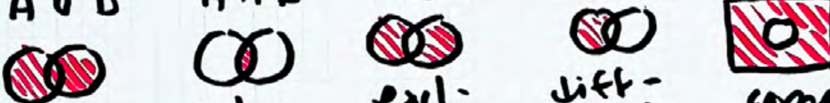
COGS 300 **control 04** Feb 5/26 ①

warm up: intersections, unions, etc.

A B

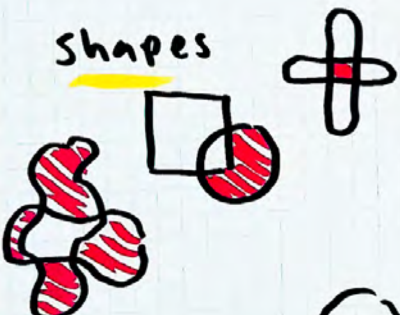
venn diagram

$A \cup B$ | $A \cap B$ | $A \triangle B$ | $A \setminus B$ | A^c

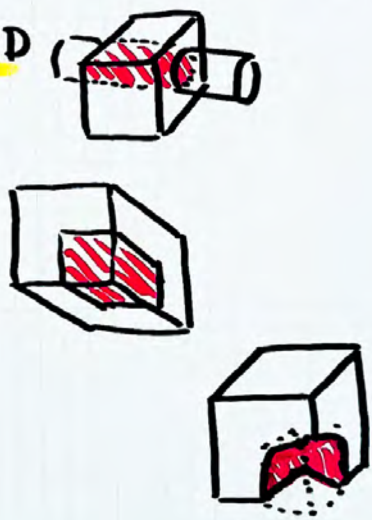


union | inter-section | excl-usion | diff-erence | compl-ement

shapes



3D



layers

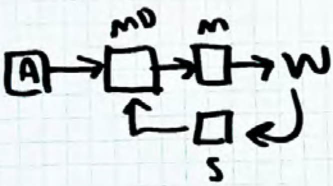
control vs. state

low-level

move vs. not

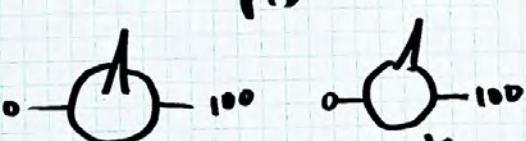
now fast

tight feedback loops



emergent

PID



knowledge

slower

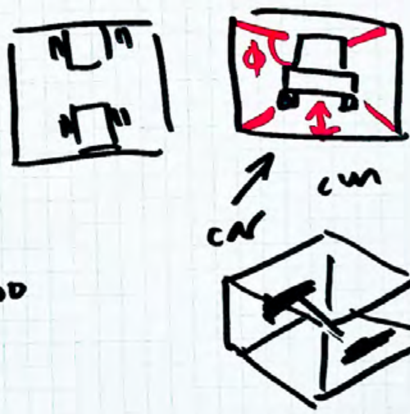
setting / commanding control

belief

models

probability

Tesla



probability is a **model** ← you decide what's in the model

blank   E

↑   ↑

down   up

2 states

$D=6$

$p(\bullet) = 1/6$ $p(\text{blank}) = 1/2$

$$\frac{\text{\# of things I care about} = 1}{\text{\# of outcomes} = 2}$$

$p(\text{even}) = 3/6 = 1/2$

1. $p(x)$ where x_i is unique
2. $p(x)$ where x_i is not unique

probability of independent events.

~~$P(E_1$~~ $p(E_1 \cap E_2)$?

$p(E)$

$p(\text{orange})$

$s_2, s_1 \in [0, 1023]$

→ N, O
N, E
G, O
G, E

1/4

$\overrightarrow{s_1}$ 0 1 2 3 .. 1023

s_2 ↓ 0 0,0
1
2
3
.
.
.
1023

$p(E) = \frac{1}{2}$

$p(O) = \frac{1}{3}$

$p(E) \cdot p(O) = \frac{1}{6}$

$p(s_1 = 1023, s_2 = 1023)$?

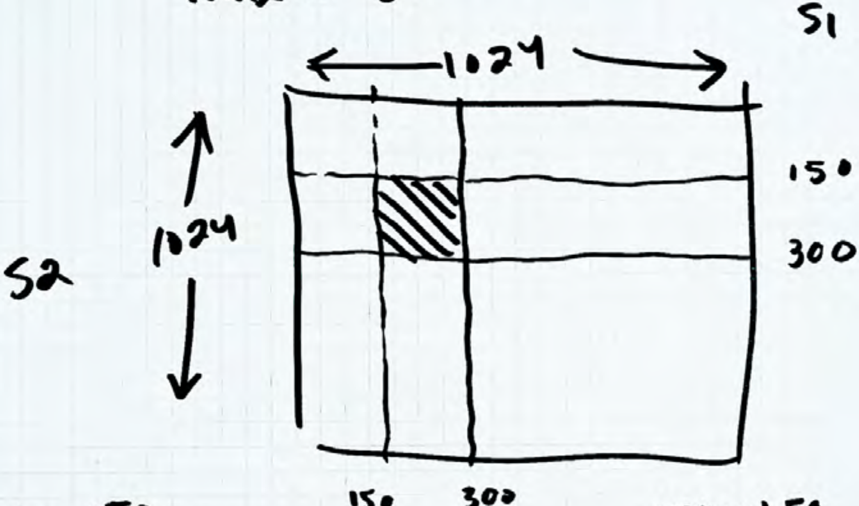
$\frac{1}{1024 \times 1024}$

given same calibration, express $p(w)$

given some calibration

min = 150
max = 300

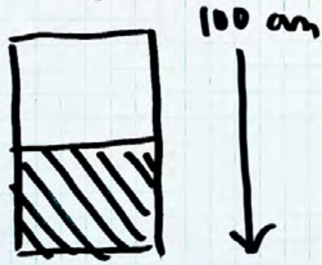
max − min = 150



$p(s_1 < 50,$
$s_2 < 500)$
?

150

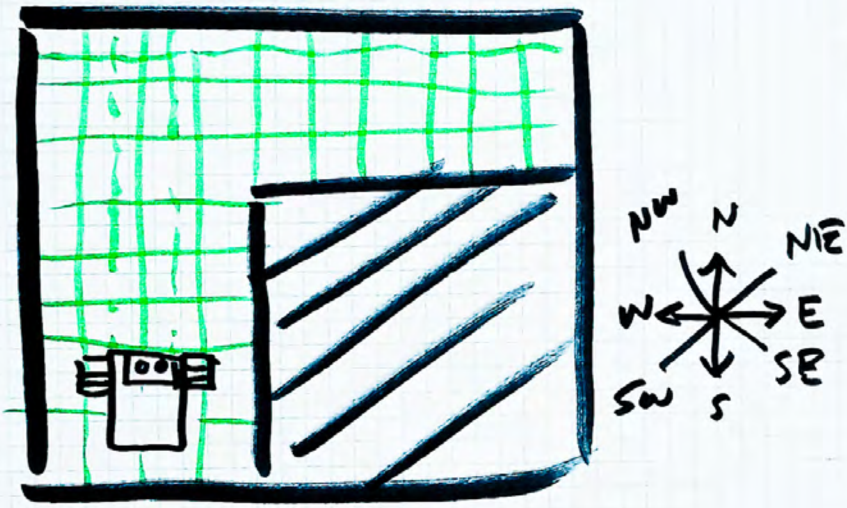
$\frac{150 \times 150}{1024 \times 1024}$



$s_1 = [0, 100]$
$s_2 = [0, 1023]$

joint event probability

$p(s_1 < 50 \mid s_2 > 500) = 1$

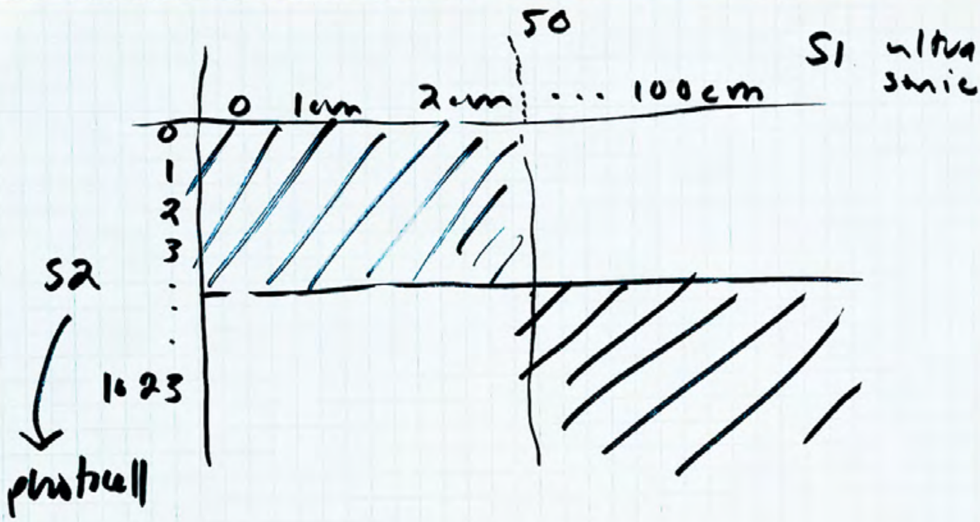


x, y position

$p(x, y, \phi)$?

ϕ orientation

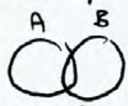
1. Discretize
2. count x, y, ϕ



50
S1 ultra sonic
0 1cm 2cm ... 100cm
0
1
2
3
S2
1023
photocell

control 04

Warm up: Intersections.



standard venn

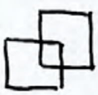
$A \cup B$ $A \cap B$ $A \Delta B$

union intersection exclusion difference $A \setminus B$

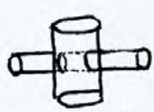
A^c

complement

operations.



other shapes.

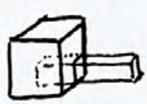


layers

↑ which ops?

$(A \Delta B) \cup$
$(C \cap B) \cup$
$(A \setminus C)$

3D.

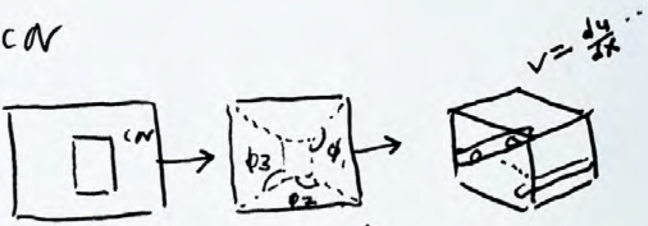


build on simple shapes.

When is something a control problem vs. a state problem?

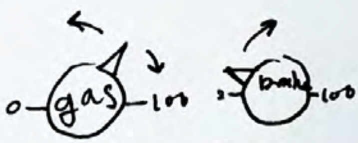
↳ tight feedback vs. "knowing"

Tesla car



no!

stop zone. → ul maybe.



PID → maintain 25 m.

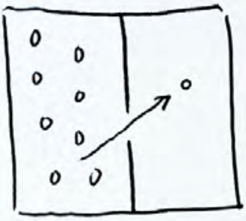
zoom into hand:

still is actually shaky

↳ PID.

cells regulate without "knowledge" through emergent processes.

Diffusion



emergent regulatory process w/o knowledge.

If we want to make decisions about unknowns, we need probability.

probability is a model not an ontological statement

H or T on coin is a highly constrained model.

It sounds silly, but truly! I could steal the coin, etc.

In robotics, most of the things that happen, we can't predict. Instead, we control environments + actions.

You will not be able to come up with if-then statements for every possible scenario.

Simple counting:

H or T

outcomes = {H, T}

$$p(H) = \frac{1}{2} = \frac{\# H}{\# \text{outcomes}}.$$

☆ using your tiles, figure out

1. p(x) where x_i is unique.
2. p(x) where duplicates allowed.

Next, union.

A or B. ?

If you only have 1 pick,

$$p(A \text{ or } B) = p(A \cup B) = p(A) + p(B)$$

$$= \frac{(\# \text{ of } A) + (\# \text{ of } B)}{\text{total}}$$

Two picks: Harder! Replacement:

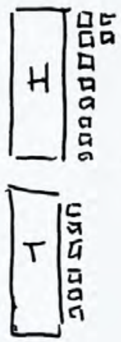
unique events (set)

2 colours = AA
AB BA
BB

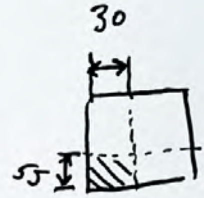
Independent(ish) events.

$p(H) = \frac{1}{2}$ $\quad p(A) = \frac{10}{16}$

$p(H \cap A) = \frac{1}{2} \cdot \frac{10}{16}$



spatial muting.



$s_1, s_2 \in [0, 255]$

Robot: $\quad s_1 \times s_2$

	0	1	2	3	...	255
0	0,0	1,0	2,0	3,0	...	
1	0,1	⋱				
2	0,2					
3	0,3					
⋮						
255						

Line following

and / $\cap$

★ $p(s_1 = 30 \cap s_2 = 255)$

$= \frac{1}{255 \times 255}$

$\frac{30 \times 55}{255}$

★ $p(s_1 < 30 \cap s_2 \geq 200)$?

☆ model line following.

states.

p(on line)

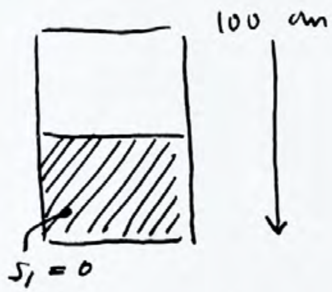
p(left of line)

⋮

2 sensors only.

sensor readings / ranges.

combine diff. sensors.



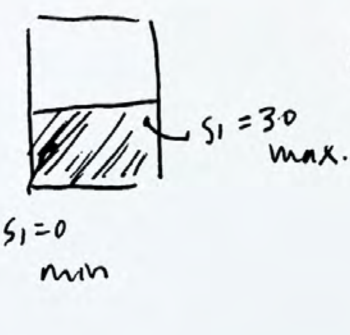
s_1 = photocell

s_2 = ultrasonic

$s_2 \in [0, 100]$

$s_1 \in [0, 255]$

☆ $p(s_2 \geq 50 \mid s_1 = 0)$?



$p(s_2 \geq 80 \mid s_1 < 30)$?

if time: model position
given sensor