Nadine: A Human-like sociable and emotional robot that remembers facts and people

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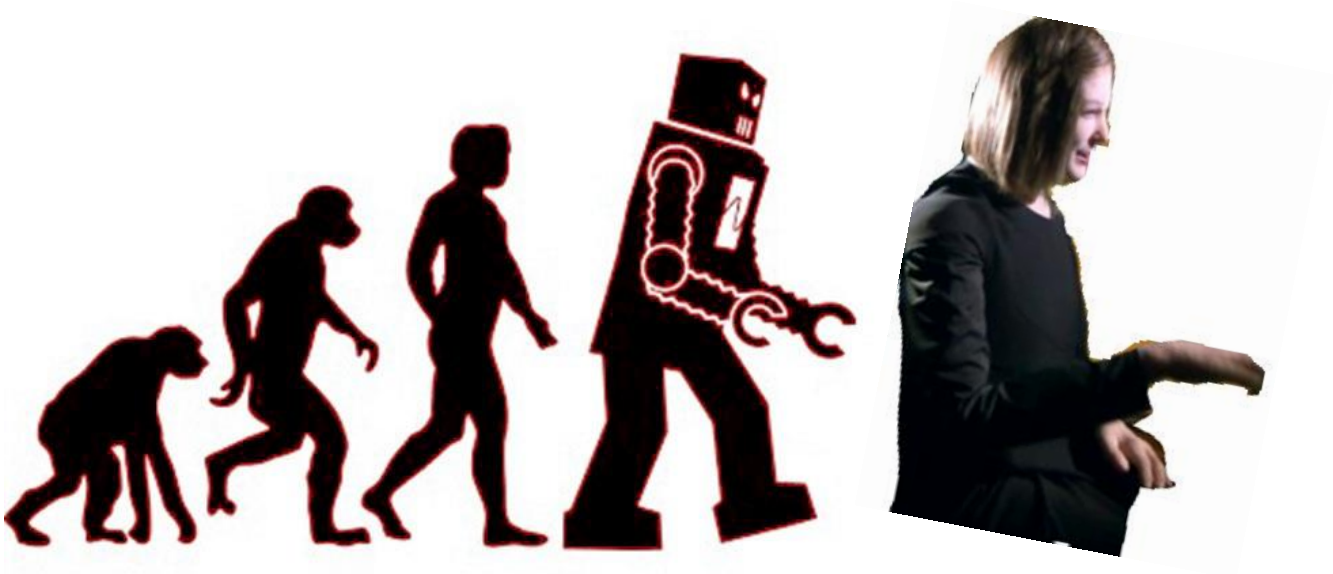
Empowering Human Capacity

- We have evolved and progressed.
- We have invented and discovered.
- **We are empowered...**

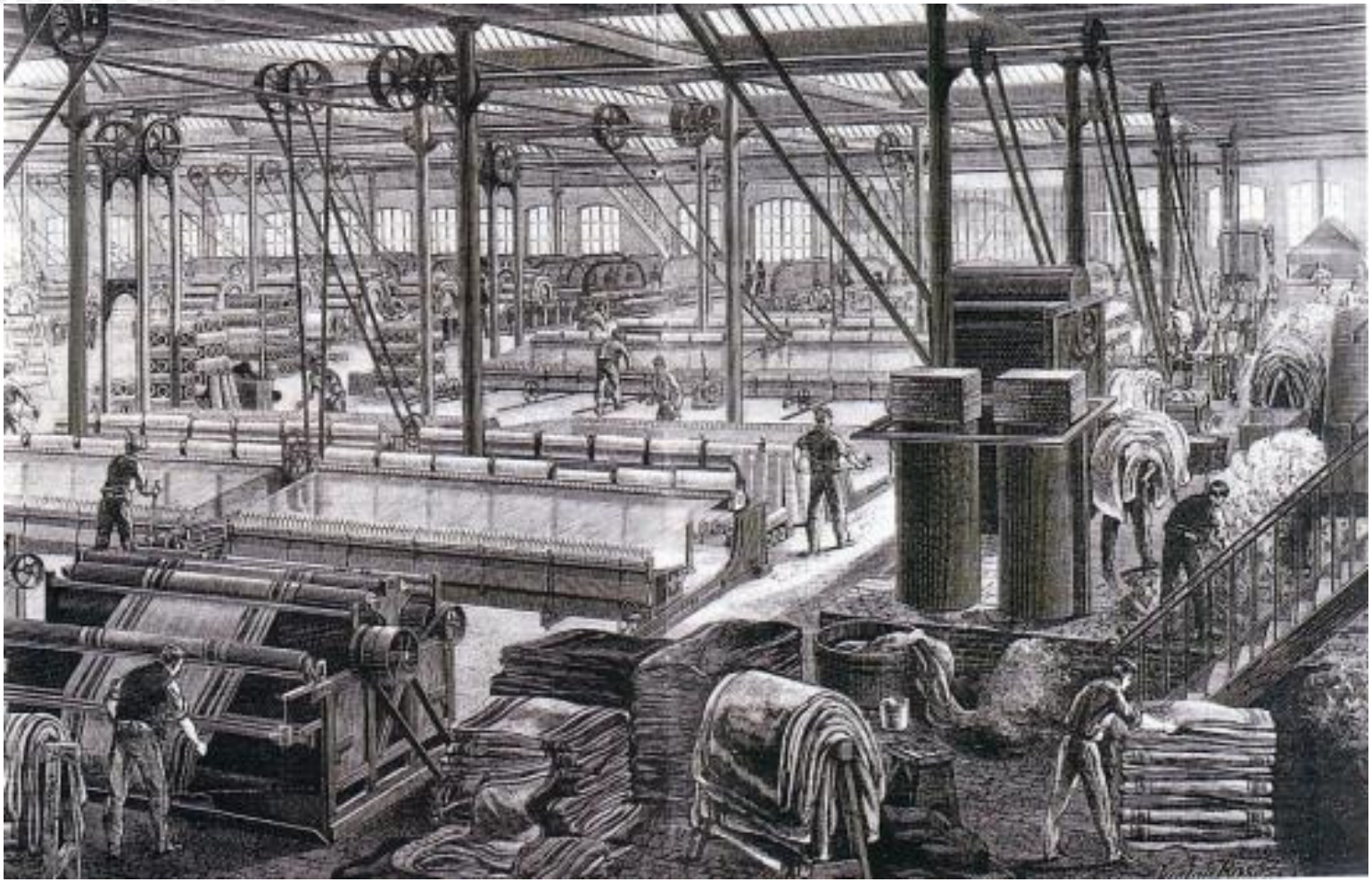


Empowering Human Capacity

Leonardo da Vinci (1452-1519) created the **robotic knight** capable of independent motion - sitting down, standing up, moving its head and lifting its visor.

Denis Diderot (1713-1784) formulates in his *Pensées philosophiques* :
"If we find a parrot who could answer to everything, I would claim it to be an intelligent being without hesitation”

From Hand Work to Factory System (19th century)



Women at the Factory Today

Robots at the Factory Today

Machines: from Mechanics to A.I.

Creating Artificial Intelligence to empower humanity?

Can a machine think? Turing Test (1950)

Put a machine and a human in a room and send in written questions. If we cannot tell which answers are from the machine or the human, the machine is thinking…

What first passed the Turing Test and is it enough?

- The first was **ELIZA**, a program written by the American Computer scientist, **Joseph Weizenbaum (1976**)

```
> Hello, I am Eliza.
* I am afraid.
> How long have you been afraid?
* Since midterms.
> Tell me more...
* I am afraid that I will fail
my course.
> Do you enjoy being afraid that
you will fail your course?
```

- BUT anything like human intelligence must be able to engage with the **real world, with social interaction** , and the Turing Test doesn't test for that..

What has changed in computers?

- **60 years ago**, computers: mainly CPU + Memory + very limited I/O.

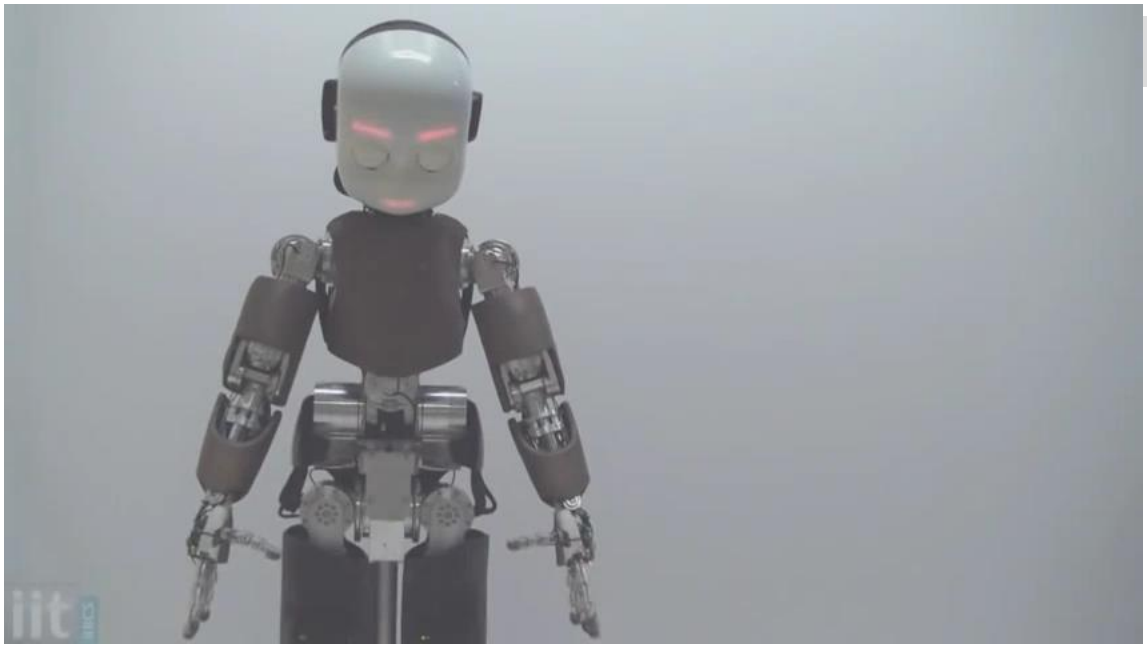
- **Today**: CPU and memory are much faster AND incredible possibilities of interfacing with people through **sensors and actuators**.

Empowering Human capacity today?

- Hardware/software tools allowing to **capture, understand**, **produce a lot of signals**: speech, sounds, gestures, shapes, forces etc…
- **Generate Big Data** that allows us to **analyse** and **model** events or **predict** the future using deep learning algorithms

SoA : Humanoid robot iCub

MANUFACTURER	RobotCub ConsortiumItalian / Institute of Technology
YEAR OF CREATION	2004
LOCATION	Europe
HEIGHT	3.3ft (1 m)
WEIGHT	48.5 pounds (22 kg)
DEGREES OF FREEDOM	53 DOF



SoA: Humanoid robot ASIMO

MANUFACTURER	Honda
YEAR OF CREATION	2000
LOCATION	Japan
HEIGHT	4 ft 3in (130 cm)
WEIGHT	110 pounds (50 kg)
DEGREES OF FREEDOM	57 DOF
POWER	Rechargeable 51.8V Lithium Ion Battery

SoA: Humanoid robot Atlas

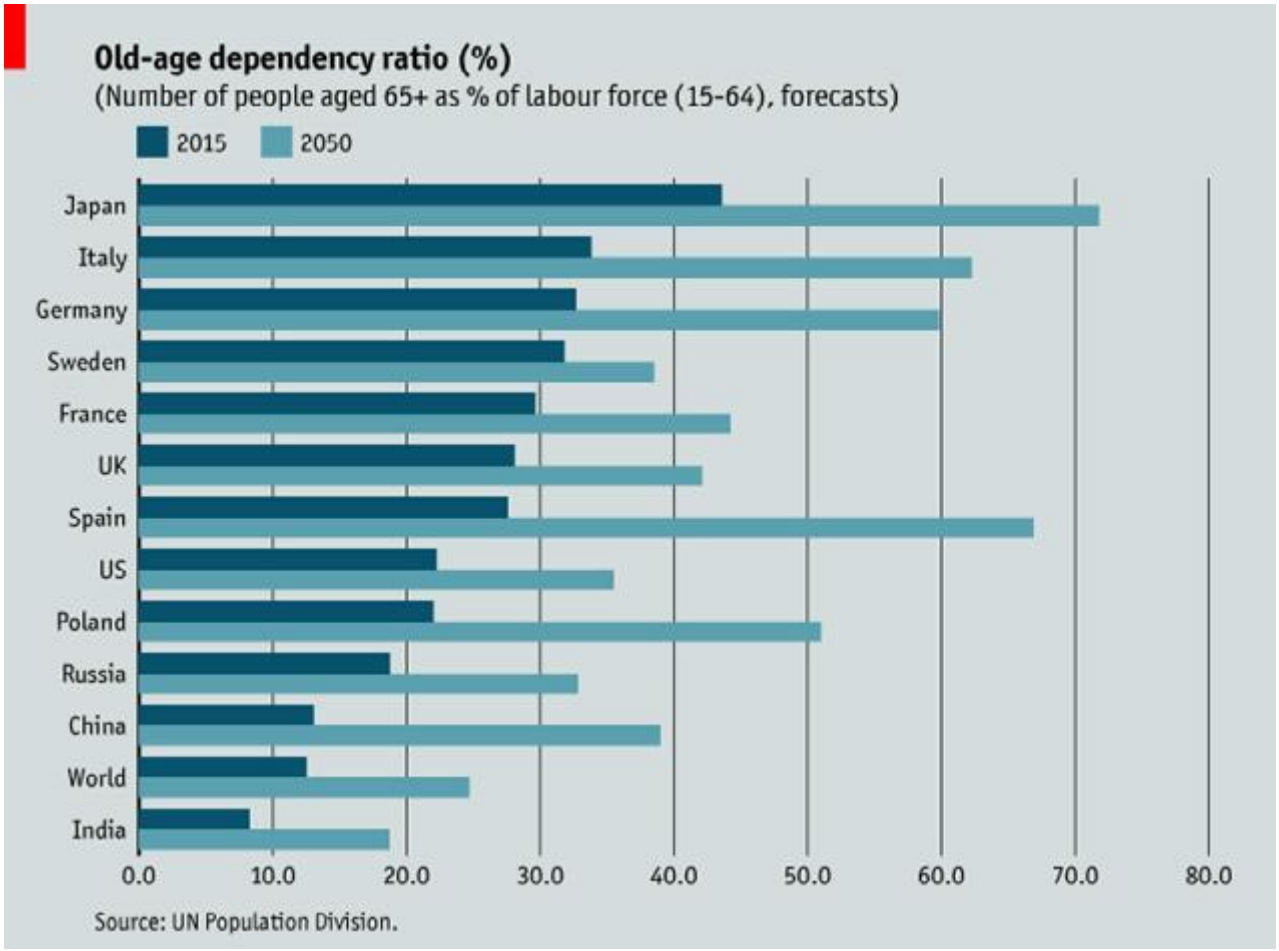
MANUFACTURER	Boston Dynamics
YEAR OF CREATION	2013
LOCATION	United States
HEIGHT	6 ft (180 cm)
WEIGHT	330 pounds (150 kg)
DEGREES OF FREEDOM	28 DOF
POWER	Electric power supply via a flexible tether

Today Societal Problems

- In most countries, aged people with special needs often feel lonely and are alone
- The situation is worsened over time…

Today Societal Problems

In 2050, Japan will have 72 dependent people over 65+ for every 100 workers; Germany will have 60 dependent people over 65+, etc…



www.weforum.org

One Solution: social robots

Paro robot baby seal

- Designed by Takanori Shibata and produced in 2002
- Responds to petting through tactile sensors by **moving its tail**
- responds **to sounds** and can **learn a name**
- can **show emotions** such as surprise, happiness and anger.

Early models of nursing-care assistant robots

-- Physically support

Robot that can lift up or set down a real human from or to a bed or wheelchair.

RIBA robot (Robot for Interactive Body Assistance)

T. Mukai, S. Hirano, H. Nakashima, Y. Kato, Y. Sakaida, S. Guo, and S. Hosoe, “Development of a nursing-care assistant robot riba that can lift a human in its arms,” in 2010 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 5996–6001, Oct 2010.

Social playing robots

-- **Entertainment**

→ **Play with children.**

→ **Interact with humans.**

Sony AIBO robot: quadruped dog-like robots

N. Suzuki and Y. Yamamoto, “Pursuing entertainment aspects of Sony AIBO quadruped robots,” in4th International Conference on Modeling, Simulation and Applied Optimization (ICMSAO), pp. 1–5, April 2011.

Human-robot interaction therapy

- **Psychic support**
- **→ Reduces stress**
- **→ Stimulates interaction**
- **→ Improves the relaxation and motivation.**

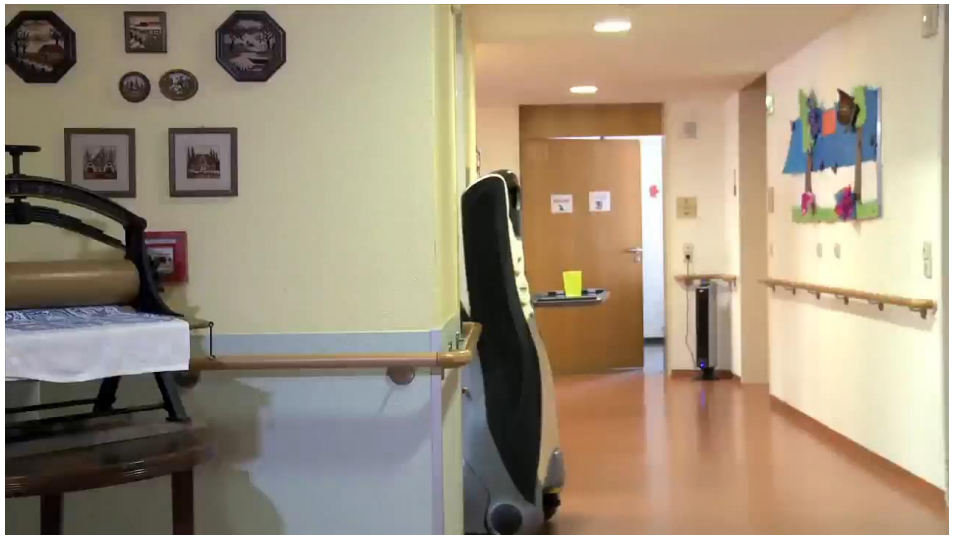
NAO robot: a semi-autonomous, programmable humanoid robot

[Shamsuddin, Syamimi, et al. "Initial response of autistic children in human-robot interaction therapy with humanoid robot NAO." Signal Processing and its Applications (CSPA), 2012 IEEE 8th International Colloquium on. IEEE, 2012.

Social service robots

Care-o-bot robot equipped with the latest state-of-art industrial components. Experience in a senior home in Germany

- **range and image sensors for object learning and detection in real-time 3D environment**



Pieskä, Sakari, et al. "Social service robots in public and private environments." *Recent Researches in Circuits, Systems, Multimedia and Automatic Control* (2012): 190-196.

Challenges in autonomous behavior generation

- Virtual characters and robots interacting with people in social contexts
  - should understand the other users' behaviors,
  - and respond back with gestures, facial expressions and gaze.

- **Challenges:**
  - Sensing and interpreting other users' behaviors, intentions
  - Making decisions appropriate to the social situation based on partial sensory input
  - Rendering synchronized and timely multi-modal behaviors

Remembering past interactions

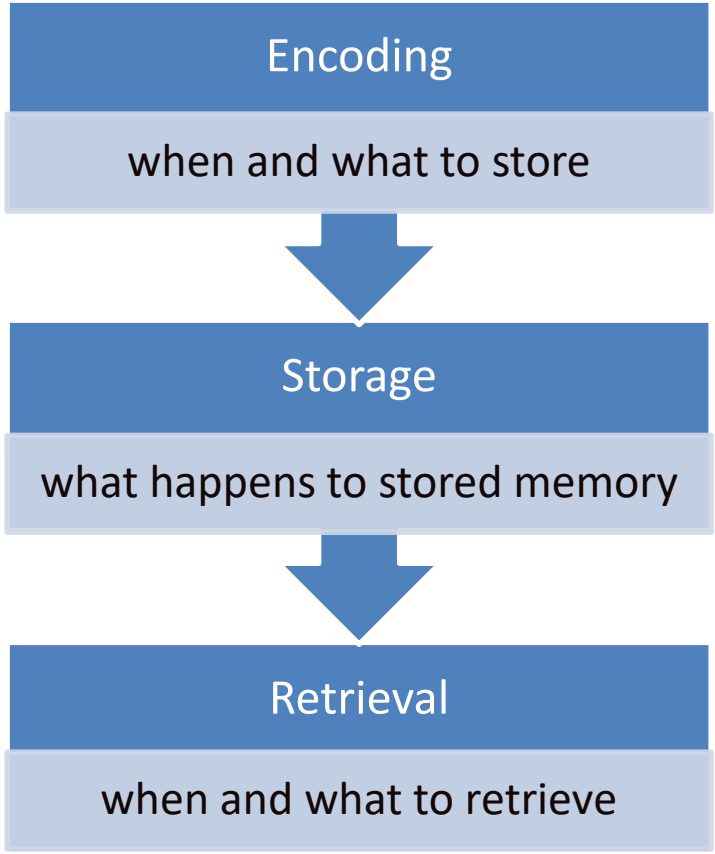
- Episodic memory is the memory of autobiographical events (times, places, associated emotions, and other contextual who, what, when, where, why knowledge) that can be explicitly stated
  - keeping the course of dialogue
  - planning long-term goals
  - explaining reasons for actions
  - learning from past experiences
  - requires a personal history of an entity

[Tul72] E. Tulving, "Episodic and semantic memory," In E. Tulving and W. Donaldson (Eds.), Organization of memory. New York: Academic Press,1972, pp. 381–403.

Episodic Memory

Social sciences as a starting point

- Conceptual definitions (Tulving [Tul72] , Schank [SA77]
  - inspiring but lack of details for implementation of robots/VH
- Findings from social sciences
  - Three phases of EM
  - Forgetting and recency effect
    - emotional memories are remembered more



[Tul72] E. Tulving, "**Episodic and semantic memory**," In E. Tulving and W. Donaldson (Eds.), Organization of memory. New York: Academic Press,1972, pp. 381–403.
[SA77] R. C. Schank and R. P. Abelson, **Scripts, Plans, Goals and Understanding: an Inquiry into Human Knowledge Structures**. L. Erlbaum, 1977.

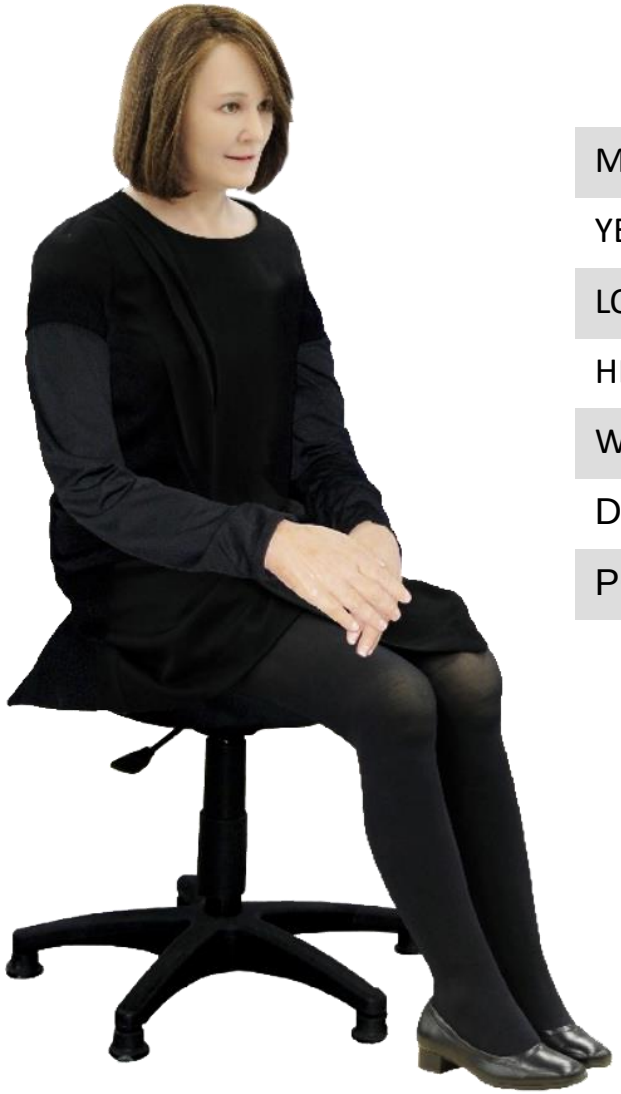
Research with Social Robot EVA (MIRALab-Unige (2008-2012)

- Overall Goal: long-term social interaction framework with a human-like robot or Virtual Human: **modeling emotions, episodic memory and expressive behaviour**
- Goal: **remembering individuals** (faces and names) and **past exchanges** over multiple interactions

Eva teaching introductory computer networks concepts

MIRALab robotic tutor (2008-2012)

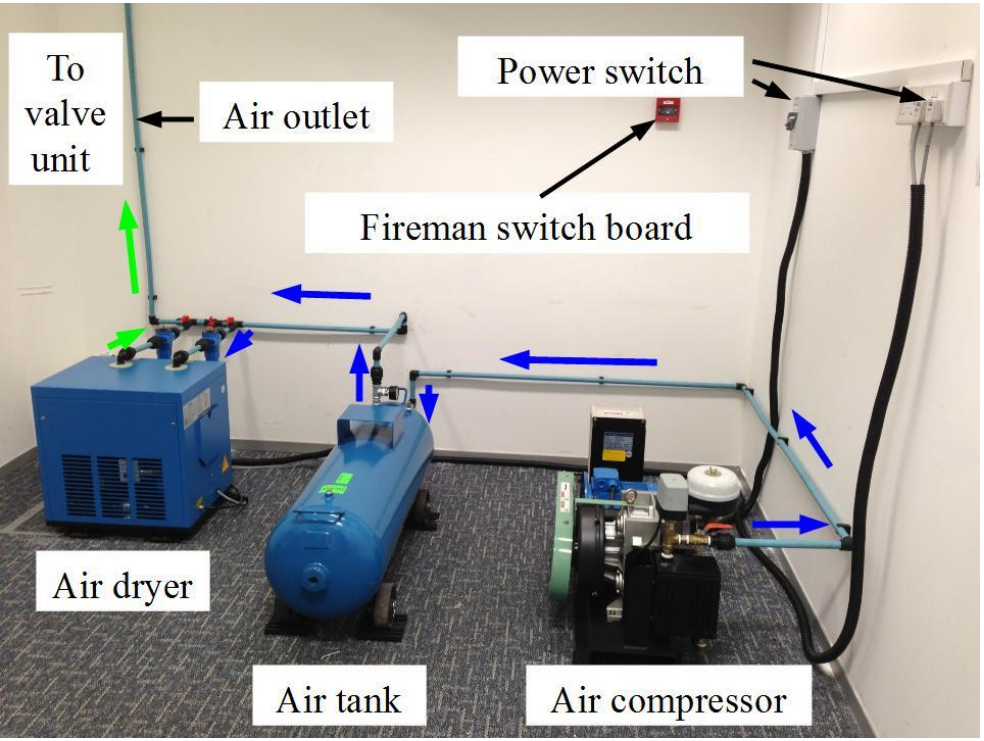
Recent social robot: Nadine

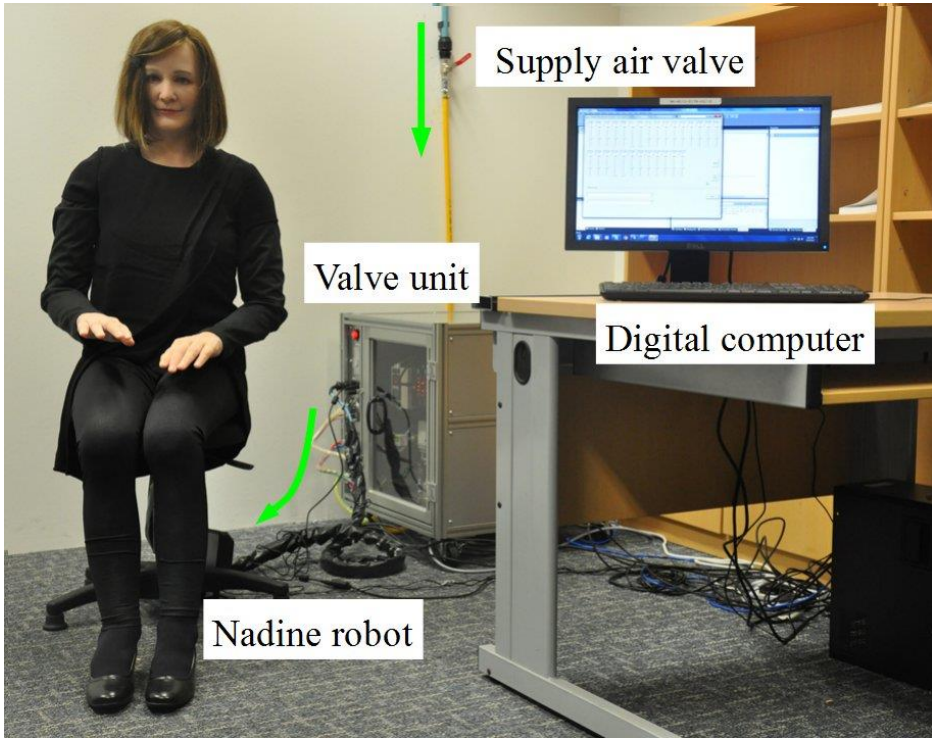


SPECIFICATIONS

MANUFACTURER	IMI, NTU / Kokoro Company Ltd.
YEAR OF CREATION	2013
LOCATION	Singapore
HEIGHT	4.31 ft (131.5 cm)
WEIGHT	77.1 pounds (35 kg)
DEGREES OF FREEDOM	27 DOF
POWER	500W

Hardware


To valve unit
Air outlet
Power switch
Fireman switch board
Air dryer
Air tank
Air compressor


Supply air valve
Valve unit
Digital computer
Nadine robot

Research Challenges

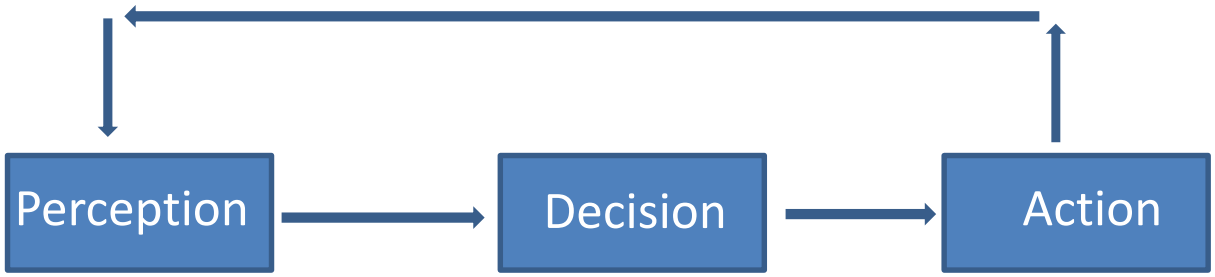
Augmented/Artificial intelligence (AI) :

1 Each partner should be aware of the situations of all other partners and the environment and be able to collaborate and interact in an intelligent way (mixed society)

2 Social robots should be able to switch smoothly **between autonomy and control mode.**

3 Develop Egocentric vision for mobile platform for Vhumans and social robots (vision centred on robot moving)

Perception/Decision/Action



- Microsoft Kinect V2:
  - Face recognition
  - Gestures recognition
  - Understanding of social situations
- Microphone:
  - Speech recognition

- Emotion Model
- Memory Model
- Social Attention
- Chatbot

- Robot controller:
  - emotional expression
  - Lips synchronization
  - online gaze generation

Mixing real people with autonomous virtual humans and social robots: ongoing research

http://imi.ntu.edu.sg/BeingThereCentre/Pages/BTChome.aspx

Decision making

- To whom should the VH/robot engage to talk?
- Should it allow the person to interrupt?
- Should it take the turn?
- Should it give the turn?
- Should it contribute to the speaking group?
- Should it interrupt someone else?
- Should it address a specific person or address the whole group?

NADINE SOCIAL ROBOT

PRESS RELEASES

Real-time interaction with Nadine in telepresence environment

- Real-time interaction with Nadine in video telepresence

[1] Demo was showed at Swissnex Singapore End of Year Party 2013

Nadine singing at Swissnex Party

Social Robots and Privacy

- Social robots capture data from people (faces, dialogs, places, habits…) like humans.
- Humans can do this only for **a few** people. Robots do it for **all** people.
- Robots can then report on any situation for anybody and can potentially remember forever.