WG4: AI for IoT

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Presentation Outline

- Grand Challenge:
  - Assisted living system
  - Definition, Motivation
- Challenges
- Roadmap
  - Current state. What would it look with today's tech
  - What can be expected in 2 years
  - What can be expected in 5 years
  - Vision: replace Hamed's aunt

Assisted living

We all age differently.

We experience different effects of growing older at different points in our lives.

Reliable, safe and robust assistive robots are expensive

Despite the positive outcomes of assistive technology, the abandonment rate is 25-33%

Older adults are not a homogenous group

Need to be very specific about the clinical characteristics of the people for whom our assistive robots are being designed

Assisted living minimum costs today

2015 Average Senior Care Costs by Type and Duration	
Type of Senior Care	**Year**
Home Care Aide Cost	$40,000
Home Health Aide Cost	$40,000
Adult Day Care Cost	$17,250
Assisted Living Cost	$43,200
Skilled Nursing Home Cost	$80,300

With the aging population and people living longer, this is not sustainable for governments and (diminishing) younger family members)

Assisted Living System Vision

Elderly can live independently for extended period of a time

- Detecting and preventing accidents/falls

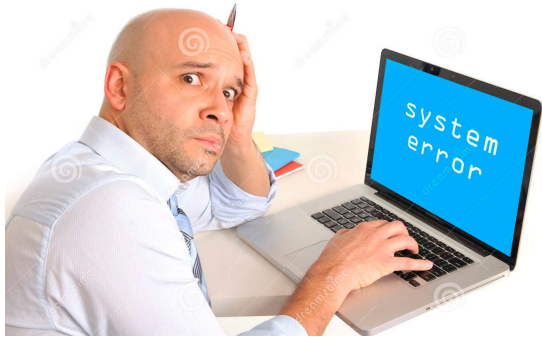
- Providing social interaction with loved ones

- Sensing patient activity, health, emotions, intent

- Assisting the patients with medical/daily needs

Technical Problems

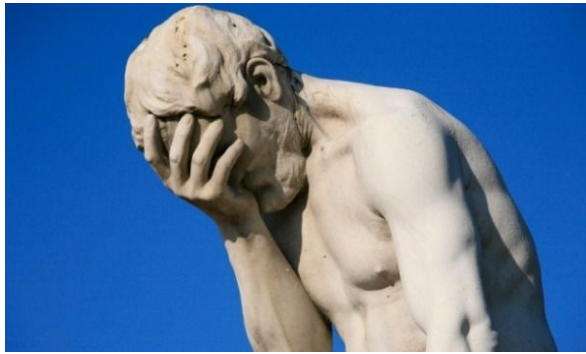
- State of the art of AI - interesting problems are still hard to solve
  - Lack of situational awareness
  - High quality models require lots of labelled data, hard to collect in real life. Learning from experience is not an option.
  - Inference must work across diverse sensor and input data that varies over time as user acquires new devices and devices are upgraded.
- How do we deal with an unreliable infrastructure?
  - Nodes dying and coming up sporadically
  - Poor or nonexistent network connection
- Where does AI run: the edge or the cloud
  - How do we establish patterns that work?
  - Federated learning: incremental training on the edge, updates to the global model in the cloud



Legal and Ethical problems

- Security and Privacy
- AI algorithms are inscrutable. How do we explain the results of an algorithm?
  - Across potentially multiple models
  - Must be clearly communicated and understood by a human
- Liability and user expectation
  - Something goes wrong, who is responsible?
  - What if AI is too good?

Top three problems



- Building and optimising models (data, event-driven inferences, conditions), i.e. translation of doctor’s knowledge to programs/models, going from global to personalised models via federated learning
- Situational awareness: fusion of information from several sensor modalities (imaging, emotion, activity, health monitoring sensors, motion) to provide actionable intelligence
- Accountability and ability to explain the decisions: can the decision taken by AI system be interpreted and explained?

Road to success (and its criteria)

State of the art **today**:

computer vision to detect motion, health monitors at homes, drug dispensers, send alarms to get help, mobility and connectivity assistance

In two years: better models, fuse info from more sensors, federated learning

In five years: acting on the model (examples: pour water, give medications). Better scrutability.

In ten years: replace a qualified nurse. Confidence. Ethics. Easy-to-deploy

The End...

Isaac Asimov's "Three Laws of Robotics"

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

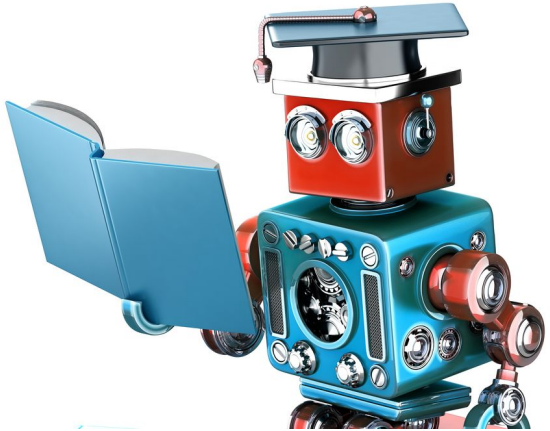
The messiness of real-world environments

Near real-time assessment and feedback

Adaptable to human emotion, context,

Ambient conditions: variety of mental/physical conditions, ambient sensors and actuators, temperature, noise, individuals around, equipment, failing sensors, failing power/Internet, different drugs and requirements

What type of AI do we need?



- Machine learning for decision making
- Actuation -
  - collaboration with roboticists & mechanical engineers
- Federated learning
  - aggregate knowledge from all deployed clients
- Low-power algorithms that work on embedded devices
- Algorithms that work on partial information and unreliable networks
- Usable AI - algorithms and systems that laymen can use
- Interpretability of decision from the learnt models (why the action was taken?)

Solutions

- A solver takes as input a set of constraints (power, network, storage, longevity etc.)
- And outputs an AI system that adheres to these limitations