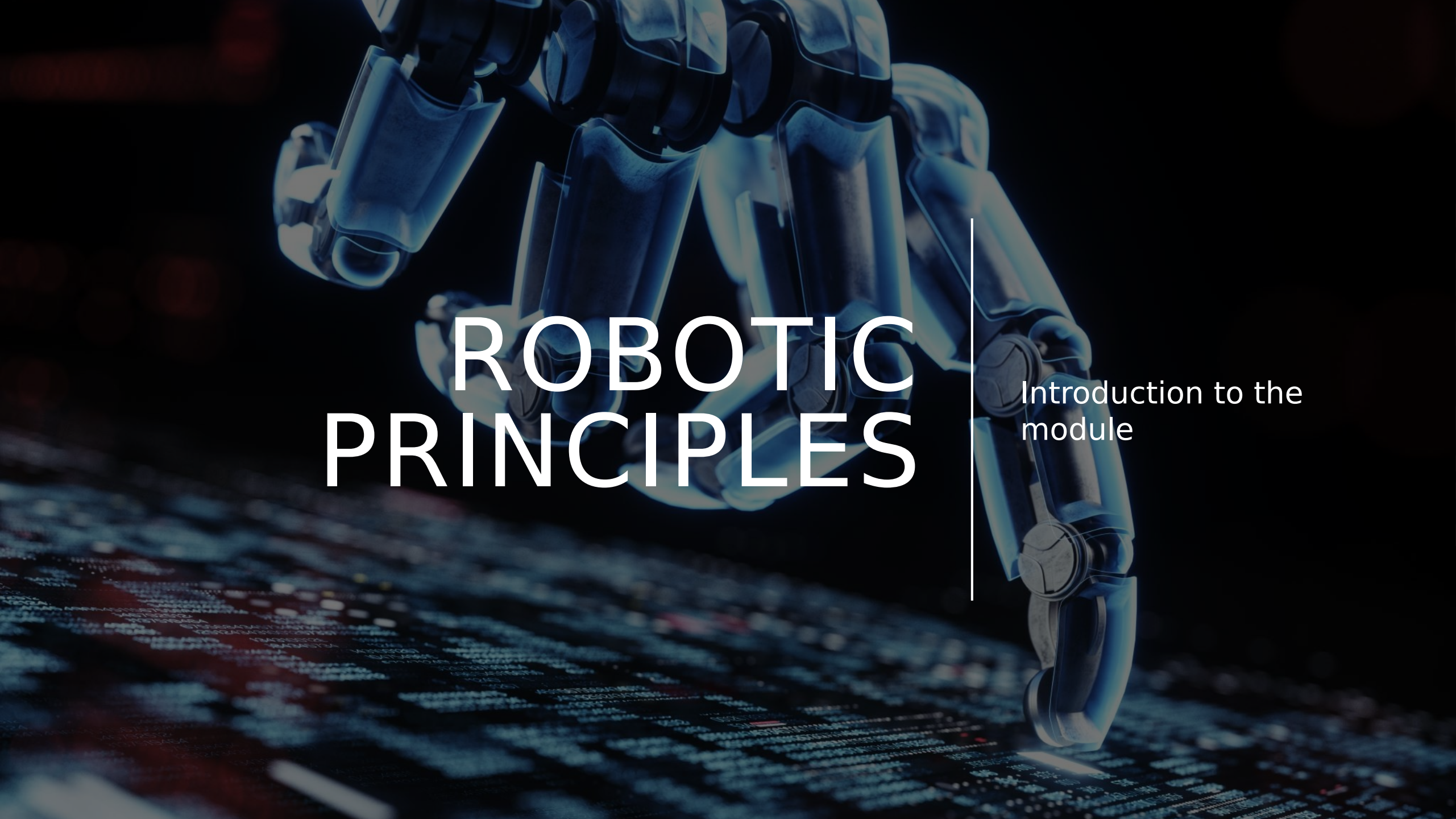


ROBOTIC PRINCIPLES

Introduction to the module

TODAY’S LECTURE

- Content of the module
- Assessment
- Software requirements
- Introduction to robotics
- Some definitions, History

CONTENT OF THE MODULE

Ethical, health and safety issues

Configuration Space

Spatial Descriptions and Transformations

Manipulator Kinematics

Control

Inverse Kinematics

Velocity Kinematics - Jacobian

Trajectory Generation

Motion Planning

ASSESSMENT

This module consists of two assessments:

In class test worth 50% of the module mark.

- Covers LO1, LO2, LO5 from your module proforma
- At the end of the semester

Coursework worth 50% of the module mark.

- Covers LO2, LO3, LO4
- Sometime around week 8

SOFTWARE REQUIREMENTS

Most of this module will be done using MATLAB

Python may also be used

We will NOT use ROS, but we may take a look at it

MATLAB

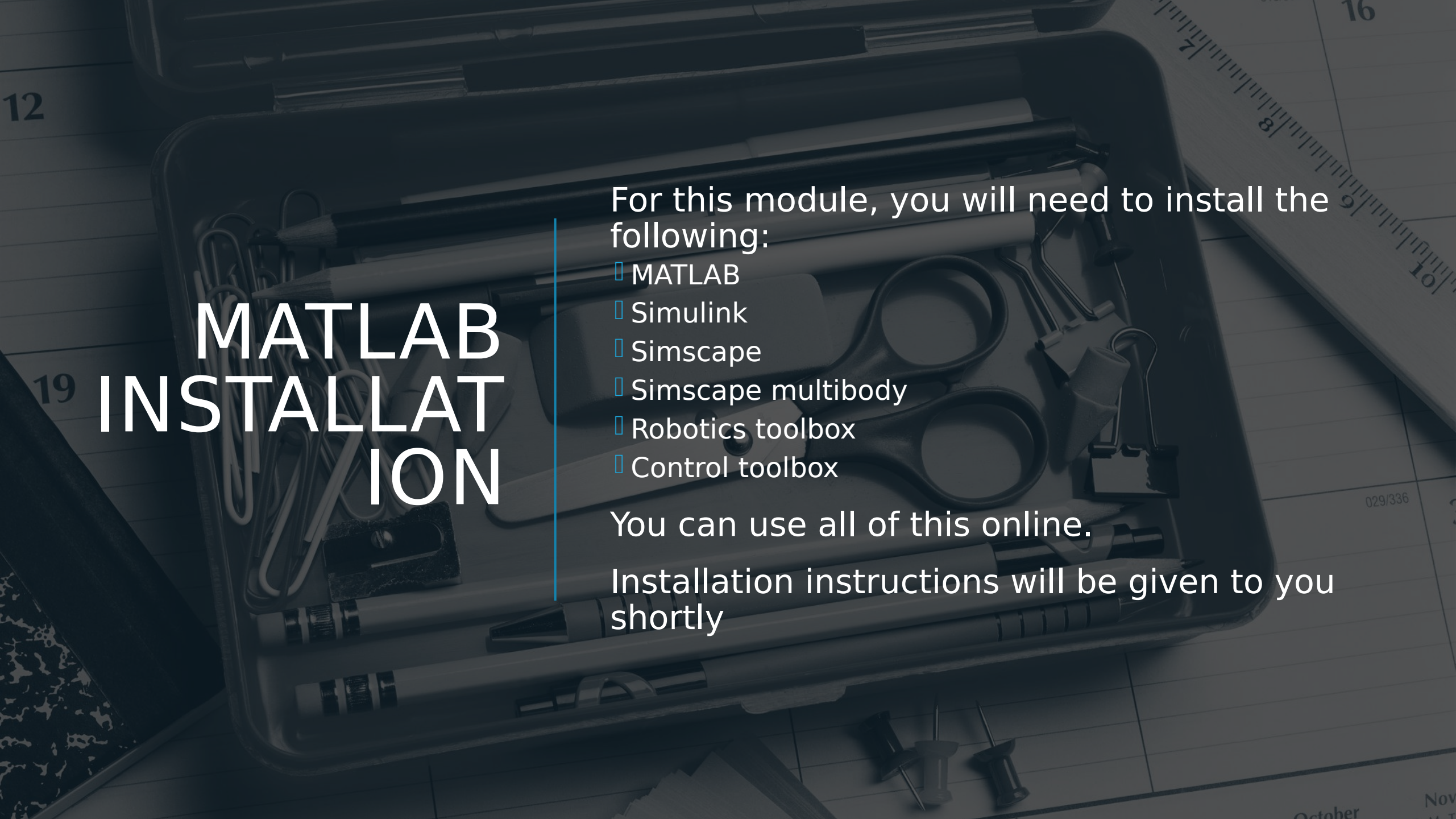
MATLAB stands for MATrix LABorotary

Is a software for matrix calculations, is its primary purpose

Very high level

Has a lot of add-ons that increase its capabilities further

- Toolboxes such as the robotics toolbox and control toolbox
- Simulink: for simulations, and is mostly graphical



MATLAB INSTALLATION

For this module, you will need to install the following:

- MATLAB
- Simulink
- Simscape
- Simscape multibody
- Robotics toolbox
- Control toolbox

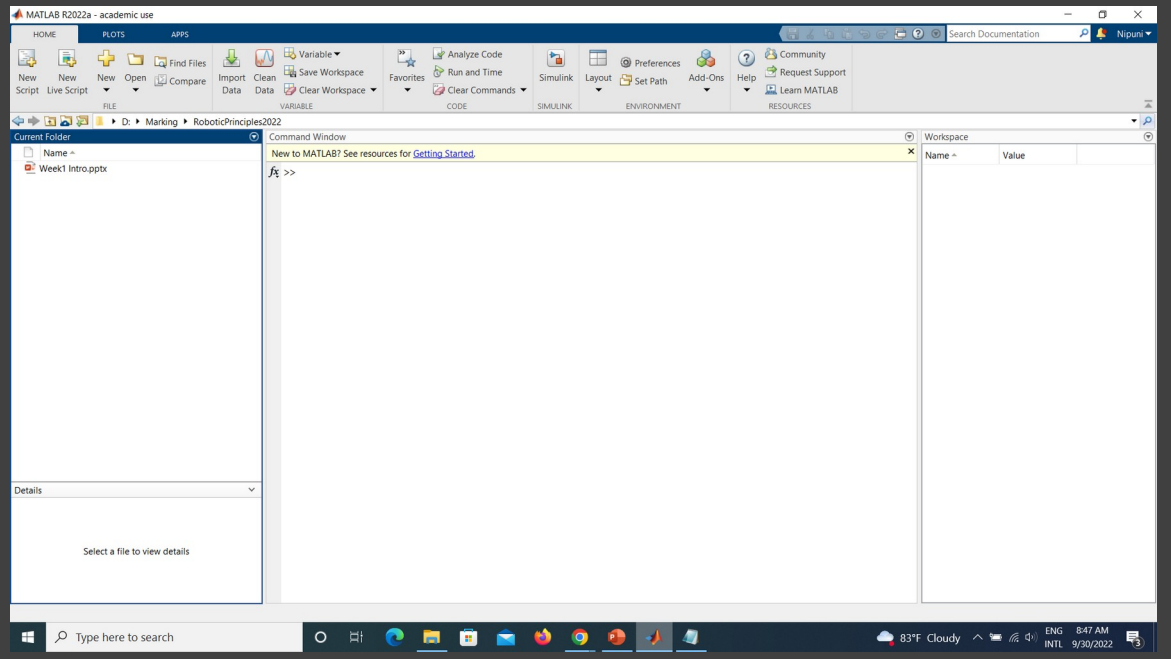
You can use all of this online.

Installation instructions will be given to you shortly

MATLAB DEMO

Some commands to try:

- help *topic*: brings up documentation on functions
- lookfor *topic*: brings up all functions with your search keyword
- CTRL+C: stops execution if something is running
- clc: clears command window, not workspace
- clear: clears workspace
- Up arrow (key): brings up previous commands



OTHER SOFTWARE

Python:

- You can use your normal python installation (python 3), jupyter notebooks would be helpful

You are NOT required to install anything other than Python and MATLAB.

GNU Octave is an open-source alternative to MATLAB.

- Functionally very similar (with minor differences in commands)
- Has limited libraries
- Limited to non-existent simulation capabilities

OTHER SOFTWARE

ROS (Robot Operating system) is the industry standard.

- Very powerful
- Can be used at a high level
- Has very good simulation capabilities in combination with Gazebo
- Has a steep learning curve
- The windows version is very new

We will not be using ROS during this course.

INTRODUC
TO ROBOT

Spot

R2-D2

Roomb
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Curiosit
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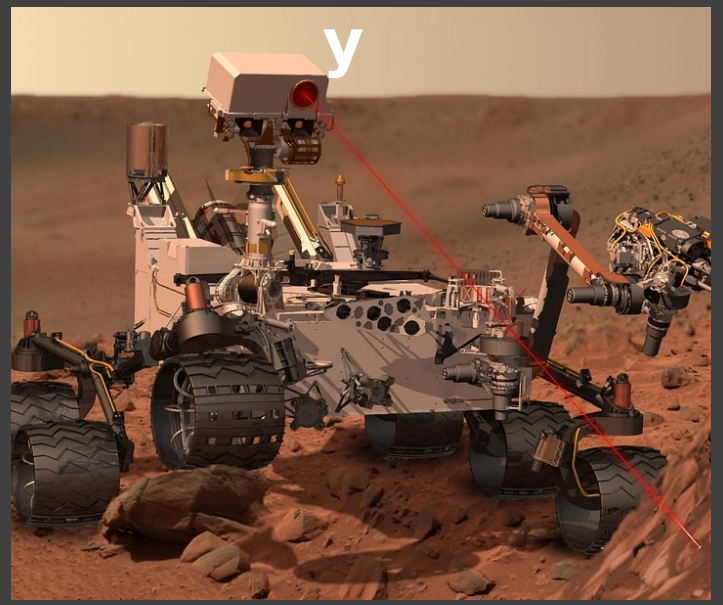
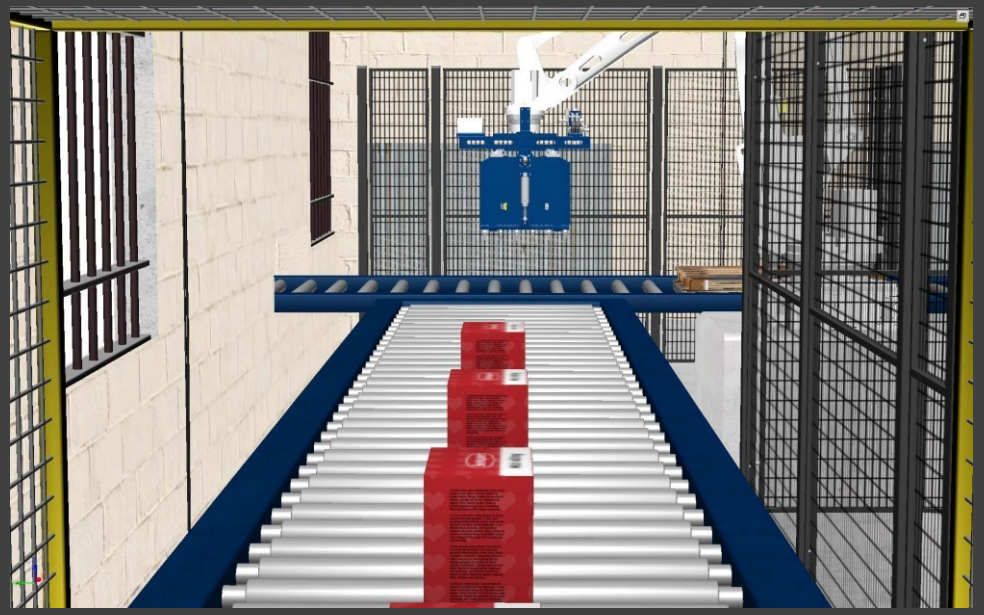


ASIMO

INTRODUCTION TO ROBOTICS



Industrial Robot Hands

[Humanoid Robot]

[Mobile robot assistant]

DEFINITION

ROBOT

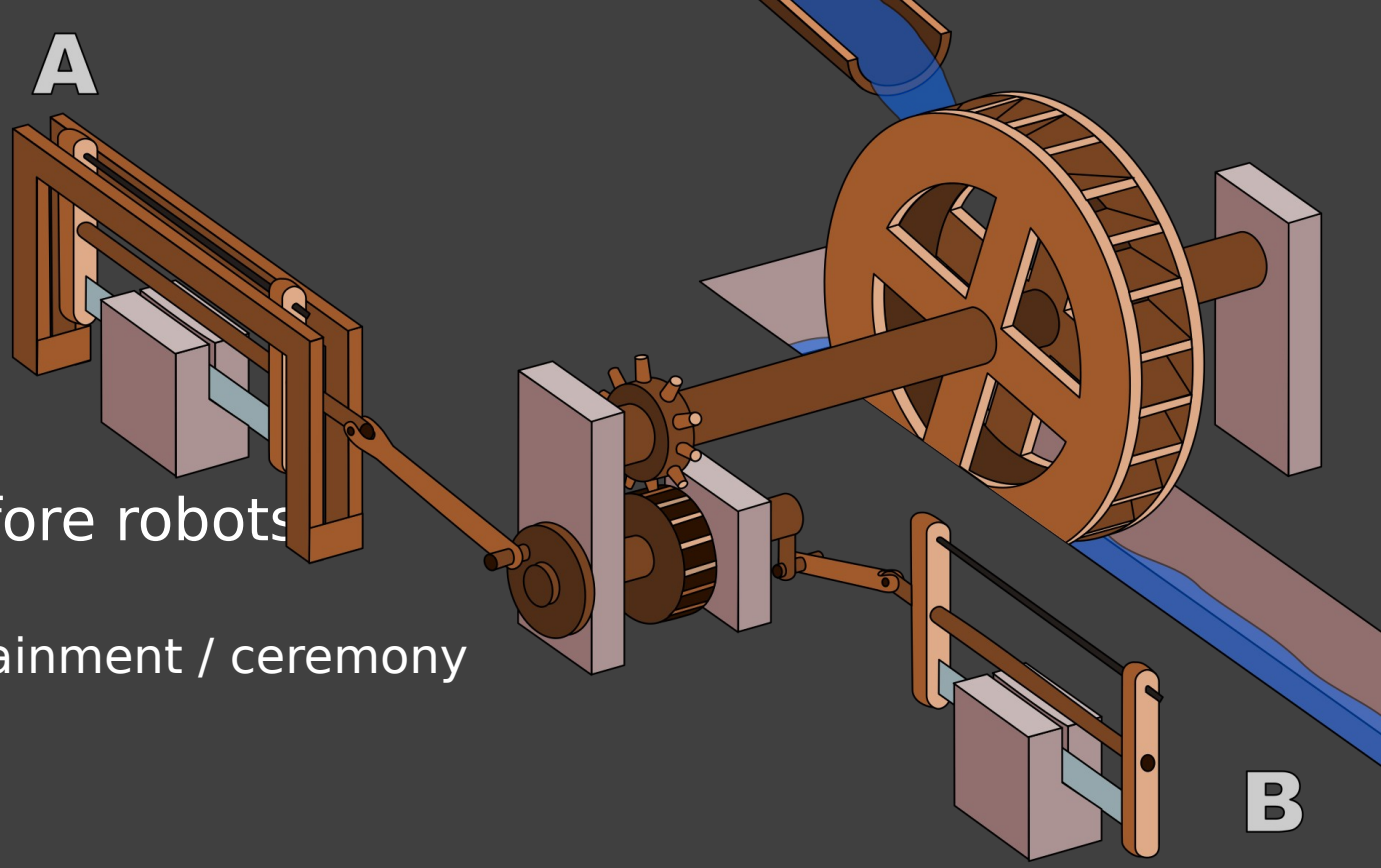
"*A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions*
for the performance of a variety of tasks"

- Robot Institute of America, 1979

ISAAC ASIMOV'S THREE LAWS OF ROBOTICS

- A robot may not injure a human being nor through inaction allow a human being to come to harm
- A robot must obey the order given it by human beings except where such orders would conflict with the first law
- A robot must protect its own existence as long as such protection does not conflict with the first and second law

HISTORY



Automata have existed long before robots

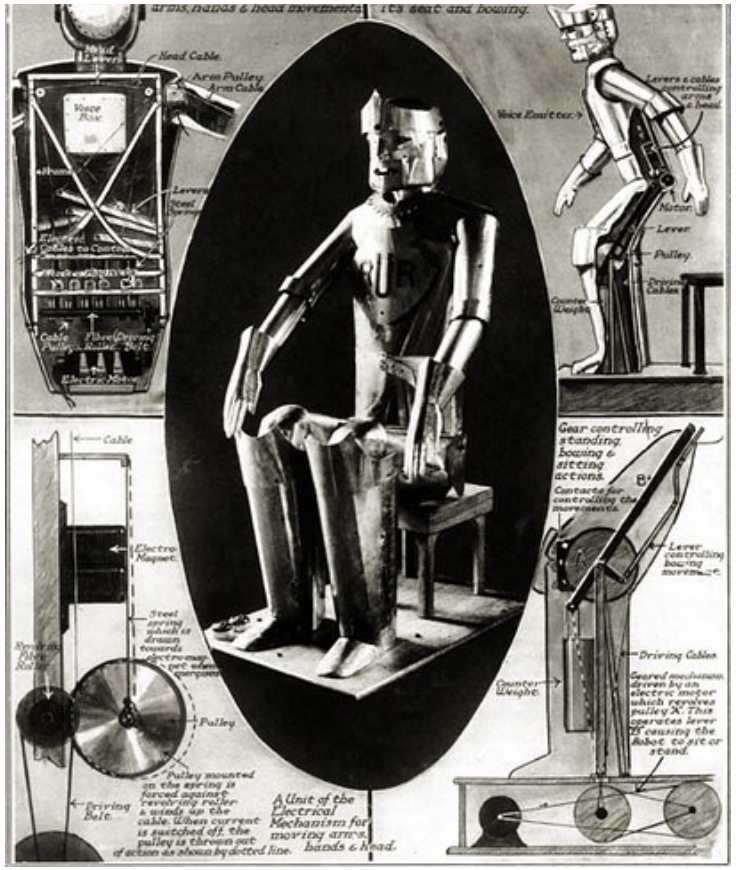
- Operated by wind, water, weight, etc
- Older examples were used for entertainment / ceremony
  - The Hero of Alexandria (Greece)
    - "vending machine" for Holy Water
    - Automatic puppets for theatre
- Later, more practical versions were developed
  - The Hierapolis Hydraulic Saw (Roman - Asia Minor)

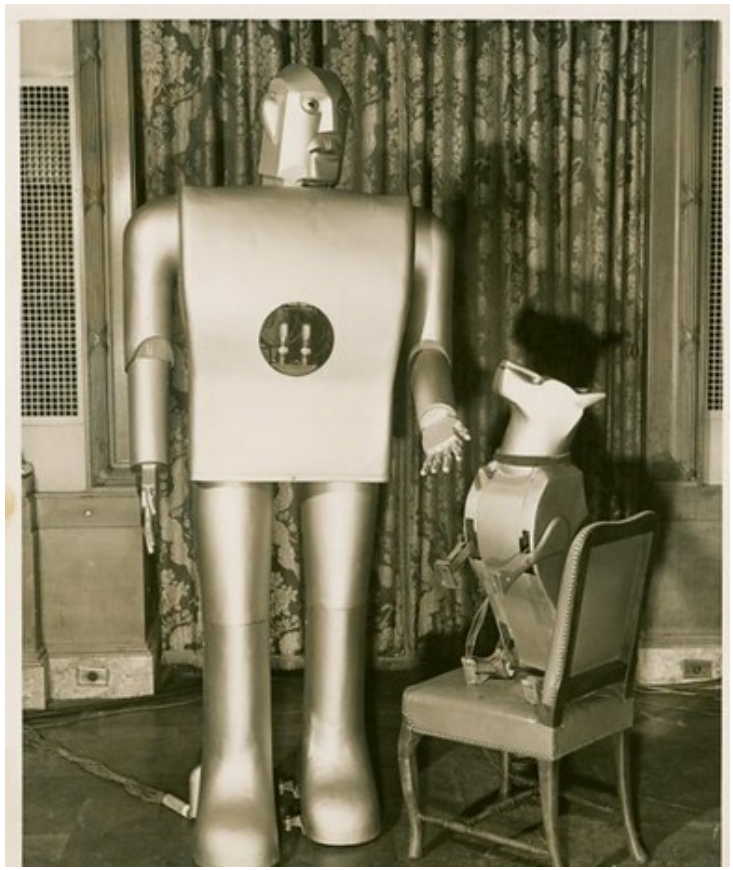
CLOCKWORK AUTOMATA

Up to the 19th century

Example: the four automata on the astronomical clock in Prague

Any other examples?

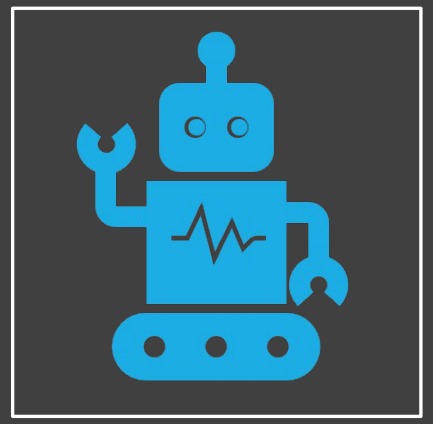




EARLY ROBOTS

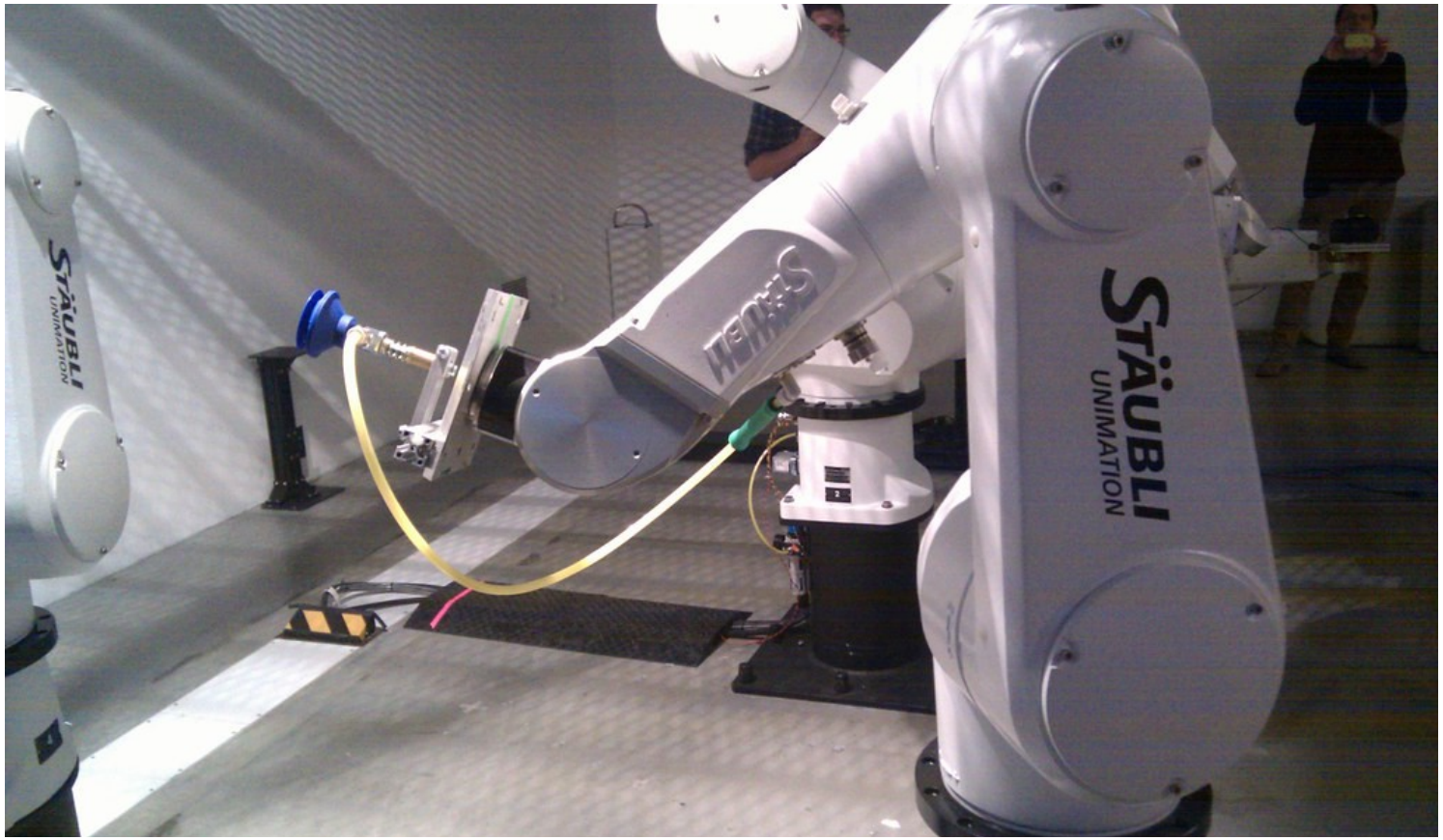
- 1921 – first use of the word 'Robot'
  - Rossum's Universal Robots by Karel Čapek a Czech science-fiction play
- 1920s & 1930s – first motor-assisted automata robots
  - Eric (UK)
    - Strings & pulleys
  - Elektro and Sparko (USA)
    - Wires & chains

TELEOPERATED ROBOTS



These early robots needed a human operator, so are sometimes called teleoperated robots.

Can you think of any modern examples?



MANUFACTURING ROBOTS

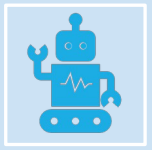
1950s – The first robot arms

Also known as Manipulators, E.g.

The Unimate Programmable Universal Machine for Assembly (PUMA)

You can see an interactive model here

PROGRAMMABLE ROBOTS



Manufacturing robots, like the PUMA, have been programmed to follow a strict set of instructions for a specific task

Can you think of situations where this would be inadequate?

AUTONOMOUS ROBOTS

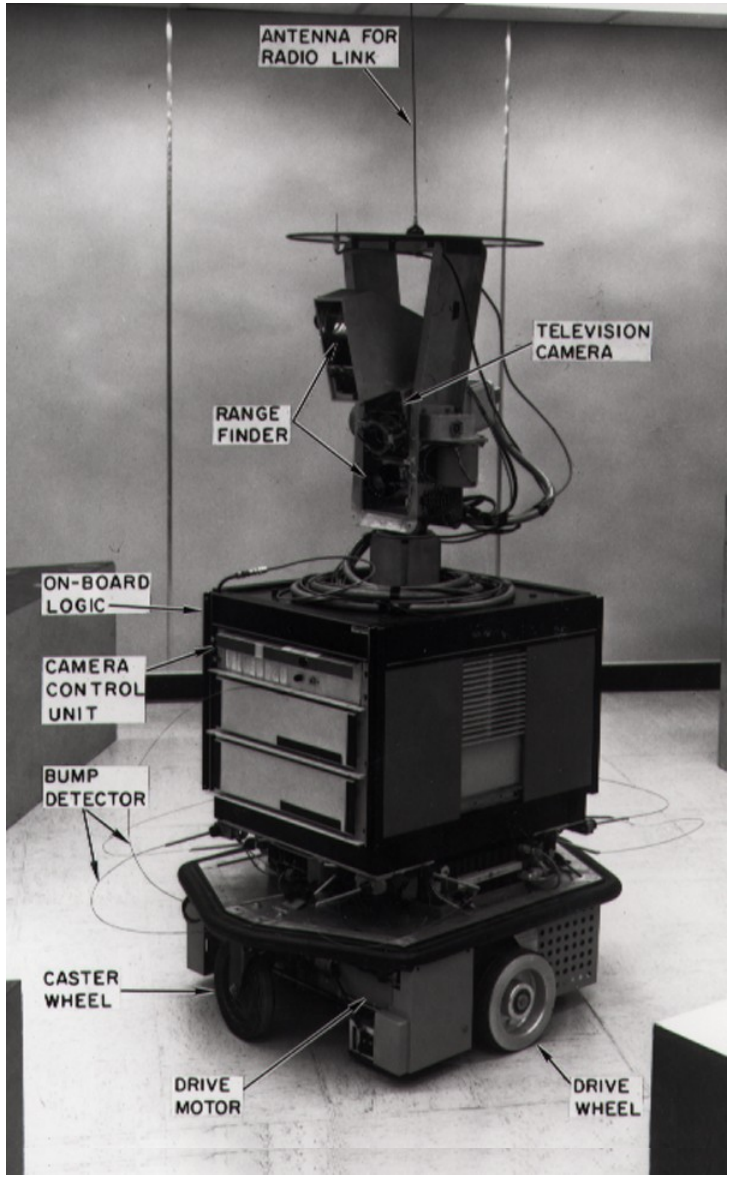
1960s

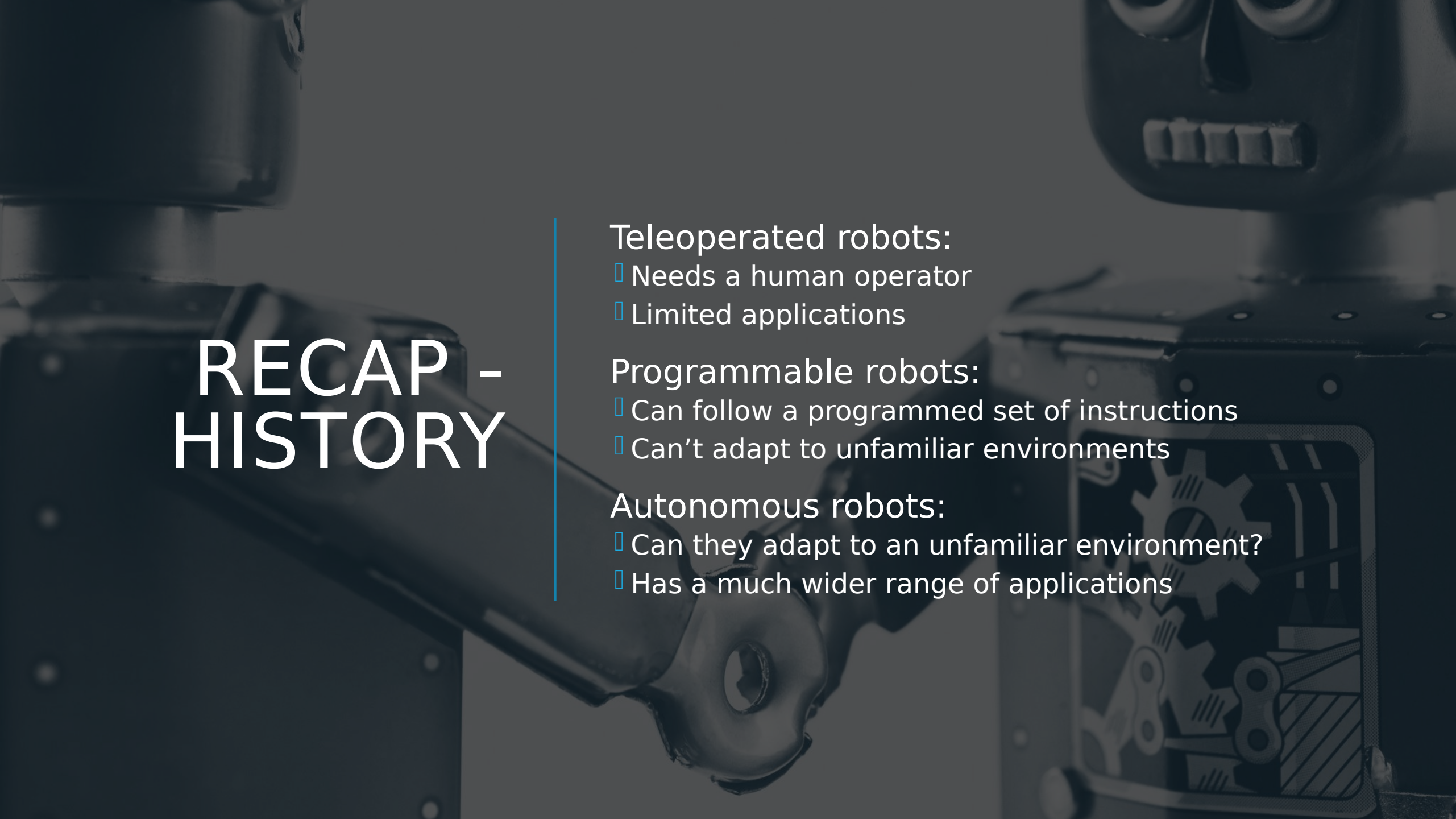
Driven by the need for space rovers

Inspired by artificial intelligence

Eg. Shakey

- Could sense its environment
- Featured an early control system





RECAP - HISTORY

Teleoperated robots:

- Needs a human operator
- Limited applications

Programmable robots:

- Can follow a programmed set of instructions
- Can’t adapt to unfamiliar environments

Autonomous robots:

- Can they adapt to an unfamiliar environment?
- Has a much wider range of applications


QUESTIONS?