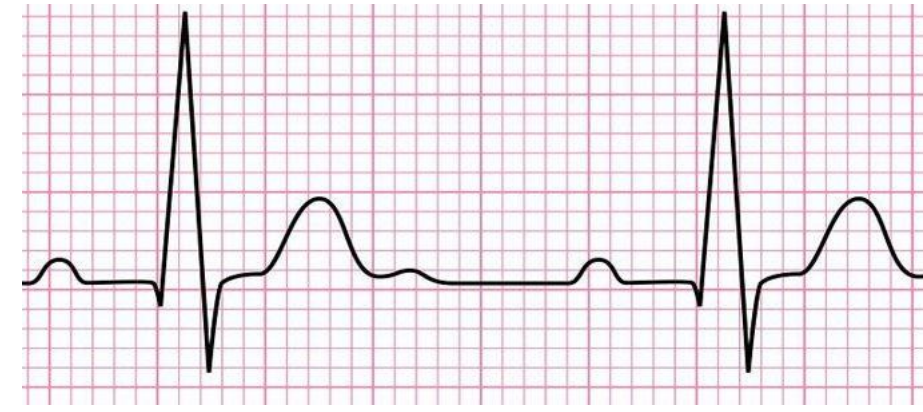
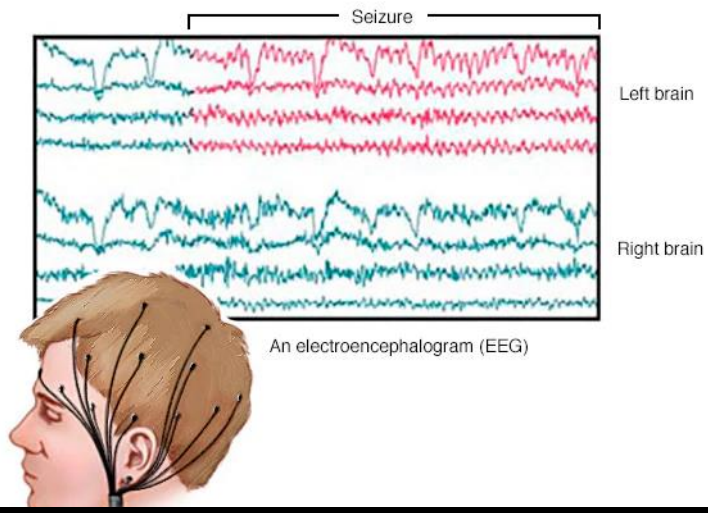
- **Surveillance is important motivation in vision.**
- **Many cities now have millions of cameras for surveillance.**
- **Face recognition is now commonly used. Emotion analysis is making progress.**



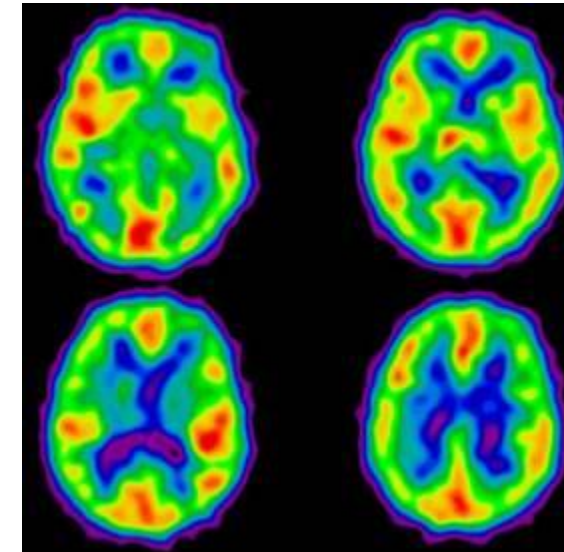
# Health

In 1948, the World **Health** Organization (WHO) defined **health**:

**"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."**

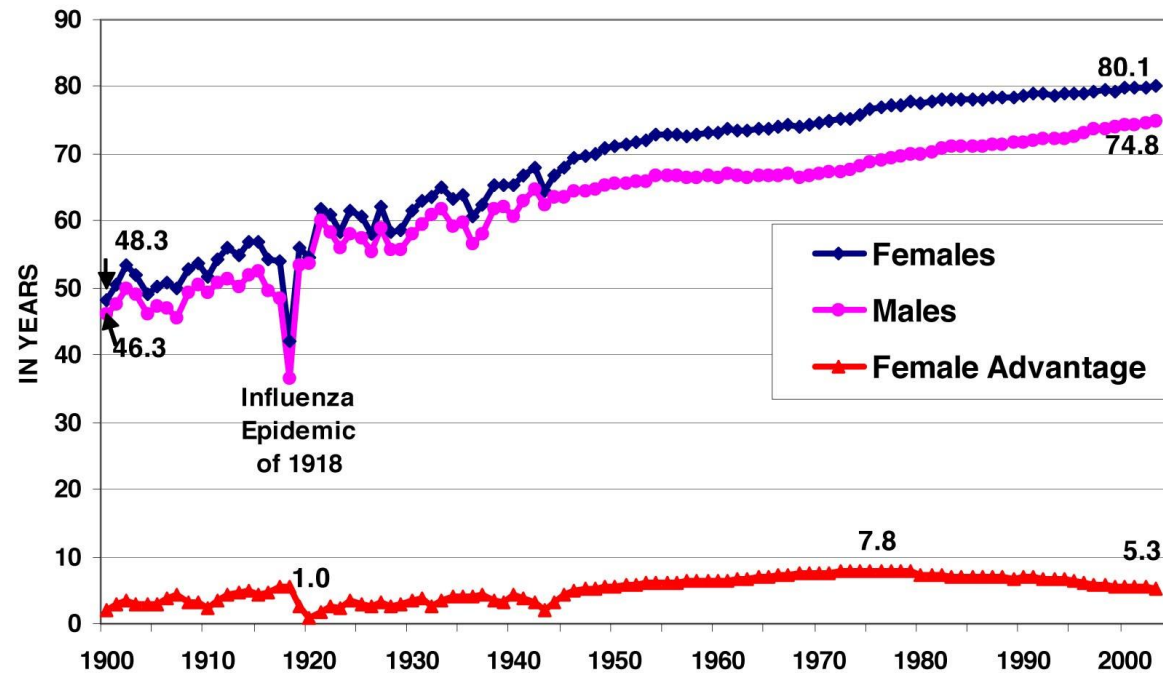


# Health Surveillance Modalities



# Important Turning Point in Health

Figure 1. Life Expectancy at Birth, by Sex: 1900 to 2003.



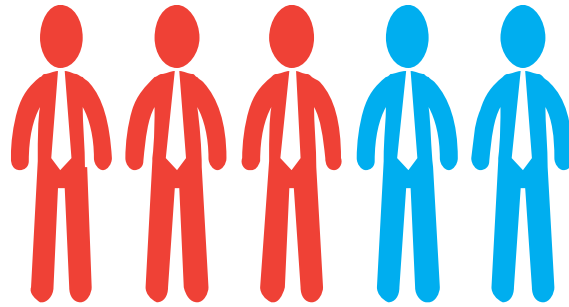
**Source:** For 1900-2002, CRS analysis based on data contained in NCHS, United States Life Tables, 2002, *National Vital Statistics Report*, vol. 53, no. 6, Nov. 10, 2004. For 2003, CRS analysis based on NCHS, Deaths: Final Data for 2003, *National Vital Statistics Report*, vol. 54, no. 13, Apr. 19, 2006.

**In the mid-20th century, the primary causes of death worldwide shifted from infections to chronic conditions.**



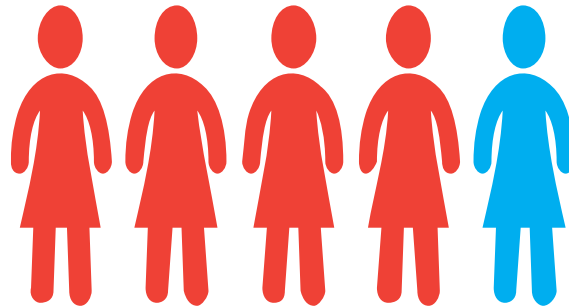
# Chronic Diseases

The Effect of Chronic Diseases, 2016\*



**7 of 10 Deaths**

Due to chronic diseases



**86% of Costs**

Driven by treating chronic diseases



Heart Disease



Cancer



Type 2 Diabetes



Brain Diseases



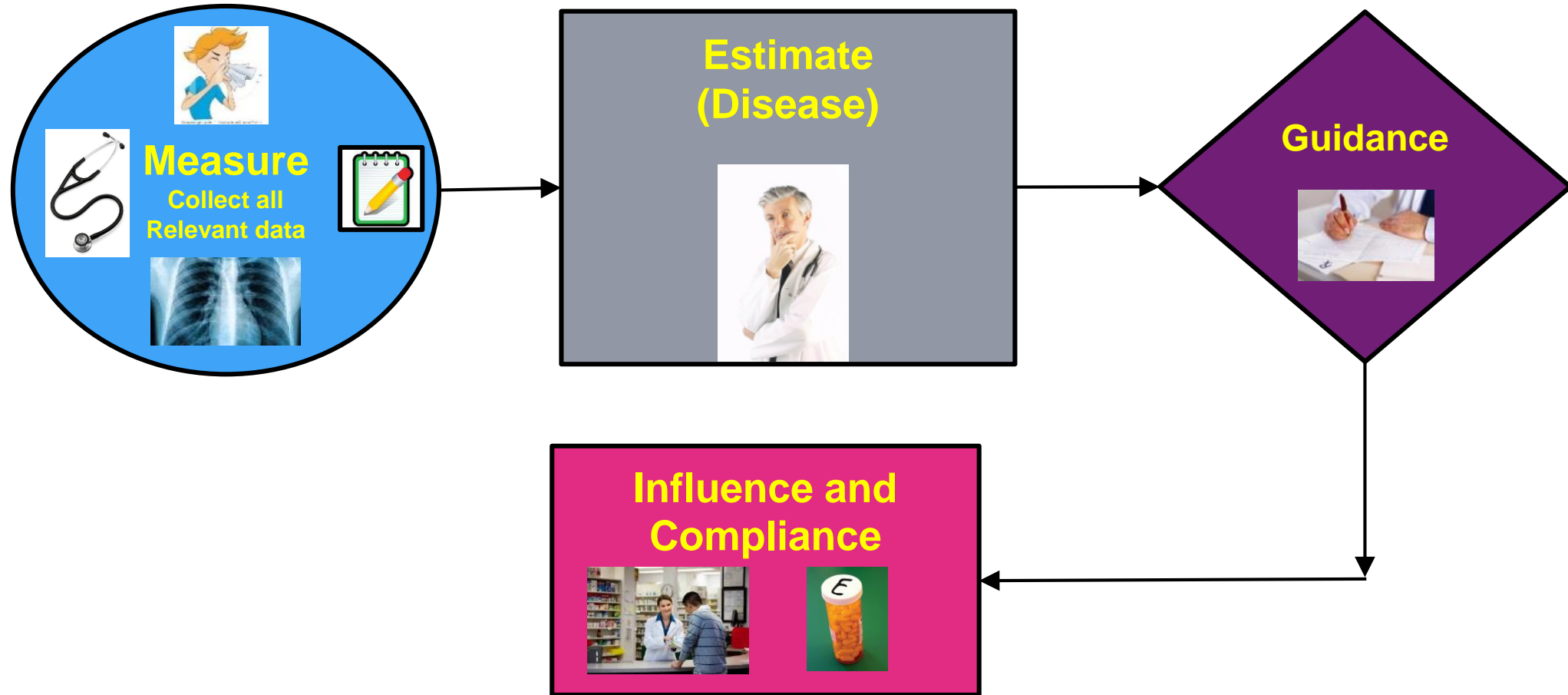
Lung Diseases



Bone Diseases

**Our Healthcare is still based on infectious disease.**

# Episodic Health Cycle: MEGI



**Health: Collect Data; Derive Actionable Information; Provide Guidance at Right Time, in Right Situation, in a Right way.**

When do people get best healthcare?



When they are about to die – in ICU.



# My dream: Empowering Personal Health



For every living person in the world.

# Health Navigator

- What if an app could guide you to better health, similar to how GPS navigation directs you to your desired destination?
- What if the app could use real-time information to redirect you around a disease, just as you're rerouted to avoid traffic?
- What if the app could provide step-by-step directions to get you to your optimal health state, whether you're a professional athlete or retired school teacher?

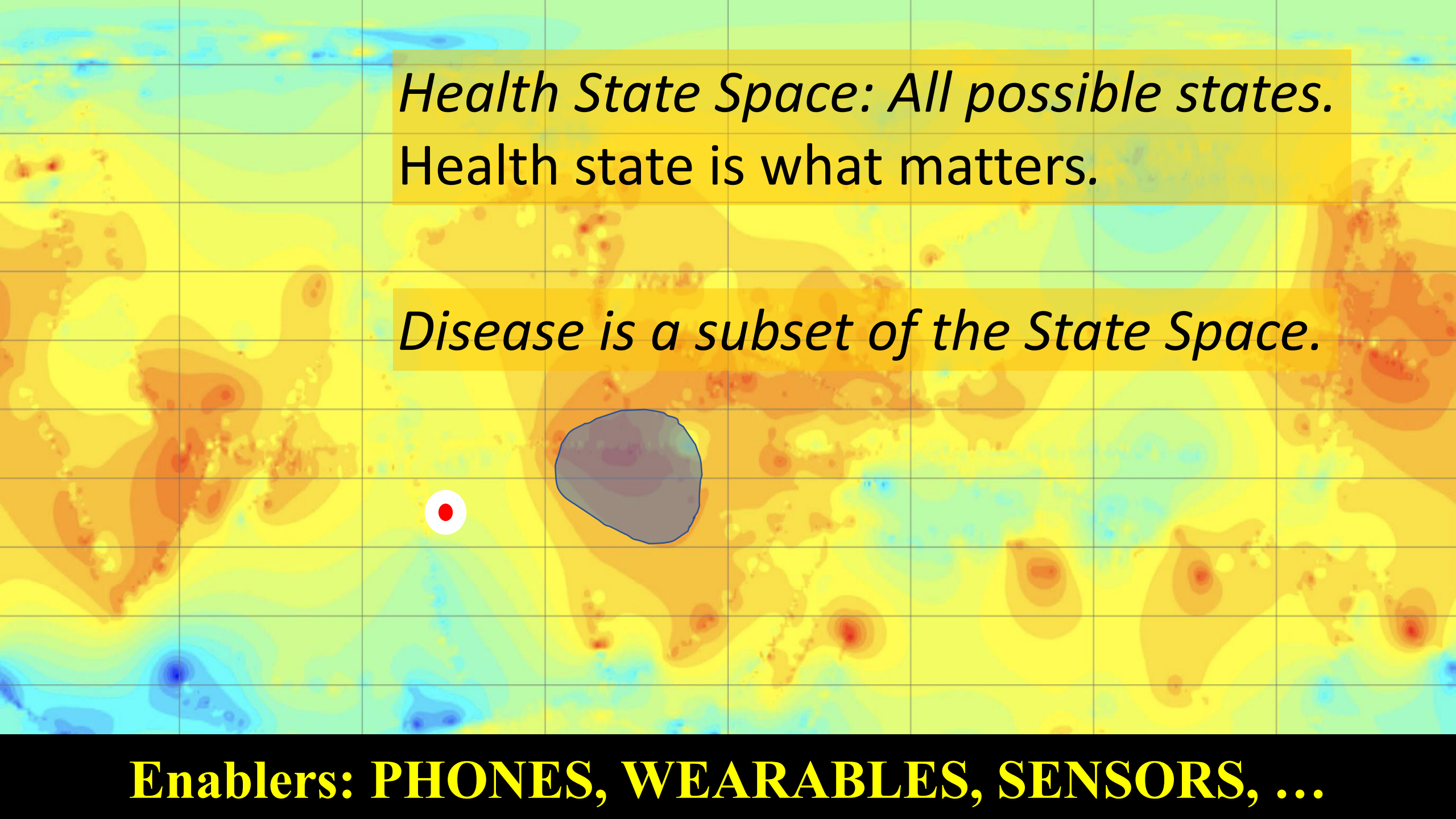
# What do we require to make this happen?

- **Key elements:**

- **Health State:** A disease is name given to a health state.
- **Personal Model:** Build a model of a person from Health perspective.
- **Perpetual Guidance:** Right advice at right time in right situation.

**Key Technologies: Sensors, Multimedia, AI.**





*Health State Space: All possible states.  
Health state is what matters.*

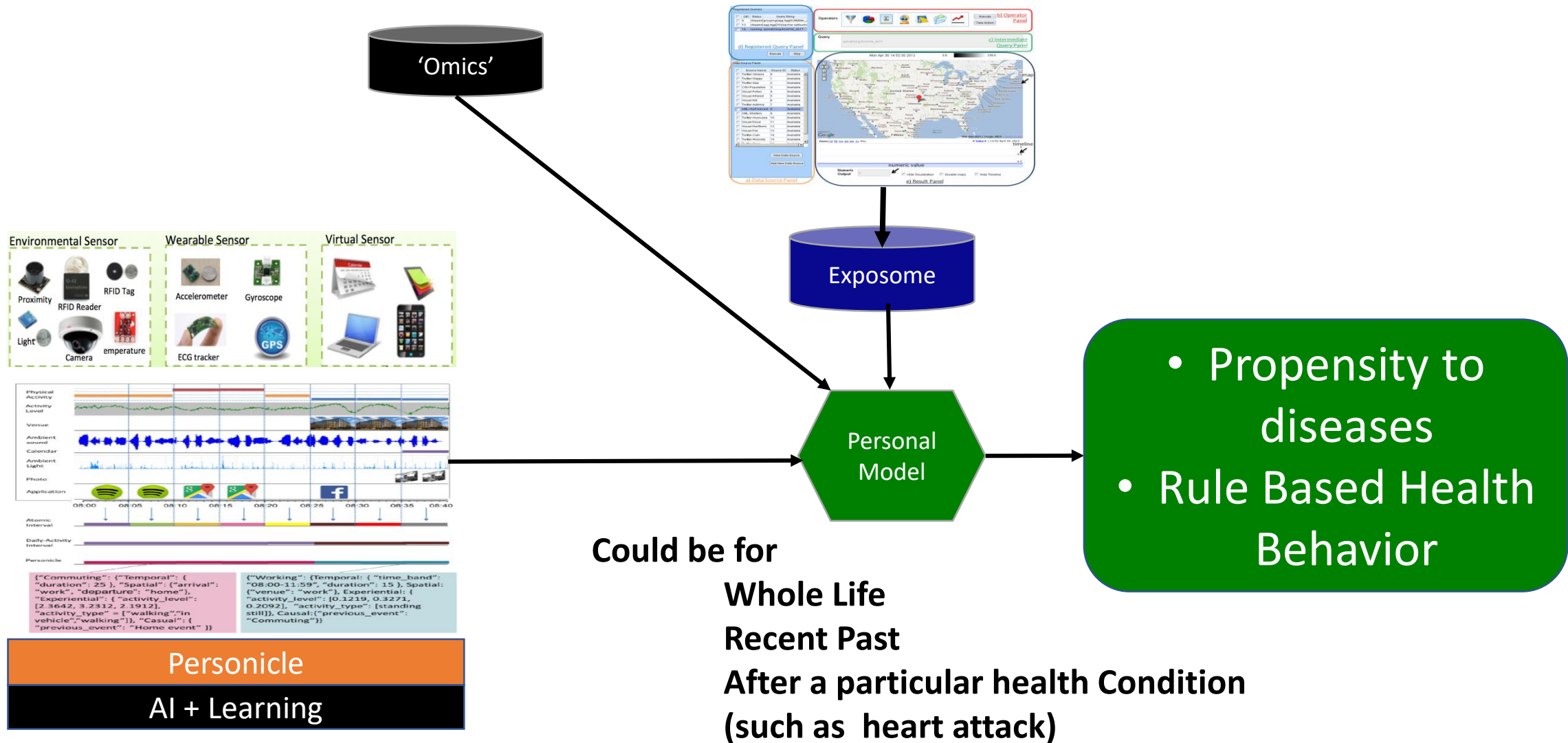
*Disease is a subset of the State Space.*

**Enablers: PHONES, WEARABLES, SENSORS, ...**

# We Control Our Health!



# Person ::= Genome + Lifestyle + Exposome





# Personal Model



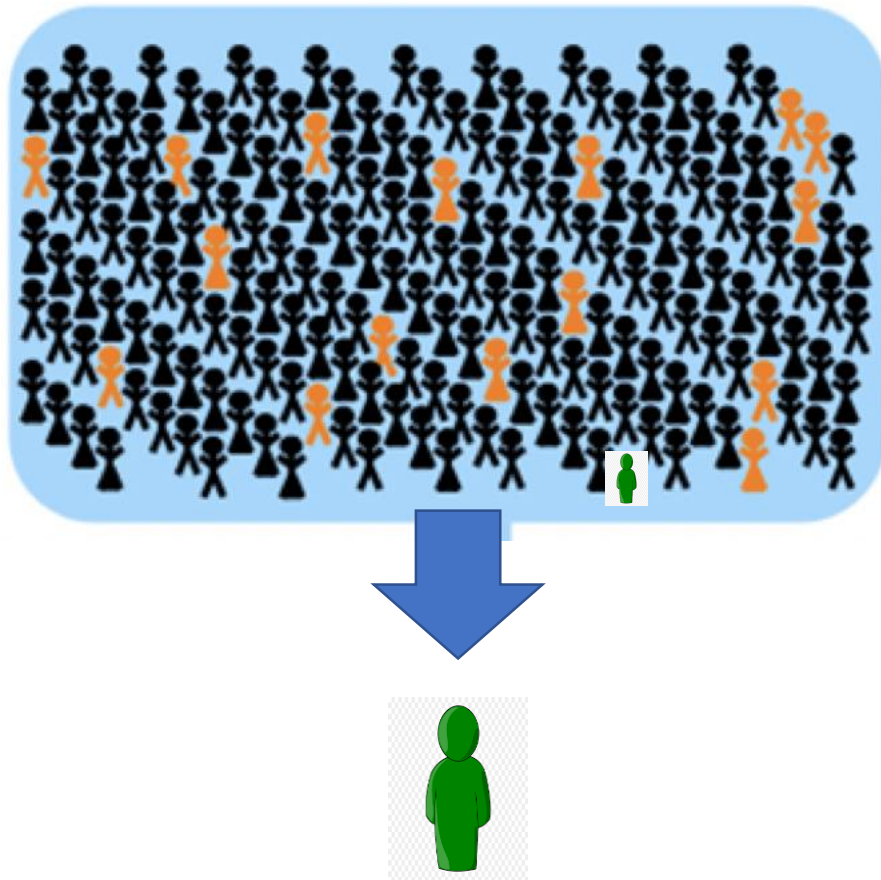
**Society exists only as a mental concept;  
in the real world there are only  
individuals.**

**-- Oscar Wilde**





# An Individual is not an average of a Population



**An Average human has:  
One breast, and  
One testicle?????**

**Longitudinal data for N-of-1 Studies.**

Businesses started building Personal Models



Businesses must understand their Customers.

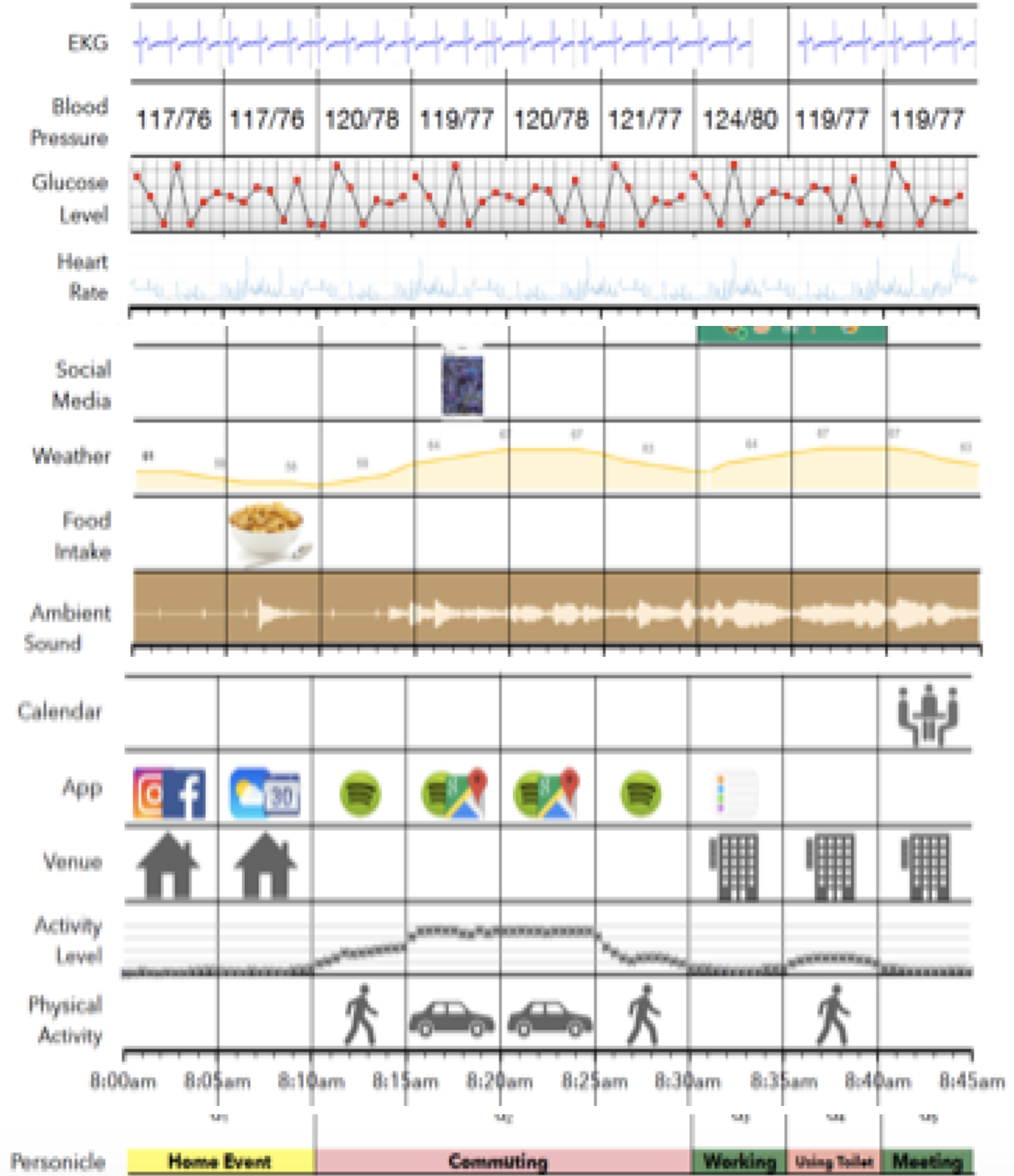
# Personal Chronicle: Personicle

Personicle is a complete chronological record of person-centered events in life (health, social, environmental) captured objectively but augmented using subjective information as needed.

Personicle is the event base that will revolutionize Health.

Use some streams and determine life events.

Add other personal streams as **NEEDED.**





# Personicle: Key Event Streams

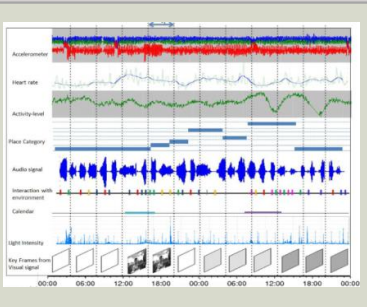
- **Lifestyle: Food, Activity, Sleep**
- **Environment: AirQuality, Weather, altitude, ...**
- **Biological: Biomarkers, diagnostics**
- **Social/Emotional**
- **Personal: Daily events, major events**

**Computer Vision will Play Key Role in Every Stream.**

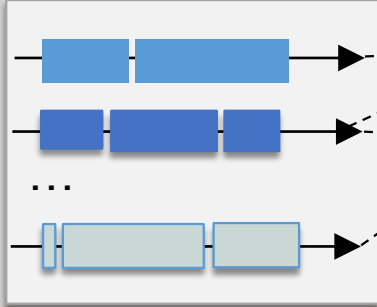
# Interactive Event Mining: Correlation and Causality

## Data-Driven Analysis

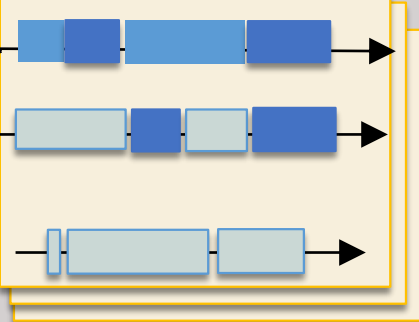
### Data Streams



### Event Streams



### Semi-interval Event Sequences



Bottom Up

## Hypothesis-Driven Analysis

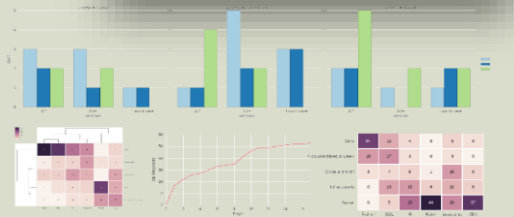
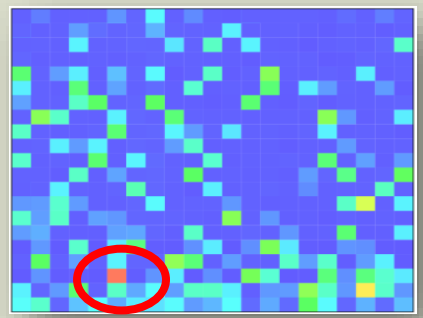
While air pressure is high, pollution starts increasing gradually, within  $T$  time units asthma outbreak happens.

Example:

$((\text{pollution\_inc\_steadily} ; \omega_T \text{ asthma\_outbreak } ) || \text{airpressure\_stayshigh})$

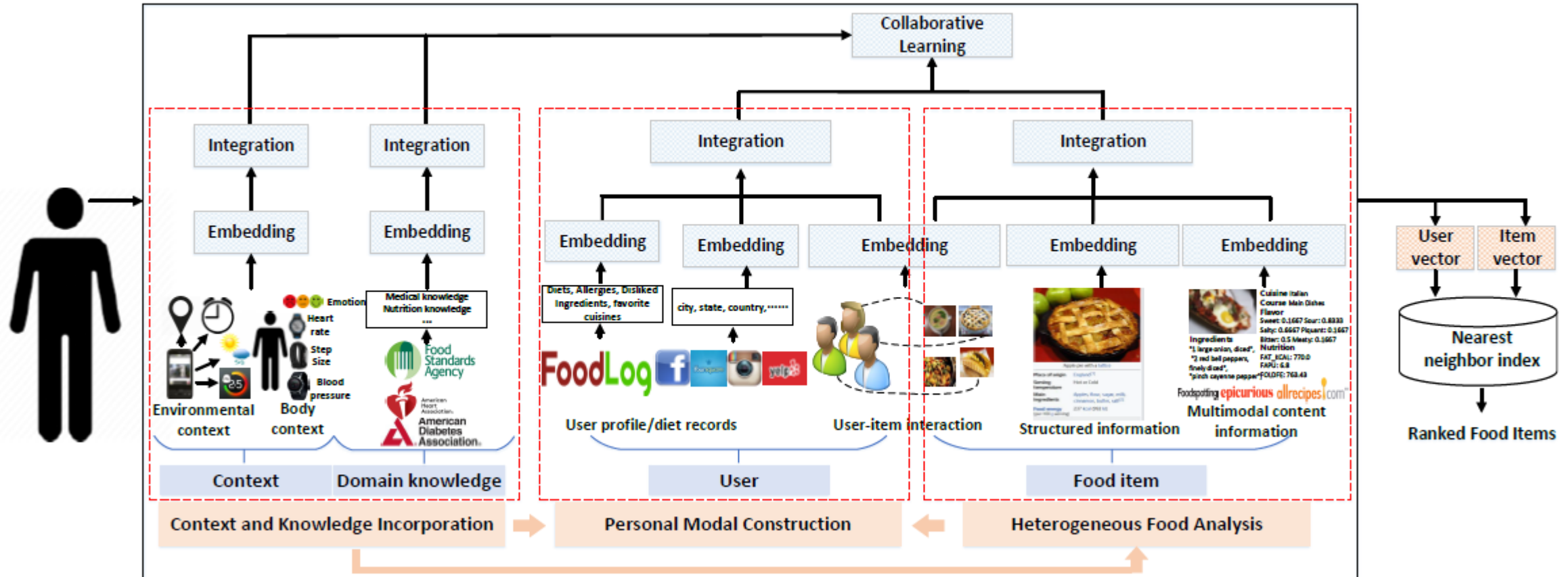


## Interactive Visualization



Top Down

# Food Recommendation



Food \* Person \* Context

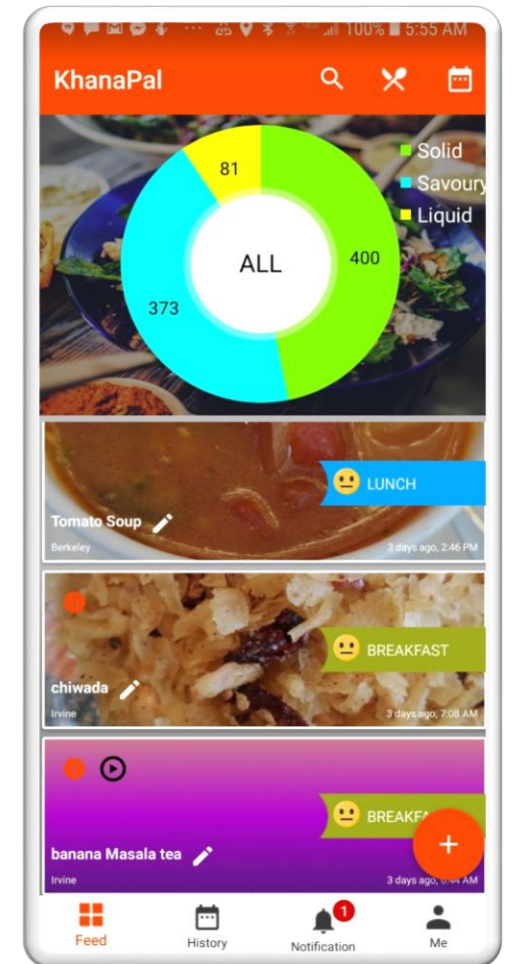
# Food is an important MISSING LINK

No good technique for **logging food diary**

Food Recognition

Nutrition in Food

People's preferences: **what when, where, weather, company, ...**



**Grand Challenge: Create a Detailed Personal Food Log.**



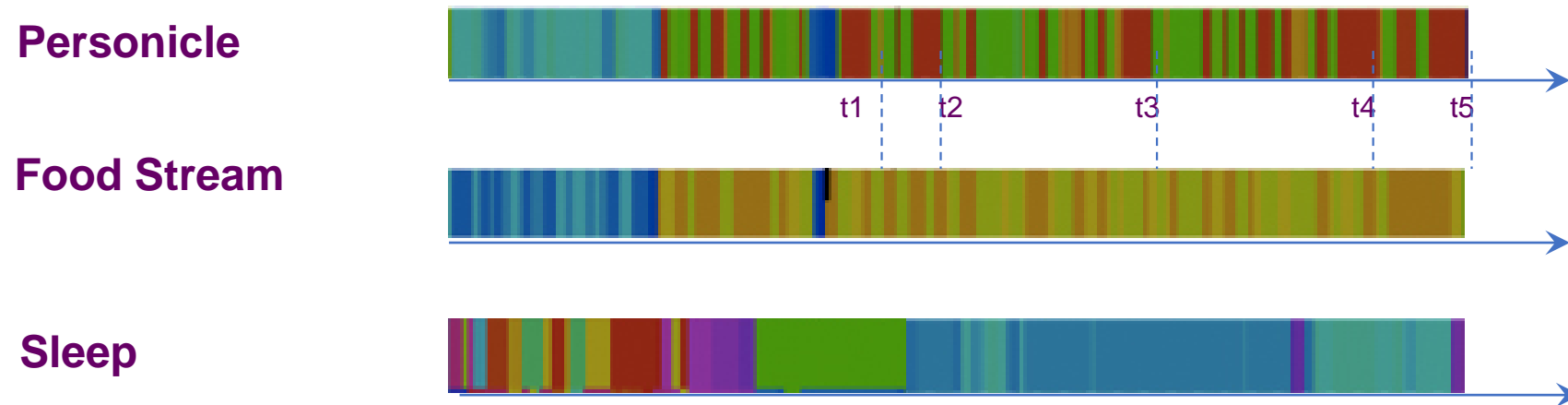
# Adding Emotional Stream to Personicle in a Smart Home

- Visual and Audio analysis for understanding emotions.
- Refine using HRV and such



# Event Mining for Rule-Based Actionable Insights

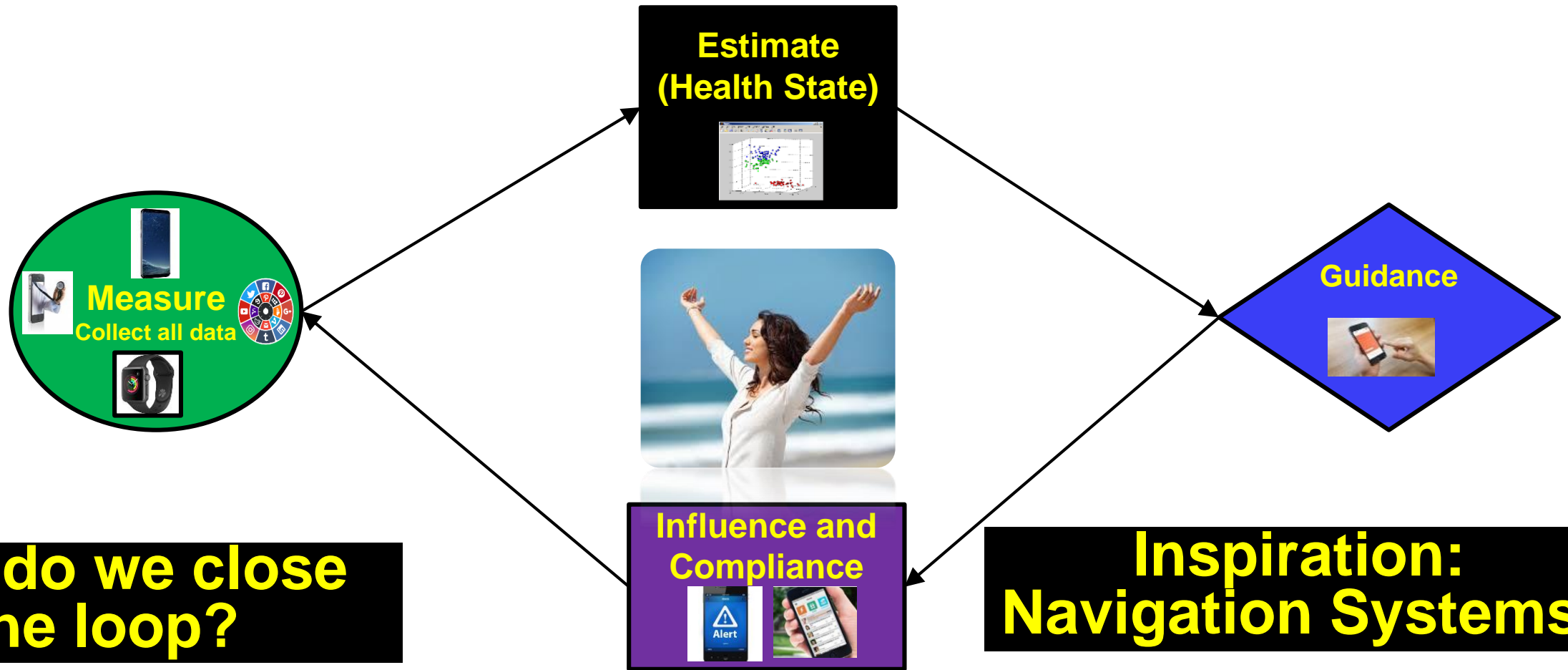
Having difficulty sleeping well on several nights.



**Spicy food and 2 glasses of wine result in sleepless nights.**

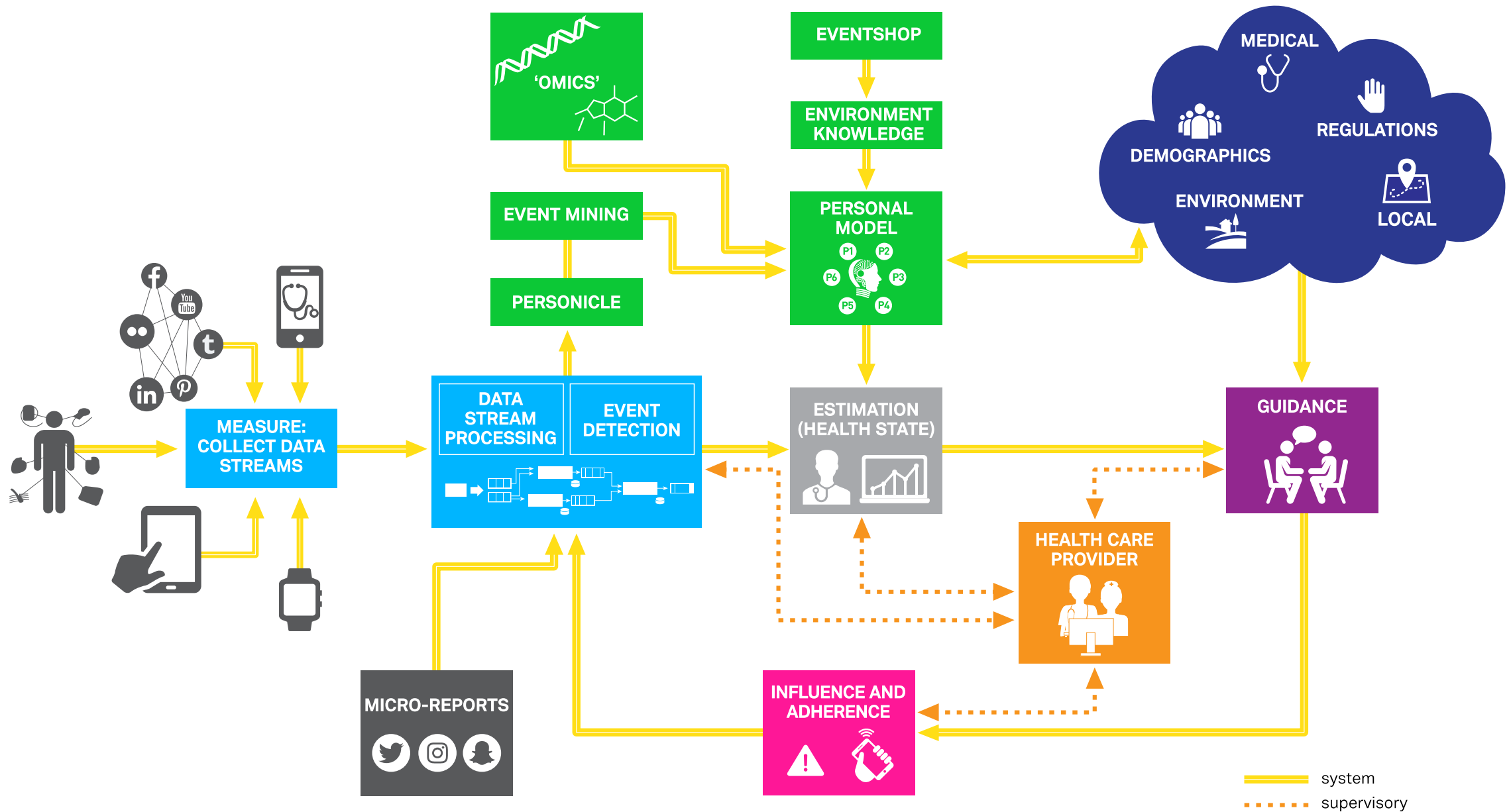
**Warn him when he is at an Indian restaurant.**

# Perpetual Health Guidance



**Data and Models may help.**

# Personal Health Navigator





# Potential Projects: 1

- **Building a Personal Health Navigator for Simple Applications**
  - Depression
  - Weight Management
  - Diabetes
  - ...

# Potential Projects: 2

- **Building Personal Model using a log of data (Phones, wearables, social media, ...)**
  - **Identifying events and then building simple personal model**
  - **Contextual/Situational Profile of a person (how profile depends on**

# Potential Projects: 3

- **Visual surveillance for Health**
  - **Face based health analysis**
  - **Emotion recognition using Surveillance cameras**

# Better Health for All



Thanks.

[jain@ics.uci.edu](mailto:jain@ics.uci.edu)