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.

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 require 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 transform-

ing 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 equation 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 the point was previously, and then dividing it by the sum of all points on the grid. This operation is $O(n)$, although more accurately it's $O(2n)$ because there's a minimum of iterating through each value twice.

Results

The code outputs the following:

```
julia SUBMIT.jl

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
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
```

Screenshots

Who did what

Zakariya

- Transitional probability/prediction

Muaz

- Conditional Evidence probability, filtering and smoothing.