

Introduction to Vision & Robotics

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Official page and lecture schedule:

www.inf.ed.ac.uk/teaching/courses/ivr

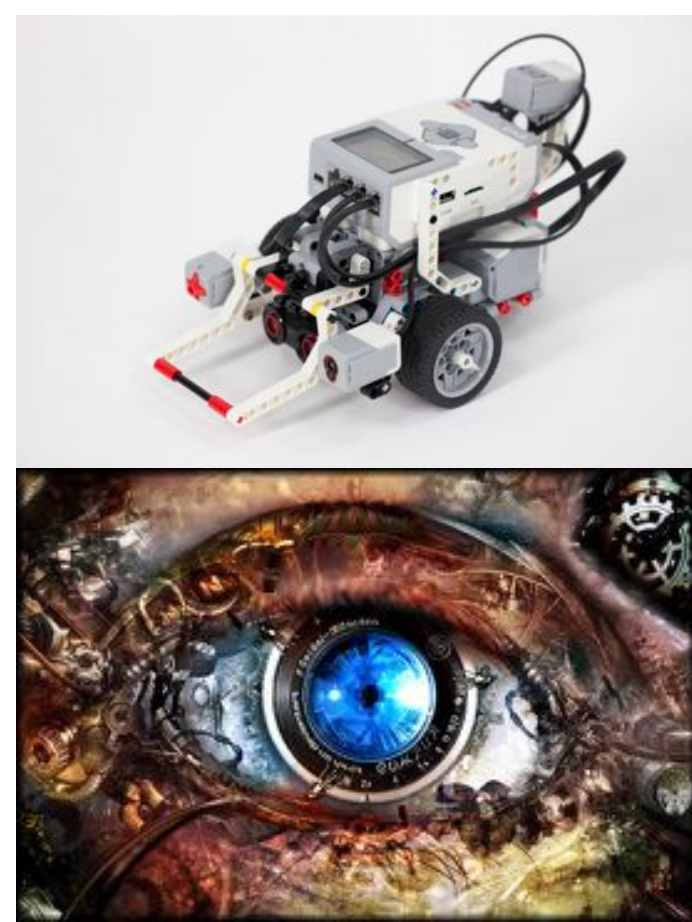
Lectures are available as videos online:

<https://www.learn.ed.ac.uk>

Practicals: Week 2 - 10

- Tuesday starting at 9:10 (AT 3.D02)
- Wednesdays starting at 14:10
- Thursdays starting at 13:10 (AT 3.D02)

Problems: please contact Dr. Fallon or Demonstrators.



Vision and Robotics: some definitions

- Connecting the computer to the “raw unwashed world” (Russell & Norvig)
- “create [from 2-d image] an accurate representation of the three-dimensional world and its properties, then using this information we can perform any visual task” (Aloimonos & Rosenfeld)
- Vision is the direct extraction of affordances from the optic array (Gibson)
- A robot is: “A programmable multi-function manipulator designed to move material, parts, or specialised devices through variable programmed motions for the performance of a variety of tasks” (Robot Institute of America)
- “Robotics is the intelligent connection of perception to action” (Brady)

Applications: dull, dirty or dangerous

Visual inspection of parts



Detecting crime on CCTV



Welding on cars

Applications: dull, dirty or dangerous

Robot vacuum cleaners



Cleaning nuclear plants

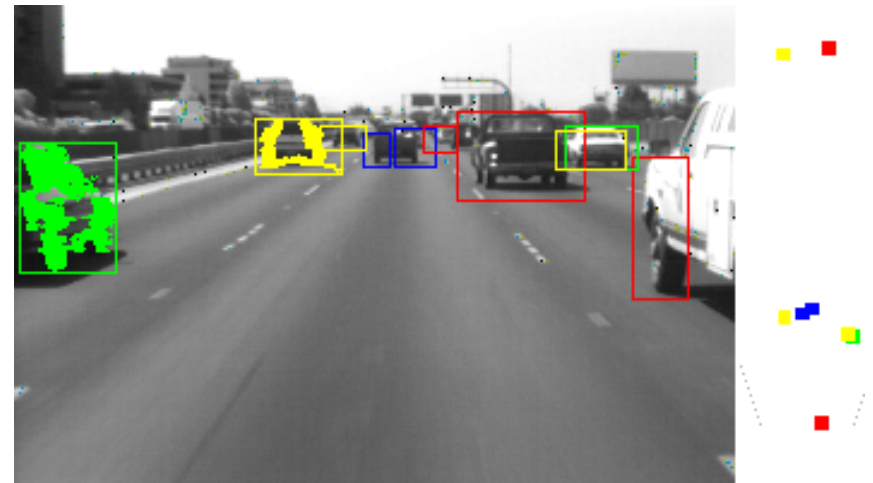


Robot sewer inspection

N.B. Overlaps with teleoperation

Applications: dull, dirty or dangerous

Visual aids for driving



Demining



Space exploration

Applications

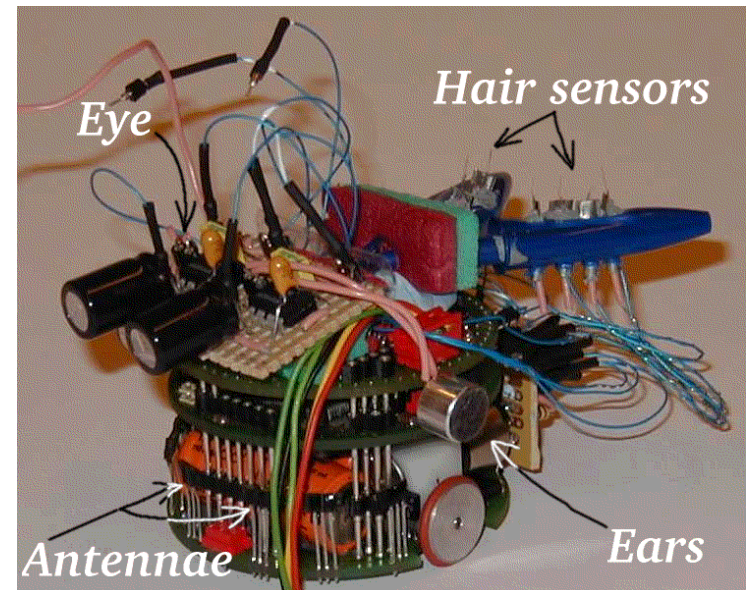
Entertainment robotics



Service robotics



Science



A challenging problem

- We don't have much introspective insight into how we see or how we control action
- Building vision and robot systems involves a variety of interacting *technology domains*:
 - *Mechanical, electrical, digital, computational...*
- This has proved to be a hard problem for AI
 - Can beat the human grandmaster at chess
 - Can't replace a house cleaner

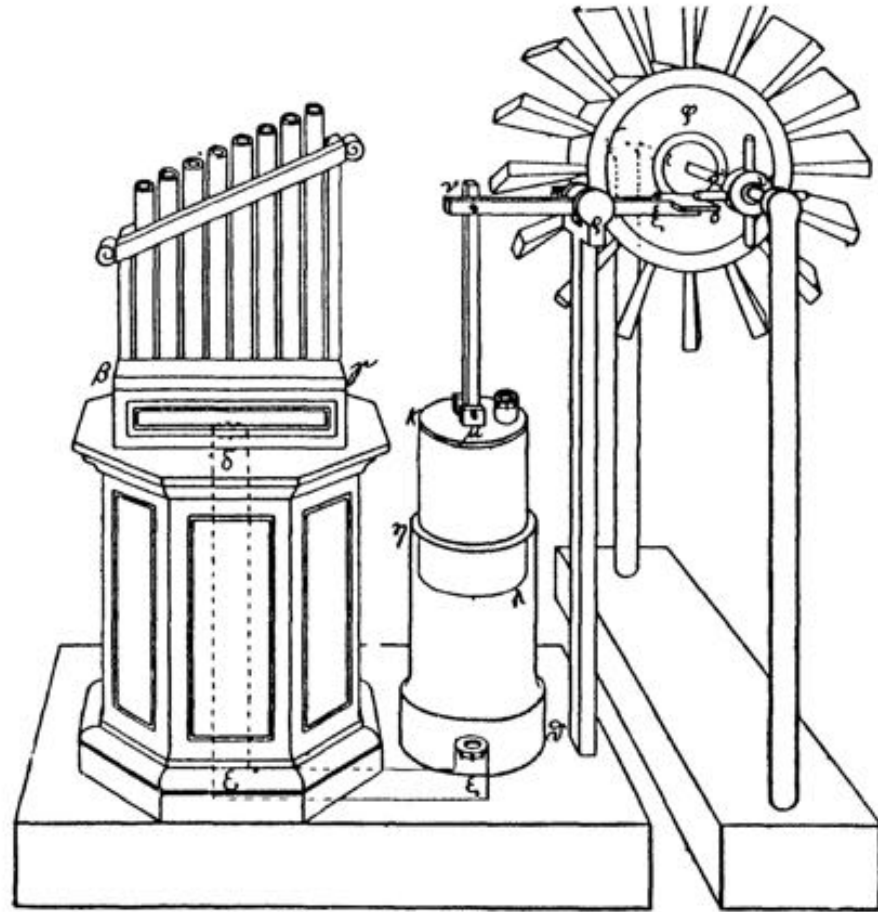
Vision and robotics uses all areas of AI:

- Problem solving, planning, search, inference, knowledge representation, learning etc...
- But we can't just plug sensors and effectors onto an AI simulation and expect it to work
- Have constraints such as:
 - Limited, noisy, raw information
 - Continuous dynamic problem space
 - Time, power, cost and hardware limitations
- Often solutions grounded in these constraints do not resemble conventional AI approaches

Ancient Greece:

hydraulic and
mechanical
automata

Hero of Alexandria
AD 100

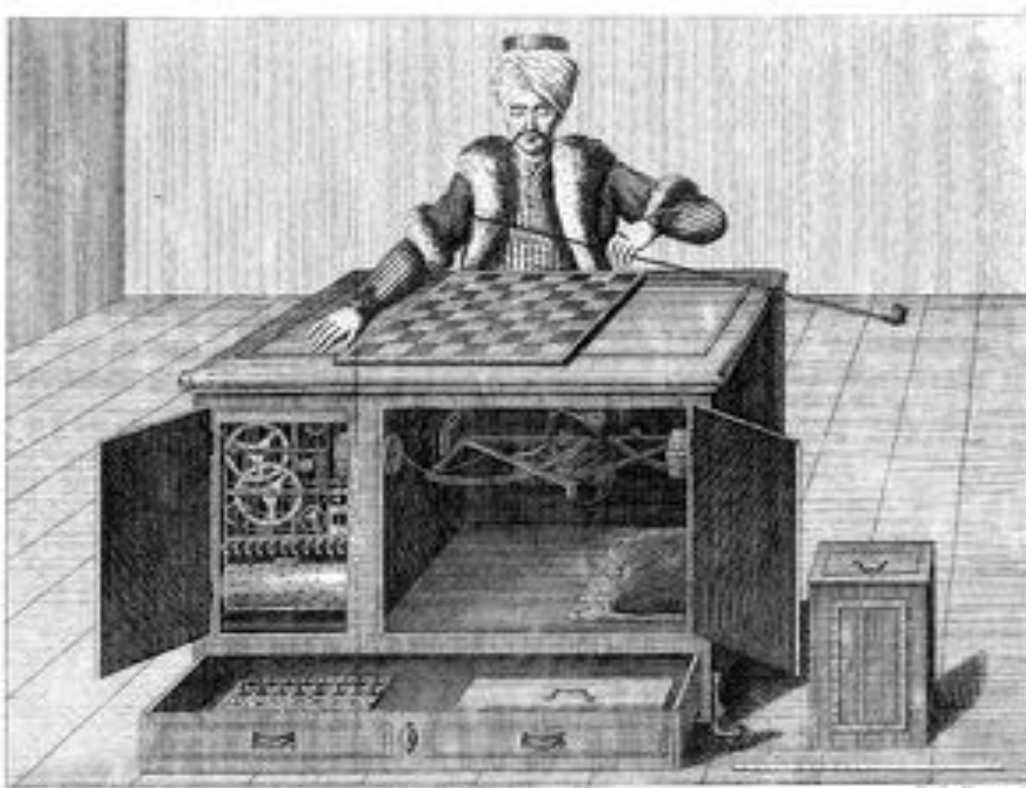


Windpowered Organ

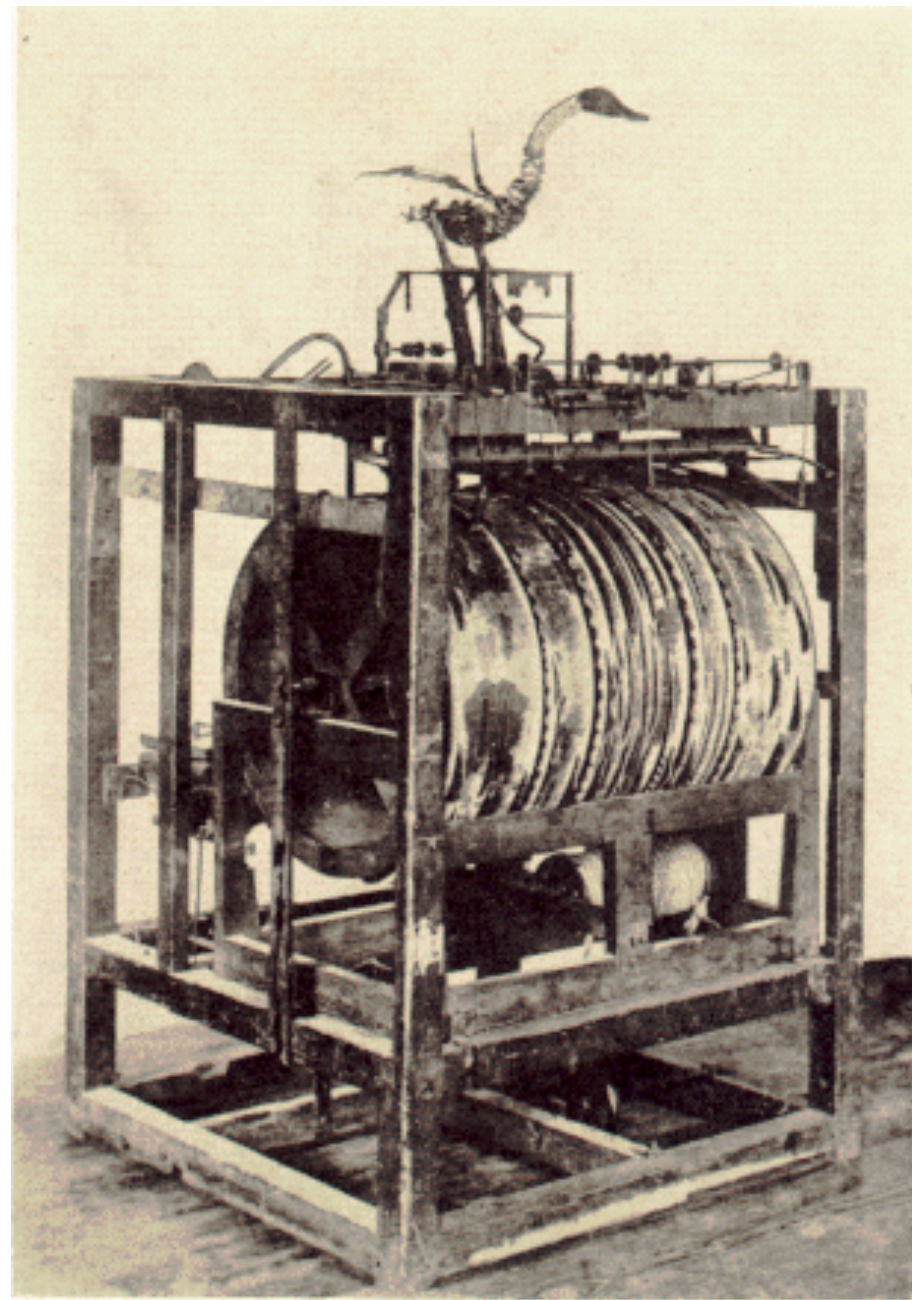
18th century:

Clockwork animals:

- Vaucanson's duck
- Mechanical Turk

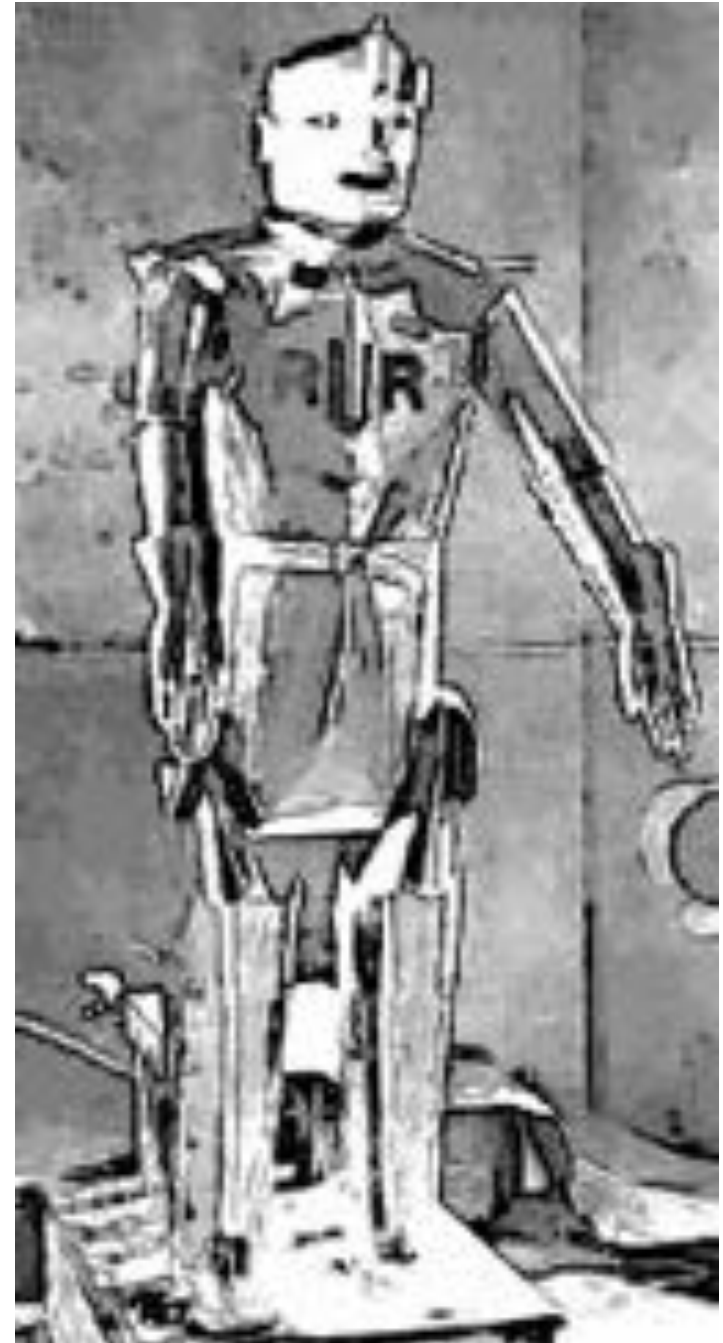


U. A. Knapton del. The Mechanical Turk Chess Player. P. G. Pirey sculp. Van der Schueren inv. en auct. Sculp. et grav. in aedibus J. Neumann, Neudamm, per J. G. Neumann, Neudamm, per J. G. Neumann, Neudamm.

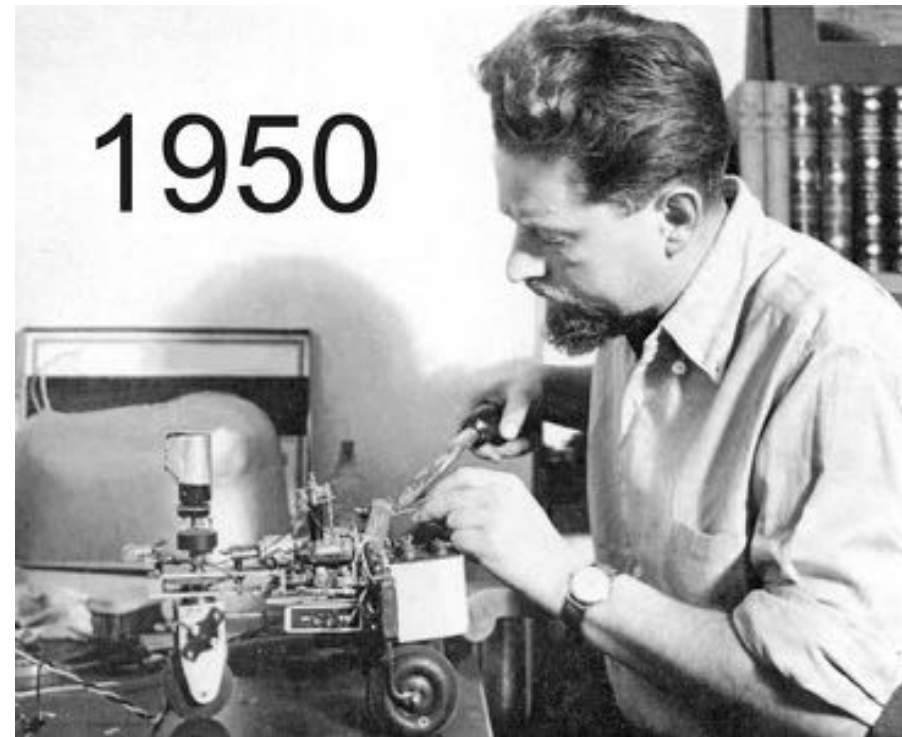
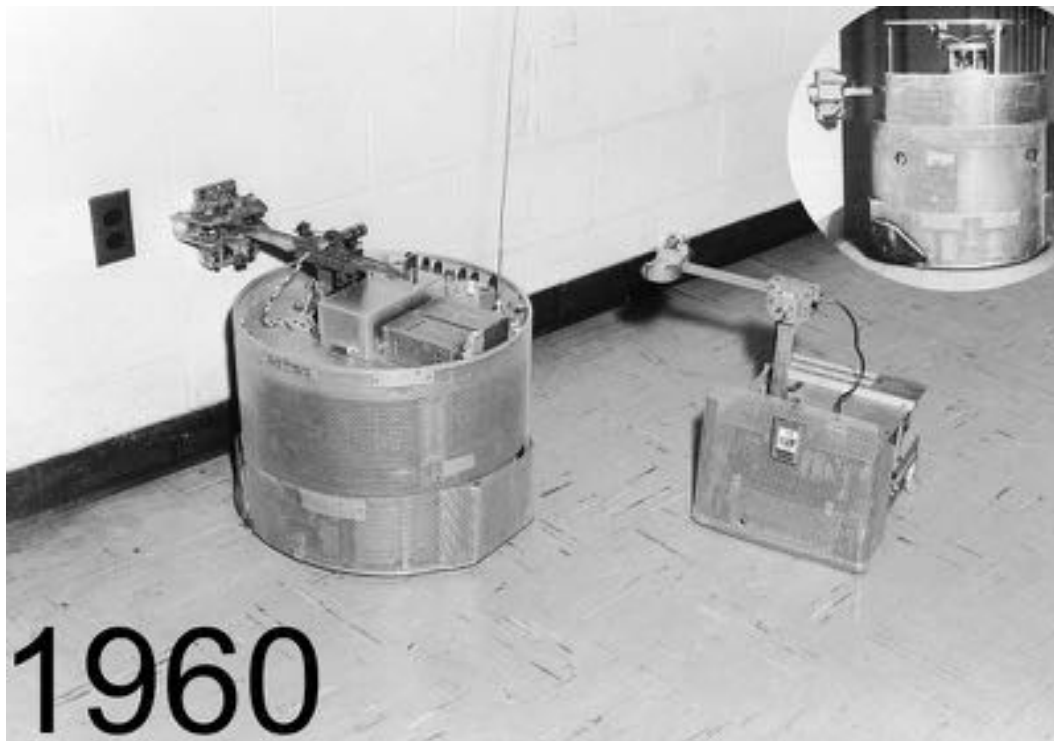


Early 20th century:

- Electronic devices for remote control (N. Tesla)
- Methods for transducing images into electrical signals
- ‘Robot’ used to describe artificial humanoid slaves
 - Karel Capek’s play “Rossum’s Universal Robots” 1920



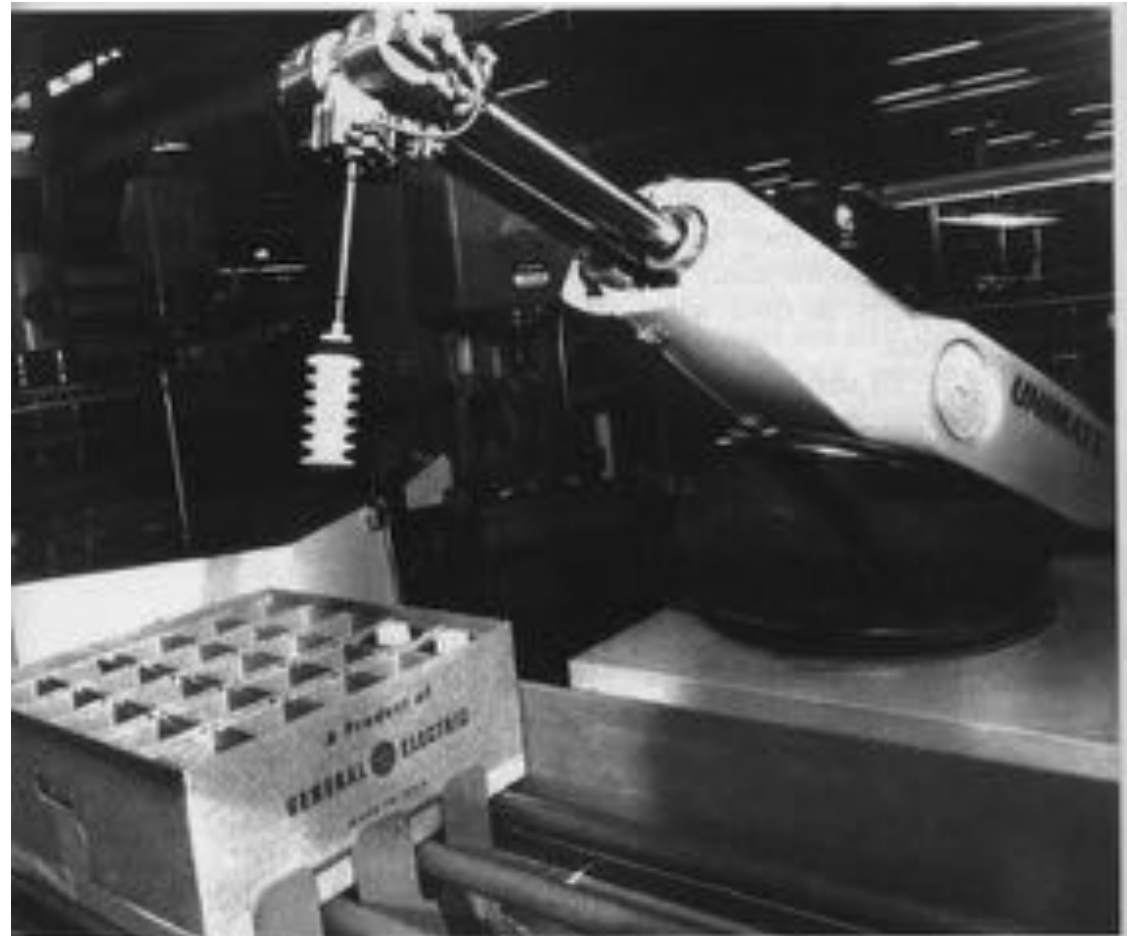
1940s –1950s:
Development of electronic
computer and control
theory



1960s:
Used for artificial
creatures e.g. Walter's
'tortoise' and John
Hopkins' 'beast'

1960s:

- Industrial robot arms: Unimation
- Methods for image enhancement and pattern recognition

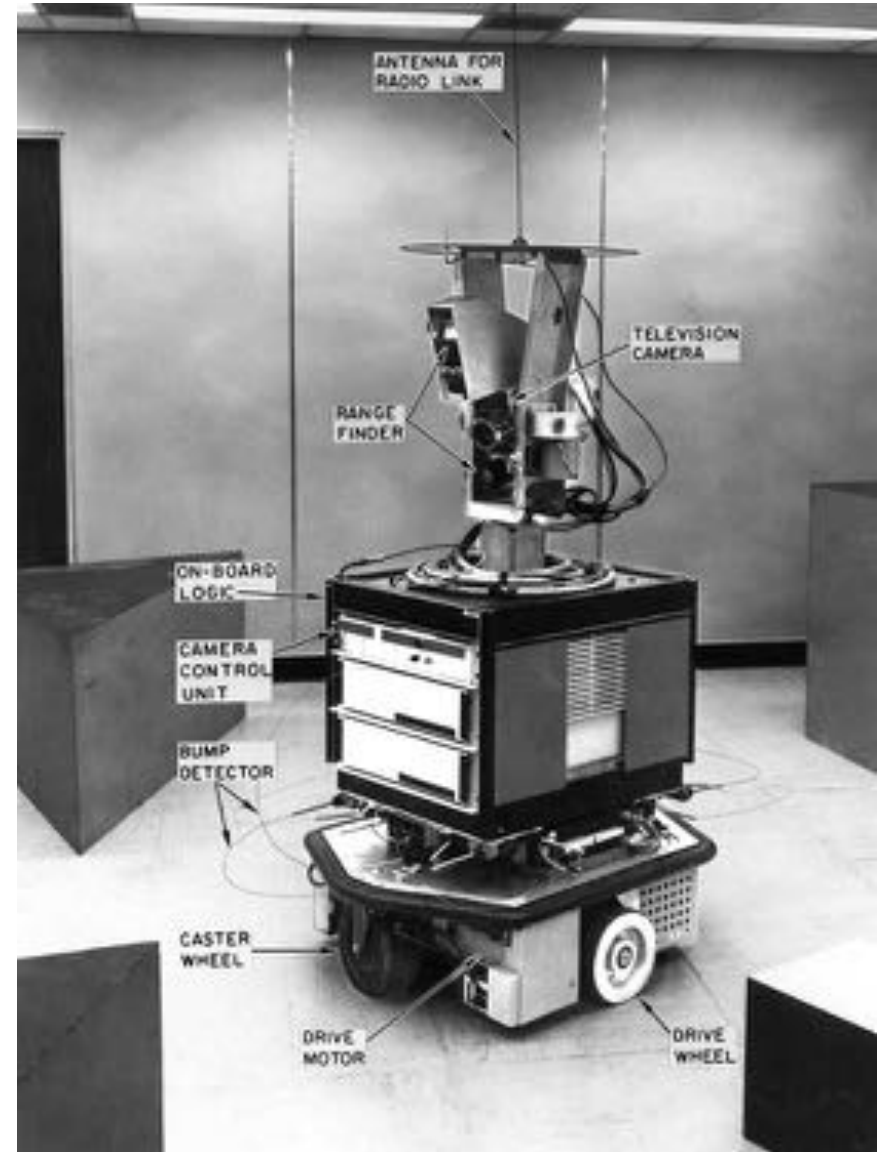


Armed for duty. A Unimate robot—really, just an arm—picks up and puts down parts in a General Electric factory.

1970s

First Recognisable robots:

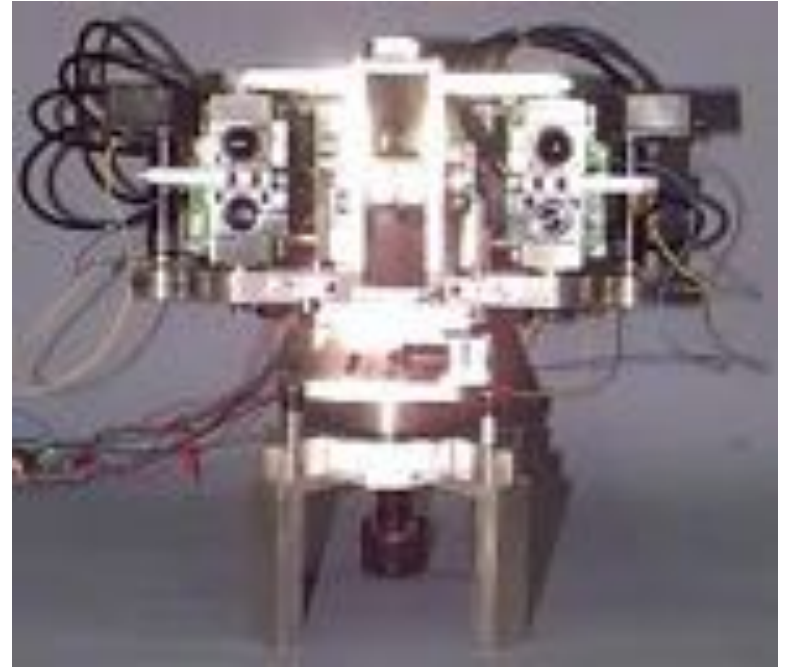
- Working in restricted domains
- Shakey in block world
- Freddy assembly task



1980s:

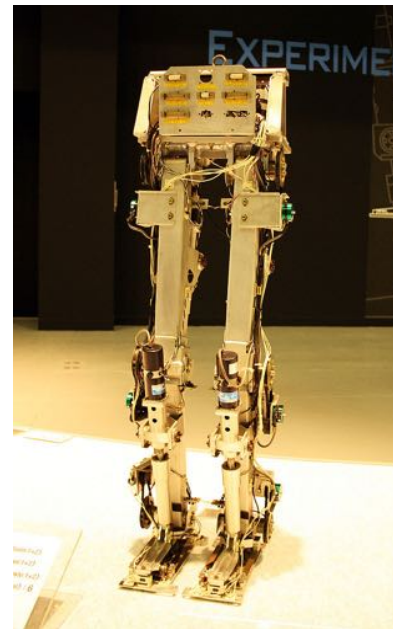
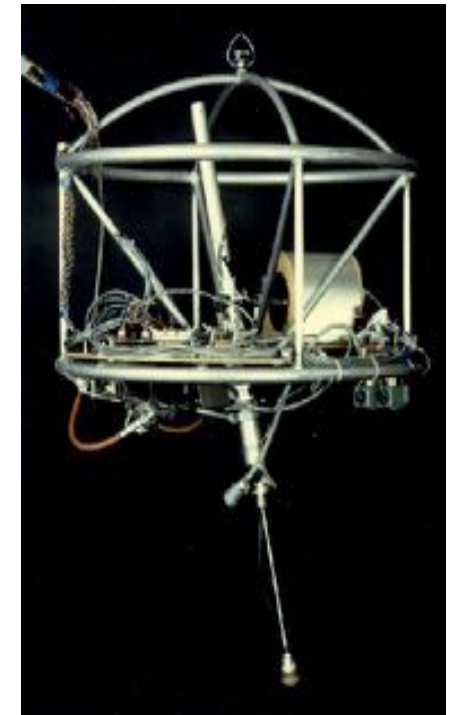
Tackling more realistic problems:

- Natural scene analysis
- Face recognition
- Dynamic locomotion
- Significant impact in manufacturing
- Active vision



Leg Lab (CMU 1980,
MIT 1986 onwards)

2000s: Asimo, Nao,
Atlas, iCub, Valkyrie,
PR2 ...



Honda E1 (1987) Asimo (2011)

Legged Locomotion



Atilla & Ghengis
MIT Brooks Lab c. 1990



HAL CyberDyne



BigDog & Atlas
Boston Dynamics

RoboCup: Robot Soccer (since 1997)



Edinferno
(2010)



Autonomous driving

- NavLab: CMU from 1987
- 1995 'No hands across America' 98% autonomous
- 2005 DARPA Grand Challenge
 - 2007 Urban Challenge
- Several U.S. states have passed laws permitting driverless cars: NV, FL, CA, MI
- 2014 Google Self-Driving Car: "fully functional" prototype
 - Tesla, Uber, Apple, Zook, NuTonomy



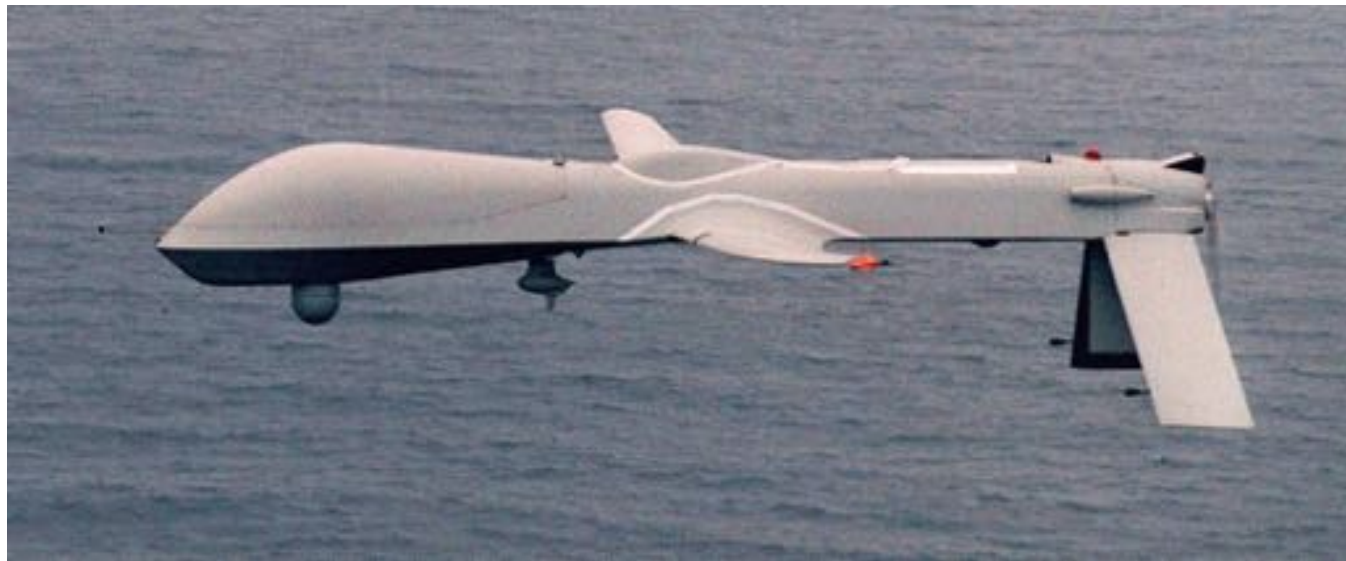
Drones: Unpiloted aerial vehicles

Usually remotely piloted

Can be airborne for several days

Applications:

- Military
- Exploration
- Transport
- Archaeology
-



Manipulation



KUKA robot (6 DoF)



Barrett Gripper (7 DoF)



“Michelangelo” hand (4 DoF)



Shadow hand (20 DoF)



EDINBURGH CENTRE FOR
ROBOTICS

Edinburgh Centre for Robotics



Introduction to Vision and Robotics

Vision Topics:

- Image capture and segmentation
- Shape description and shape matching
- Object recognition and interest points

Robotics Topics:

- Sensing: Exteroception and proprioception
- Acting: Moving, reaching, grasping
- Connecting sensors and effectors: Robot control
- **Note:** Vision for Robots removed from syllabus this year. Active Vision will still be on the course

Overview of the course:

- Lectures:
 - Sensing and Vision
 - Effectors and Control
 - Architectures and wider issues
- Supervised practicals:
 - Using real and simulated robots
 - Image capture, processing and classification
- Pract 1: Assessed vision practical (20%) 20%
- Pract 2: Assessed robotics practical (20%) 20%

Assessment
60%

Flipped Classroom Concept

- Videos of Lectures and all Lecture Notes are stored on/accessed on **Learn**:
 - <https://www.learn.ed.ac.uk>
 - No lectures in the traditional sense.
- More control of your education in this course.
 - 25 short videos on different topics.
 - Watch the videos in your own time
- Distance Learning: Course being delivered to a group of remote students via live streaming (using **Collaborate**)
 - Course unmodified for local students
- 4 interim in-class quizzes:
 - Informal. Not used for final assessment

Flipped Classroom Concept

- Videos of Lectures and all Lecture Notes are stored on/accessed on **Learn**:
 - <https://www.learn.ed.ac.uk>
 - No lectures in the traditional sense.
- Video Lectures recorded by:
 - Prof. Bob Fisher and Dr. Michael Herrmann
 - They are not involved in delivery of this class. Please don't contact them

Learn: My Learn Page

THE UNIVERSITY of EDINBURGH | Learn

My Learn Self-Enrol Content Collection Courses Help

My Learn Notifications Dashboard

My Courses

Courses where you are: Instructor

- Advanced Vision (Level 11) (2015-2016)(SV1-SEM2)
- Introduction to Vision and Robotics (2015-2016)(SV1-SEM2)
- Introduction to Vision and Robotics (2016-2017)(SV1-SEM1)
- Introduction to Vision and Robotics (2016-2017)(SV1-SEM1)

Alerts for downtime

No planned alerts

Please check the [service alerts page](#) for up-to-date information.

We recommend that staff using Learn sign up to the [Learn-info](#) mailing list for alerts and news about the Learn service.

Follow IS Helpline Service Alerts & announcements @isalerts

My Announcements

No Instruction Announcements have been posted in the last 7 days.

No Course or Organisation Announcements have been posted in the last 7 days.

[More announcements...](#)

Problem printing pdf's from Learn

Printing PDFs Issue

There is an intermittent issue with printing PDFs on campus which results in print jobs only printing symbols on a page.

If IVR doesn't appear here, then contact Dr. Fallon. (ITO needs to fix this)

Learn – IVR Pages: Video and Lecture Notes

The screenshot displays the 'Learn' LMS interface for the University of Edinburgh. The top navigation bar includes 'My Learn', 'Self-Enrol', 'Content Collection', 'Courses', and 'Help'. The user 'Maurice Fallon' is logged in. The course title 'Introduction to Vision and Robotics (2016-2017) [SV1-SEM1]' is visible in the left sidebar. The main content area shows 'Course Information' with details on tracking, attached files, and course structure.

Course Information

Enabled: Statistics Tracking
Attached Files: Course Introduction Slides (2.886 MB)

Introduction to Vision and Robots

Main course website:

- <http://www.inf.ed.ac.uk/teaching/courses/ivr/>
- For schedule information and assignments

Course Lecturer:

- Dr. Maurice Fallon maurice.fallon@ed.ac.uk

Video recordings (Spring 2016):

- <http://groups.inf.ed.ac.uk/ivision/VIDEO2015/ivr.htm>

IMPORTANT INFORMATION

This course is not taught by the traditional lectures. Instead, we use an Inverted Classroom method. This means that you will have about 8 hours of video to watch in your own time. This material is accessible. There are still 2 full class meetings each week. At each meeting we will be discussing any questions that you either suggest in advance or raise in class on the day. There will not be a traditional 'lecture'.

Reading List referred to in these lecture notes

- **R&N:** Russell & Norvig Chapters 24 & 25 in *Artificial Intelligence: A Modern Approach*, Prentice Hall, 1995, ISBN 0130803022. Highly recommended
- **M.** Robin R. Murphy. *Introduction to AI Robotics*, MIT Press, 2000, ISBN 0262133830. Recommended, supplementary for robotics
- **N.** Ulrich Nehmrow. *Mobile Robotics: A Practical Introduction*, Springer; 2nd ed. edition (8 July 2003). Recommended.

Other Reading Material

Lecture Streaming: Blackboard Collaborate Ultra

The screenshot displays the Blackboard Collaborate Ultra interface. At the top, the University of Edinburgh logo and 'Learn' branding are visible. A navigation bar includes 'My Learn', 'Self-Enrol', 'Content Collection', 'Courses', and 'Help'. The course title 'Introduction to Vision and Robotics (2018-2017) [SV1-SEM1]' is shown in the left sidebar. The main content area is titled 'Blackboard Collaborate Ultra' and 'Sessions'. A 'Show All Upcoming Sessions' dropdown is present. Below this, a 'Course Room' card with a 'Join room' button is shown. A table lists upcoming sessions with columns for Name, Starts, and Ends.

Name	Starts	Ends
VR Lectures	22/09/2016, 08:45	22/09/2016, 10:15
VR Lectures	26/09/2016, 08:45	26/09/2016, 10:15
VR Lectures	29/09/2016, 08:45	29/09/2016, 10:15
VR Lectures	03/10/2016, 08:45	03/10/2016, 10:15
VR Lectures	06/10/2016, 08:45	06/10/2016, 10:15
VR Lectures	10/10/2016, 08:45	10/10/2016, 10:15
VR Lectures	13/10/2016, 08:45	13/10/2016, 10:15

Introduction to Vision and Robotics

Two Assignments:

- **Vision:** detecting objects from a series of images, training classifiers and feature detectors.
 - Programming in MATLAB
- **Robotics:** build a robot using Lego EV3. Develop a motor controller, sensor perception, carry out navigation tasks
 - Programming in Python
 - New assignment/interface this year

Both assignments examined using demonstration

Lab Groups

LABORATORY GROUP 2 FH
Room 3.D02, Tue 09:00-11:00 (26 students)

[Alex Wilson](#)
[Andra Zaharia](#)
[Andreea Cucu](#)
[Arthur Wilcke](#)
[Becca Bonham-Carter](#)
[Catalina Rotaru](#)
[Dimitar Vashkov](#)
[Eliisabet Hein](#)
[Georgi Hristov](#)
[Giuseppe Li](#)
[Hanne Carlsson](#)
[Jessica Kelly](#)
[Justin Alisaukas](#)
[Justin Reigis](#)
[Matthew Martin](#)
[Oliver Morgan](#)
[Oscar Postlethwaite](#)
[Peter Galer](#)
[Pierre Gianferrara](#)
[Povilas Pazera](#)
[Ramona Comanescu](#)
[Siim Sammul](#)
[Stiliyan Emanuilov](#)
[Vladimir Stepanov](#)
[Weiting Goh](#)
[Yanitsa Mihaylova](#)

LABORATORY GROUP 3 FH
Room 3.D02, Thu 14:10-16:00 (11 students)

[Alex Zhang](#)
[Dainius Cerniauskas](#)
[Julian Xu](#)
[Kexin Huang](#)
[Onji Bae](#)
[Peter Carragher](#)
[Teodor Todorov](#)
[Tom Bock](#)
[Tom Lutzeyer](#)
[Tudor Ferariu](#)
[Vanessa Chang](#)

LABORATORY GROUP 1 FH
Room 3.D02, Fri 13:10-15:00 (14 students)

[Brynnagh Mulherin](#)
[Dylan Angus](#)
[Ink Pansuwan](#)
[Ivan Georgiev](#)
[Jake Houston](#)
[Karen Xu](#)
[Kendeas Theofanous](#)
[Levi Fussell](#)
[Philip Igbaro](#)
[Robert Mitchell](#)
[Saumya Jain](#)
[Stefan Ivanov](#)
[Vesko Stefanov](#)
[Zhuyun Zhao](#)

Theon under lab groups:

https://portal.theon.inf.ed.ac.uk/reports/upt/open/TP082_Laboratory_Groups/

Lab Location: Forrest Hills

Located in:

5 Forrest Hill, Edinburgh EH1 2QL
(off of Forrest Road)

Third floor lab



Introduction to Vision and Robotics: Demonstration Assessments

Both assignments examined using demonstration

Sign up in pairs for the vision assignment **NOW**

- <http://tinyurl.com/ivr-labs>

Also choose the timeslot for lab demonstration on 28
October



Further reading:

Russell & Norvig Artificial Intelligence: A Modern Approach, Prentice Hall, 1995.

Solomon & Breckon, "Fundamentals of Digital Image Processing - A Practical Approach with Examples in Matlab", Wiley-Blackwell, 2010.

Ulrich **Nehmzow**, Mobile Robotics: A Practical Introduction, Springer; 2. ed. (2003).

Robin R. **Murphy**, Introduction to AI Robotics, MIT Press, 2000.

W. **Burger**, M. **Burge**; Principles of Digital Image Processing, Springer, 2009.

R.C. **Gonzalez**, R.E. **Woods**, S.L. **Eddins**; Digital Image Processing Using MATLAB, 2nd edition, Prentice Hall, 2009, ISBN 9780982085400.

Ethem **Alpaydin**: Introduction to Machine Learning. The MIT Press, October 2004,

Phillip J. **McKerrow**, Introduction to Robotics, Addison Wesley, 1998.

Ulrich **Nehmzow**, Mobile Robotics: A Practical Introduction, Springer; 2. ed. (2003).

Some historical highlights:

W.G. Walter (1950) An imitation of life. Scientific American, May, 42-45.

N. J. Nilsson (1984) Shakey the robot. Tech report 223, SRI International.

V. Braitenberg (1984) Vehicles. Cambridge, MA: MIT Press.

Freddy: www.ipab.inf.ed.ac.uk/IAS.html

MIT Leg Lab: www.ai.mit.edu/projects/leglab

CMU NavLab: www.cs.cmu.edu/afs/cs/project/alv/www/

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