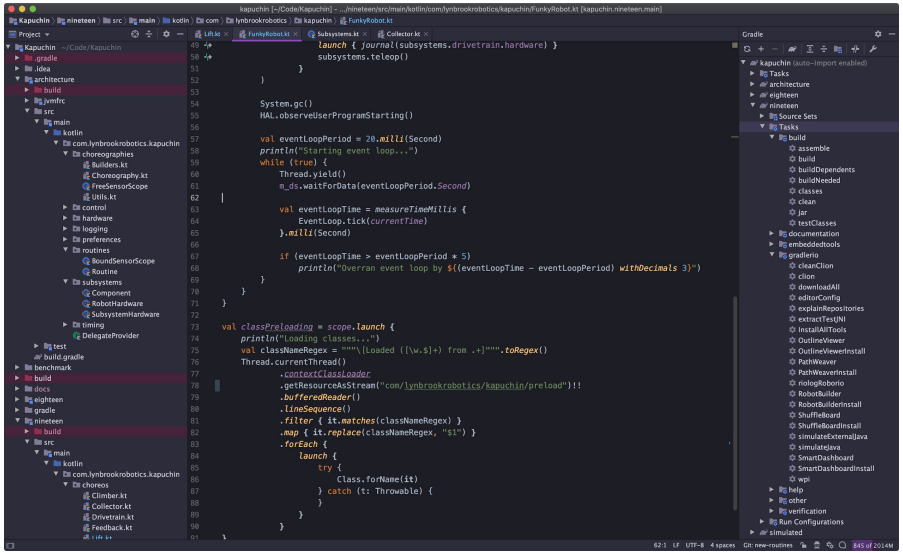
Software Workshops

Week 1 - 10/11/19

What do we do?

- Code in Kotlin
- Sensors
- Controlling motors and pneumatics
- Control theory
- Computer vision
- Microcontrollers



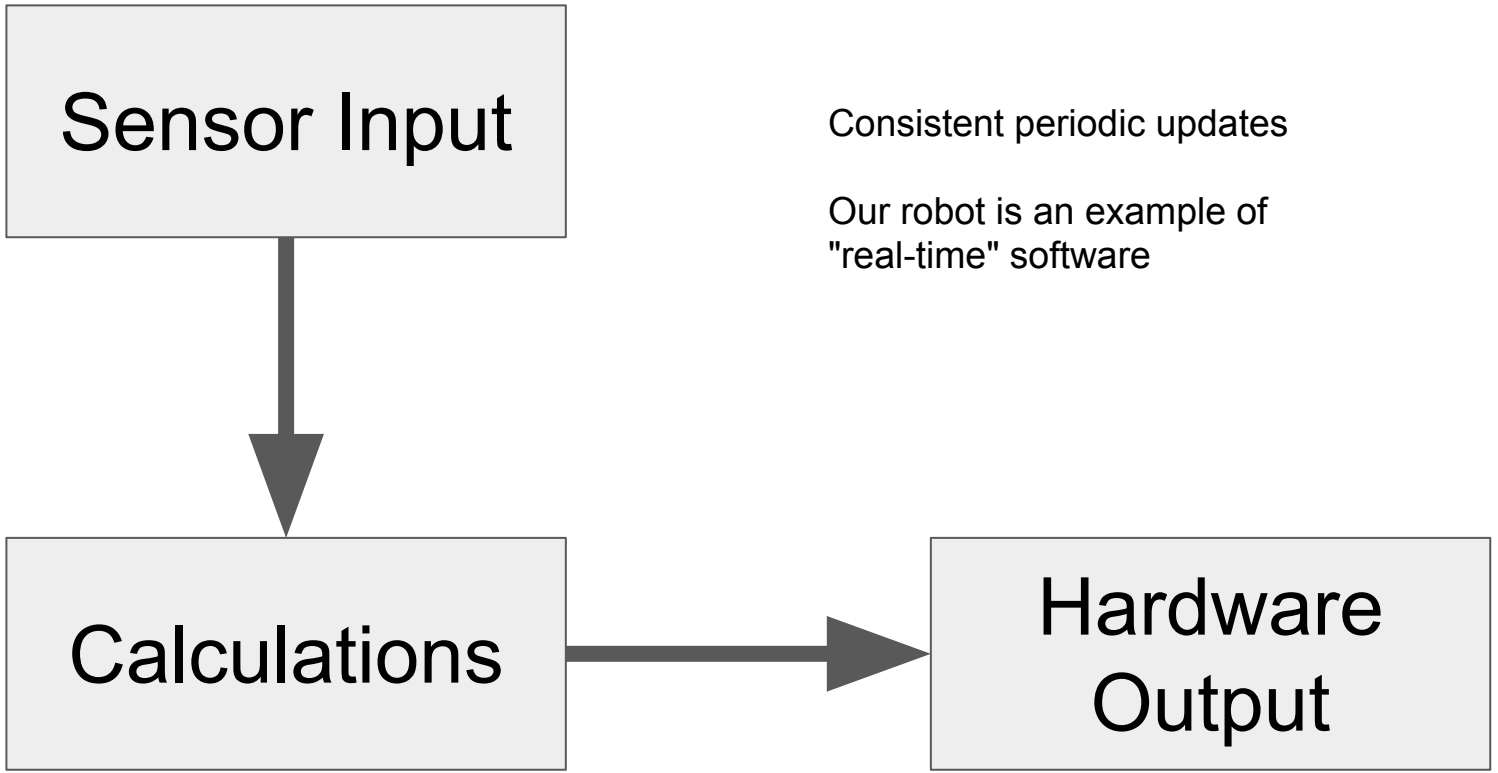
What will you learn?

- **Kotlin**
- Various tools
  - IntelliJ, Git, Gradle, Command line
- Electronics
  - Sensors, motor controllers, PWM
- Programming concepts
  - Real-time Control
  - Object oriented programming, Functional programming
  - JVM
- Control Theory

https://tinyurl.com/846software

Start Kotlin tutorials when all setup

Link to tutorial at the bottom of the setup document



Consistent periodic updates

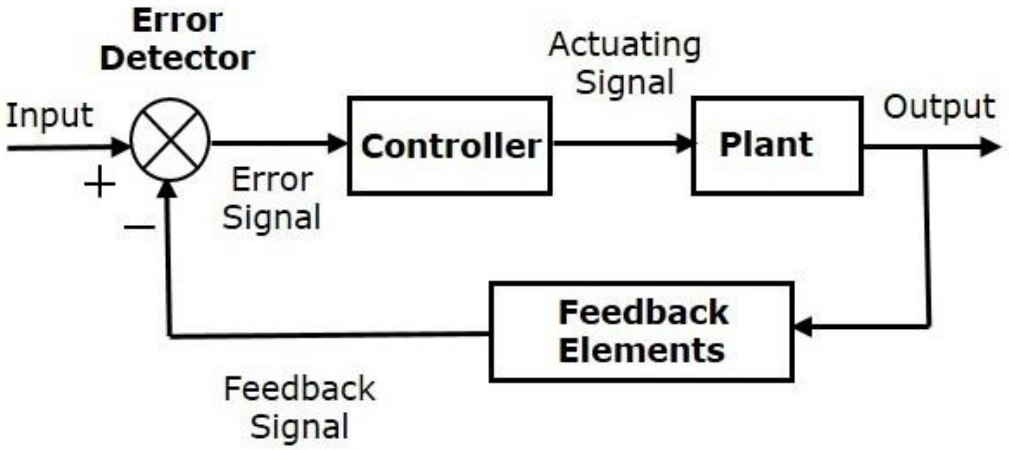
Our robot is an example of "real-time" software

Sensor Input

- Mechanical
  - Limit switch, hall effect, potentiometer, encoders, gyro
- Driver Input
  - Joystick, Xbox controller, steering wheel
- Camera
  - Limelight
  - Vision system

Calculations

- Control Theory
  - What do we output to accomplish a goal?



Hardware Output

- Motors
- Pneumatics
- LEDs

Kotlin!

If you have a background in…

- Java: https://tinyurl.com/javakotlin
- Python: https://tinyurl.com/pythonkotlin

Control Challenges

- janismac.github.io/ControlChallenges/

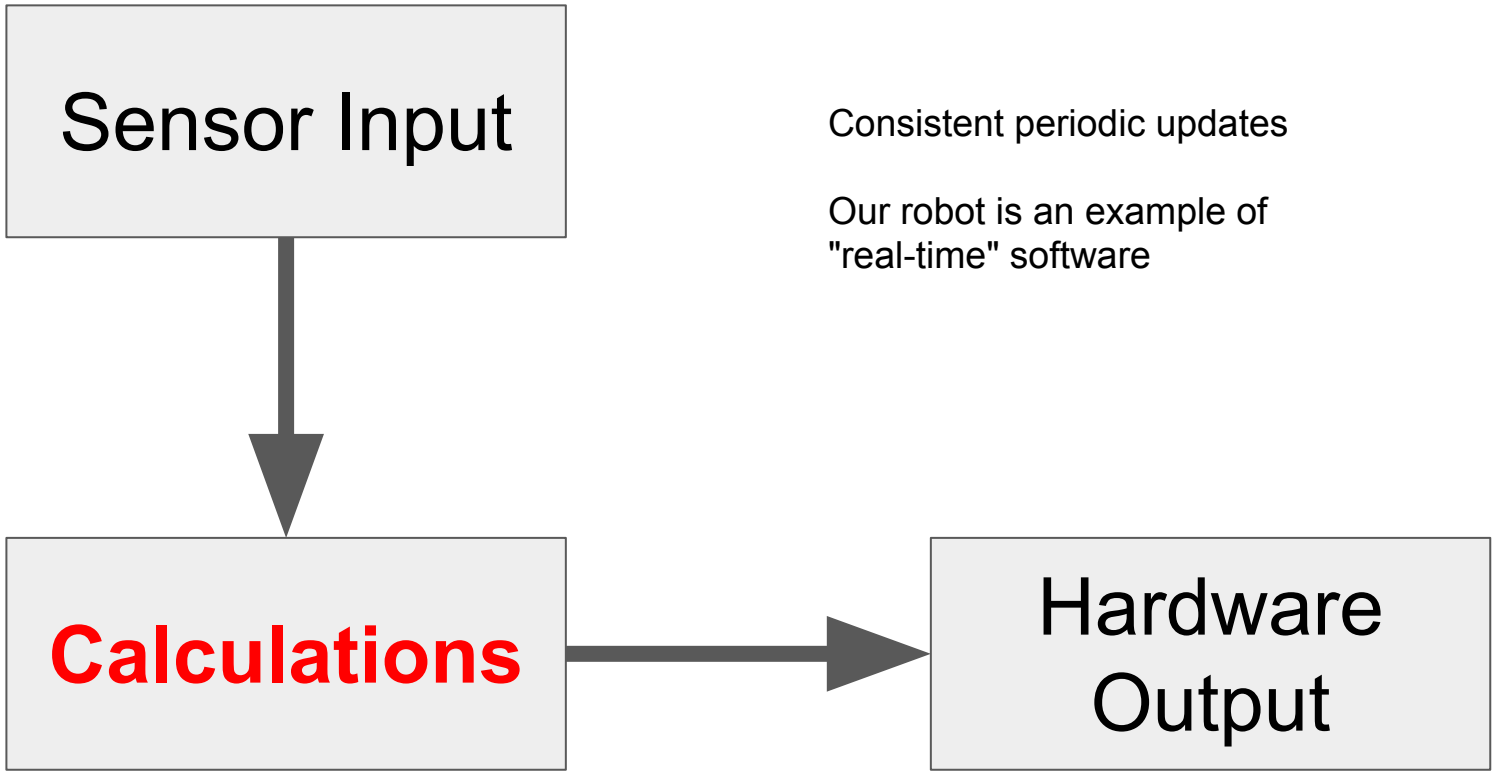
Homework

- https://learngitbranching.js.org
  - Finish the first 4 levels

https://tinyurl.com/846softwaresurvey

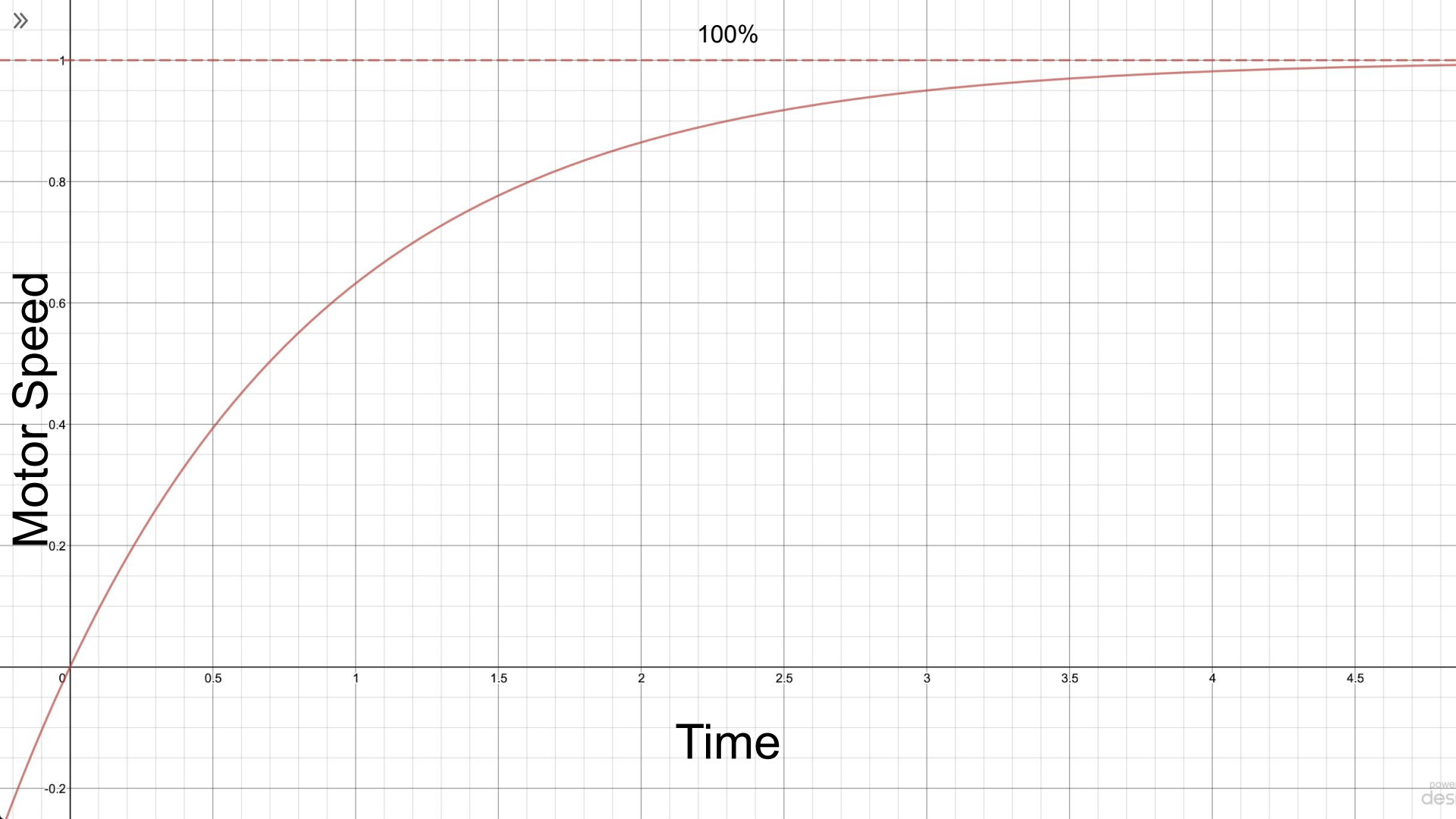
Software Workshops

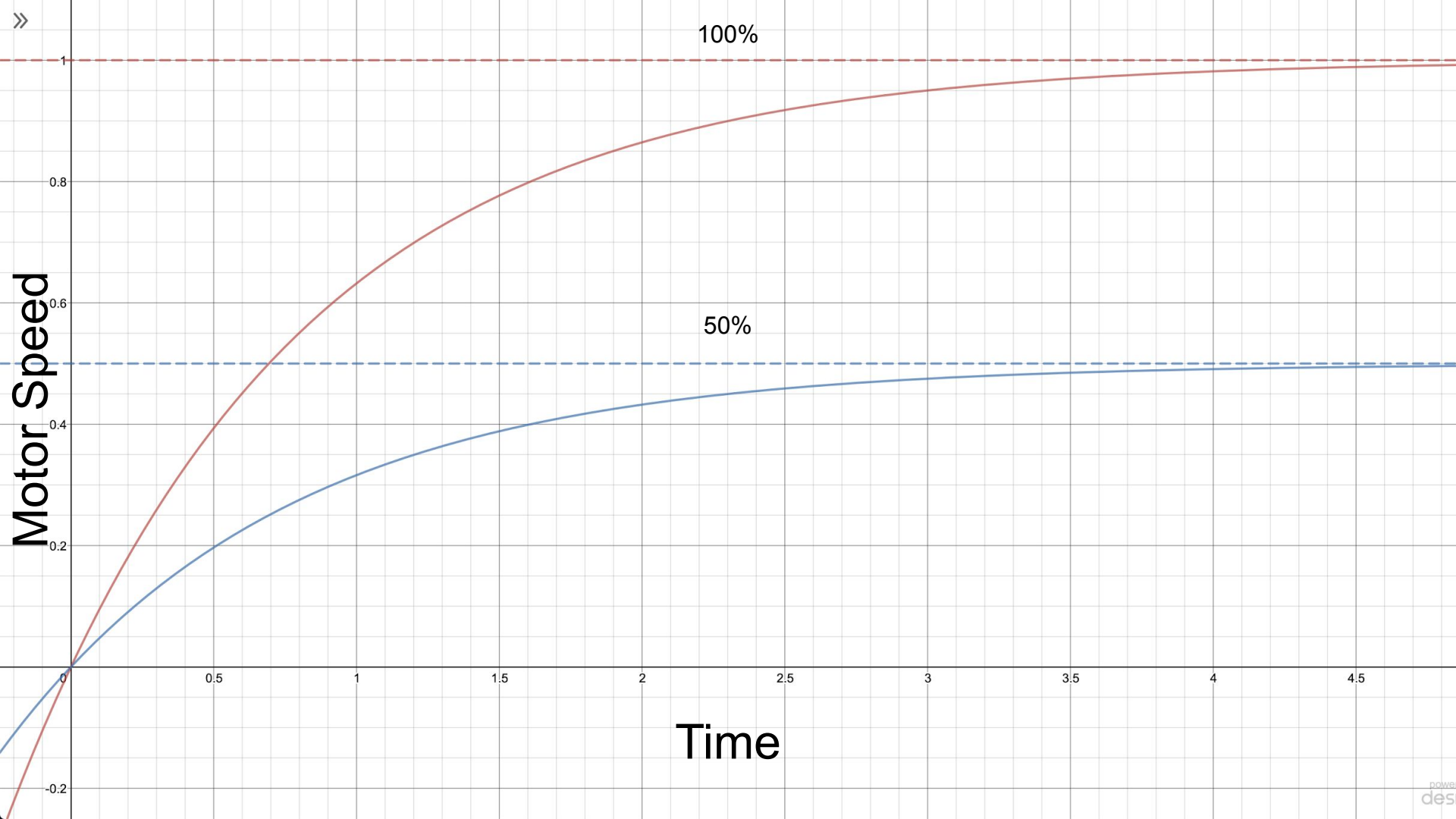
Week 2 - 10/18/19



Consistent periodic updates

Our robot is an example of "real-time" software


100%
Motor Speed
Time
1
0.8
0.6
0.4
0.2
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5


100%
50%
Motor Speed
Time
1
0.8
0.6
0.4
0.2
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

Basic Algorithm

If the speed is too slow…

    More power

If the speed is too fast…

    Slow down

Basic Algorithm

If the block is too far left...

    Move right

If the block is too far right...

    Move left

janismac.github.io/ControlChallenges/

Control Theory

- At least 1 input and output
- Open loop
  - Output calculated using just input
- Closed loop
  - Use feedback
  - Measure the "error" of the output and correct it

Bang Bang Control

- 2 States
- Most simple algorithm for control
- No tuning
- Examples
  - Thermostat
  - Pump

janismac.github.io/ControlChallenges/

Proportional Control

- Feedback system
- Error is how far off your block is
  - Error = (what you want) - (what you have)
- Output is proportional to this error

janismac.github.io/ControlChallenges/

Proportional + Derivative Control

- Simulating friction
- When the block is going too fast when its approaching the target, we slow it down

janismac.github.io/ControlChallenges/

Feed Forward

- Sustain a target
- Feed forward is based on prior knowledge, not error

Bang Bang

- Easy to code
- Fast startup
- Systems with only ON/OFF state

Proportional + Derivative

- Harder to tune (multiple constants)
- Prevents too much oscillation

Software Workshops

Week 3 - 11/1/19

Checklist!

- IntelliJ
- OpenJDK - https://adoptopenjdk.net
  - JDK 11
  - Hotspot
  - Check by running "java -version"

https://tinyurl.com/846week3

Software Workshops

Week 4 - 11/8/19

Checklist!

- Install IntelliJ community
- OpenJDK - https://adoptopenjdk.net
  - JDK 11
  - Hotspot
  - Check by running "java -version"
- Use label maker by the teachers desk to put your name on your charger!

https://tinyurl.com/846wk4

- Windows:
  - Open file explorer and find the downloaded .zip file
  - Click "Extract All" on the top bar
- Open IntelliJ
  - Click "Open"
  - Find the control-workshops-19 folder you just downloaded
  - Click "Import Gradle Project" on the bottom right popup
    - If you don't see this, you may have opened the wrong folder

Challenge #1

- Make a function that moves the lift to a certain position
- Parameters: the target position to go to (Length)
- Use proportional control only
- Find base code in Routines.kt
- Your kP (proportional gain) should be in Percent / Length
    - E.g. 50.Percent / 3.Inch

- Uncomment line 24 in FunkyRobot.kt

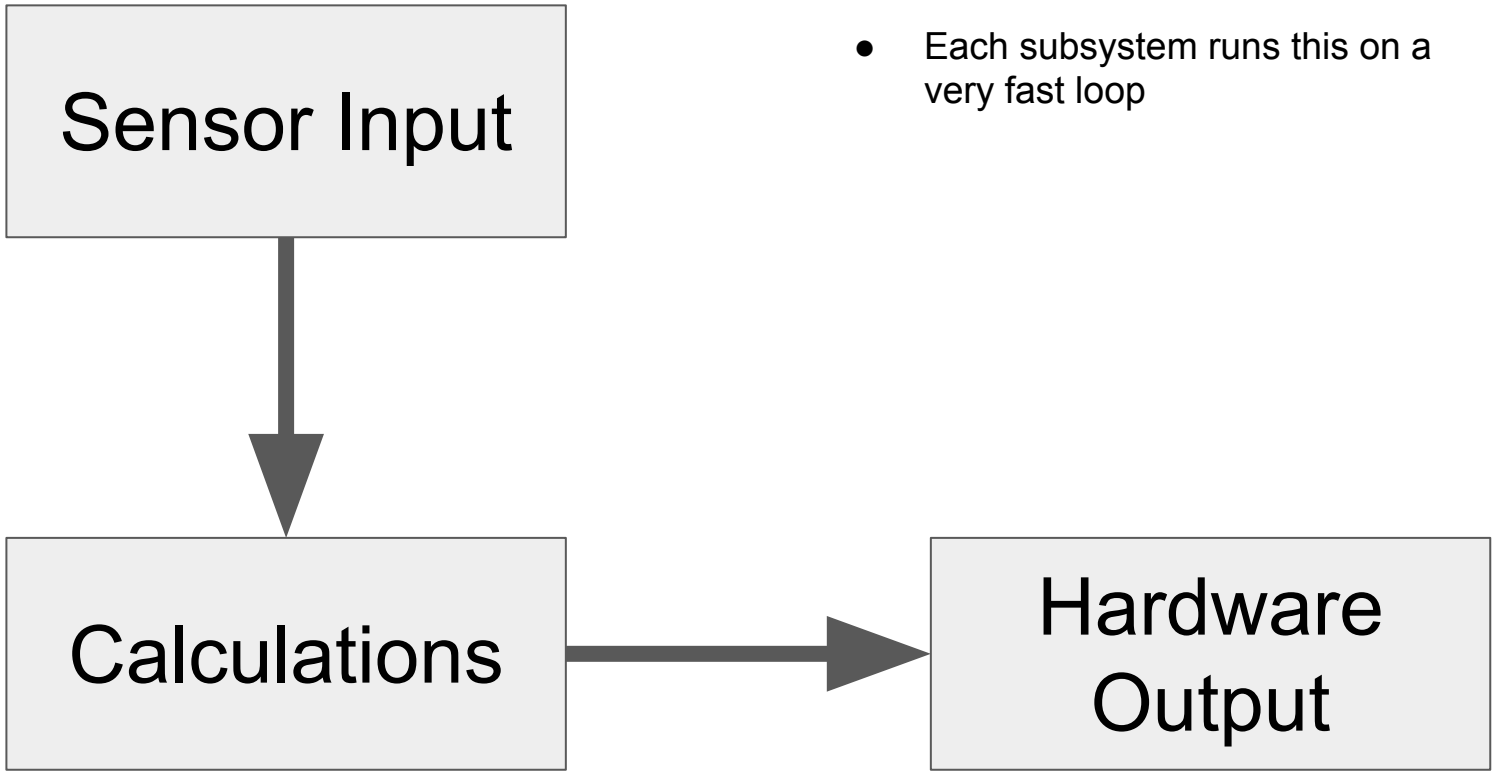
http://janismac.github.io/ControlChallenges/

Challenge #2

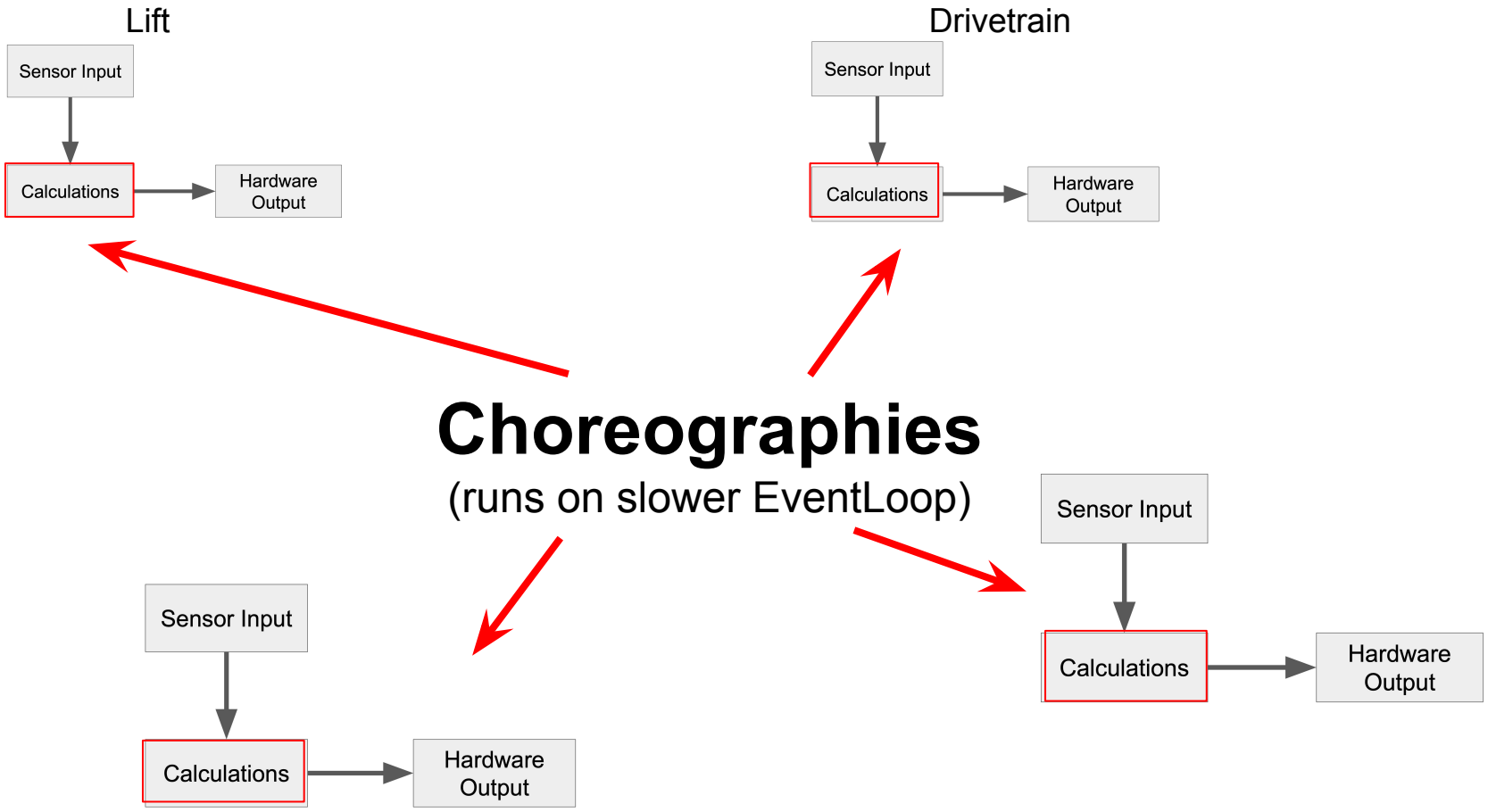
- Modify challenge #1
- Make the routine exit once the lift is close enough to the target
- To make a routine finish, return null from the controller
- Parameters: the target position to go to (Length), the tolerance (Length)

Challenge #3

- Modify challenge #2
- Add derivative control!



- Each subsystem runs this on a very fast loop


Lift
Sensor Input
Calculations
Hardware Output
Drivetrain
Sensor Input
Calculations
Hardware Output
Choreographies
(runs on slower EventLoop)
Sensor Input
Calculations
Hardware Output
Sensor Input
Calculations
Hardware Output

Routines

- Write the calculations for the fast loop
- Sensor input —> **Calculation** —> Hardware Output (only to 1 subsystem!!)

Choreographies

- Coordinate different subsystems (routines) together
- Run routines sequentially or concurrently

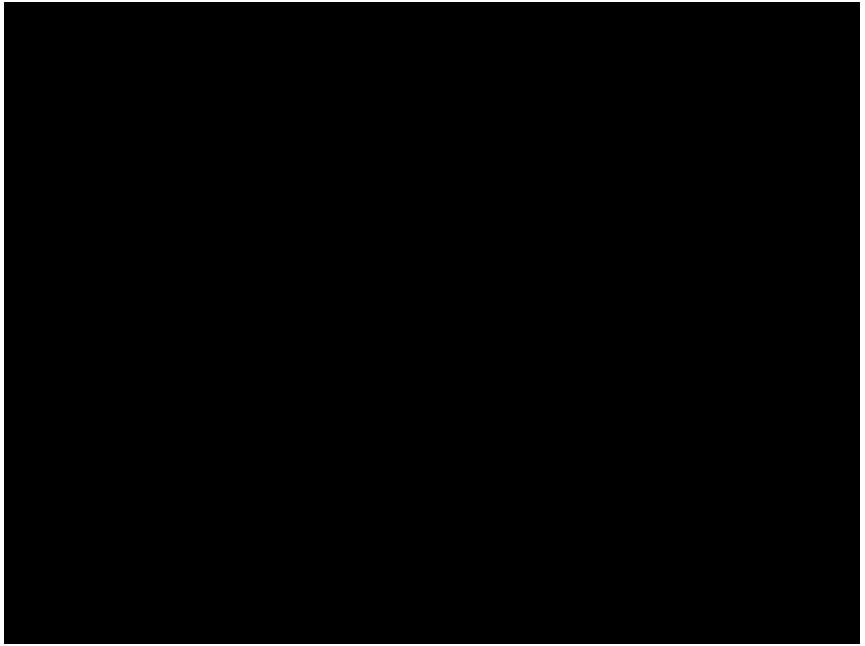
Challenge #4

- Picking up a hatch panel
- Base code in Choreographies.kt

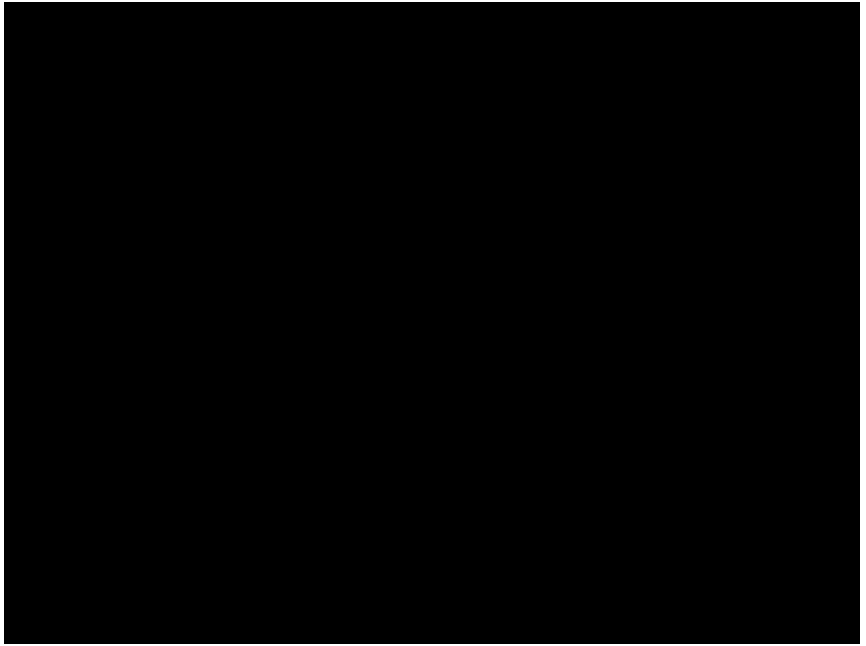
- Comment line 24 in FunkyRobot.kt to disable challenge 1/2/3
- Uncomment lines 27-34 in FunkyRobot.kt

- Hint: quickly comment/uncomment multiple lines
  - Highlight the lines you want to comment
    - Mac: command + /
    - Windows: control + /

When the trigger is pressed/held



When the trigger is released



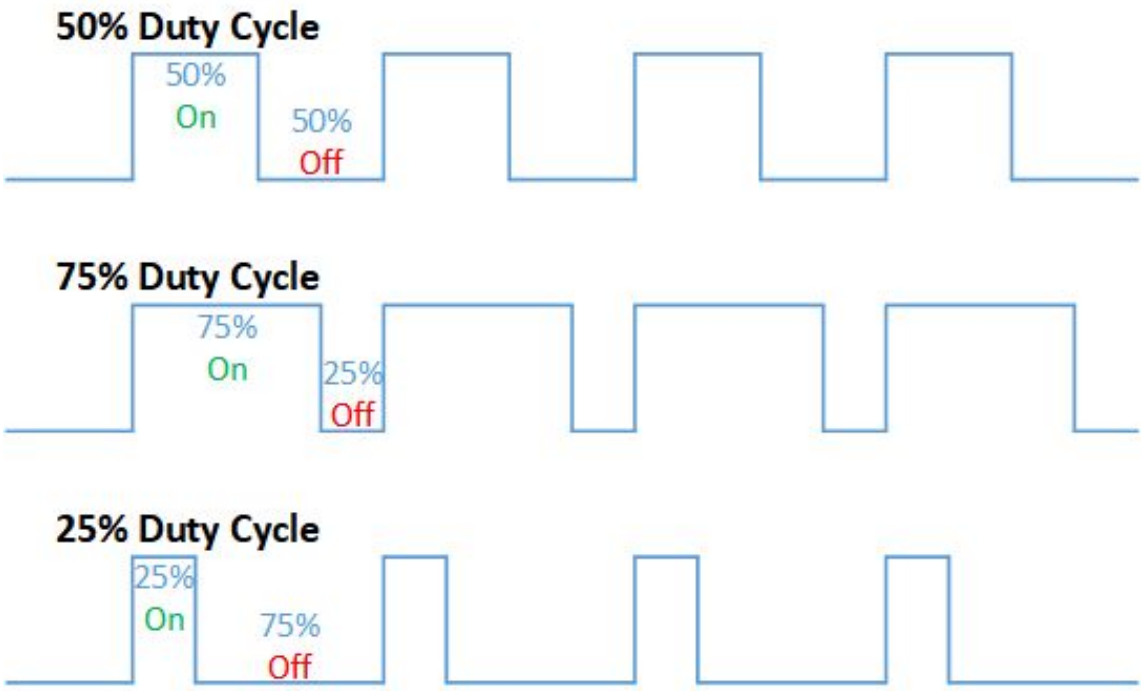
Software Workshops

Week 5 - 11/15/19

What is PWM?

PWM (Pulse Width Modulation)

- Control power output
- 0-100% by switching on/off very quickly



What is the CAN bus?

CAN (Controller Area Network)

- Communicate between different devices
  - Speed controllers, pneumatics, roboRIO
- Send packets of data
- Chain multiple devices together