Goals 3 Submission:

1. **Proposed File Organization & API:**
   Files:

   goals/3/
   –DriveSystem.py
   - Motor Class
     - Class: Controls one motor using two PWM GPIO pins.
     - __init__(self, io, pinA, pinB)
       - Sets up pins and initializes PWM.
     - setLevel(self, level: float)
       - Sets motor speed and direction.
     - stop(self)
       - Stops motor movement.
   - DriveSystem Class
     - Class: Controls both left and right motors for movement.
     - __init__(self, io, left_pins: tuple[int, int], right_pins: tuple[int, int])
       - Creates left and right Motor objects.
     - drive(self, mode: str)
       - Drives with a named movement mode.
     - stop(self)
       - Stops both motors.

   –Sense.Py
   - IR Class
     - Class: Reads a single IR sensor.
     - __init__(self, io, pin: int)
       - Sets up one GPIO pin for input.
     - read(self) → int
       - Returns 1 if tape detected, 0 otherwise.
   - LineSensor Class
     - Class: Reads three IR sensors as a unit.
     - __init__(self, io, pin_L: int, pin_M: int, pin_R: int)
       - Assigns pins for left, middle, right sensors.
     - read(self) → tuple[int, int, int]
       - Returns a 3-tuple of IR values.

   –street_behaviors.py
   - LineFollower Class:
     - Class: Follows a black tape line and detects intersections or ends.

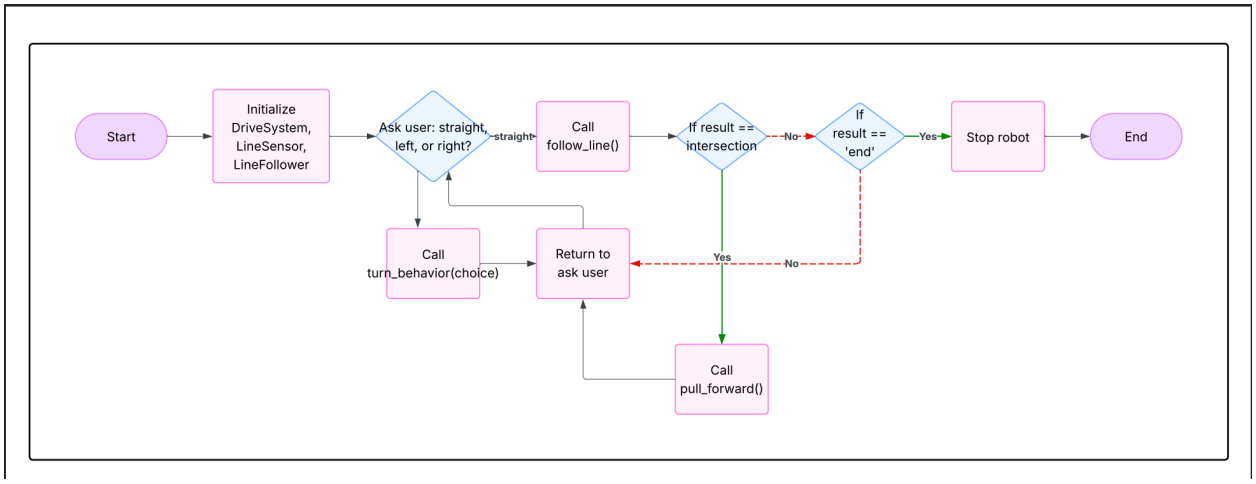
- __init__(self, io, drive: DriveSystem, sensor: LineSensor)
    - Sets up timers and state filters.
- follow_line(self) → str
    - Drives using IR feedback; returns “intersection” or “end”.
- update_detectors(self, L: int, M: int, R: int)
    - Updates filtered detector states.
- raw_side_estimate(self, L: int, M: int, R: int) → float
    - Estimates position relative to line.

- TurningBehavior
    - Class: Turns robot left or right until a new street is found.
    - __init__(self, drive: DriveSystem, sensor: LineSensor, choice: str)
        - Prepares turn direction and filter state.
    - turn(self) → float
        - Spins until center IR detects tape; returns spin duration.
- PullForward
    - __init__(self, drive: DriveSystem, duration: float)
        - Sets duration and drive system.
    - pull_forward(self)
        - Moves forward for fixed time, then stops.

– brain.py

- Main script: Ties together all behaviors.
- Prompts user to drive straight, turn left, or turn right; calls appropriate methods based on result.

High- level Brain Flowchart:

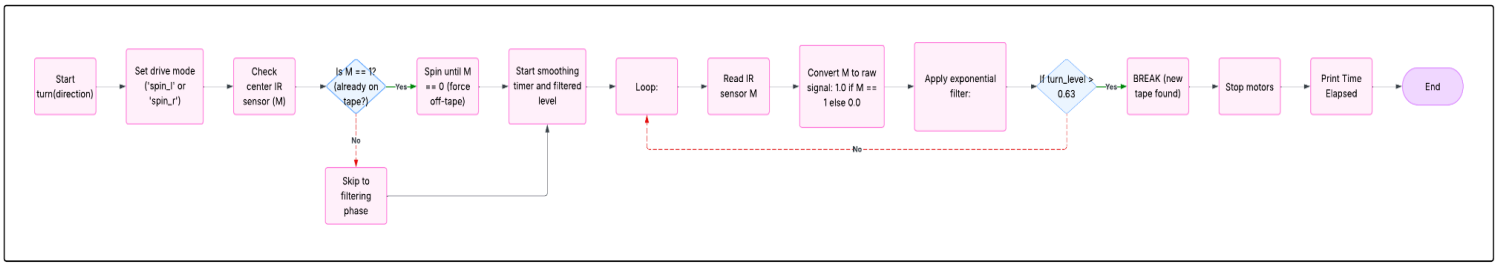


2. **ll the detector/estimator parameters: initialization values, thresholds, time constants,**

Detector / Estimator	Raw Condition	Time Constant	Thresholds (for up/down)	Notes
Intersection Detector	**(L, M, R) == (1, 1, 1)**	**t_intersection = 0.17 s**	**> 0.63 (active), < 0.37 (inactive)**	**Detects full tape coverage by all sensors**
End-of-Street Detector	**(L, M, R) == (0, 0, 0) and side_state == "center"**	**t_end = 0.6 s**	**> 0.63 (active), < 0.37 (inactive)**	**Ensures robot truly left the line**
Road-Side Estimator	**Based on (L, M, R) pattern**	**t_side = 0.1 s**	**> +0.5 → right, < -0.5 → left**	**Estimates position when tape is lost**
Turn Completion Detector	**M == 1**	**t_spin = 0.1 s**	**> 0.63 (stop turning**	**Used for Turning in Turn Behavior**

3. **Pull_Froward Time Constant**
    a. We set the pull_through as 0.4s

4. **An appropriate description of how your turn detector works/handles the IR'sdown/up phases.**



Phase	Description
Down phase	**After spinning begins, all IR sensors read 0 → center sees white.**
Filtering Spin Prematurely	**Exponential smoothing prevents noise from ending the spin too early**
Up Phase rises	**Once center sensor stabilizes on tape (M == 1), the smoothed signal rises**
Threshold reacquired	**When turn_level > 0.63, spin stops, meaning tape is reliably reacquired.**

5. The spin time versus angle graph and data.

Angle (degrees)	Spin-Time (s)
-45	0.4228894711
-180	1.436908007
-90	0.7219238281
-135	1.298382282
45	0.4650485516
180	1.899983883
90	0.7853589058
135	1.331197023
-45	0.4708380699
-180	1.404350519
-90	0.7121009827
-135	1.208133698
45	0.5308260918
180	1.826150656
90	0.8224673271
135	1.441086531
-45	0.3430445194
-180	1.428478956
-90	0.7359361649
-135	1.216475487
45	0.4228894711
180	1.795144796
90	0.9133358002
135	1.335222483
-180	1.381184816
-45	0.4699723721
-90	0.7685005665
-135	1.074148417
45	0.5299720764
180	1.717182398

90	0.7795078754
135	1.226864815
-180	1.441272497
-45	0.3413629532
-180	1.471766472
-90	0.7385005951
-135	1.052924156
45	0.4527132511
180	1.714266062
90	0.8560261726
135	1.443194628