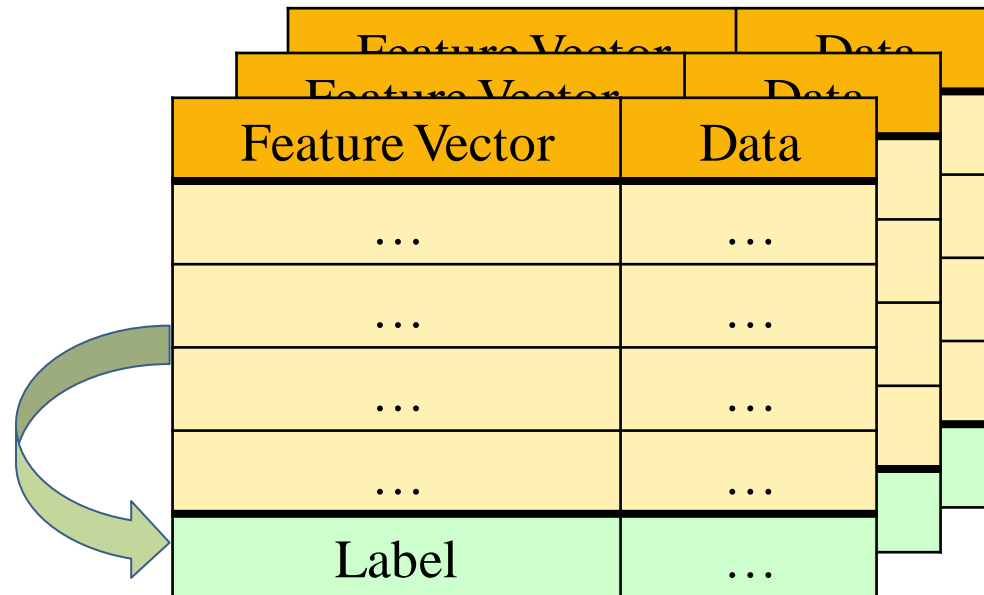**Grace Series Talk:**
The Path and the Features
-- Prof. I-Ling Yen

Features

➤ Big data

♦ Feature vector

♦ Label

♦ Association

▪ Feature values leads to the label value

Feature Vector	Data
…	…
…	…
…	…
…	…
Label	…

Your feature values derive your path

Feature Vector	Data
…	…
…	…
…	…
…	…
Label = Path	…

Preferences and Talents

➢ Features: Preferences + talents $\Rightarrow$ Career path

◆ Intertwined

➢ My academic path

◆ BS: Physics, National TsingHua University, Taiwan

◆ Career after graduation

▪ Teacher, research assistant (repetitive tasks)

◆ MS: CS, University of Houston

▪ Talents/Preferences + Job market

▪ Job choice: only if there is research

◆ PhD: CS, University of Houston

▪ Talents/Preferences + Job market + Job prospect (repetitive tasks?)

▪ Assistant Prof. in Michigan State University

▪ Associate and Full Prof. in UTD, since 1997

Research

➢ Features

- ◆ Problem solving
- ◆ Creativity
  - ▪ Dijkstra: Self stabilization, program verification, algorithms
  - ▪ The framework of theory of computation, computability, decidability, NP, P, … and the proof mechanism
- ◆ Perfectionism
  - ▪ Knuth: S in Latex
  - ▪ Steve Jobs
- ◆ Benefit society?

Research

➢ My research Path

♦ Ionization simulation (Tsinghua)

▪ For solar cell design, study the effect of deep or shallow ion implantation

♦ Dependability (Houston)

▪ Fault tolerance, consistency, …

▪ self-organizing systems

▪ Inherent fault tolerance
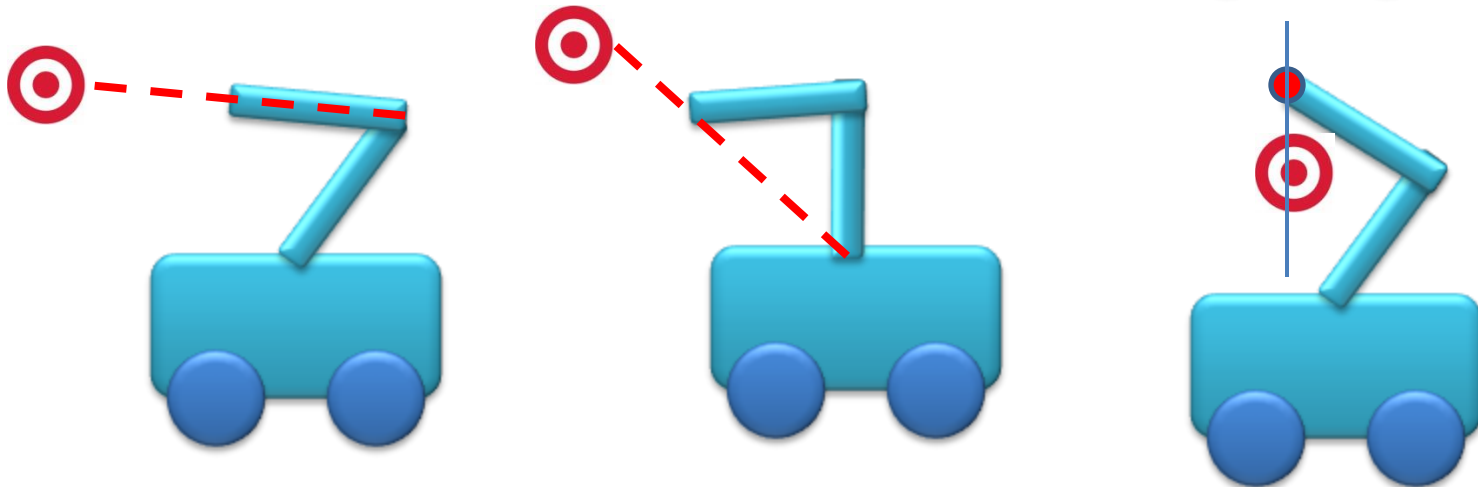
Research

➢ My research path

 ♦ Security (UTD)

   ▪ Homomorphic encryption and secret sharing
     • $X + Y = Z$; $\boxed{E(X) \ ?+? \ E(Y) = E(Z)}$

   ▪ System security
     • Key management at the low level
     • Single sign on

   ▪ Information flow control
     • Access control: within a domain
     • A: x; B: z = x+y; C: v = u*z; d: read v;
       - Who should C check with?
       - How to know that v depends on x, y, u from A, B, C?
       - How to know how much of x is in v?
       - How to define AC/IFC policies?
       - How to assure that the parties follow the AC/IFC policies?
       - How to build an efficient AC/IFC system?
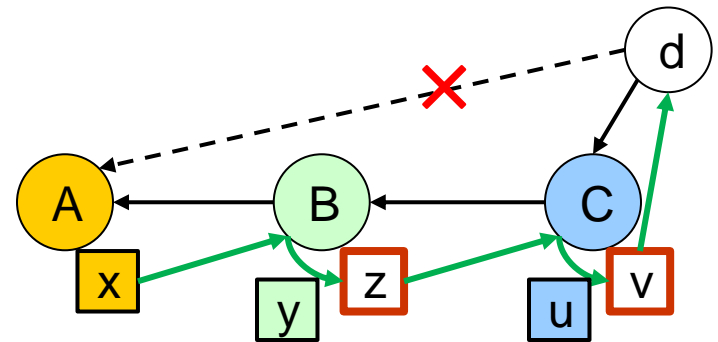
Research

➢ My research path

 ◆ Benefit the society?

 ◆ SPW

 ▪ Rescue mission

 • E.g., search for survivors

 ▪ Field SPW

 • E.g., automated lawn care

 ▪ Elderly care

 • Fall prevention

 • Daily life management

SPW

- IoT, CPS $\Rightarrow$ smart physical world (SPW)
  - CPS involves more actuators and has complex control
    - Research focuses on the control and interactions with the PTs
  - IoT research currently is more like sensor network with simple control of some actuators
    - Some research considers big data, which mainly focuses on sensor data
  - The difference is fuzzy
- SPW toward a better human life
  - Use a new terminology to avoid bias towards either
  - Desired SPW:
    - Consider sensors and actuators
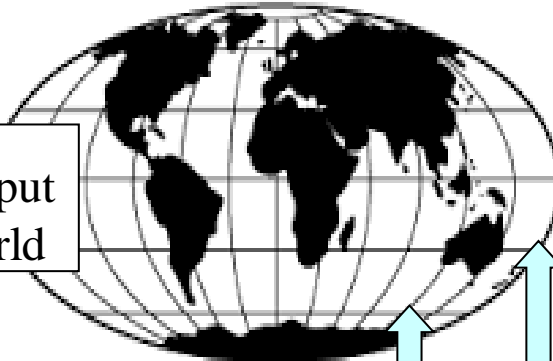   - Use AI techniques to automate various tasks in our daily lives
    - Also use HI

SPW

Machine Learning
Big Data Analysis
Semantic Computing

Sensor analysis for Situation recognition

Situation DB

Machine Learning
Big Data Analysis
Semantic Computing

Situation facts

Reactive action Reasoning

Scenario DB

Raw sensor input about the world

Start

Reactive actions (tasks)

Evaluation & Feedback

Control tasks

Service Composition Reasoning, Execution (to achieve the task)

Automated Composition Reasoning, Semantic Computing, Learning

SPW

- ➢ Techniques for an intelligent SPW
  - ▪ Scenario analysis, reaction decision making
  - ♦ Knowledge-base based approaches
    - ▪ Establish rule bases for situation analysis, reaction decision making
      - • Fuzzy rule base, probabilistic reasoning, etc.
  - ♦ Data mining based approaches
    - ▪ Build a repository to store a large number of real world scenarios
      - • For scenarios and reasoning results for situation analysis and reaction decision making
    - ▪ Mine the repository for similar cases and the associated solutions
    - ▪ Evaluate them and make a decision
  - ♦ Service composition reasoning
    - ▪ Define an extended service model for PTs, PT-SOA
    - ▪ Facilitate composition reasoning based on PT-SOA

SPW Intelligence

➢ Techniques for an intelligent SPW

♦ Current AI and machine learning techniques may not be sufficient to achieve some tasks

♦ Human is also a precious resource in SPW

▪ Use human intelligence (HI) to assist with the tasks

♦ **⇒ AI + HI**

▪ Gaming based crowd sourcing

• Many young gamers are very skillful at control tasks

• Can we use their skills to help with real world tasks?

• Help is provided in the gaming world (virtual), but being mapped to the real world tasks

• Rewards are given in the gaming world for successfully accomplishing the real world tasks

AI + HI

➢ Potential issues

♦ Skill

▪ For some tasks, HI needs to be trained to help

• When help with vacuuming, knock down and break precious objects

♦ Security

▪ Someone may purposely mess up the task

▪ …

♦ Privacy

▪ From some tasks, some private information may be released

▪ …

♦ Liability

AI + HI

- ➢ Potential issues
  - ◆ Skill
    - ▪ Before assigning a real world task, get trained
      - • By simulated tasks and past tasks
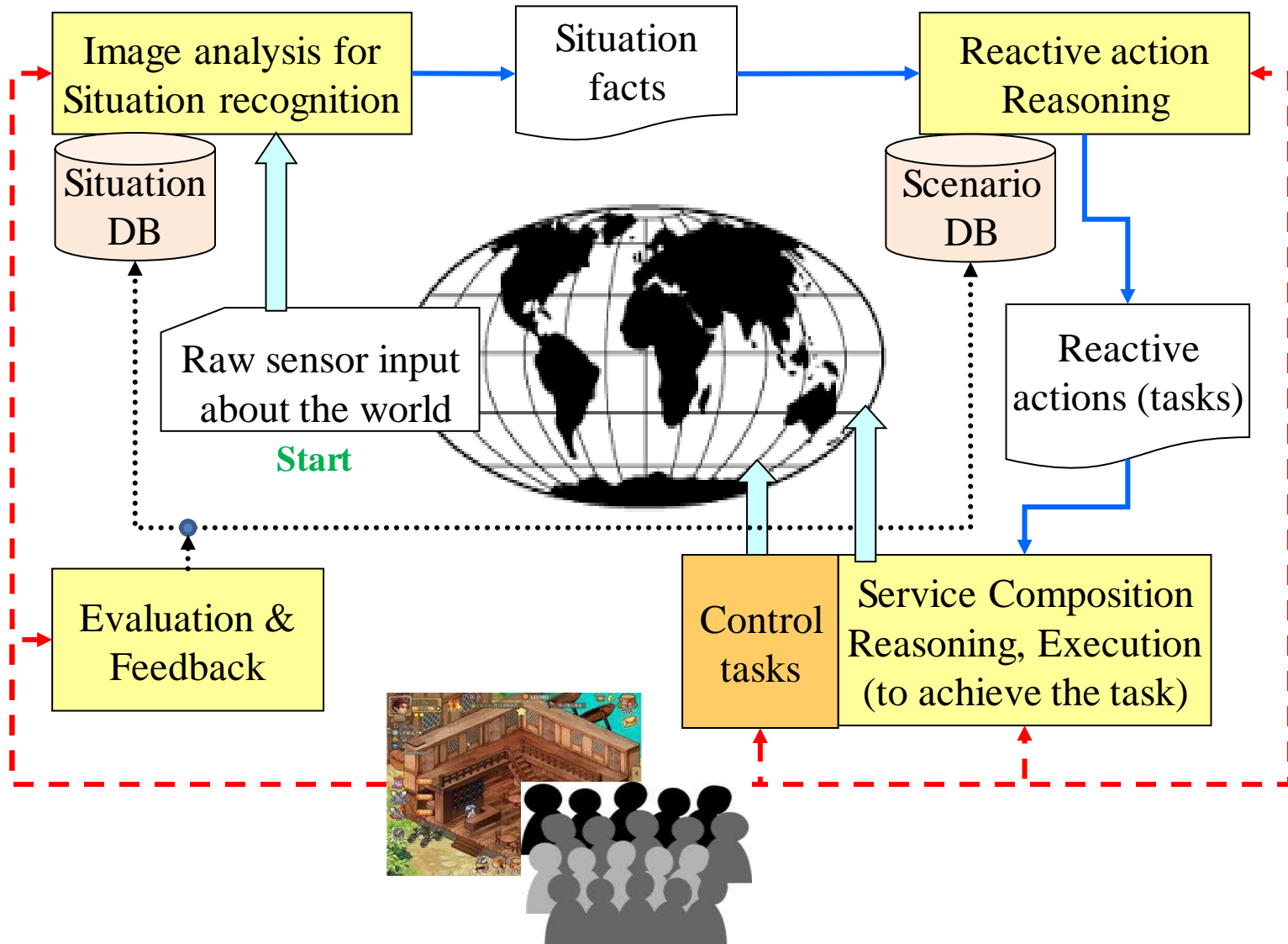   - ▪ Combine AI and HI to ensure the success of the task
  - ◆ Security
    - ▪ Use trust management of people
      - • Associate with real world identities (identities should be protected) and use virtual and real world information to help with trust analysis
    - ▪ Mix simulated & real tasks, make them non-distinguishable
    - ▪ Use multiple human resources for fault tolerance
      - • May have timeliness issues
  - ◆ Privacy
    - ▪ Intelligently map real world to virtual world

AI + HI

Image analysis for Situation recognition → Situation facts → Reactive action Reasoning

Situation DB

Scenario DB

Raw sensor input about the world
Start

Reactive actions (tasks)

Evaluation & Feedback

Control tasks

Service Composition Reasoning, Execution (to achieve the task)

**Your feature values
derive your career path
and, hopefully, it benefits society**

Feature Vector	Data
…	…
…	…
…	…
…	…
Label = Path	…