Fundamentals of Artificial Intelligence
NAO Planning Competition 2022/2023

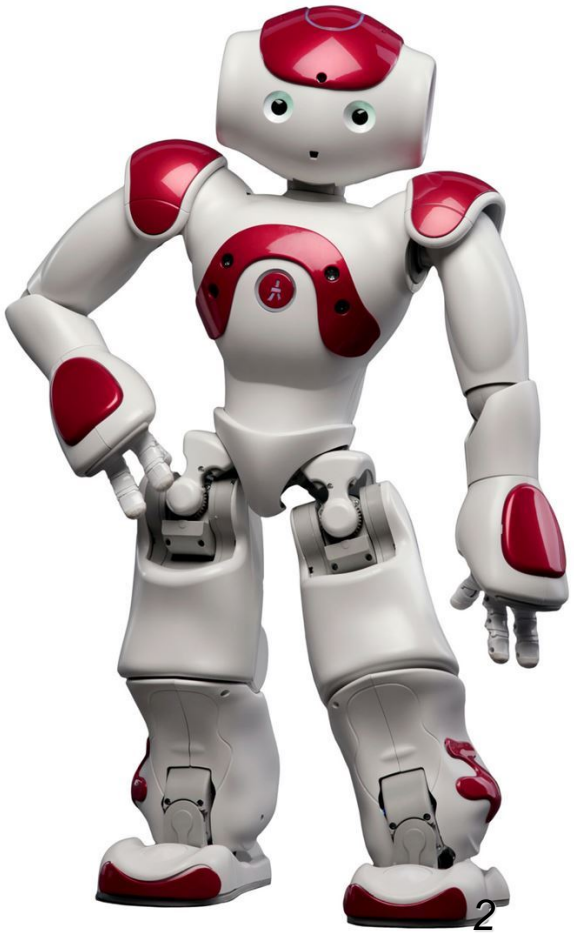
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Michela Milano
Allegra De Filippo
Dipartimento di Informatica – Scienza e Ingegneria
Università di Bologna

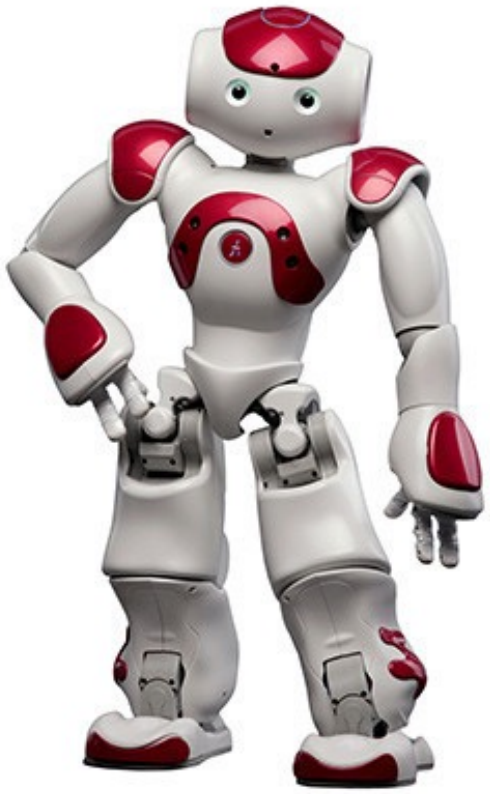
michela.milano@unibo.it
allegra.defilippo@unibo.it

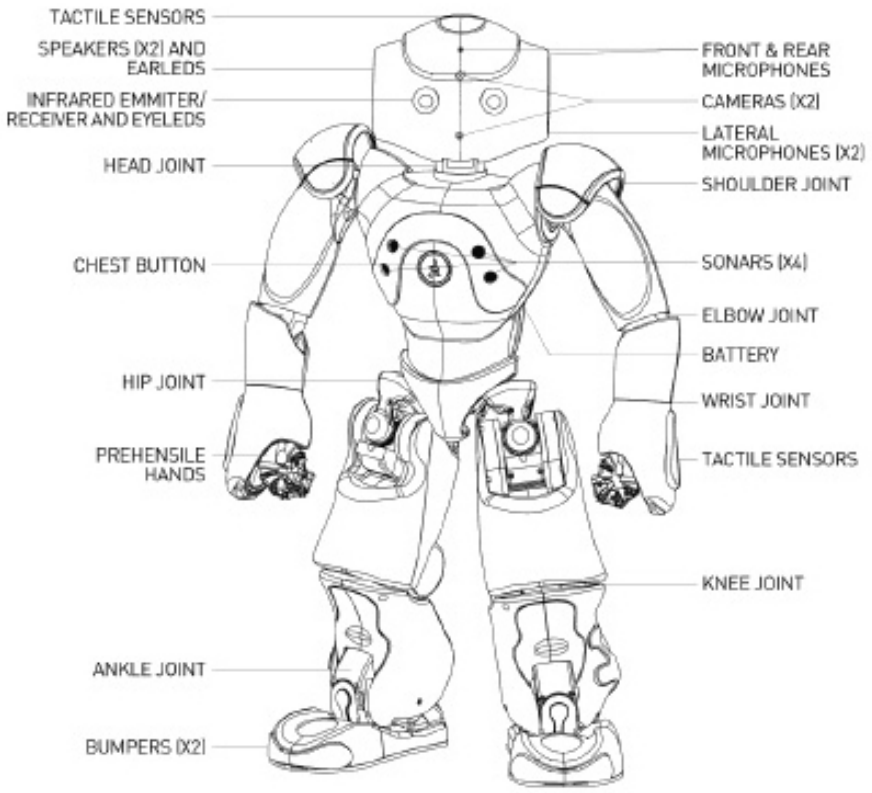
NAO Planning – objective of the competition

- To stimulate the comprehension and the discussion regarding the basic algorithm for planning, in the context of AI discipline
- To test your skill on a fun and intuitive case study: the humanoid NAO robot
- To WIN the competition!



NAO Robot – some info





ALDEBARAN Robotics

NAO Robot – some info

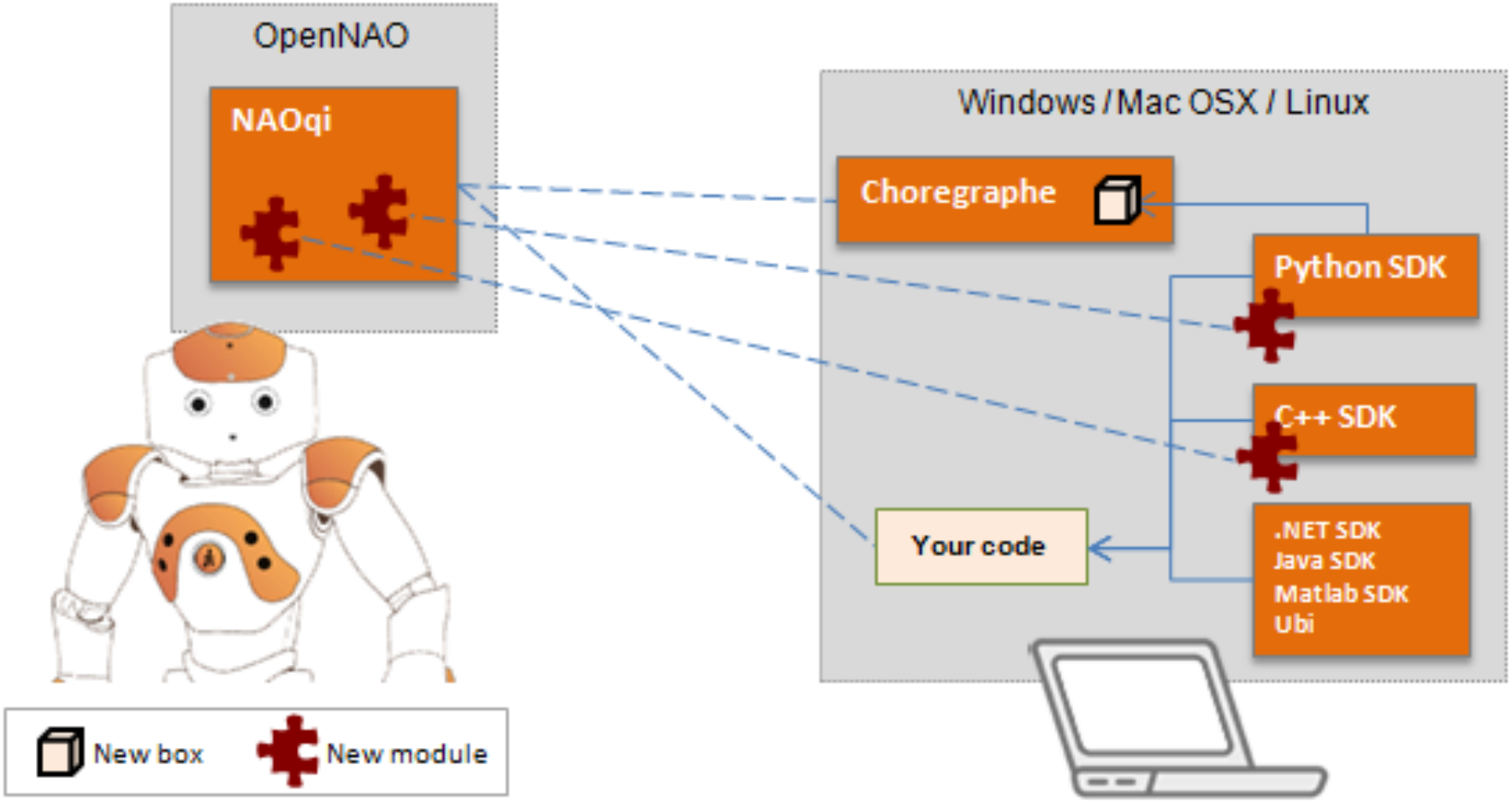
MOVE
- 25 degrees of freedom
- Motors controlled by software
- Complex movement capabilities

SENSE
- 2 HD camera
- 4 microphones
- 2 bumpers
- 2 sonars

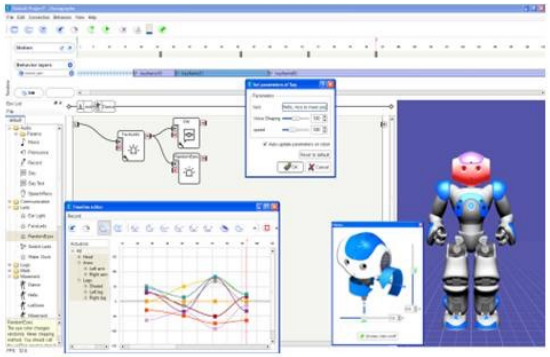
INTERACT
- 2 speakers
- multiple LEDs
- tactile sensors
- prensile hands
- infrared sensors
- WiFi connection

THINK
- Intel Atom 1,6 GHz CPU
- 1 Gb RAM
- 8 Gb Flash Memory
- Software suite

NAO Robot – some info

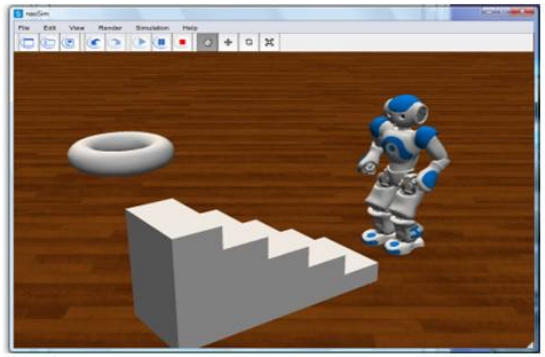


NAO Robot – Software Suite



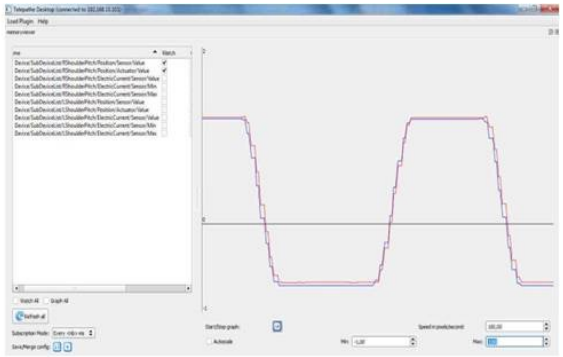
Choregraphe

- ✓ Graphical Development of Behaviors
- ✓ Ergonomic and user-friendly Interface



NAOsim

- ✓ Physical Simulation Engine
- ✓ Behaviors Simulation and validation



Monitor

- ✓ Ergonomic Interface to monitor actuators and sensors data

SDK

- ✓ Compilation and debugging tools
- ✓ MatLab, Java, Python, C++, .NET, MS Robotics Studio

VM → https://liveunibo-my.sharepoint.com/:u:/g/personal/allegra_defilippo_unibo_it/ERaHXL9C3KJJql5cVgPXyKQBGkxLVQc0hzsaV_5G-V_HgA?e=FB9z8T

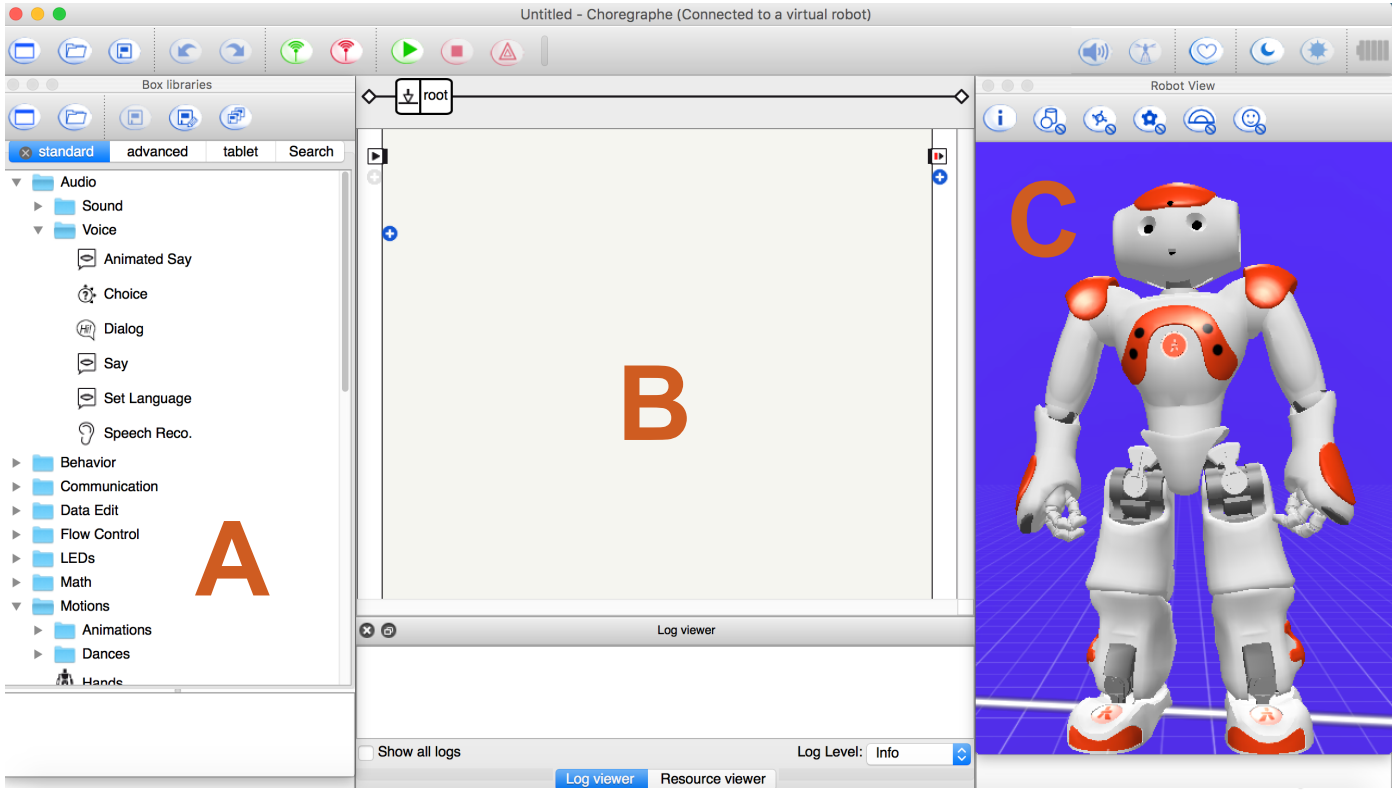
NAO Robot – Choregraphe

A Box libraries panel

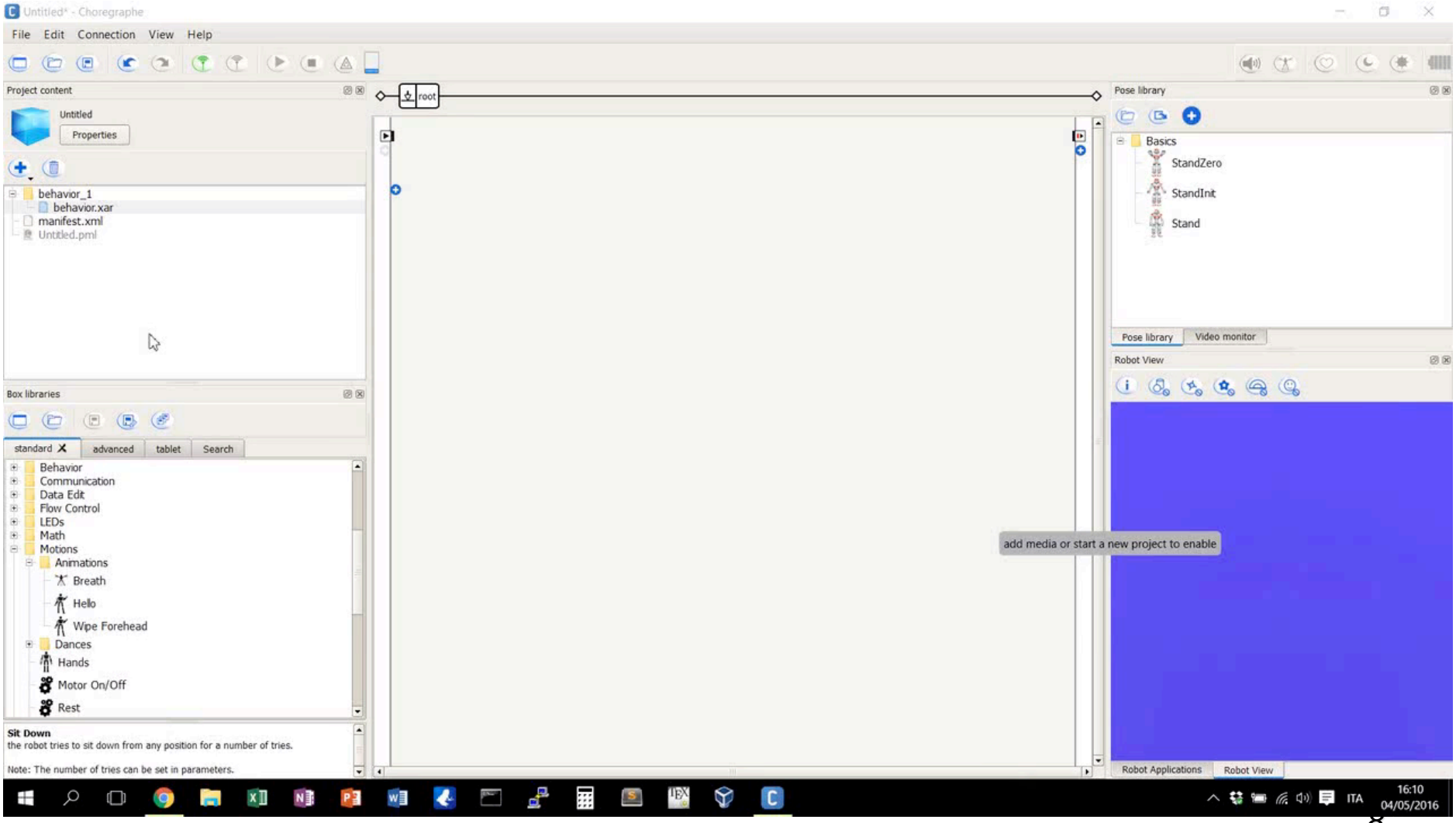
B Flow diagram panel

C 3D Robot View for simulation

here to download Choregraphe



NAO Robot – Choregraphe

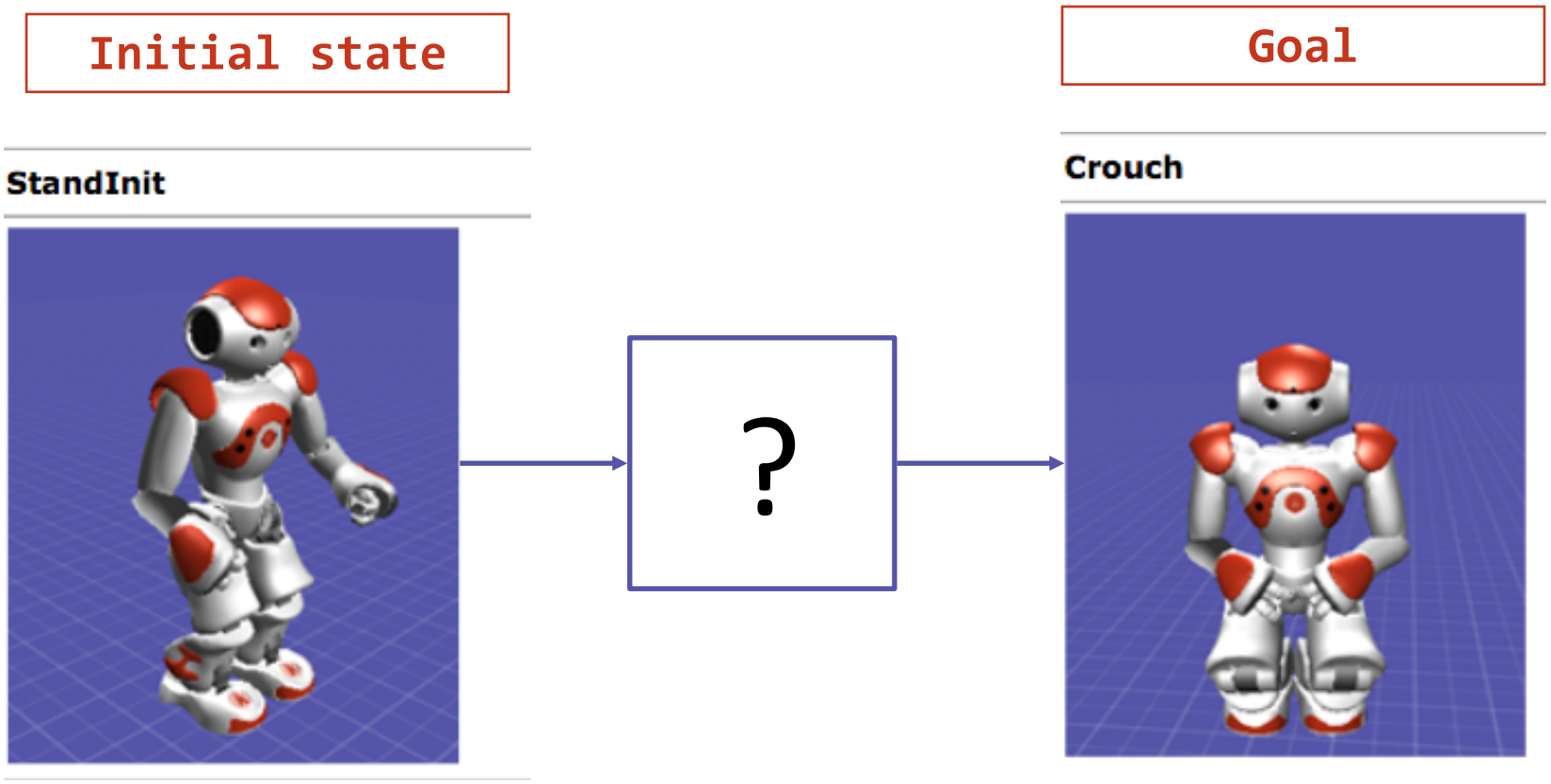


NAO Planning – competition rules

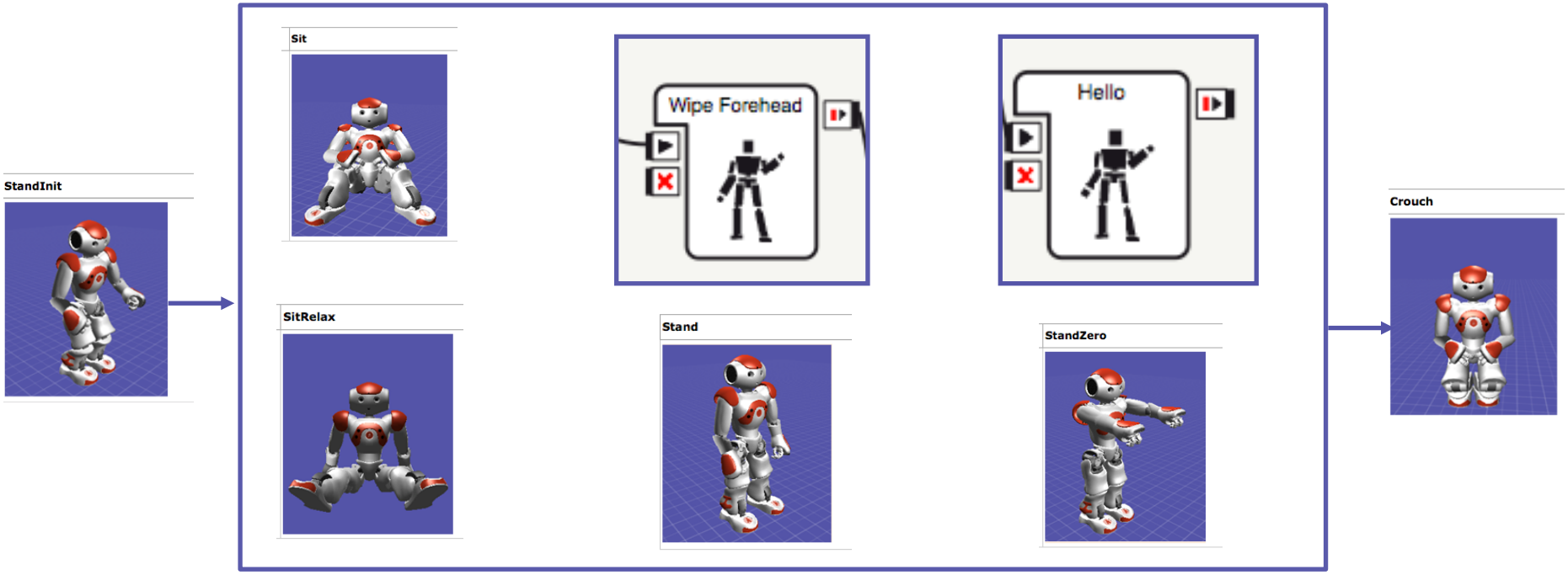
- Teams divided into groups of **1 to 2 students**
- Each group must **plan a choreography** (sequence of positions) given a problem description
- Each group must **choose a music** suitable for the choreography (by respecting the total time limit of 3 minutes) and **test it on the virtual NAO** (using Choregraphe)
- A **day of voting** will then take place (during the last lectures) in which **the winning choreography will be decided**, considered the most satisfying from the **artistic point of view**

NAO Planning – problem description

Modeling the **problem**



NAO Planning – problem description



Mandatory positions

NAO Planning – competition rules

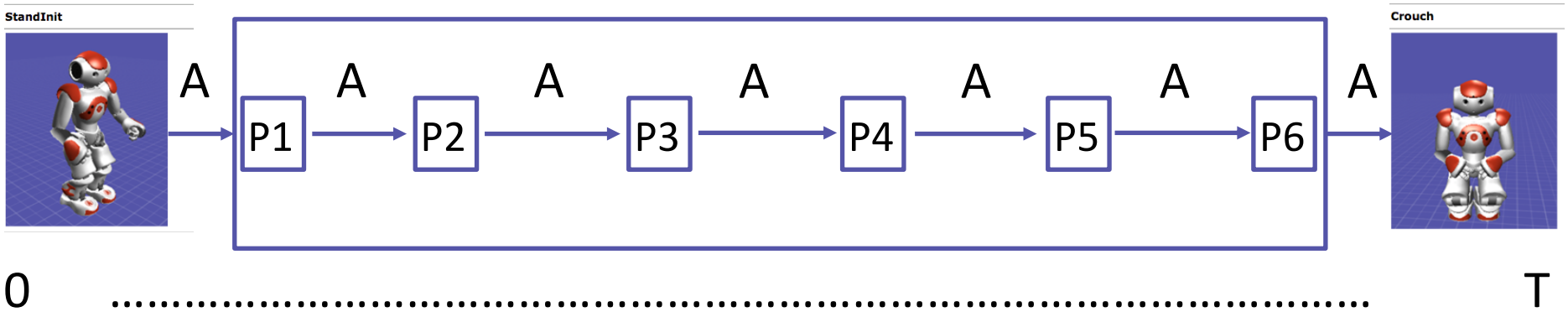
- To move from a mandatory position to another, you can use positions from the available **set of intermediate positions** (see next slide)

- **Constraints** to be satisfied:
  - possible incompatibilities between two consecutive positions (use simulator in choreographe to understand if and what they are)
  - time constraints
  - constraints on the number of intermediate positions to be used in the whole choreography

- Generate an **algorithm A** able to plan the sequence of positions satisfying the given constraints (using a heuristic, or a planner for each sub-sequence of intermediate positions, … we leave you free on the implementation choice)

- Hint: use Python

NAO Planning – problem description



- **P1…P6** = mandatory positions
- **A** = algorithm to generate the transition between 2 mandatory positions by using the given pool of positions
- **T =** total time of choreography (3 minutes)
- **A** must use **at least 5** of the positions in the set and/or in the following .crg files

NAO Planning – set of intermediate positions

- **rotation_handgun_object:** Nao makes a movement with the arm holding (possibly) an object
- **right_arm:** right arm rotation
- **double_movement:** rotation of both upper limbs
- **arms_opening:** opening and rotation of both upper limbs
- **union_arms:** movement of union of the arms
- **move_forward/backward:** 3 steps forward/backward
- **diagonal_left/diagonal_right:** 1 left/right diagonal step
- **rotation_foot_Lleg/foot_Rleg:** movement with one foot

NAO Planning – crg files (for other intermediate positions)

.crg files to import directly on Choregraphe [1]:

- **sing_with_me:** NAO plays guitar
- **arm_dance:** NAO dances by moving arms
- **birthday_dance:** NAO dances birthday dance
- **sprinkler:** NAO dances sprinkler dance
- **workout:** NAO trains

NAO Planning – position description

- All positions are coded in Python language and executable on a simulated robot (see here for further details of simulated NAO and here to download the robot positions)

- Choose a suitable music of 3 minutes of duration for your choreography.

N.B. Playing music cannot be tested on a simulated robot. Your algorithm A needs to solve the problem for simulated tests.

Repository → **https://github.com/ProjectsAI/NAO_Planning_Challenge**

NAO Planning – organization

- The **demonstration and voting day** will take place around the middle of December

Important Dates:

  - sending projects by **November 25** included (11.59 pm Italian time)
  - presentation of projects, discussion, votes and winner (mandatory presentation of the whole team): during the last lessons of Module 1

- **Registration** by **October 25** included (11.59 pm Italian time) by using the module on Virtuale and by specifying the name of your team and the email of all the members

- It will be possible to withdraw from the competition in any moment (by email!)

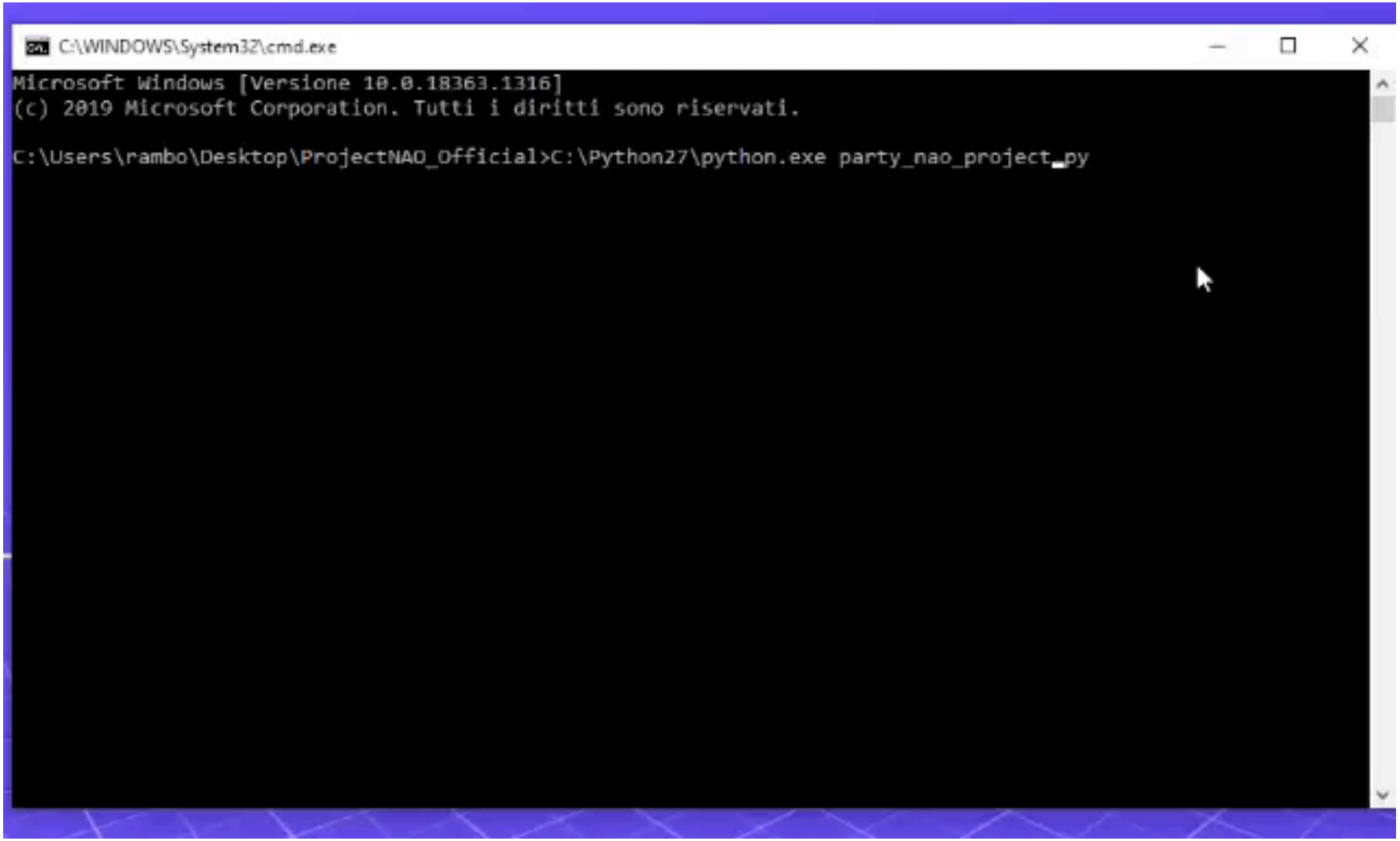
- Some rules can be changed in every moment, with a notification on the course website and by email.

NAO Planning – deliver

- **What:**
  - A readme.txt file to specify
    - names and emails of the team participants
    - any necessary libraries that must be present
    - other useful information to test your project on simulated NAO
    - a link to the repository containing the folder with the files of the entire project

- **How:**
  - Deliver ON VIRTUALE a .txt file containing link to repositories (Github, Dropbox, Drive etc.) and the required information

NAO Planning – Demo



Performing NAO – AI and creativity

- Performing Robots: automatic generation of theatrical dance movements in robots

The objectives of this project:

- to devise techniques for **automatic and creative** generation of complex movements in robots, such as choreographies
- strong interdisciplinarity, involving robot learning, human-robot interaction, cognitive studies of movement, creativity

https://site.unibo.it/performingrobots/en

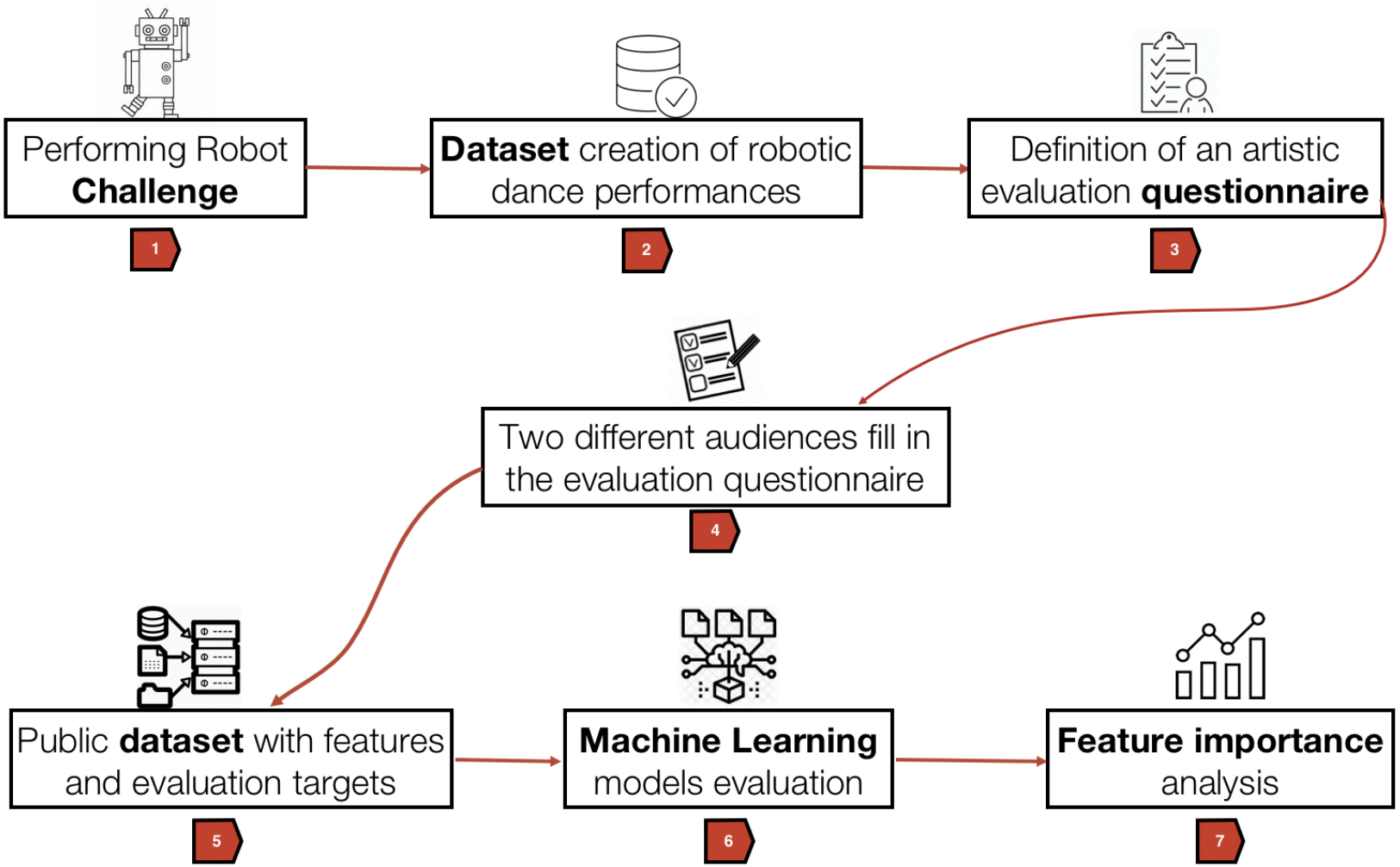
Performing NAO – AI and creativity

AI and creativity research:

how can we train a neural network to try to recognize the artistic beauty of a choreography?

- At the end of the course, all the choreographies and the related scores received during the day of presentations and voting will create a dataset for a neural network (which we are developing)

Performing NAO – AI and creativity



Performing NAO – AI and creativity

The survey questions are the following:

- The performance embodies **a theme or tells a story**
- The performance has **rhythmic coherence with music**
- The performer presents **fluidity of movement** transitions
- The performer is able to **involve the public**
- The performer extensively **uses the surrounding space**
- The performer movements have **human characterization**
- The choreography can be **reproduced also by or with a human performer**

Performing NAO – AI and creativity

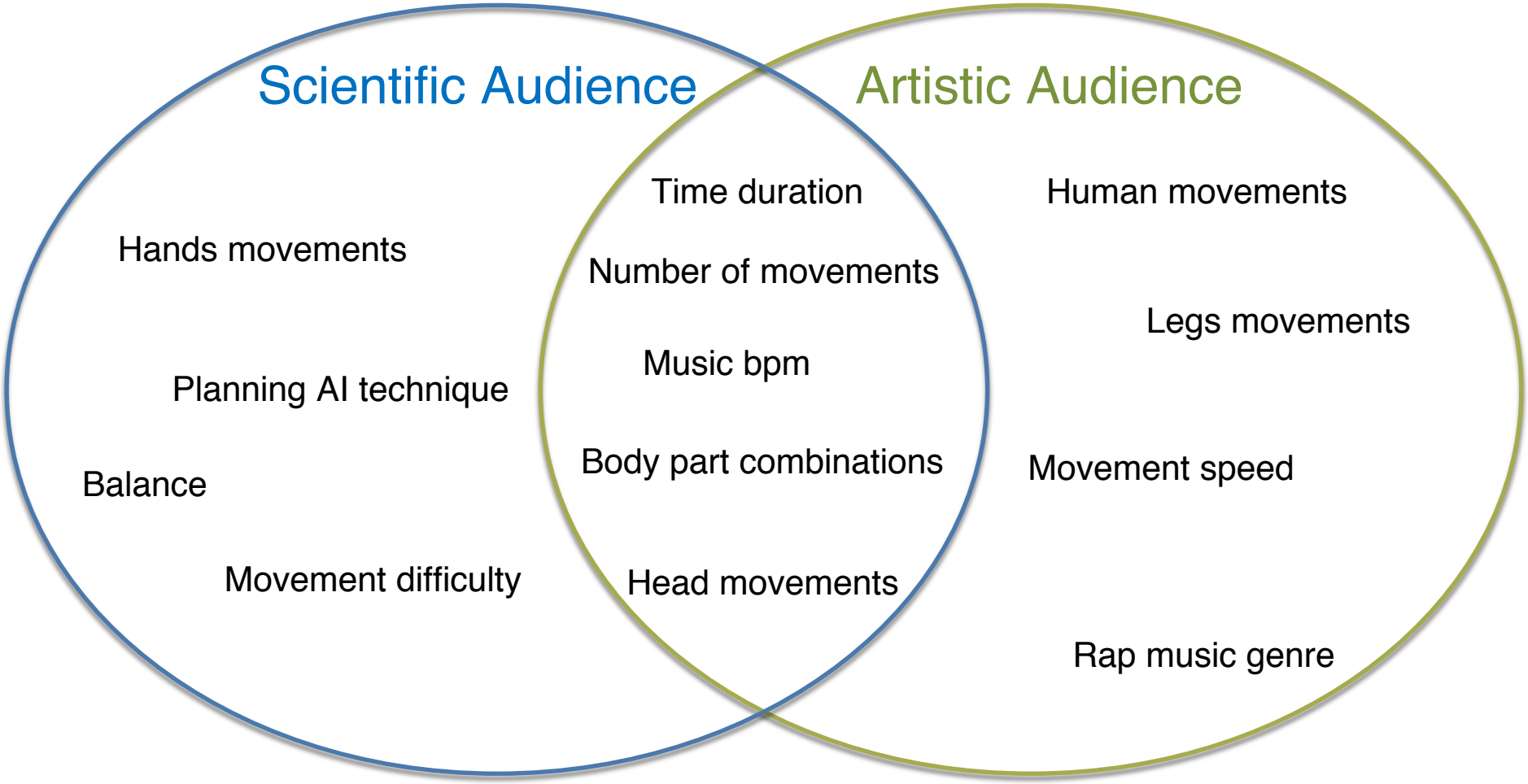
- We collect all the evaluations for each choreography, for each evaluation target and for each participant

Audience with artistic background

Audience with scientific/technical background

- We build two different datasets based on the different audience backgrounds

NAO Planning – final info for improving your work…



NAO Planning – final info…

- Participation is not mandatory
- You can participate in only one of the two competitions
- Bonus of 2 points on the final grade for those taking part in one of the two competitions