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
Your feature values derive your 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
  - \( X + Y = Z; \quad E(X) \oplus E(Y) = E(Z) \)

- System security
  - Key management at the low level
  - Single sign on

- Information flow control
  - Access control: within a domain
  - \( A: x; \quad B: z = x + y; \quad C: v = u \times z; \quad d: \text{read } v \)
    - 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 ⇒ 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

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

Raw sensor input about the world

Evaluation & Feedback

Control tasks: Service Composition Reasoning, Execution (to achieve the task)

Machine Learning
Big Data Analysis
Semantic Computing

Start

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
  - $\Rightarrow$ 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 → Raw sensor input about the world

Scenario DB

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