Program 2

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Modules

Transitional Probability

$Transitional\ Probability(Pos_i, Dir) =$
$(Pos_{from\ left} : Drift(Left), Pos_{from\ straight} : Drift(Straight), Pos_{from\ right} : Drift(Right))$: (For smoothing)

$Transitional\ Probability(Pos_i, Dir) =$
$(Pos_{from\ left} : Drift(Left), Pos_{from\ straight} : Drift(Straight), Pos_{from\ right} : Drift(Right), Pos_{from\ behind} : Drift(Straight))$: (For prediction)

Left, *Right*, and *Straight* are all positions defined in relation to what *Dir* is: if *Dir* is EAST, then *Left* is SOUTH, *Right* is NORTH, and Straight is EAST for example.

Here, transitional probability has two forms: one which is all paths that converge to a point, and another where they diverge from a point. Prediction (as the name implies) wants all the possible paths to a point, which is why we include $Pos_{from\ behind}$. Smoothing however, does not use that, which is why it's not included.

Prediction

$$Prediction(Grid, Direction) = \left\{ pos_i \in Grid \mid \sum_{(Pos_j, DriftProb)}^{Transition\ Probability(pos_i, direction)} DriftProb \cdot P(Pos_j) \right\}$$

$Prediction(Grid, Direction)$ (as the name implies) attempts to predict where the agent will be given previous information. It does this by transforming the grid by the expression $\sum_{(Pos_j,DriftProb)}^{Transition\ Probability(pos_i,direction)} DriftProb \cdot P(Pos_j)$.This gets the probability of an agent drifting (or if direction is straight, accurately going to) a point, and what is the probability the agent would be at the point Pos_j.

Evidence Conditional Probability

$Evidence\ Conditional\ Probability(Pos_i, Evidence) =$
$\prod_{dir=W}^{\text{Directions}} Sense(evidence[pos_i dir], actual[pos_i + dir])$

This is the expression we use to get the evidence conditional probability: it's the product of each the evidecne's value at a direction times what's actually in the value of the direction. So if *Left* has opened, but evidence says it's closed, it's 0.2. Taking the product of all direction's sensed value and actual value, it will result in the Evidence Conditional Probability at Pos_i given *Evidence*

Filtering

$Filtering(Grid, Evidence) = \{pos_i \in Grid \mid$
$\frac{P(pos_i) \cdot Evidence\ Conditional\ Probability(pos_i,Evidence)}{\sum_{pos}^{all\ positions} P(pos_i) \cdot Evidence\ Conditional\ Probability(pos_i,evidence)}\}$

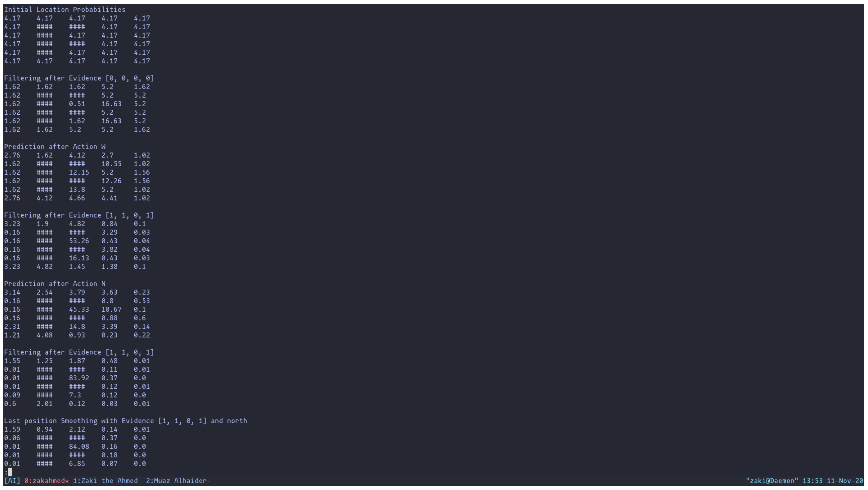
Filtering is a transformation upon the grid: each value gets transformed by the expression $\frac{P(pos_i) \cdot Evidence\ Conditional\ Probability(pos_i,Evidence)}{\sum_{pos}^{all\ positions} P(pos_i) \cdot Evidence\ Conditional\ Probability(pos_i,evidence)}$, which for purposes of making it easier to talk about, will be expressed as $Filter\ Step(pos_i, Evidence)$. *Filter Step* is conditional probability of each point times what probabilty of the point previously, and then dividing it by the sum of all points on the grid.

Results

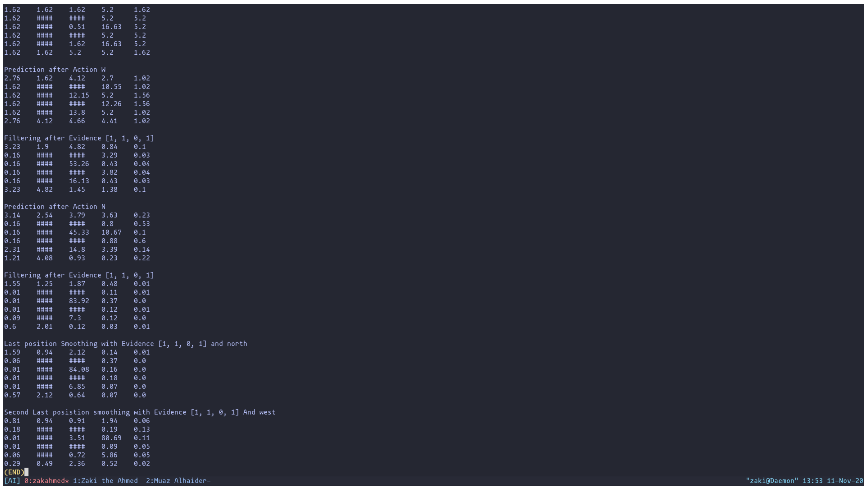
The code outputs the following:

```
julia SUBMIT.jl
```

Screenshots



```
Initial Location Probabilities
4.17    4.17    4.17    4.17    4.17
4.17    ####    ####    4.17    4.17
4.17    ####    4.17    4.17    4.17
4.17    ####    ####    4.17    4.17
4.17    ####    4.17    4.17    4.17
4.17    4.17    4.17    4.17    4.17

Filtering after Evidence [0, 0, 0, 0]
1.62    1.62    1.62    5.2     1.62
1.62    ####    ####    5.2     5.2
1.62    ####    0.51    16.63   5.2
1.62    ####    ####    5.2     5.2
1.62    ####    1.62    16.63   5.2
1.62    1.62    5.2     5.2     1.62

Prediction after Action W
2.76    1.62    4.12    2.7     1.02
1.62    ####    ####    10.55   1.02
1.62    ####    12.15   5.2     1.56
1.62    ####    ####    12.26   1.56
1.62    ####    13.8    5.2     1.02
2.76    4.12    4.66    4.41    1.02

Filtering after Evidence [1, 1, 0, 1]
3.23    1.9     4.82    0.84    0.1
0.16    ####    ####    3.29    0.03
0.16    ####    53.26   0.43    0.04
0.16    ####    ####    3.82    0.04
0.16    ####    16.13   0.43    0.03
3.23    4.82    1.45    1.38    0.1

Prediction after Action N
3.14    2.54    3.79    3.63    0.23
0.16    ####    ####    0.8     0.53
0.16    ####    45.33   10.67   0.1
0.16    ####    ####    0.88    0.6
2.31    ####    14.8    3.39    0.14
1.21    4.08    0.93    0.23    0.22

Filtering after Evidence [1, 1, 0, 1]
1.55    1.25    1.87    0.48    0.01
0.01    ####    ####    0.11    0.01
0.01    ####    83.92   0.37    0.0
0.01    ####    ####    0.12    0.01
0.09    ####    7.3     0.12    0.0
0.6     2.01    0.12    0.03    0.01

Last position Smoothing with Evidence [1, 1, 0, 1] and north
1.59    0.94    2.12    0.14    0.01
0.06    ####    ####    0.37    0.0
0.01    ####    84.08   0.16    0.0
0.01    ####    ####    0.18    0.0
0.01    ####    6.85    0.07    0.0
:
[AI] 0:zakahmed* 1:Zaki the Ahmed  2:Muaz Alhaider-                                                        "zaki@Daemon" 13:53 11-Nov-20
```



```
1.62    1.62    1.62    5.2     1.62
1.62    ####    ####    5.2     5.2
1.62    ####    0.51    16.63   5.2
1.62    ####    ####    5.2     5.2
1.62    ####    1.62    16.63   5.2
1.62    1.62    5.2     5.2     1.62

Prediction after Action W
2.76    1.62    4.12    2.7     1.02
1.62    ####    ####    10.55   1.02
1.62    ####    12.15   5.2     1.56
1.62    ####    ####    12.26   1.56
1.62    ####    13.8    5.2     1.02
2.76    4.12    4.66    4.41    1.02

Filtering after Evidence [1, 1, 0, 1]
3.23    1.9     4.82    0.84    0.1
0.16    ####    ####    3.29    0.03
0.16    ####    53.26   0.43    0.04
0.16    ####    ####    3.82    0.04
0.16    ####    16.13   0.43    0.03
3.23    4.82    1.45    1.38    0.1

Prediction after Action N
3.14    2.54    3.79    3.63    0.23
0.16    ####    ####    0.8     0.53
0.16    ####    45.33   10.67   0.1
0.16    ####    ####    0.88    0.6
2.31    ####    14.8    3.39    0.14
1.21    4.08    0.93    0.23    0.22

Filtering after Evidence [1, 1, 0, 1]
1.55    1.25    1.87    0.48    0.01
0.01    ####    ####    0.11    0.01
0.01    ####    83.92   0.37    0.0
0.01    ####    ####    0.12    0.01
0.09    ####    7.3     0.12    0.0
0.6     2.01    0.12    0.03    0.01

Last position Smoothing with Evidence [1, 1, 0, 1] and north
1.59    0.94    2.12    0.14    0.01
0.06    ####    ####    0.37    0.0
0.01    ####    84.08   0.16    0.0
0.01    ####    ####    0.18    0.0
0.01    ####    6.85    0.07    0.0
0.57    2.12    0.64    0.07    0.0

Second Last posistion smoothing with Evidence [1, 1, 0, 1] And west
0.81    0.94    0.91    1.94    0.06
0.18    ####    ####    0.19    0.13
0.01    ####    3.51    80.69   0.11
0.01    ####    ####    0.09    0.05
0.06    ####    0.72    5.86    0.05
0.29    0.49    2.36    0.52    0.02
(END)
[AI] 0:zakahmed* 1:Zaki the Ahmed  2:Muaz Alhaider-                                                        "zaki@Daemon" 13:53 11-Nov-20
```

Who did what

Zakariya

- Transitional probability/prediction algorithm, code and report.

Muaz

- Conditional Evidence probability, filtering and smoothing algorithm and code.