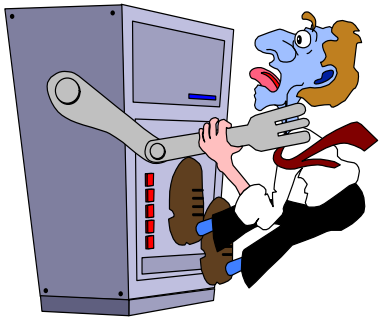
Artificial Intelligence



University of Venice, Italy

a.a. 2013/14

Prof. Marcello Pelillo

What is Artificial Intelligence (AI)?

There is no universally accepted definition of Artificial Intelligence.
A tentative one is the following:

AI is the endeavor of building an intelligent artifact

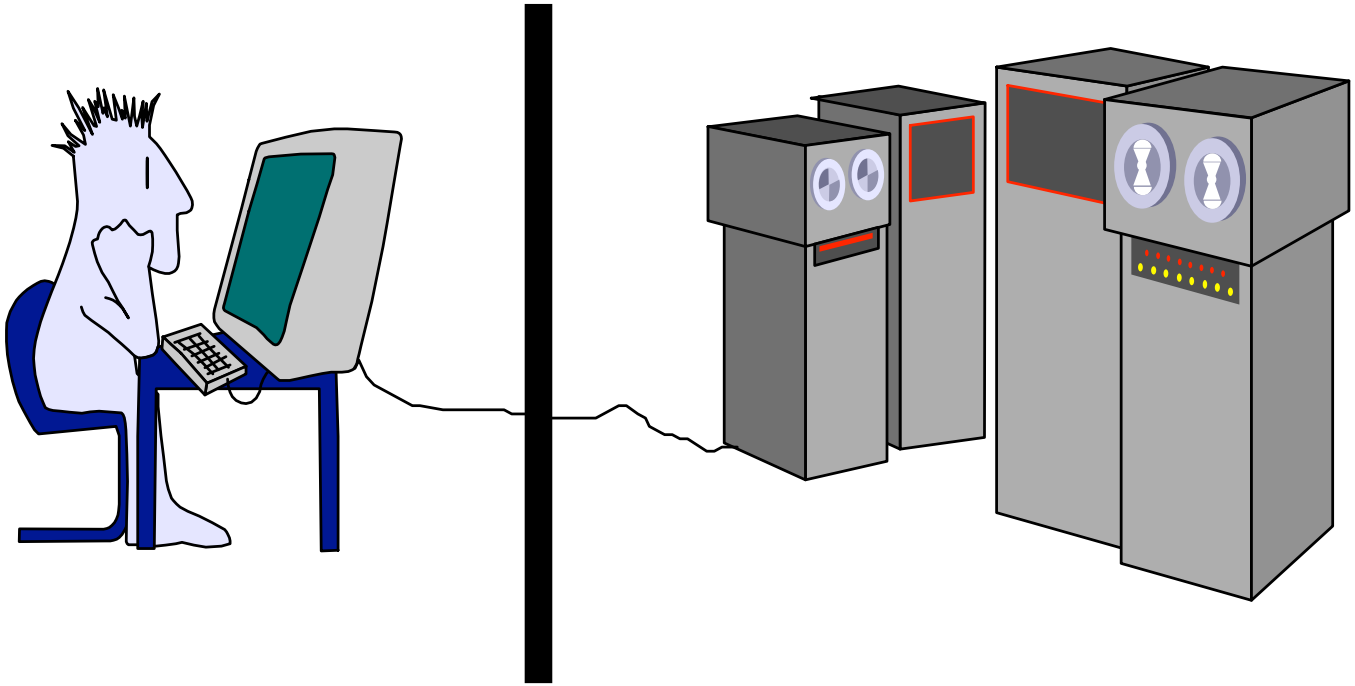
But... what is “intelligence”?

Some definitions:

- ✓ It is the ability to learn (Buckingam, 1921)
- ✓ This faculty is judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances (Binet and Simon, 1961)
- ✓ It is the ability to perform well in an intelligence test (Boring, 1961)

The Turing Test

Nel 1950, Alan M. Turing proposed an operational definition of intelligence (the “Turing test”).



Can Machines Think? The Turing Test

(From, A. M. Turing, *Computer Machinery and Intelligence*, 1950)

« I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous, If the meaning of the words "machine" and "think" are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, "Can machines think?" is to be sought in a statistical survey such as a Gallup poll. But this is absurd.

Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words. »

The Imitation Game

« **The new form of the problem can be described in terms of a game which we call the 'imitation game."** It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart front the other two. **The object of the game for the interrogator is to determine which of the other two is the man and which is the woman.** He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A." The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?

Now suppose X is actually A, then A must answer. **It is A's object in the game to try and cause C to make the wrong identification.** His answer might therefore be:

"My hair is shingled, and the longest strands are about nine inches long." »

« In order that tones of voice may not help the interrogator the answers should be written, or better still, typewritten. The ideal arrangement is to have a teleprinter communicating between the two rooms. Alternatively the question and answers can be repeated by an intermediary. **The object of the game for the third player (B) is to help the interrogator.** The best strategy for her is probably to give truthful answers. She can add such things as "I am the woman, don't listen to him!" to her answers, but it will avail nothing as the man can make similar remarks.

We now ask the question, "What will happen when a machine takes the part of A in this game?" Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman?

These questions replace our original, "Can machines think?" »

An Imaginary Dialogue

Q: Please write me a sonnet on the subject of the Forth Bridge.

A : Count me out on this one. I never could write poetry.

Q: Add 34957 to 70764.

A: (Pause about 30 seconds and then give as answer) 105621.

Q: Do you play chess?

A: Yes.

Q: I have K at my K1, and no other pieces. You have only K at K6 and R at R1. It is your move. What do you play?

A: (After a pause of 15 seconds) R-R8 mate.

Passing the Turing Test

To pass the test a machine must possess the following skills:

Natural language processing

to interact with the interrogator

Knowledge representation

to memorize information before and during the dialogue

Automatic reasoning

to use the acquired knowledge to answer the question and draw conclusions

Learning

to adapt to new situations

The “Total” Turing Test

The machine can access an audio/video feed so that the interrogator can test its perception skills; further, the interrogator can pass objects to be manipulated.

This requires:

Perception

to analyze and comprehend images and sounds)

Robotics

to manipulate objects and navigate

Lady Lovelace's Objection

« Our most detailed information of Babbage's Analytical Engine comes from a memoir by Lady Lovelace (1842).

In it she states,

“The Analytical Engine has no pretensions to *originate* anything. It can do *whatever we know how to order it* to perform” »

But, machines can *learn*.

Arthur Samuel (1901-1990) wrote a checkers-playing program for the IBM 701 in 1952. His first *learning* program was completed in 1955 and demonstrated on television in 1956.

Very soon the program systematically start to beat its inventor…

The Mathematical Objection

« There are a number of results of mathematical logic which can be used to show that there are limitations to the powers of discrete-state machines.

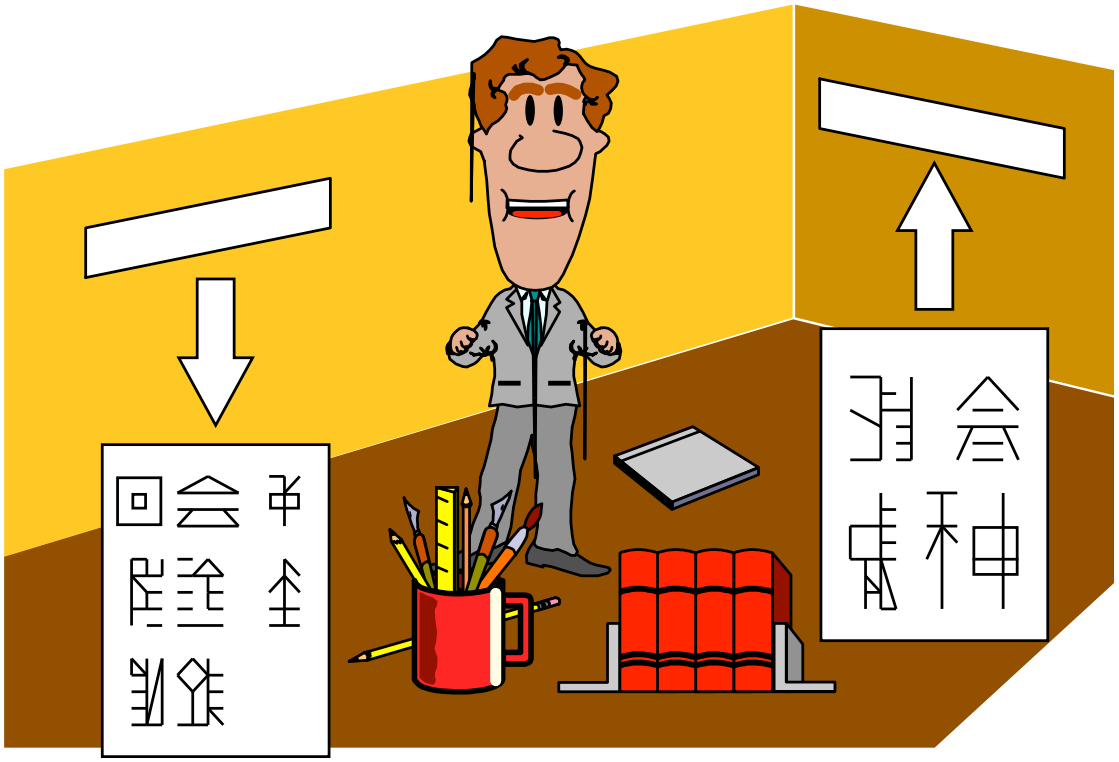
The best known of these results is known as Godel's theorem (1931) and shows that in any sufficiently powerful logical system statements can be formulated which can neither be proved nor disproved within the system, unless possibly the system itself is inconsistent. »

The Argument from Consciousness

This argument is very, well expressed in Professor Jefferson's Lister Oration for 1949, from which I quote:

« Not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt, and not by the chance fall of symbols, could we agree that machine equals brain-that is, not only write it but know that it had written it. »

Searle's Chinese Room



Strong and Weak AI

Weak AI:

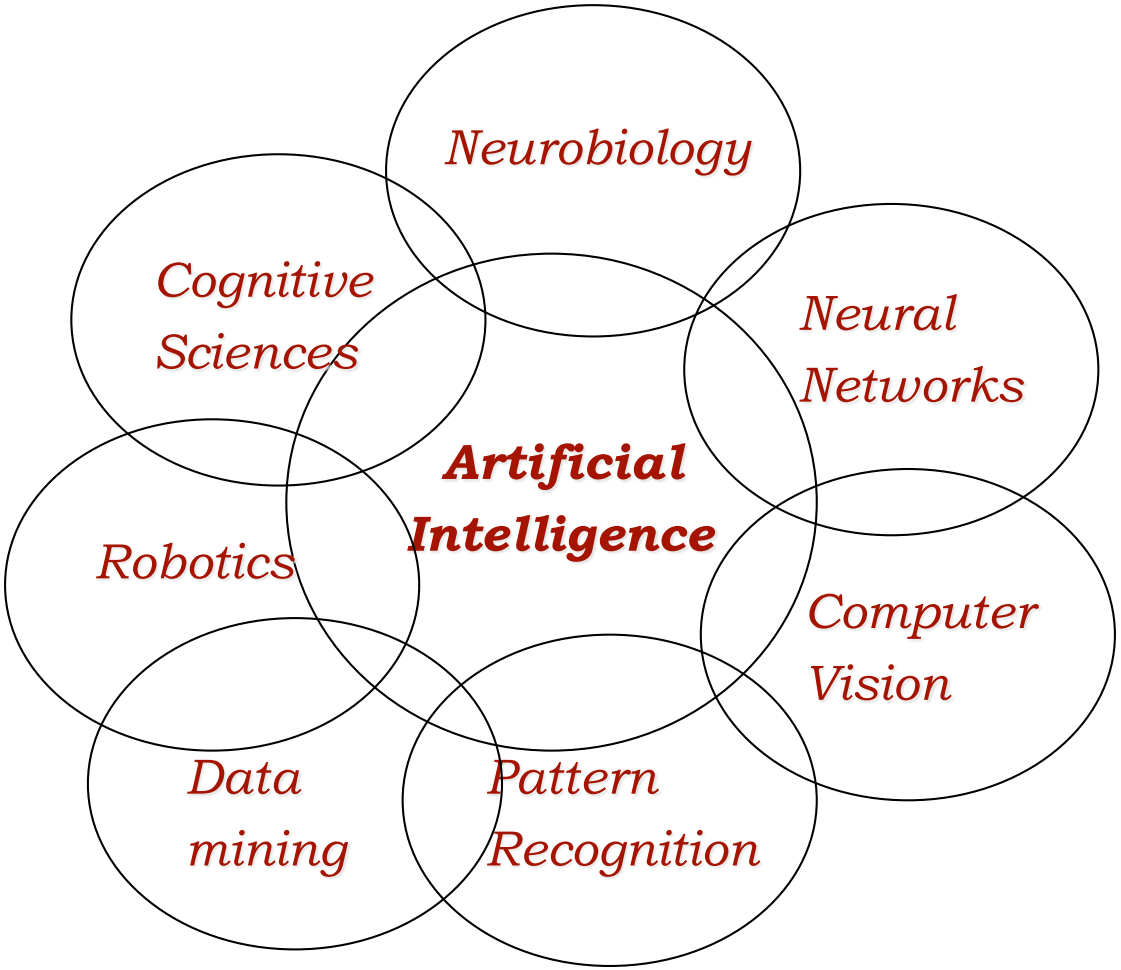
Can a machine exhibit intelligent behavior?

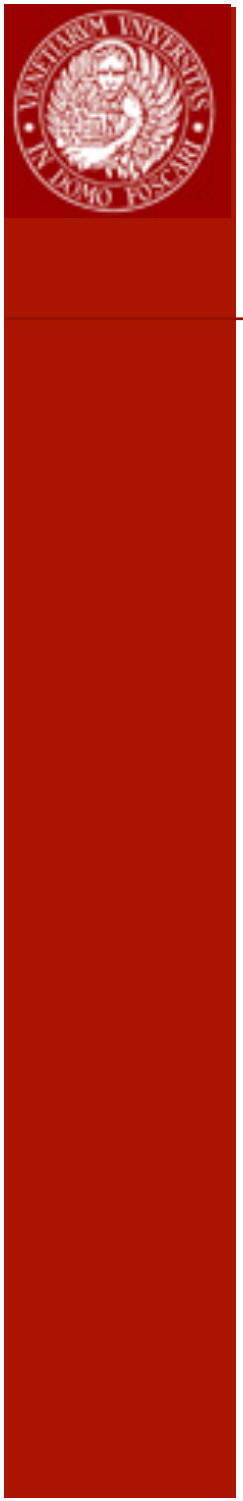
Strong AI:

Can a machine have self awareness?

Engineering vs Scientific attitudes towards AI.

An Interdisciplinary Endeavor





Two Approaches to AI

Symbolic (declarativism)

⇩

Deals with:
Theorem proving,
problem solving,
games, reasoning, etc.

⇩

Psychology

⇩

Serial systems

Sub-symbolic
(non-declarativism)

⇩

Deals with:
Pattern recognition,
perception, learning,

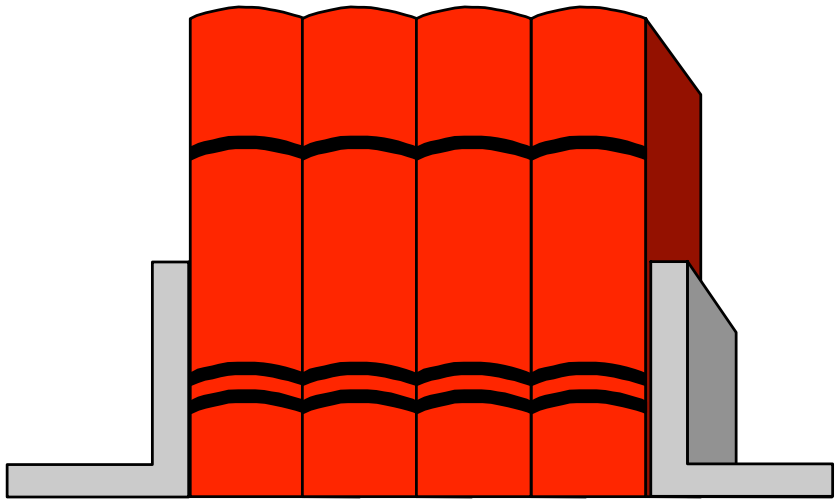
⇩

Neurobiology

⇩

Parallel systems

Some History



Early Attempts (1943-1956)

1943: McCulloch and Pitts propose a model for an artificial neuron and analyze its properties

1949: Donald Hebb proposes a learning mechanism in the brain, still of great interest

1950-53: Shannon and Turing work (independently) on chess-playing programs

1951: Minsky and Edmonds develop the first “neural” computer

1956: Newell e Simon develop the “Logic Theorist”

Hanover, 1956: The Birth of AI

A PROPOSAL FOR THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

J. McCarthy, Dartmouth College
M. L. Minsky, Harvard University
N. Rochester, I.B.M. Corporation
C. E. Shannon, Bell Telephone Laboratories

August 31, 1955

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. […]

First successes…

1961: Newell and Simon develop General Problem Solver (GPS)

1952-: Samuel develops a checker playing game

1957: First attempts at automatic translation

1958: McCarthy invents LISP

1963 - : Minsky and students study problems on micro-worlds (es., ANALOGY, SHRDLU)

1962: Rosenblatt develops the Perceptron, a neural net that learns from examples

… and first failures

1966: Financing to “automatic translation” projects in the USA is canceled

1969: Minsky and Papert publish Perceptrons, where they show that the Rosenblatt model cannot solve some very simle problems

1971-72: Cook and Karp develop the computational complexity theory, showing that a lot of problems are “intractable” (NP-complete).

The Expert-System Boom

1969: Feigenbaum *et al*. (Stanford) develop DENDRAL, an ES for making predictions on molecular structures

1976: MYCIN, an ES with some 450 rules for the diagnosis of infectious diseases

1979: PROSPECTOR, an ES for mineral explorations

1982: R1, a commercial ES for configuring DEC VAX systems

The Resurgence of Neural Networks

1982: Hopfield (Caltech) develops a neural model based on the analogy with phisical (ferromagnetic) systems

1985: Hopfield e Tank applied their model to “solve” intractable (NP-complete) problems

1986: The PDP group (re)introduces *back-propagation*, a learning algorithm for layered (feed-forward) neural networks, thereby overcoming the limitation of *Perceptrons*

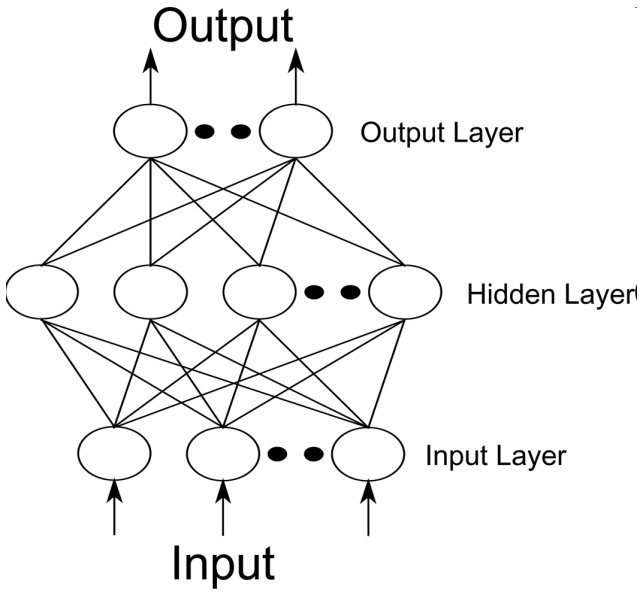
1987: Sejnowski and Rosenberg develop *NETtalk*, a neural network that “learns” to talk

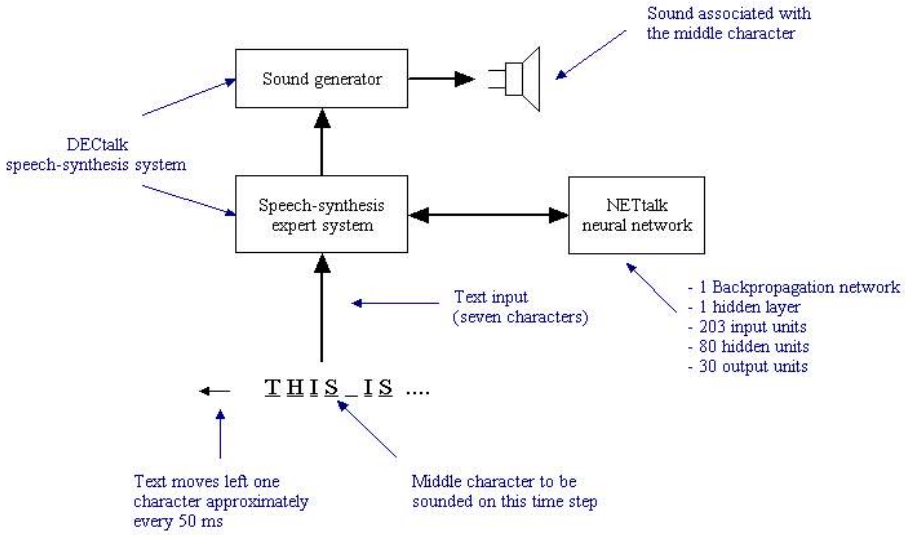
NETtalk:
A Neural Net that Learns to Talk

T. J. Sejnowski and C. R. Rosenberg

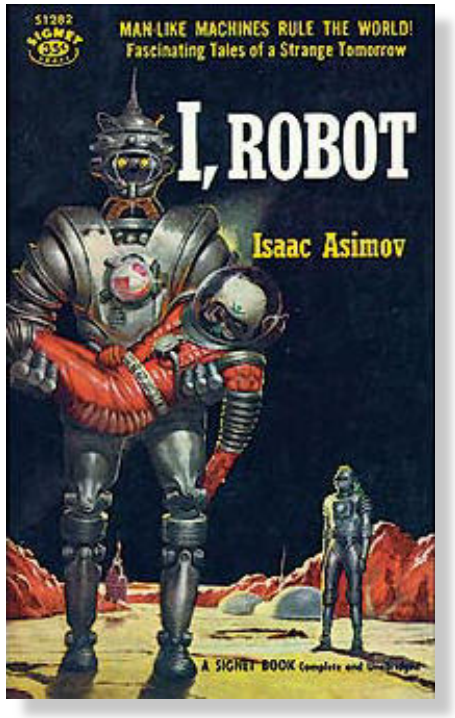
"Parallel networks that learn to pronounce English text"

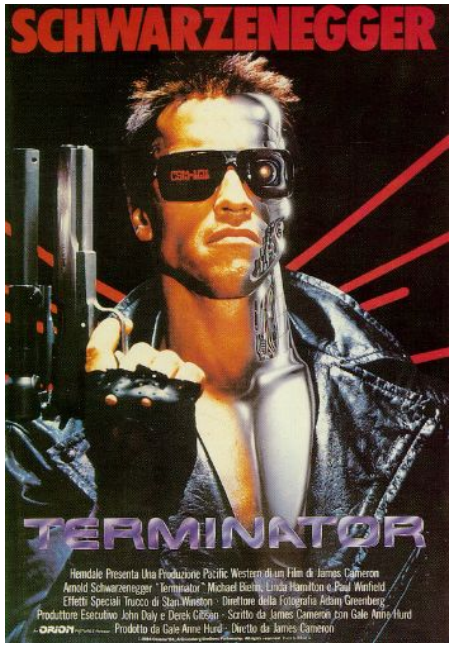
Complex Systems 1, 145-168 (1987)





Far away from HAL 9000 & Co., but…



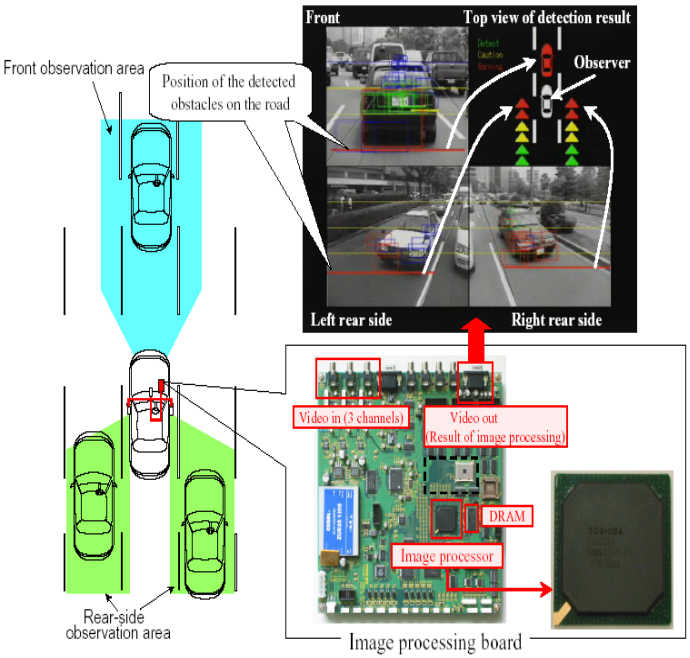


IBM:
Deep Blue vs. Kasparov (1997)

SONY and the “humanoids”

Robot SDR-4X II

TOSHIBA: Computer-Assisted Driving



Biometry

Biometry develops techniques for the automatic reocognition of a person's identity.

Typical biometric information

Physiological:

- Face
- Fingerprints
- Voice
- Retina
- Iris
- Hands
- DNA
- …

Behavioral:

- Signature
- Keystroke
- Gait
- …

Biometry e anti-terrorism

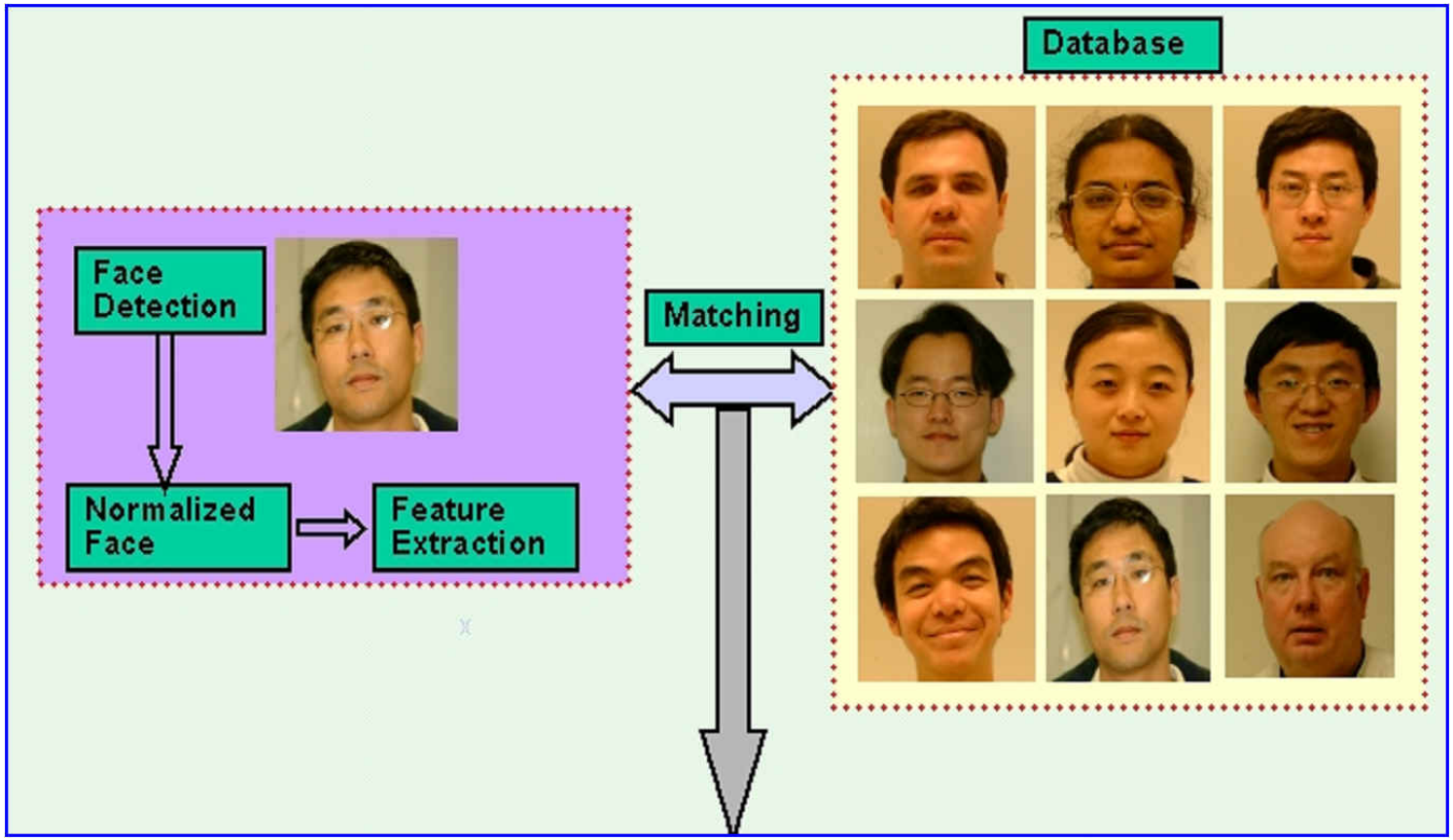
« A comprehensive immigration reform must include a better system for verifying documents and work eligibility. A key part of that system should be a new identification card for every legal foreign worker.

This card should use biometric technology. »

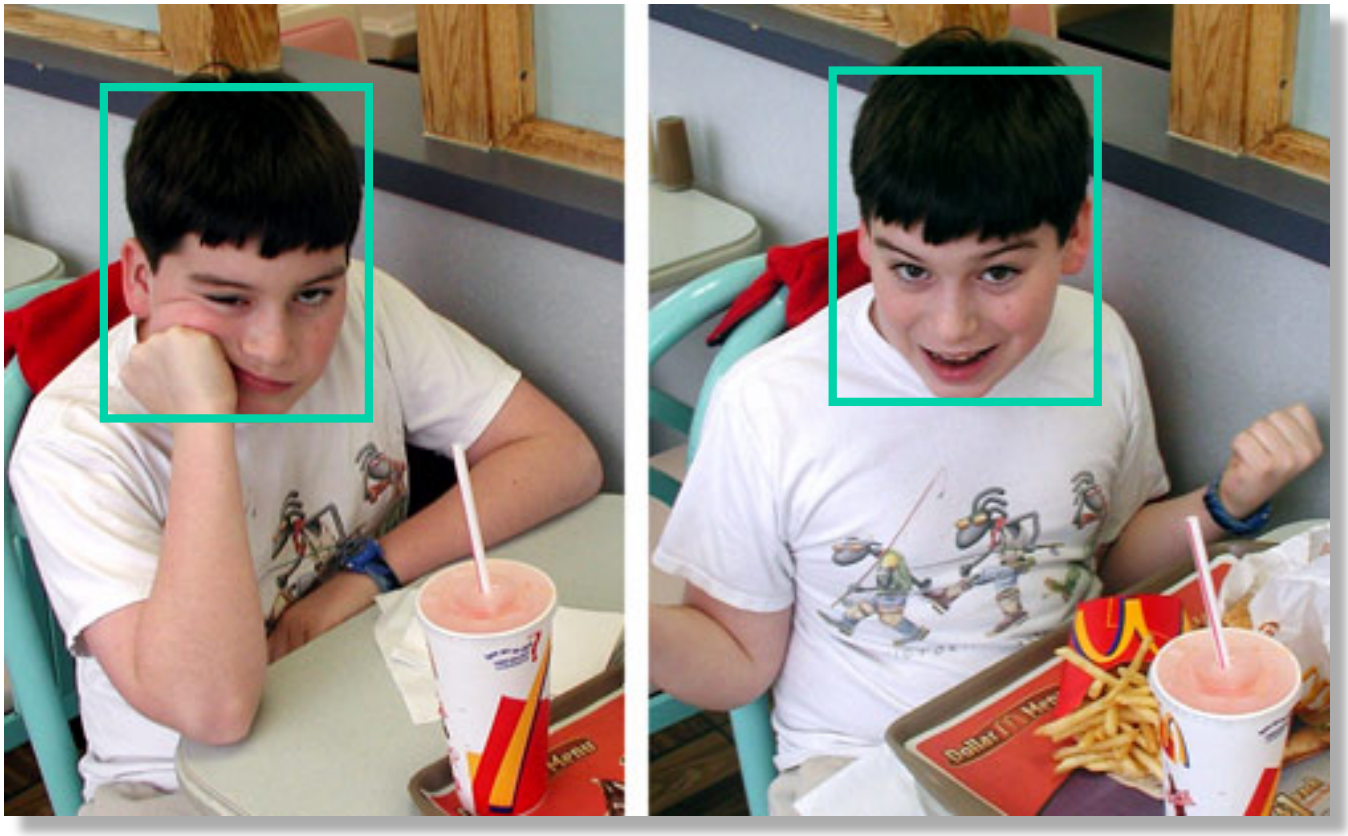
George W. Bush

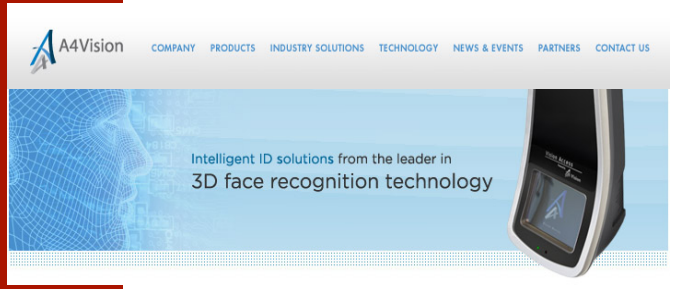
May 15, 2006

Face Recognition



Face Recognition





CYBULA
high performance pattern recognition systems

AYONIX
advanced image technologies

NEUROtechnology

Cognitec
The Face recognition company

Betaface
Face detection & recognition

SensibleVision

OmniPerception
Computing with Vision

ID 1 ONE

TCC
The Covenant Consortium

Attrasoft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Share your family tree and photos with the people you know and love.
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Find the Celebrity in You™
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Post your celebrity matches on your blog!
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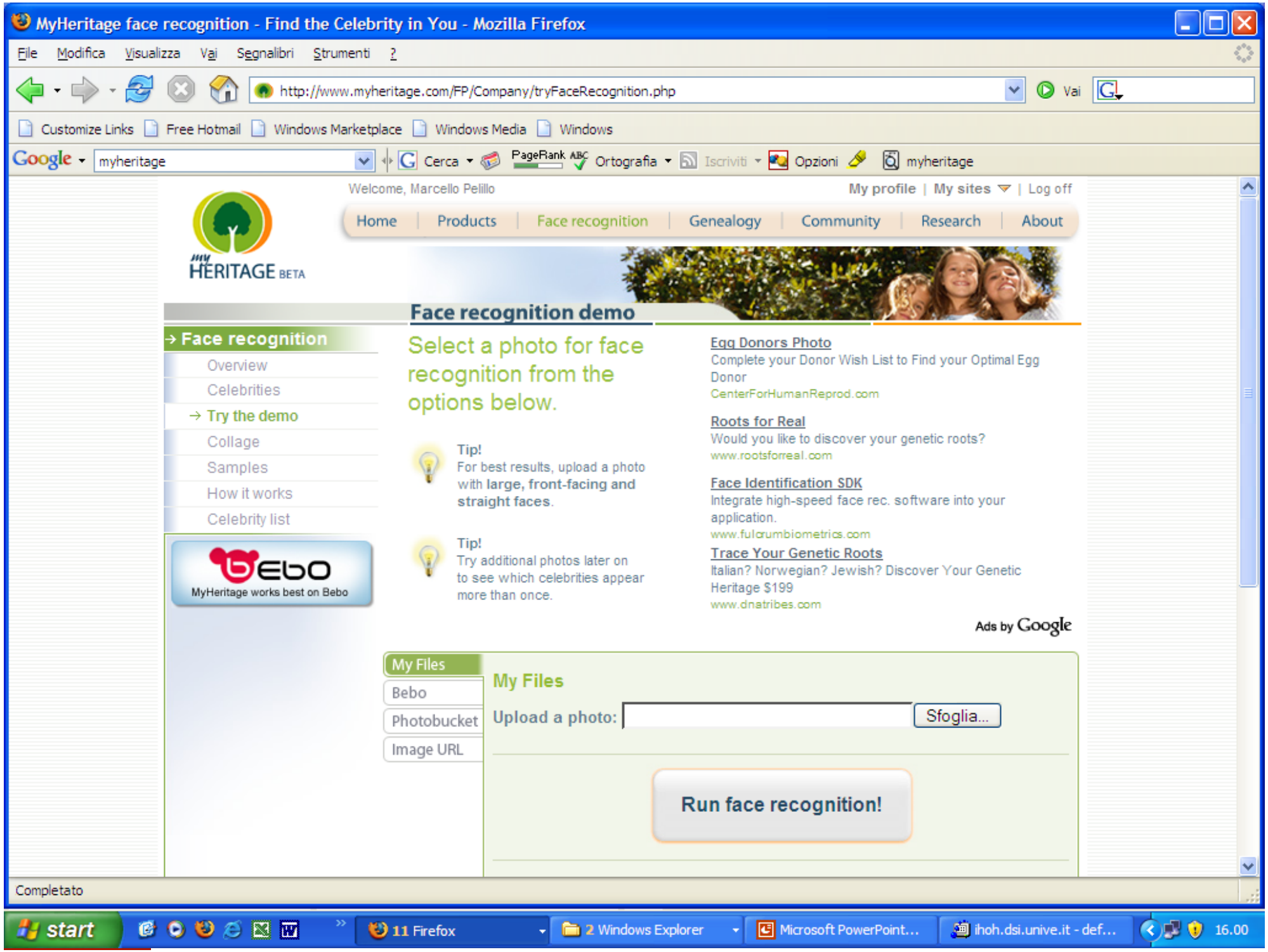
MyHeritage face recognition - Find the Celebrity in You - Mozilla Firefox
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Select a photo for face recognition from the options below.
Tip!
For best results, upload a photo with large, front-facing and straight faces.
Tip!
Try additional photos later on to see which celebrities appear more than once.
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Complete your Donor Wish List to Find your Optimal Egg Donor
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MyHeritage face recognition - celebrity matches - Mozilla Firefox

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Russell Crowe

0 100 (76%)

Gender: All

Topher Grace

0 100 (71%)

Gender: All

Peter Gallagher

0 100 (73%)

Gender: All

John von Neumann

0 100 (63%)

Gender: All

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Fingerprint Recognition

?


sequiam
BIOMETRICS


COGENT SYSTEMS


3D
REAL LIFE BIOMETRICS


GUARDWARE


digitalPersona.


Biometric
Access
Company


L-1
IDENTITY
SOLUTIONS


STARTEK


PRECISE™
BIOMETRICS


Kimaldi


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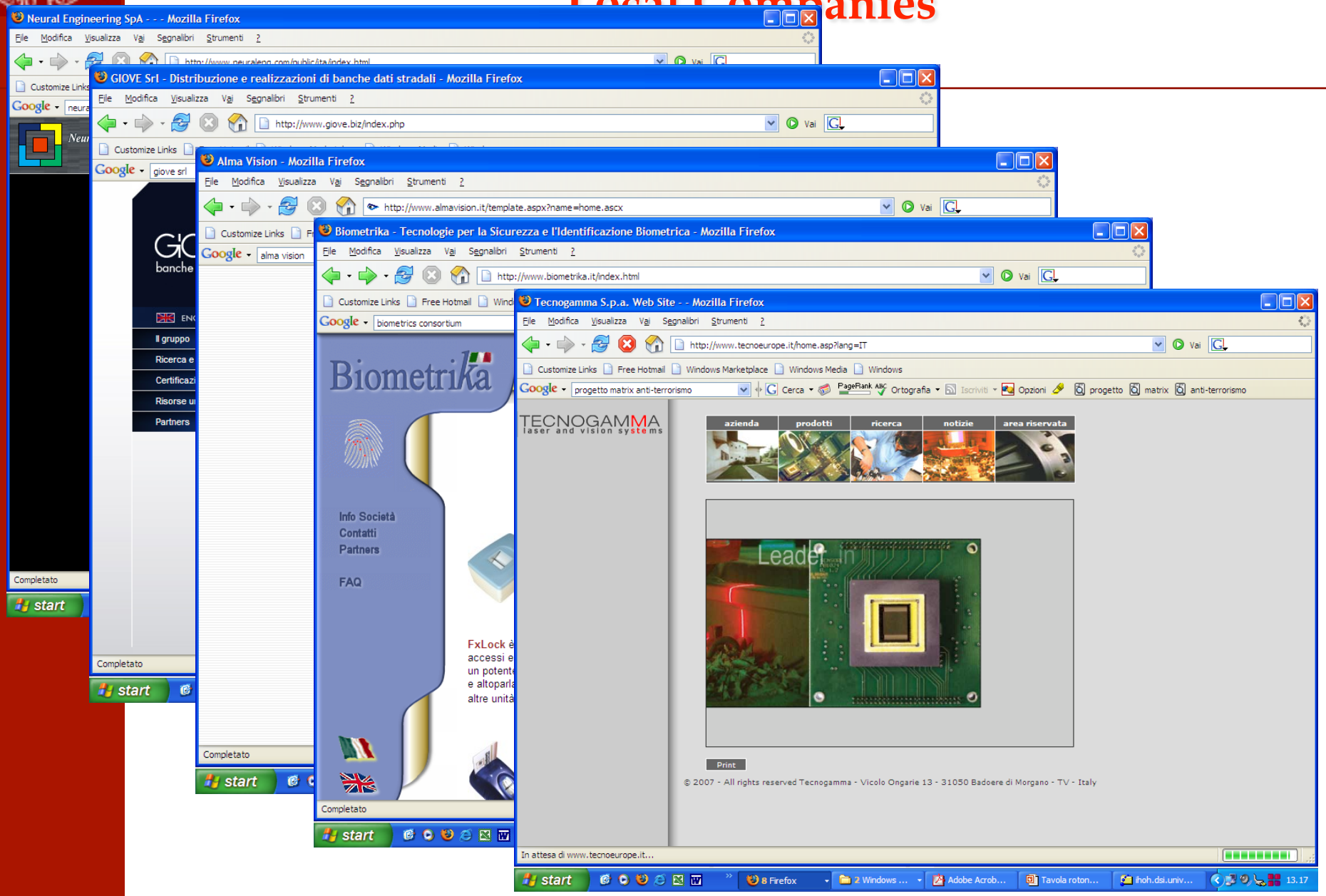

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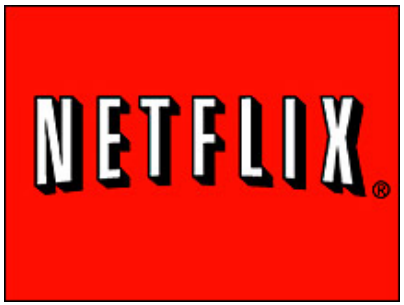
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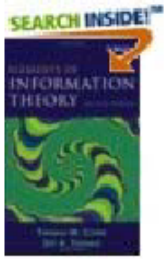
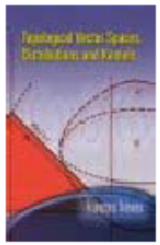
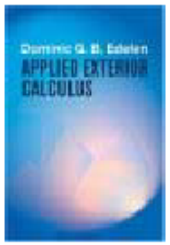


Elements of Information Theory (Wiley Series in Telecommunications and Signal Processing)

Action in Perception (Representation and Mind)



Topological Vector Spaces, Distributions and Kernels



Applied Exterior Calculus (Dover Books on Mathematics)

The Malliavin Calculus (Dover Books on Mathematics)

Copernican Questions: A Concise Invitation to the Philosophy of Science

Optimal Filtering (Dover Books on Engineering)

Riemannian Geometry

See More Recommendations

Other Commercial Applications of AI

- Video-surveillance
- Traffic monitoring
- Plate recognition
- Road sign recognition
- Speech synthesis and recognition
- Web profiling
- Medical image analysis
- Virtual reality
- Man-machine interaction (e,g,, gesture recognition)
- Expert systems
- …..

This AI Course

Main Topics

- Problem solving
- Machine learning and automated reasoning
- Perception

Recommended Texts

S. Russell, P. Norving,
Artificial Intelligence: A Modern Approach (2nd edition)
(trad it., Intelligenza Artificiale: Un approccio moderno)

C. M. Bishop.
Pattern Recognition and Machine Learning. Springer, 2007.