Robotic Agents (CMPSC 311)

Calibration

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Why Calibrate?

- Sensors are imperfect:
  - two sensors of the same type from the same manufacturer may produce slightly different outputs.
- The sensor is just one component in the measurement system.
- Sensors may respond differently in similar conditions due to sensor design.
- Heat, cold, humidity, etc. can affect sensors.
- Sensors can age with time.
Sensor Characteristics to Look For

- **Precision**: producing the same output for the same input.
- **Resolution**: detecting small changes in the measured parameter.

Sensors can be calibrated for accuracy if they give consistent measurements with good resolution.
Sensor Calibration

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- When you use EV3 Color Sensor in Light Sensor Mode (e.g., reflected light mode), you should calibrate it.
- You need to “teach” the sensor what is “Black” and what is “White”.
- White reads as 100 and Black reads as 0.
- Perform calibration whenever light conditions change.
A program that calibrates EV3 Color Sensors for black and white.

- Reset the existing calibration values.
- Place the robot on “black”.
- Read the data from the robot and calculate adjustment if needed for black.
- Repeat above steps for calibrating “white”.
Calibration

- Other sensor calibration steps:
  - Record the true value
  - Record the sensor value
  - Adjust the sensor value based on the true value
Sensor Errors

- **Offset error**: sensor always reports a value that is a fixed amount off the expected value (common in gyros, light sensors, accelerometers).
  - Can use `LinearCalibrationFilter` in leJOS to measure and correct this error.

- **Scale error**: under or over-rates the changes in the expected value.
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Calibration in leJOS

- leJOS supports sensor calibrating using filters
- LinearCalibrationFilter is used to calibrate sensors for offset and scale errors
  - uses linear interpolation.
  - has two modes of operation:
    - operational mode: corrects samples coming from the sensor;
    - calibration mode: calculates calibration parameters.
Calibrating non-sensors

- Measure the wheel diameter and enter it into the program.
- Run the program and check if the robot traveled the actual distance (e.g., \texttt{travel(100)})
- Adjust the diameter value (e.g., if distance traveled shorter than the actual distance, decrease the diameter)
Calibrating non-sensors

Robotic measurements (e.g., wheels)

- Next, measure the track width (distance between the center of the right and left wheels) and enter it into the program
- Run the program and check if the robot rotated the actual distance (e.g., `rotate(360)`) 
- Adjust the track width (e.g., if over-rotated, decrease the track width)