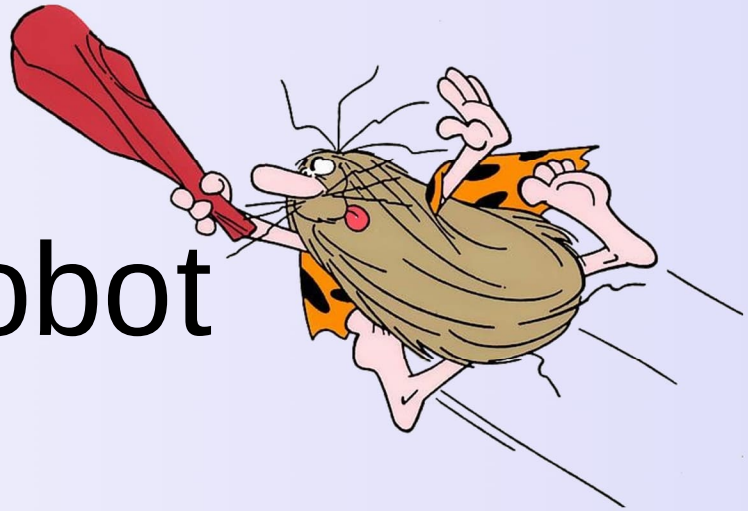
EDUTUS UNIVERSITY

Troubleshooting your LEGO robot



- Attila Faragó -

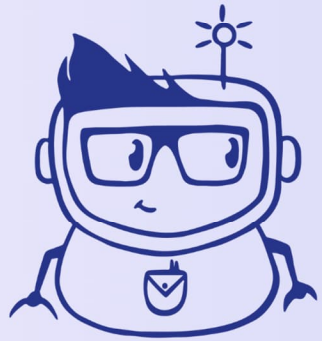
— 20 23 —

EDU ROBOT CAMP

EDUTUS UNIVERSITY

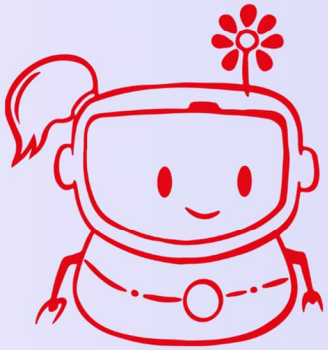
Key sources of trouble to “shoot at” 🔫

1. Programming errors
2. Mechanical errors
3. Strategy errors
4. Connection errors



EDUTUS UNIVERSITY

Mechanical errors



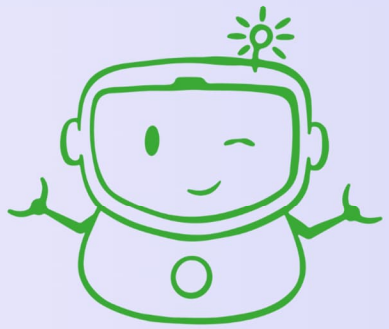
EDUTUS UNIVERSITY

Mechanical errors

Some possible causes

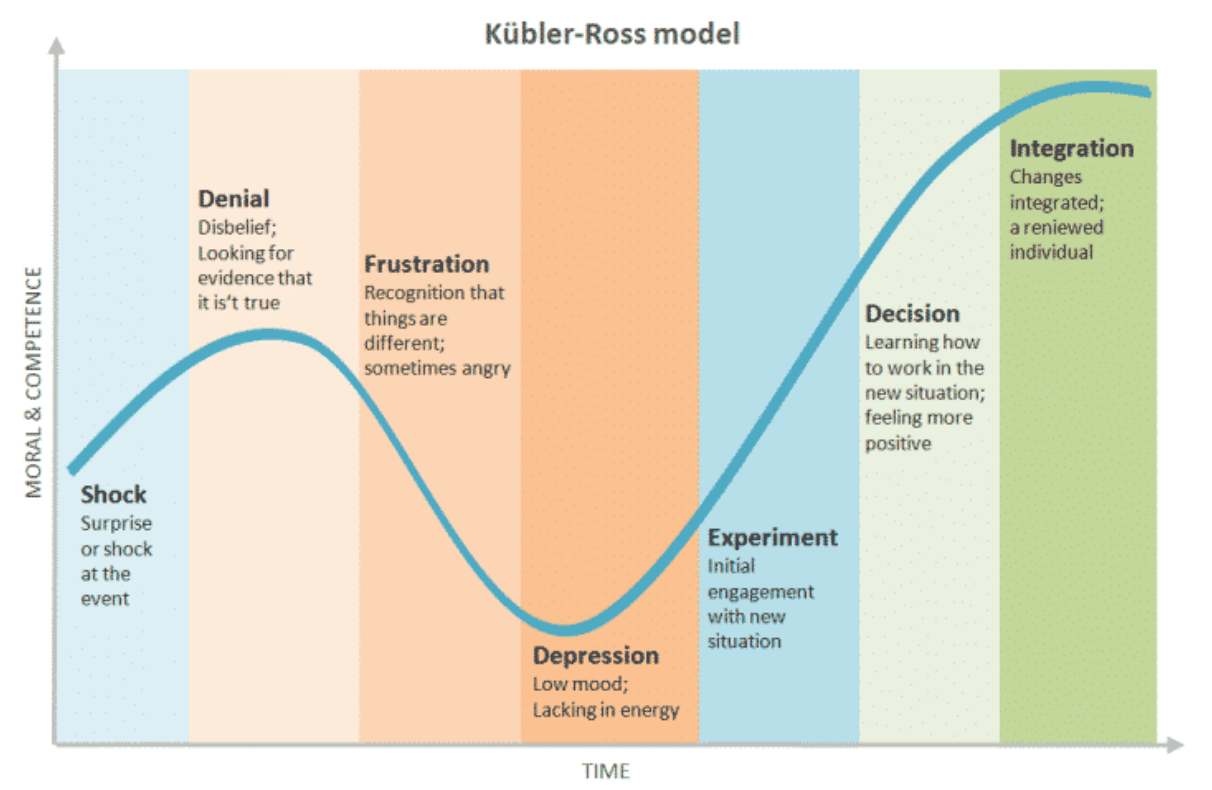
1. Robot assembly at site
2. Center of gravity
3. Improper structural integrity
4. Gaps
5. Motor „play”

What can you do?



What can you do?

1. Talk about it
2. Accept
3. Cool down and chill out
4. Prepare!
5. Experiment
6. Improve



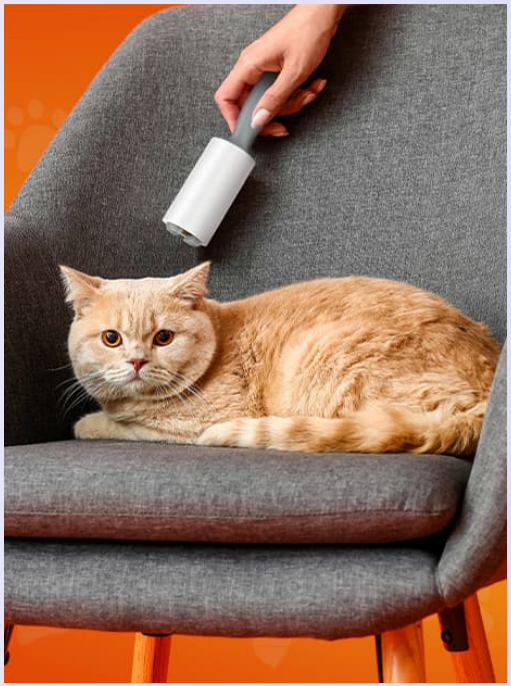
EDUTUS UNIVERSITY

Suggested Practice Excercises

- Practice robot assembly including drive straight tests
- Practice routine of basic moves
  - drive 10cm, 100cm, rotate 90deg * 8, measure
  - learn to correct this before any program change
- Calibrate centre of gravity
- Add proper back/caster wheels – check ability to turns, check under weight
- Experiment with main wheels
  - width of grip vs spinning, need of acceleration and deceleration
  - experiment with different wheels expansion vs stiffness
  - experiment with size and discuss importance of speed, preciseness
  - https://flltutorials.com/translations/en-us/RobotGame/Wheels.pdf
- Are the base structure, actuators, claws stable enough to last a full day?
- Validate motor „play” or sloppiness
  - Experiment with backing up to wall or moving the wheels simultaneously
  - Different motors have different plays – EV3 large vs EV3 medium motor

Troubleshooting at competition

1. Start mechanical validation after assembly!
   Try basic move straight and 4x move, turn routine – check and adjust until perfect
2. Clean wheels regularly
   Tape or cat fur cleaner

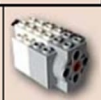


Learn all about your motor from Philo

https://www.philohome.com/motors/motorcomp.htm

Weight

 2838	 2986	 71427	 43362	 5292	 47154	 NXT	 E-Motor	 PF Medium	 PF XL	 9V Train	 RC Train
48g	10g	42g	28g	55g	40g	80g	50g	31g	69g	72g	53g

 PF Train	 PF Large	 EV3 Large	 EV3 medium	 PUP Train	 PUP medium	 Boost Ext.	 Boost Int.	 Control+ L	 Control+ XL	 Spike M	 Spike L
57g	42g	82g	39g	57g	34g	43g	-	53g	76g	49g	71g

Supposed to be equivalent to 71427, 43362 motor is 30% lighter. This is generally an advantage, except when the motor is used as a counterweight, or to balance the structure, for example in COG-shifting walkers.

No-load characteristics

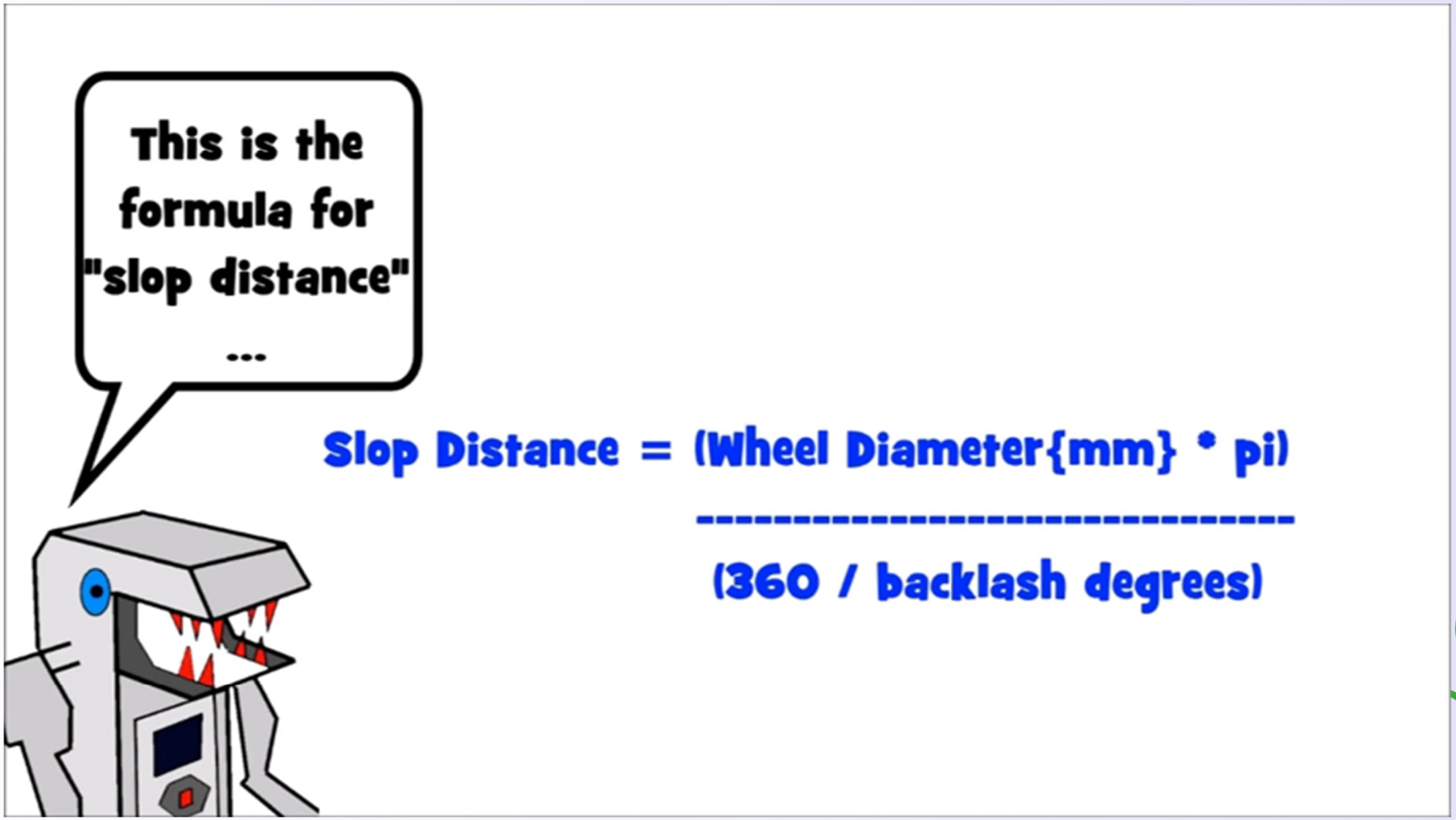
Test conditions: motor is powered by a variable, regulated power supply. An ammeter measures current flowing through the motor, a voltmeter monitors tension across. The rotation speed is measured by a RCX equipped with a light sensor, looking at an half-white/half black cylinder.

9 V supply	 2838	 2986	 71427	 43362	 5292	 47154	 NXT	 E-Motor	 PF Medium	 PF XL	 9V Train	 RC Train
Rotation speed (rotations per minute)	4100 rpm	35 rpm	360 rpm	340 rpm	1700 rpm / 1240 rpm	460 rpm	170 rpm	780rpm	405 rpm	220 rpm	2000rpm	2000rpm
No-load current	35 mA	6 mA	3.5 mA	9 mA	160 mA	31 mA	60 mA	17.5mA	65 mA	80 mA	90mA	90mA

9 V supply	 PF Train	 PF Large	 EV3 Large	 EV3 Medium	PUP Train	PUP medium	Boost Ext.	Boost Int.	Control+ L	Control+ XL	Spike M	Spike L
Rotation speed (rotations per minute)	1900rpm	390 rpm	175rpm	260 rpm	1760 rpm	380 rpm	255 rpm	350 rpm	315 rpm	330 rpm	228 rpm	213 rpm

Motor sloppiness

https://www.youtube.com/watch?v=I3RidtCDjtY



EduCamp: Activities

- Discussion - Talk about mechanical errors with kids // What mechanical errors have you encountered? How did you solve it?

- Practice post-robot-assembly-test on each robot: straight 10-50-100cm, turn 90deg, (straight 30 - turn 90)*8

- Check motor sloppiness together

EDUTUS UNIVERSITY

Strategy errors

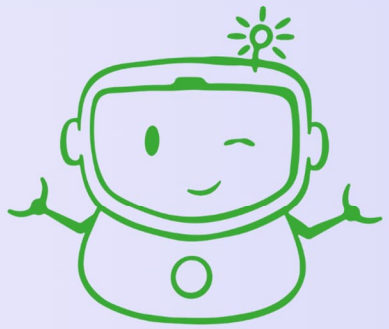
EDUTUS UNIVERSITY

🎯 Strategy errors

Some possible causes

1. Lack of hardware design
2. Too few sensors or too many sensors
3. Understand the rules and ask – read the FAQ/s
4. All or nothing strategy
5. Surprise rule challenge
6. Second day challenge

What can you do?



EDUTUS UNIVERSITY

🎯 Suggested Practice Excercises

- Read all the rules, FAQs, forums and ask in email if you are unsure
- Spend time designing the robot for stability and efficiency
  - Iterate: fail, learn, retry, assemble again – black horse strategy
- Spend time thinking about different mat strategies
  - Print an outline and draw as many different runs as possible – keep it for later
  - Use a whiteboard!
  - Iterate: fail, learn, retry, assemble again – black horse strategy
- Think about how many ports you can effectively use
  - Iterate: fail, learn, retry, assemble again – black horse strategy
  - Try using sensors to get a perfect run
  - Only runs that are reproducible help you – 50% accuracy is your worst enemy
  - Too many sensors are not helpful – sometimes gyro or color sensors win 1 sec and fail 50% time
- it is OK not to solve all tasks, have fun, have 100% reliable runs
- Coaches: shake the table! :D, turn off / on the lights, tilt the table by 1%

EDUTUS UNIVERSITY

🎯 Troubleshooting at competition

Surprise rule challenge

- Practice at home, add some funny surprises regularly
- Weight the surprise rule – what is possible, what does not worth it?

Second day challenge

- Practice “speed” strategy assessment
- What is realistic in 1 day?
- Practice aiming for less and achieving it

🎯 EduCamp: Activities

- Draw a game map on a sheet of paper
- Draw possible strategy on the mat that could be accomplished on a clean machine (no custom blocks or code) in 60 mins
- Discuss and evaluate each group together – is it realistic? How they compare?

EDUTUS UNIVERSITY

Connection errors

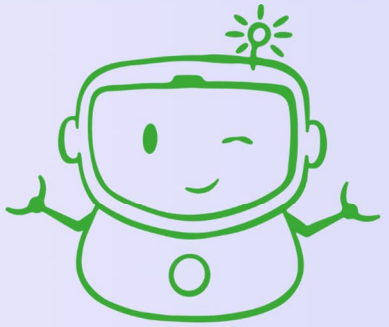
EDUTUS UNIVERSITY

Connection errors

Some possible causes

1. Cable error or connector error
2. Bluetooth issues
3. Streaming “chaos” mode

What can you do?



EDUTUS UNIVERSITY

Suggested Practices

- Spend time with planning cable management, do not force
- Check and test each motor/sensor/cable separately, match motors
- EV3: Check and replace cables, hub can hang on half-connected state
- EV3dev: plan for restart / timing

- Bluetooth:
  - SPIKEV2/V3 reboot hub, restart app, restart computer
  - OS should not be pwd protected from kids - competition problem
  - EV3 practice enable /disable
  - BT interference can cause gyro issues – turn off regularly

- EV3 debug and SPIKE streaming mode is problematic – avoid them for competition, they change a lot!

EduCamp: Activities

- Hide and seek: rotate teams, each one does _ONE_ trick alteration on the other robot, then team needs to find what was wrongly connected / changed
- Practice 4x BT turn off-turn on
- Practice 4x hub-app-pc restart routine

EDUTUS UNIVERSITY

Programming errors

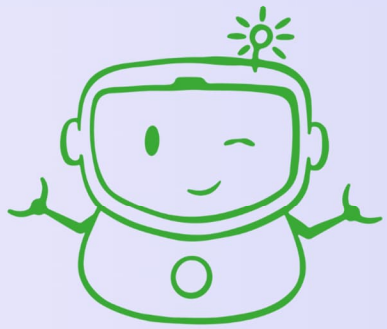
EDUTUS UNIVERSITY

Programming errors

Some possible causes

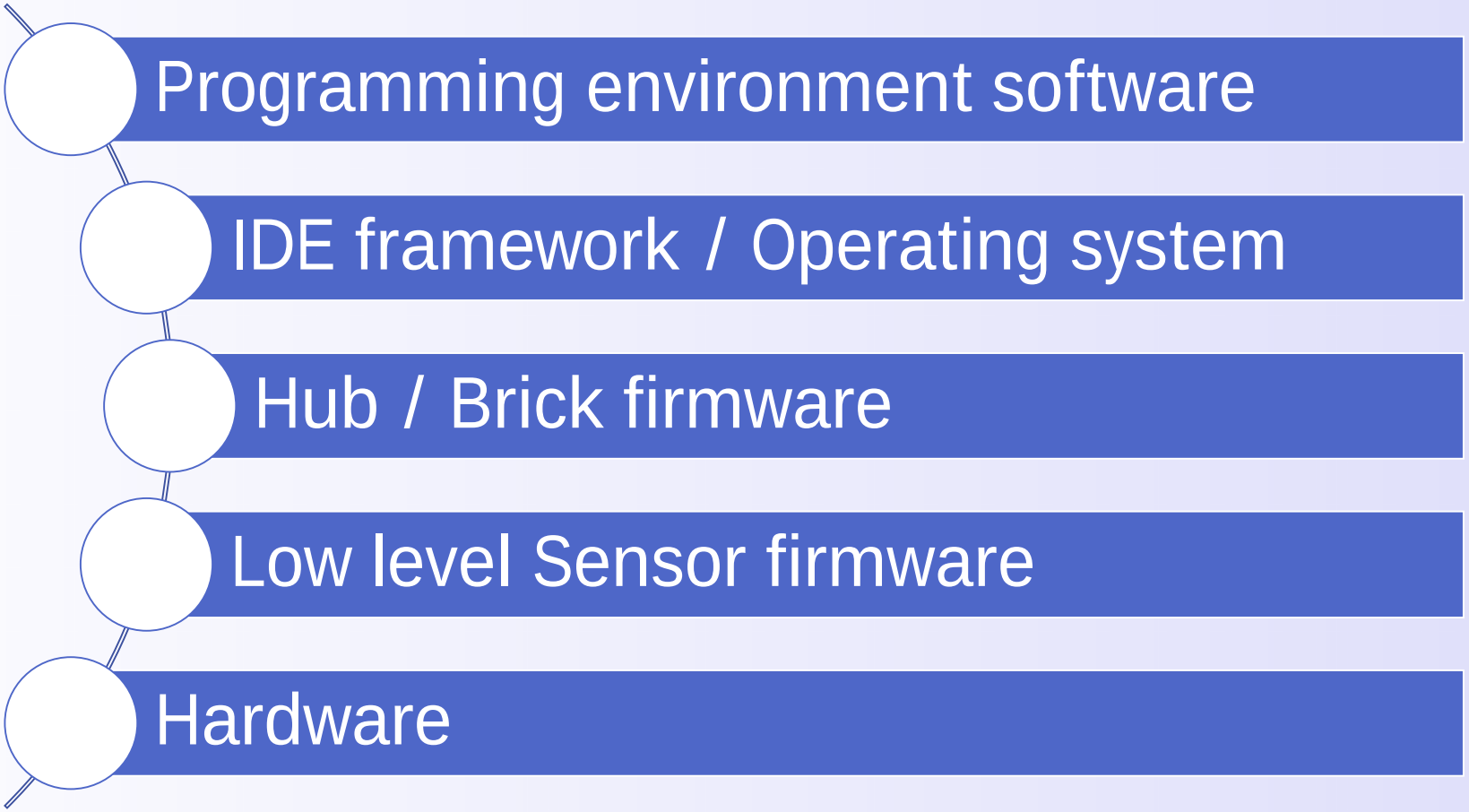
1. Lack of hardware design
2. Too few sensors or too many sensors
3. Understand the rules and ask – read the FAQ/s
4. All or nothing strategy
5. Surprise rule challenge
6. Second day challenge

What can you do?



EDUTUS UNIVERSITY

Understand the layers



Programming environment software

Primary target IDEs

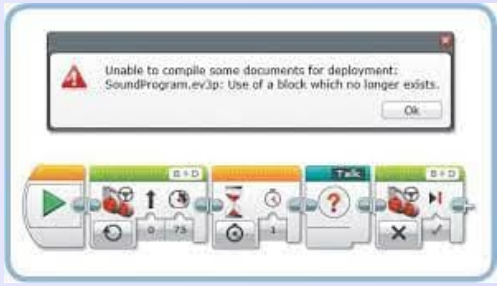
- SPIKE 2 WordBlocks / RI WordBlocks — scratch
- SPIKE 3 WordBlocks — scratch
- EV3Lab by NI / LabView — EV3G
- Ev3dev — python
- (and many more IDEs)

EDUTUS UNIVERSITY

EV3Lab / EV3G

EV3Lab (xml/zip) → LabView → (compile) → EV3lms bytecode → EV3FW interpreter on hub (linux)

1. EV3 VM Instruction Break Error → // resolved https://www.youtube.com/watch?v=kwW8fl9YPBk
2. Myblock does not work → myblock testing condition https://afarago.github.io/EV3TreeVisualizerPages/features.html#myblocks
3. File read error → make sure file exists
4. EV3 slow → downgrade to 1.09 (1.10 is for makeblock, but is slower)
5. EV3 slow compilitaion / memory low → install education version vs home
6. EV3 crashes → save often, use ev3treevis for decoding
7. Missing myblocks → use ev3treevis, check code https://magbuhatrobotics.files.wordpress.com/2017/05/appendix-a.pdf



Trick: can even insert LabView instructions into ev3g for maximum efficiency, can even create own sensor blocks or separate apps

- http://toviscsapat.hu/#robot_tovisblocks+en
- http://toviscsapat.hu/#robot_ev3apps+en

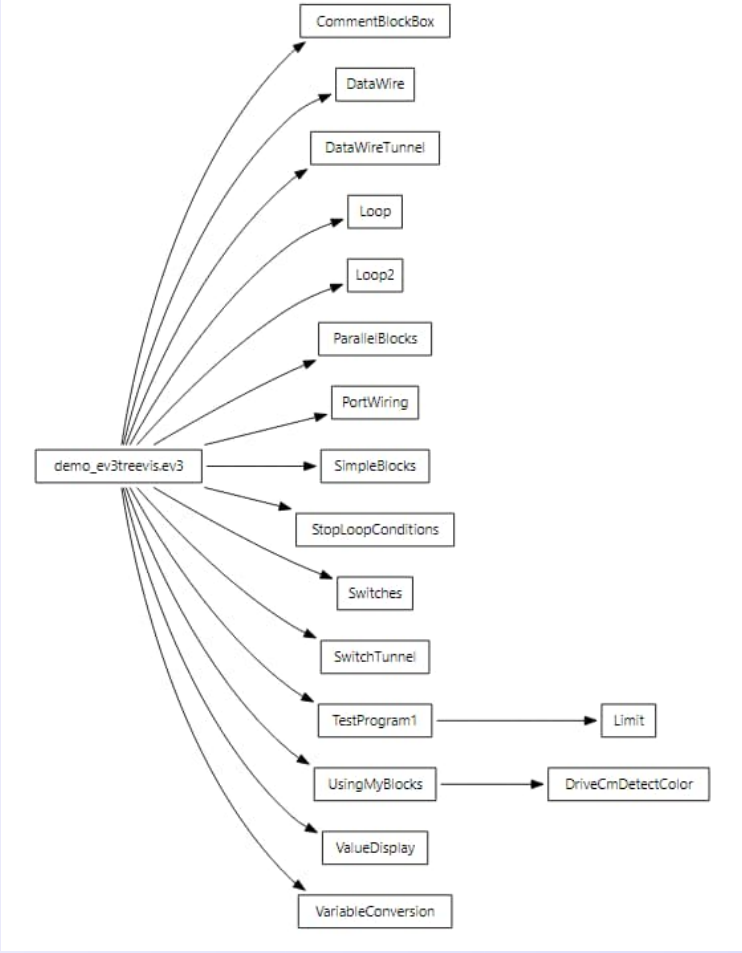
EDUTUS UNIVERSITY

EV3Lab / EV3G

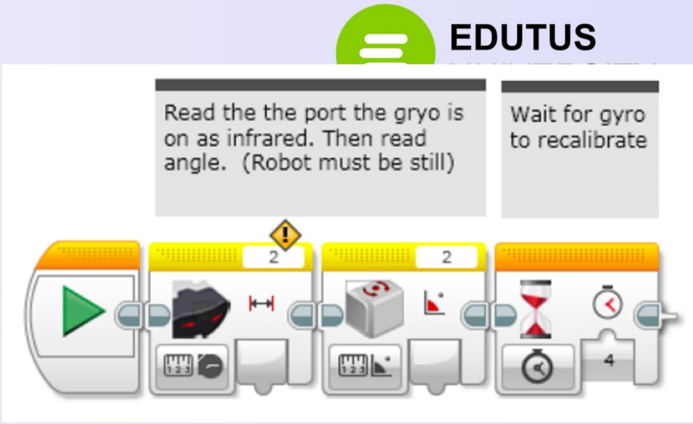
Understand your code and myblocks better

https://ev3treevis.azurewebsites.net

decode compiled code



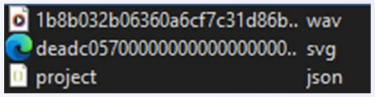
EV3 sensors



1. EV3 gyro drift
    1. *Understand: Gyro → integrate deg/sec rate*
    2. Firmware calibration happens at init and mode change (~)
    3. Avoid reset – do it only at the very start, use diff afterwards
    4. https://ev3lessons.com/en/ProgrammingLessons/advanced/GyroRevisited.pdf
    5. Experiment with N4 (?) second axis http://toviscsapat.hu/#robot_tovisblocks+en
    6. Consider NOT using gyro when not needed
2. EV3 color sensor reliability
    1. RLI mode → shield sensor
        1. Use auto sensor calibration strategies (read/move/store)
    2. COL: Color mismatch → shield sensor
        1. experiment with table distance 1.5 units
        2. Use raw mode
3. EV3 does not start → check all connections
    1. write auto-detect block / power-on self-test (POST)

SPIKE V2, V3

SPIKE llsp, llsp3 (zip/xml) → scratch.sb3 (zip, xml) → project.json

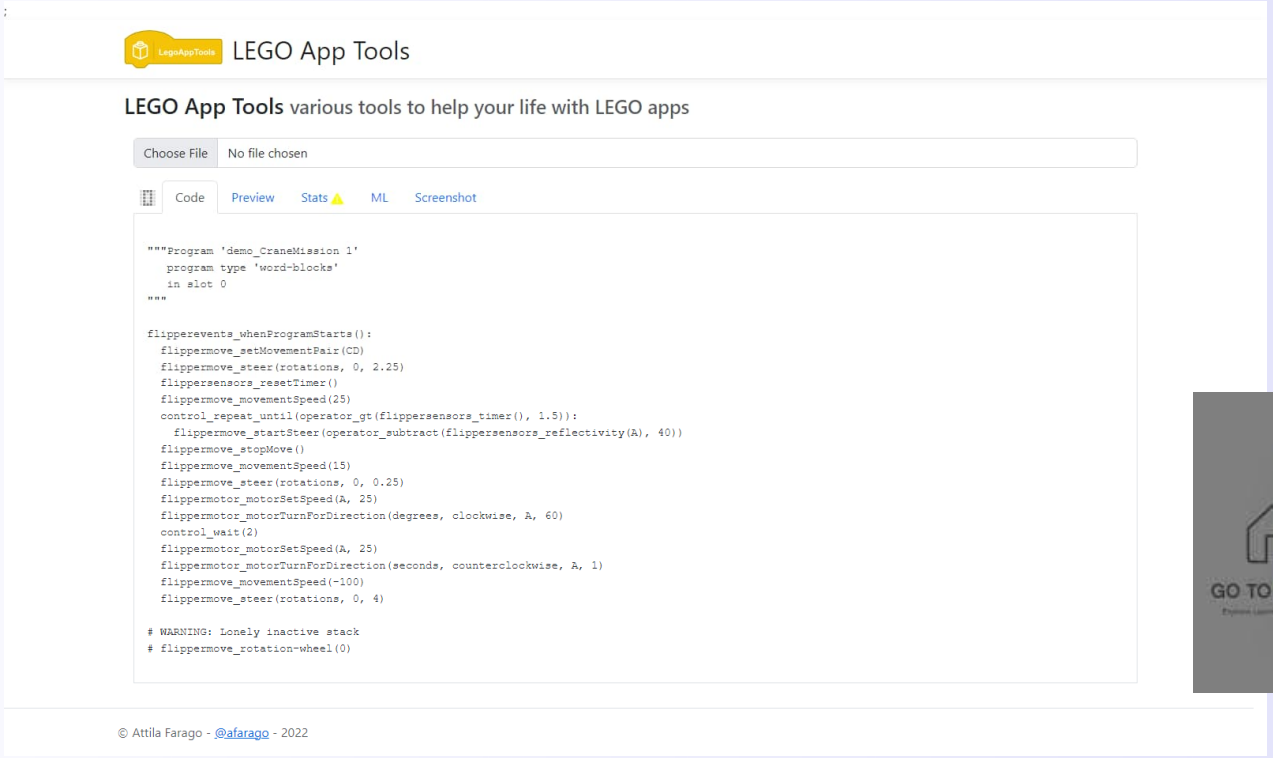


1. Gyro reset error
    1. Understand: Gyro → integrate deg/sec rate
    2. interference, problems reported when used with color sensors
    3. Energy problems, auto resets sometimes, at 180deg
    4. Consider NOT using gyro when not needed
2. Program lost
    1. Extract and open “Icon.svg” in explorer
3. Color sensor reliability
    1. RLI mode → shield sensor
       Use auto sensor calibration strategies (read/move/store)
    2. COL: Color mismatch → shield sensor
       experiment with table distance 1.5 units
4. Too many blocks, can get unreliable >700 blocks
    1. Try textual programming languages such as python
    2. Reduce repeated logic (Don’t Repeat Yourself – DRY)

EDUTUS UNIVERSITY

SPIKE V2, V3

Understand your code better - https://legoapptools.azurewebsites.net



Suggested Practice Excercises

- Practice disconnected, wrong cables with the team
- Check reliability with/without gyro – compare and discuss
- When using gyro, limit speed and rate of turn
- Do not compensate errors in programming
- Create reliable runs and code!
- Split the code and test
  testing means several goal–experiment–evaluate–improve cycles
- Document the code
- Save and backup several times
- Use acceleration and deceleration blocks – create or use (SPIKE/RI)

EDUTUS UNIVERSITY

Troubleshooting at competition

Ask “why is it needed”?

- except surprise rule and second day challenge

EduCamp: Activities

- Start activity with empty workspace (no myblocks/custom code)
- repeat 5x: move till black line and back up 30 cm
- Check reliability – create an experiment of 10x of the above, who scores the most reliablility points?
- !!! You and other teams can use any creative light conditions to interfere