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# **Dataflow programming languages:**



## Simulink

- Data-flow programming within <u>MatLab</u>, very engineering-oriented
- PRO: Compile/<u>deploy</u> to many systems
- Sapienza students licenses
- Android devices
- Apple iPhone/iPad
- Raspberry Pi
- Arduino
- Beagleboard



CONTRACTOR OF



- Xilink FPGA boards

- Nao robot

- Lego Mindstorms EV3
- Parrot mini drones



#### Features

**Typed wires?** (but no standard colors) YES YES (in Matlab or in Simulink) **Functions**? **Functional programming?** NO? **Recursion?** (but in Matlab only) YES (for, foreach, while) Loops? YES **External languages?** - Matlab, C, Fortran YES - Python ecc... YES (through Matlab) File I/O YES 2022-23 **Modularization?** (subsystems) YES

Simulink

# Subsystems: looping constructs



Subsystems are used for:

- Hierarchical model definition (modularization)
- Repeated execution (for/while/foreach)



### Conditionals: switch + merge

Conditional execution (if/case) is made by:

- if/case block with tested input and "enable" outputs
- a separate circuit/subsystem for each case (with "enable" port)
- a merge block collecting all alternate outputs



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### Lego EV3 line follower

# EV3 with light sensor facing down



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### Follow the B/W border of the line



### Line follower: control system

#### Line Tracking

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#### Line follower details

SIMULINK ... loading

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### Lego Bike: keep a bicicle up by steering (@UNI-FI)



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Sensors:

- gyroscope
- ultrasound distance
- front wheel angle
- rear wheel rotation
- Actuators
  - front wheel angle
  - rear wheel speed
  - rear stand

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#### Lego Bike: control system



### Lego Bike in action



# Simulink for teaching Computational Thinking?

#### PRO

- algorithms as circuits
- enhance modularization with submodules
- good for data/signal analysis
- good for control systems
- a lot of packages and examples
- robotic simulation (ROS or Control toolbox)

TLDR: good for electronic/technical schools

#### CON

- algorithms as circuits (!)
- could be overwhelmingly complex
- diagrams less readable than LabVIEW
- exec. constraints not shown in diagram

