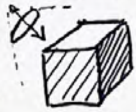
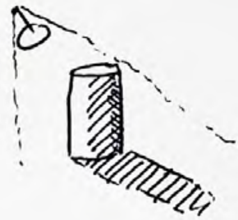
Slate 02

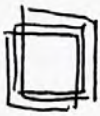
Warm up: shading + blurs.





choose light source

more lines = darker



motion blur

use many lines to indicate blur or shadow.

Last time: Bayes Theorem

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}$$

sensor noise model

area or point on map

$$p(pos|sensor) = P(sensor|pos) \cdot \frac{P(pos)}{P(sensor)}$$

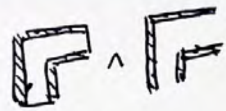
model of sensor

$p(pos | s_1, s_2)$ ... why not add history?

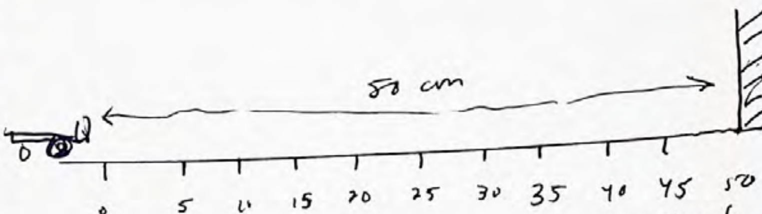
$p(pos | sensors, previous)$

Intuition: 

x, y, ϕ

lasers. 

probability we measured pixel wrong is low.

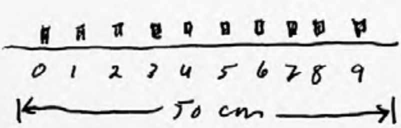


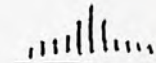
N = # of bins.
discretization

$p(pos) = 1/10$ put in array

$p(pos_i) = 1/10$ belief[N]

```
for (int i = 0; i < N; i++) {
        belief[i] = 1/10;
}.
```



→ 

update.

$$p(d<5 \mid s=25\text{ cm}) = \frac{p(s=25 \mid d<5)\,p(d<5)}{p(s=25)}$$

Just Bayes

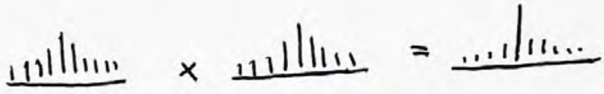
$$= \frac{0.01 \cdot 5/50}{1/50} = 0.05$$

Key insight: why not multiply?

$$P(A \cap B) = P(A) \cdot P(B).$$

beliefs before

beliefs now.



much more certain!

That's for a stationary point. But what about motion?

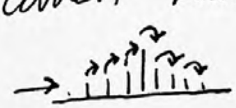
change beliefs to predict.

$array_1$ = beliefs[N]

$array_2$ = predictions[N]

☆ How can we make predictions? (we measure later).

1. move current belief: pred[i] = bel[i-1]



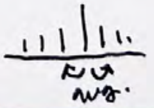
How much?

↳ guess based on output

↳ guess based on encoder.

...

2. blur.



(9)

prediction [i] = pred.[i-1] + pred[i] + pred[i+1]

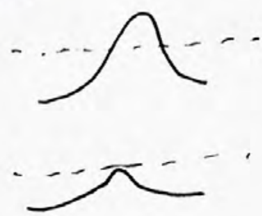
very blurry.

kernel → $\begin{bmatrix} 0.1 \\ 0.8 \\ 0.1 \end{bmatrix}$

prediction [i] = 0.2 pred [i-1] +
0.6 pred [i] +
0.2 pred [i+1]

B~~[illegible]~~ize.

Normalize



too high
$\sum p(i) = 1.$

normalize.

$$p(i) = \frac{p(i)}{\sum p(i)}$$

update beliefs w/ ~~[illegible]~~ predictions.

bel[i] = pred[i]

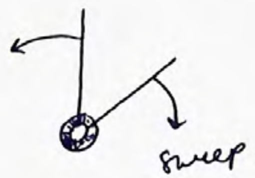
then.

update w/ sensor:

bel[i] = p(sensor | i) · bel[i]

* Error demo.

If time: object detection.
same idea as robot but
imagine a sonar tower.



1. set up initial bayes. e.g. to model
2. initialize beliefs.
3. update prediction..
   ↳ what moves?

COGS 300 State 02 Feb 12 / 26 ①

warm up: shading + blurring

dark regions get cross hatch

draw cone for light

trace light

use box to build intuition

cast shadow

far away ⇒ blur

position

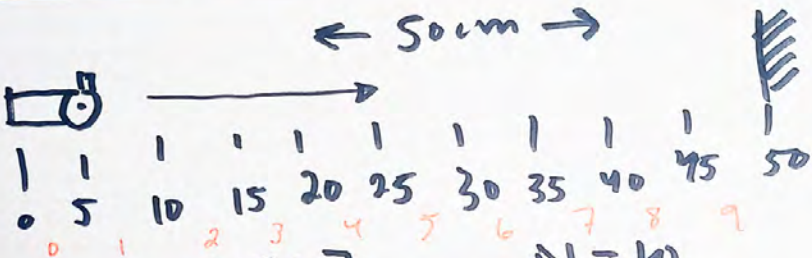
knowledge (sensors, history)

sensor model

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)} = \frac{P(\text{sensor}|\text{pos}) \times P(\text{pos})}{P(\text{sensor})}$$

area on map

sensor range



$N = 10$

belief [N]

$p(pos) = 1/10 = 5/50$

```
for (i=0; i<N; i++) {
        belief [i] = 1/10;
}
```

initialization

$$p(d<5 \mid s=30) = \frac{p(s=30 \mid d<5)\, p(d<5)}{p(s=30)} = \frac{0.01 \cdot \frac{1}{10}}{1/50} = 0.05$$

$$p(E_1 \cap E_2) = p(E_1) \cdot P(E_2)$$

beliefs   predictions.

* How can we make a prediction?
  - ↳ sensors?
    - ↳ speed
  - ↳ change array?

3

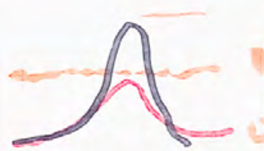
$pred[i] = bel[i-1]$

amount we move

blur our predictions. → bc sensors are bad

$$pred[i] = 0.1 \cdot pred[i-1] + 0.8 \cdot pred[i] + 0.1 \cdot pred[i+1]$$

weighted average



$bel[:] = pred[:]$

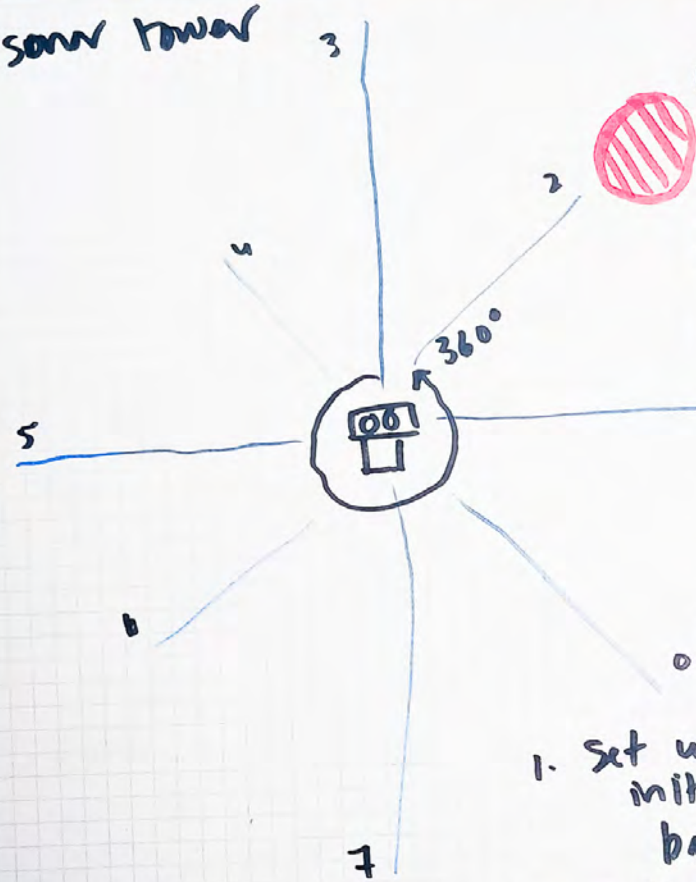
normalizing

$$bel[:] = \frac{bel[:]}{\sum bel[i]}$$

update

$$bel[:] = p(sensor \mid i) \cdot bel[:]$$

sonar tower



pos

$P(A) = 1/8$

$P(B) = 1/360$

A = pos of object

B = sensor div

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

1. Set up initial bayes
2. Initial bel[i]
3. update w/ predictions