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## Deep Learning and Digital Health

Yu Cao

*University of Massachusetts Lowell*

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# Deep Learning and Digital Health

**Presented by**

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Lowell, MA 01854, USA

I have no actual or potential conflict of interest in relation to this program/presentation.

# Basic Information about Myself (1)

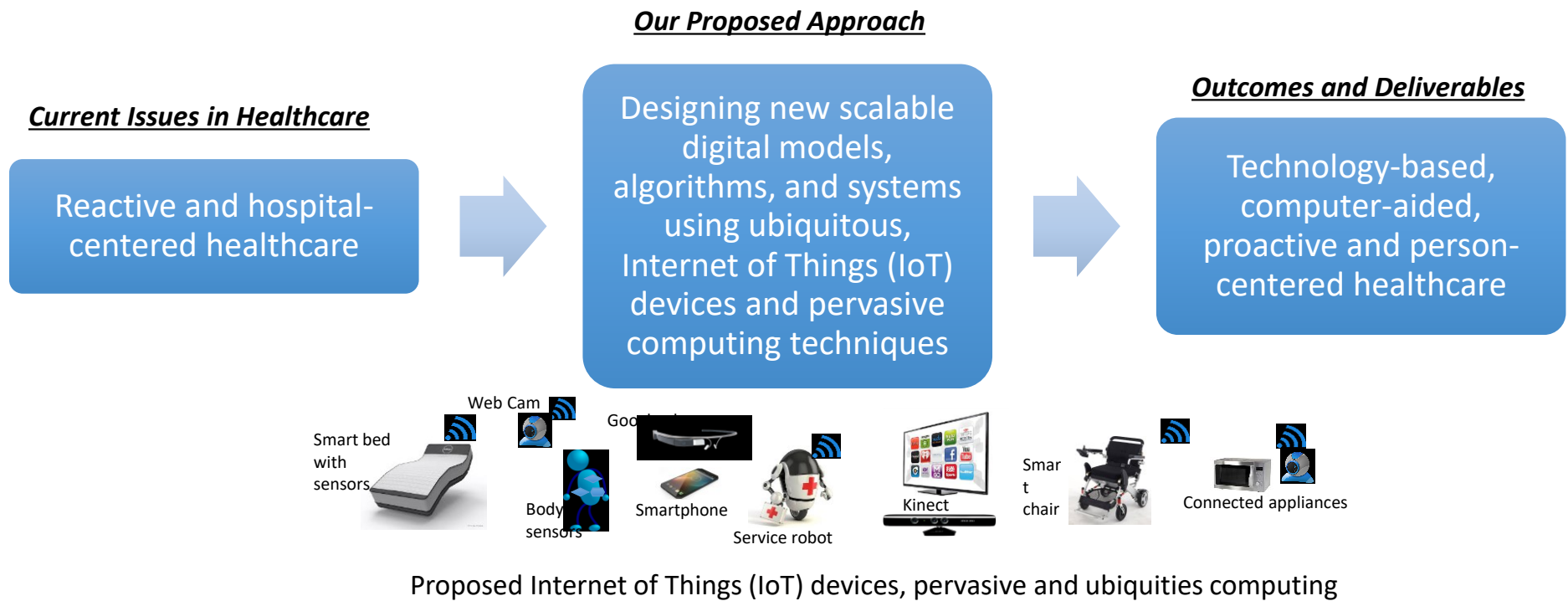
- Prof. Yu Cao, Ph.D.,
  - Associate Professor (06/2016 - present), Assistant Professor (08/13-06/16) of Computer Science, UMass Lowell
  - Co-director, UMass Center for Digital Health (effective from 06/2016)
  - Assistant Professor of Computer Science at University of Tennessee (08/2010-06/2013)
  - Assistant Professor of Computer Science at California State University (07/2007-06/2010)
  - Research Fellow of Biomedical Engineering at Mayo Clinic, Rochester, Minnesota (2006-2007)
  - Ph.D. in Computer Science from Iowa State University (2002-2007)

# Basic Information about Myself

- Research interests and expertise
  - Big Data Analytics
    - Scalable machine learning/deep learning algorithms and system for big data analytics
  - Computational Intelligence
    - Learning-based data stream analysis
    - Time series causality analysis
  - Multimedia Computing
    - Content-based image, video, and text retrieval and analysis
  - Biomedical Informatics
    - Digital health

# Our Research Focus on Digital Health - Research Focus 1

## Designing scalable pervasive healthcare monitoring, rehabilitation, and public health systems



# Our Research Focus on Digital Health - Research Focus 2

**Building high performance networking and computing infrastructure for health data transmission and computation**

## Our Proposed Approach

### Current Issues in Healthcare

Ever growing health data and unreliable, unsecure networking

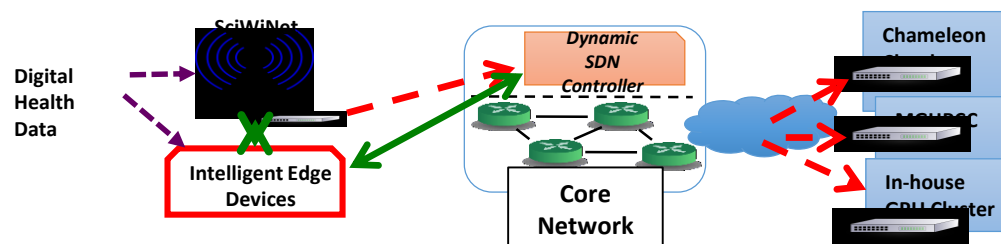


Building high performance, secure networking and computing system using Software Defined Network (SDN), fog and cloud computing, and heterogeneous computing architectures



### Outcomes and Deliverables

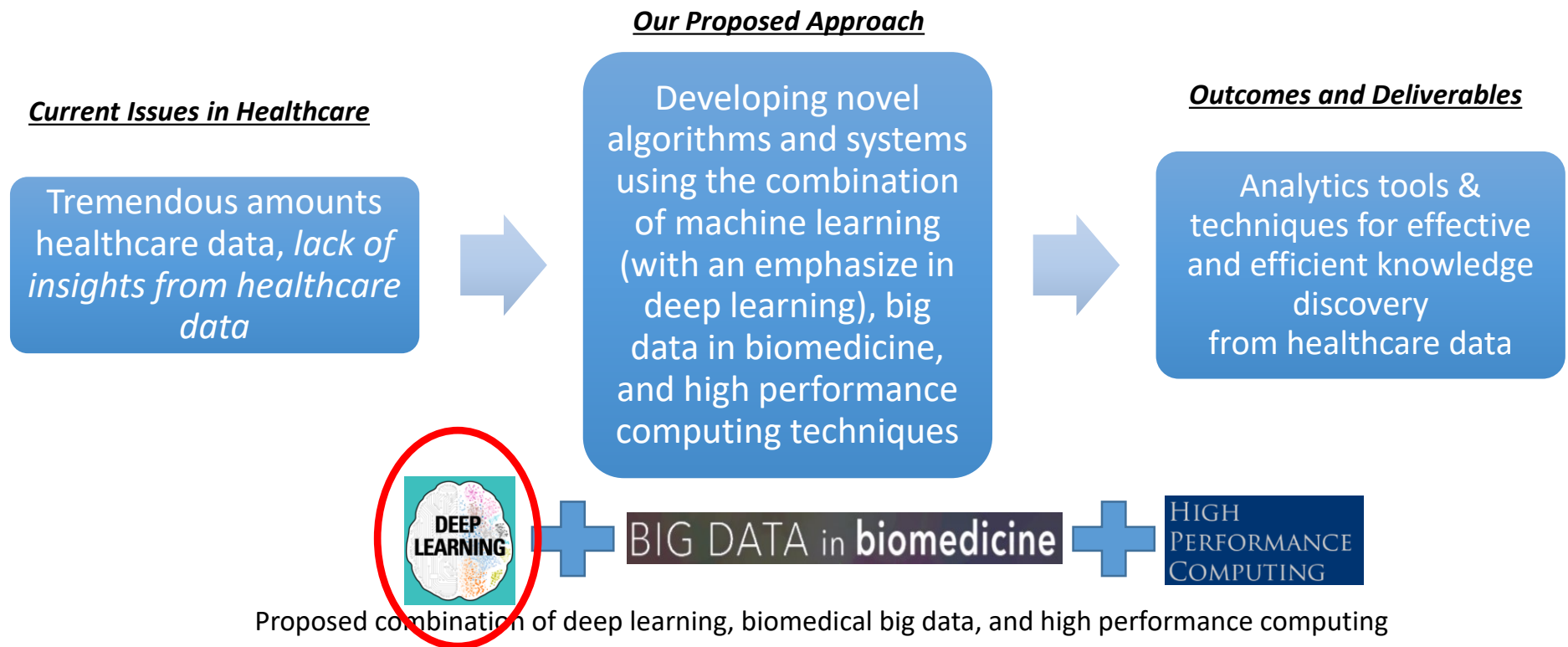
Reliable and secure networking and computing system for health data sharing and computation with privacy preserving



Proposed high performance, secure, networking and computing infrastructure

# Our Research Focus on Digital Health - Research Focus 3

**Developing novel algorithms and systems for big data analytics in healthcare**





# Our recent results in the field of deep learning with applications to digital health

- (1) Medical imaging informatics for large-scale mining/classification
- (2) Biomedical sensor informatics for scalable behavioral activity profiling

# Medical imaging informatics - Sample project 1

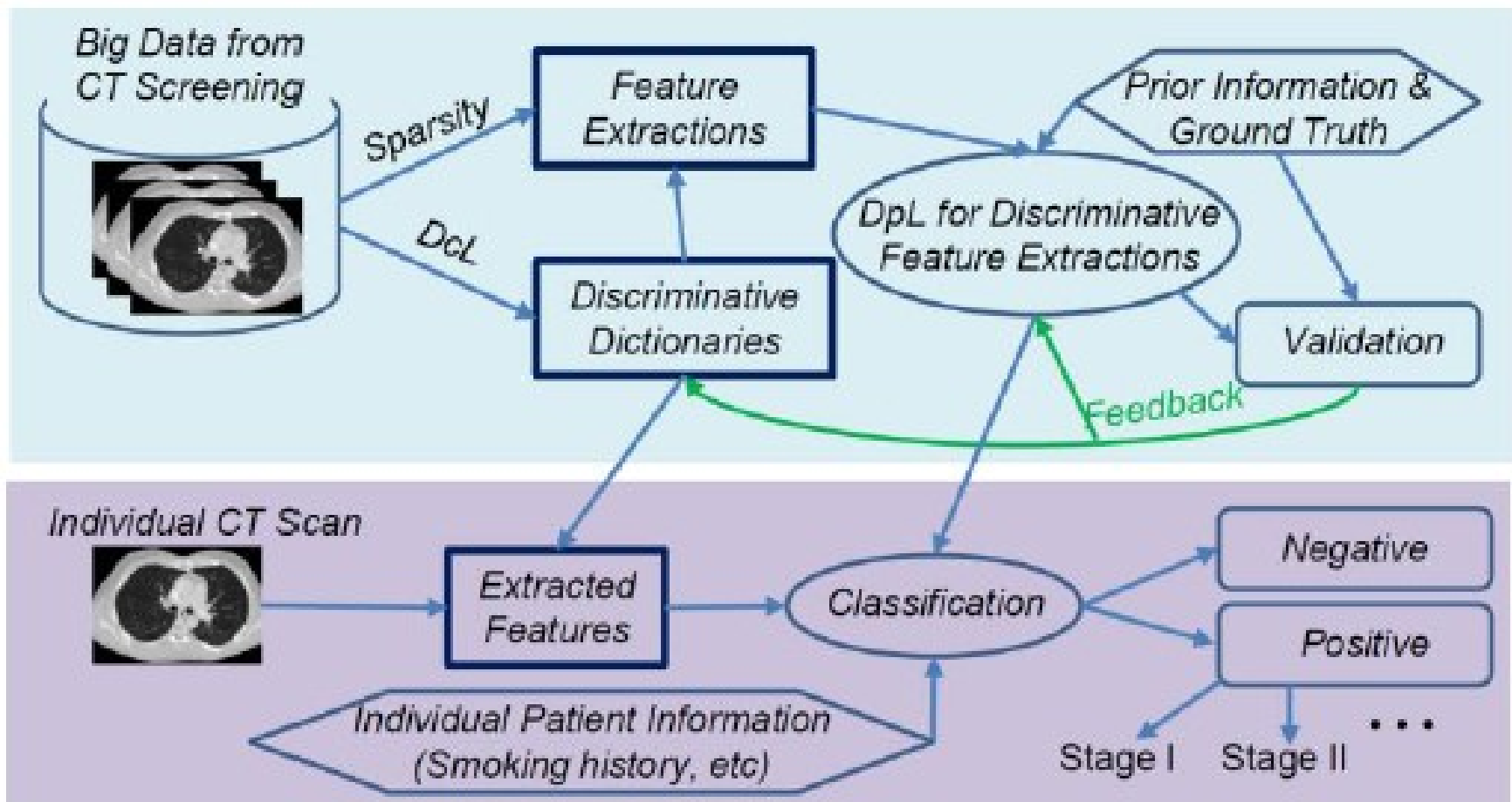
- Project name: Improving Tuberculosis Diagnostics using Deep Learning and Mobile Health Technologies among Resource-poor and Marginalized Communities

# Tuberculosis(TB)

- A **chronic and infectious** disease
- Affects the **most disadvantaged populations** and involves complex treatment regimes
- More than **9 million** estimated new case and **1.5 million** deaths every year
- Over 80% were in South-East Asia, Western Pacific and African(2013)
- Majority of the infected populations was from **resource-poor** and **marginalized** communities.

# Medical imaging informatics - Sample project 2

- Project name: Imaging Biomarkers for Lung Cancer Screening



# Medical imaging informatics - Sample project 3

- Project Name: Semantic Medical Image Retrieval:  
A search engine that can understand the medical terms

The screenshot displays the GoldMiner website interface. At the top, the browser address bar shows the URL `goldminer.arrs.org/home.php`. Below the address bar is a navigation menu with the GoldMiner logo and the ARRS logo. A search bar is located below the navigation menu, with a search button on the right. Below the search bar are three navigation links: "GoldMiner CME (NEW!)", "GoldMiner Global", and "Advanced Search". Below these links are two more navigation links: "Medical Images from A to Z" and "'Top 40' Images". Below these links is a section titled "This Week's Most Viewed Images" which contains a row of seven medical image thumbnails. Below this section is a section titled "GoldMiner CME" which contains a scrollable area with text. At the bottom of the page are three navigation links: "About us", "Terms of use", and "Feedback".

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GoldMiner CME (NEW!) GoldMiner Global Advanced Search

Medical Images from A to Z "Top 40" Images

This Week's Most Viewed Images

GoldMiner CME

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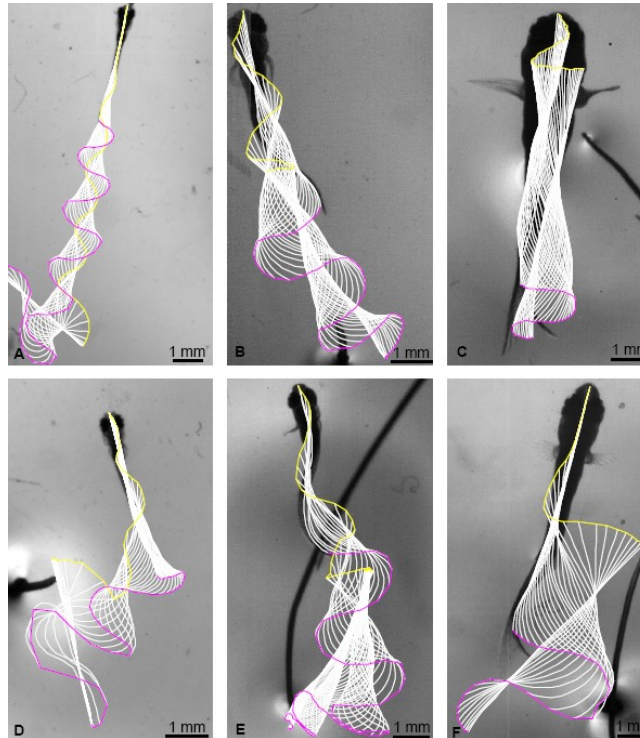
# Medical imaging informatics - Sample project 4

- Improving Colonoscopy Quality through Automated Monitoring
  - A software-based system that **produces objective quality related indicators** through analysis of the video of a colonoscopy procedure;
  - To provide **objective evidence for clinical practice**



# Medical imaging informatics - Sample project 5

- Animal Motion Capturing, Uploading, Analyzing, and Tracking Software for Biological Science
  - A **fully automated visual tracking software**
  - Has been used by a few leading biological labs (California Institute of Technology, University of Groningen (Netherlands))



# Medical imaging informatics - Sample project 6

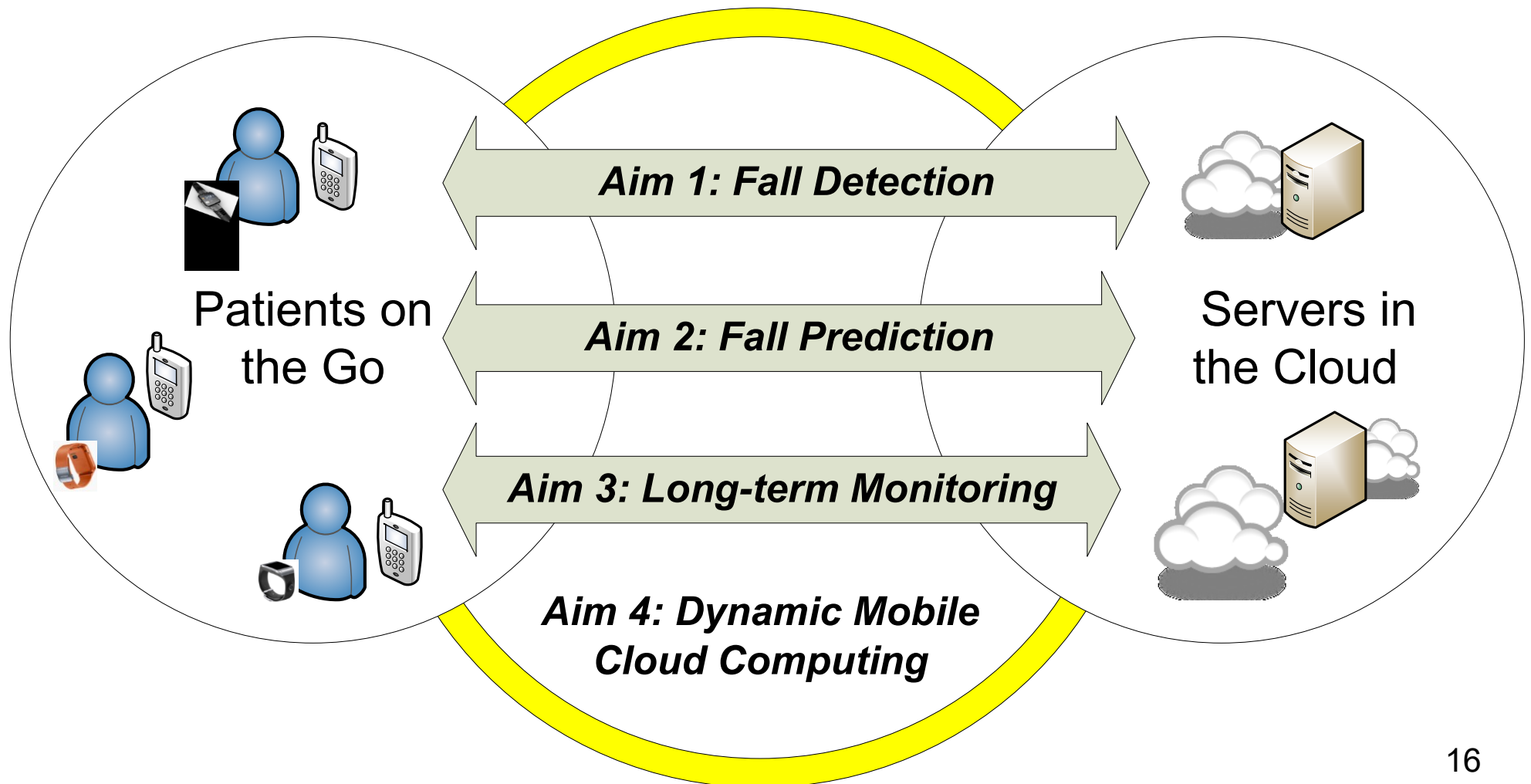
- Xbox 360 and Kinect-based motion sensing for in-home rehabilitation





# Biomedical sensor informatics - Sample project 1

- Project Name: Pervasive fall detection for stroke mitigation



# Biomedical sensor informatics - Sample project 2

- Project name: Wearable device-based Multimedia Computing Platform for Computer-aided Dietary Monitoring

## Smart watch or Smart Glass

### Data Capturing and Transmission Software

1. One Tap to Start Video Recording
2. Taking Food Video from Different Angles
3. Recording Dietary Context Information If Possible
4. One Tap to Stop Video Recording

Bluetooth Connections

*Multimedia Food Data*

## Smartphone

### Data Transmission Software

1. Receiving Multimedia Food Data
2. Uploading the Data to Server at Cloud

Cellular Network

*Multimedia Food Data*

## Server at Cloud

### Data Storage and Analysis Software

1. Storing the Multimedia Food Data
2. Organizing and Representing the Food Data into Multimedia Food Journal
3. Analyzing the Multimedia Food Journal to Derive Dietary Information

# Acknowledgment

- National Science Foundation



National Science Foundation  
WHERE DISCOVERIES BEGIN

- National Institute of Health (RIMI Program)



- Mayo Clinic, Rochester, MN



- Harvard Medical School, Cambridge, MA



- University of Massachusetts Lowell, Lowell, MA

