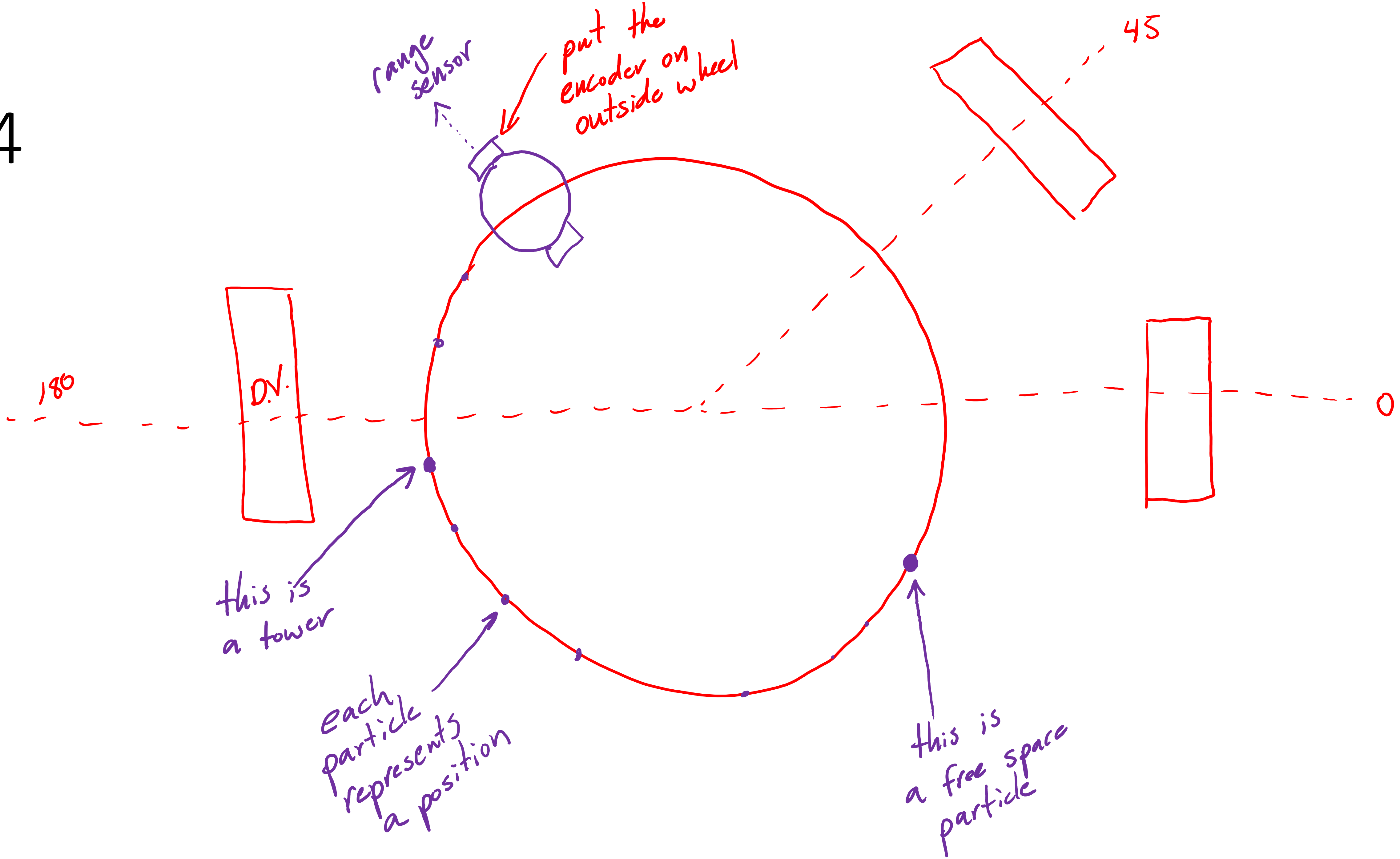
Lab 4


range sensor
put the encoder on outside wheel
45
180
D.V.
0
this is a tower
each particle represents a position
this is a free space particle

- Midterm Friday (50 min)
  - Bring laptop (Canvas quiz)
  - calculator

~~Example~~

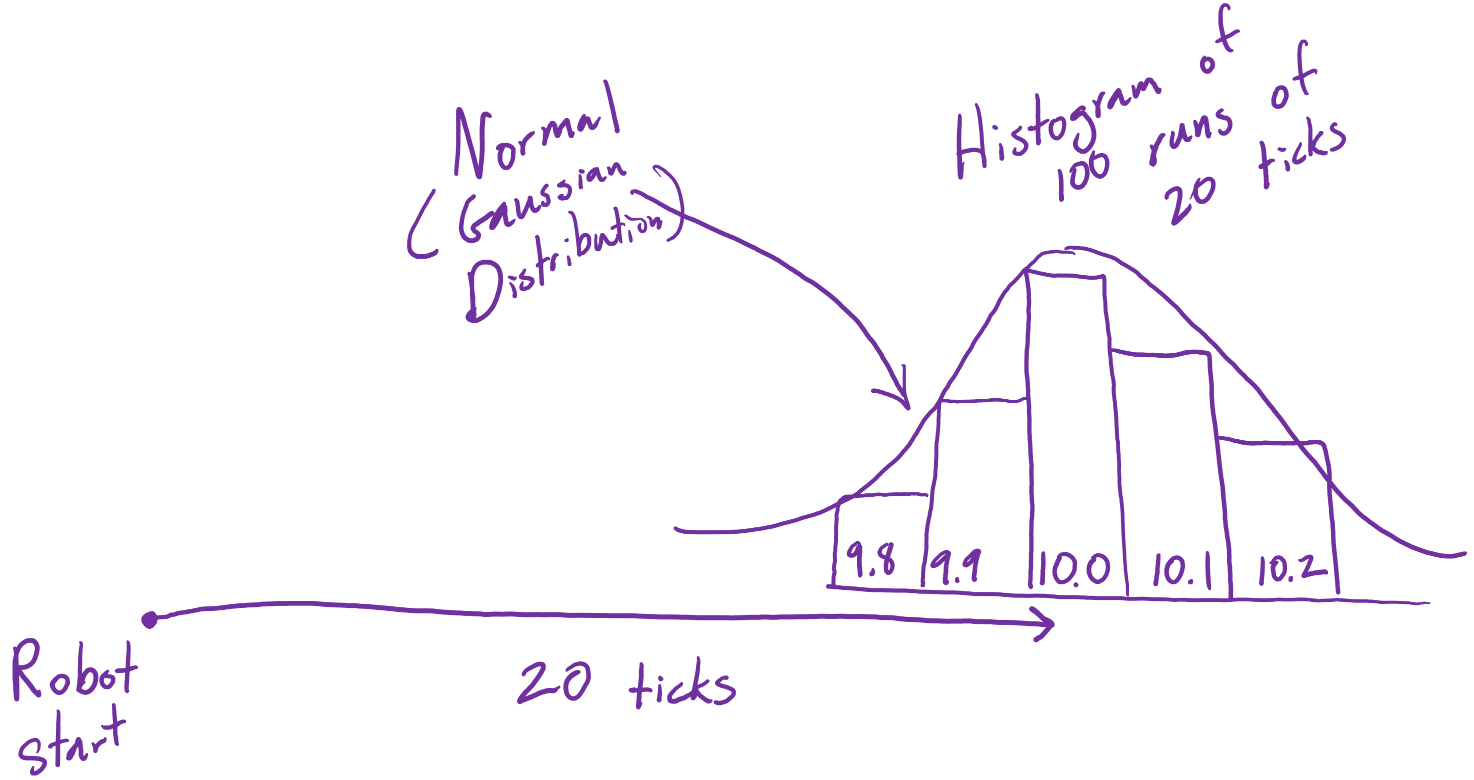
Noise:

1. sensor noise

2. motion noise

Motion Model

Add encoder to the wheels

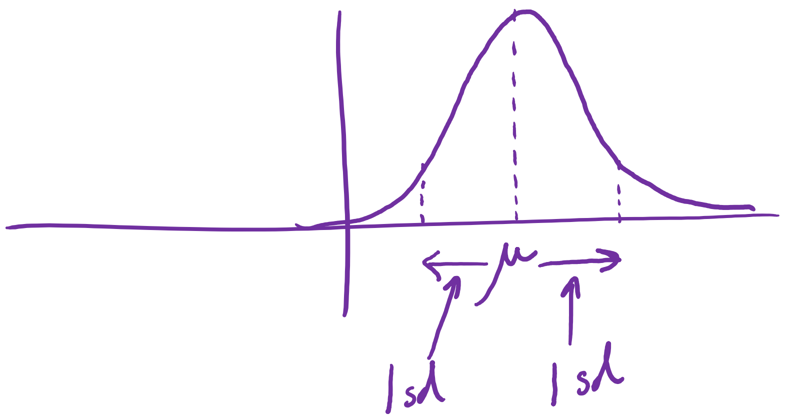


Gaussian Distributions

- Defined by 2 parameters:

μ = mean

σ = standard deviation



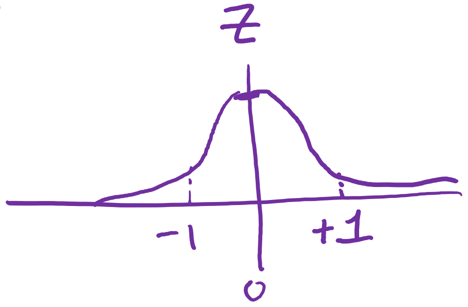
Sampling from a Gaussian Distribution

Box - Muller Transform:

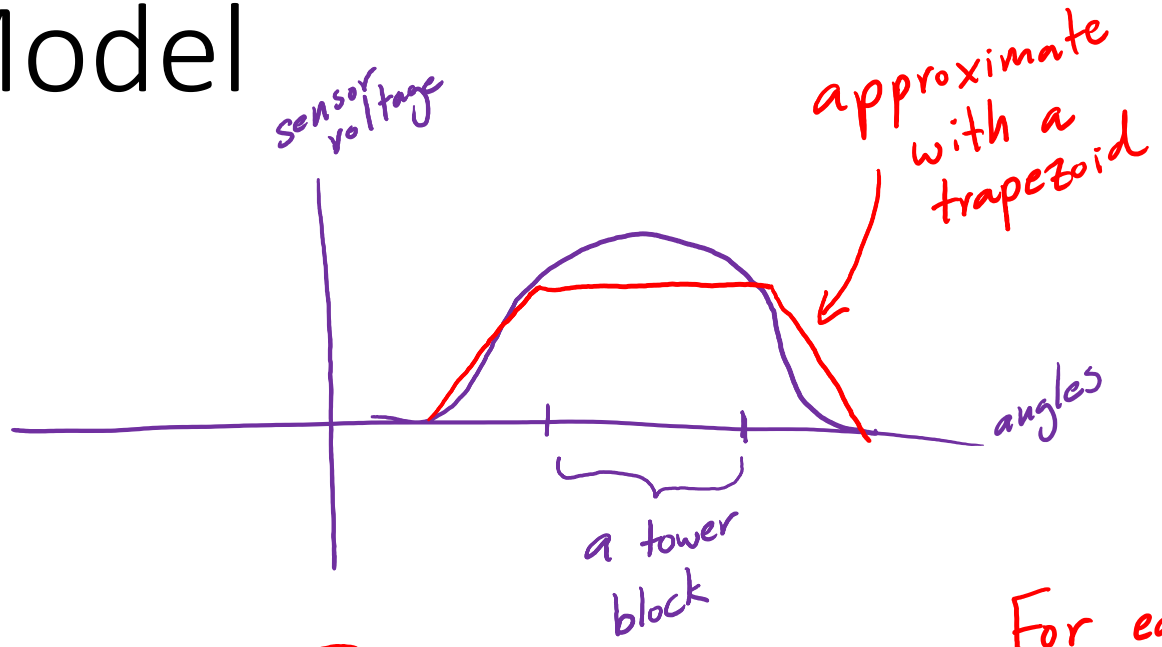
1. generate 2 random numbers between 0 and 1 (call these numbers U_1 and U_2)

Z has a mean of 0 and s.d. of 1

$$Z = \sqrt{-2 \cdot \ln(U_1)} \cdot \cos(2\pi \cdot U_2)$$



Sensor Model



Note: without taking any sensor reading you know if a particle is near a tower or not

For each particle, we need to compute a weight (likelihood):

$p(z | x)$ = probability of getting a sensor reading Z given that the robot is at position X

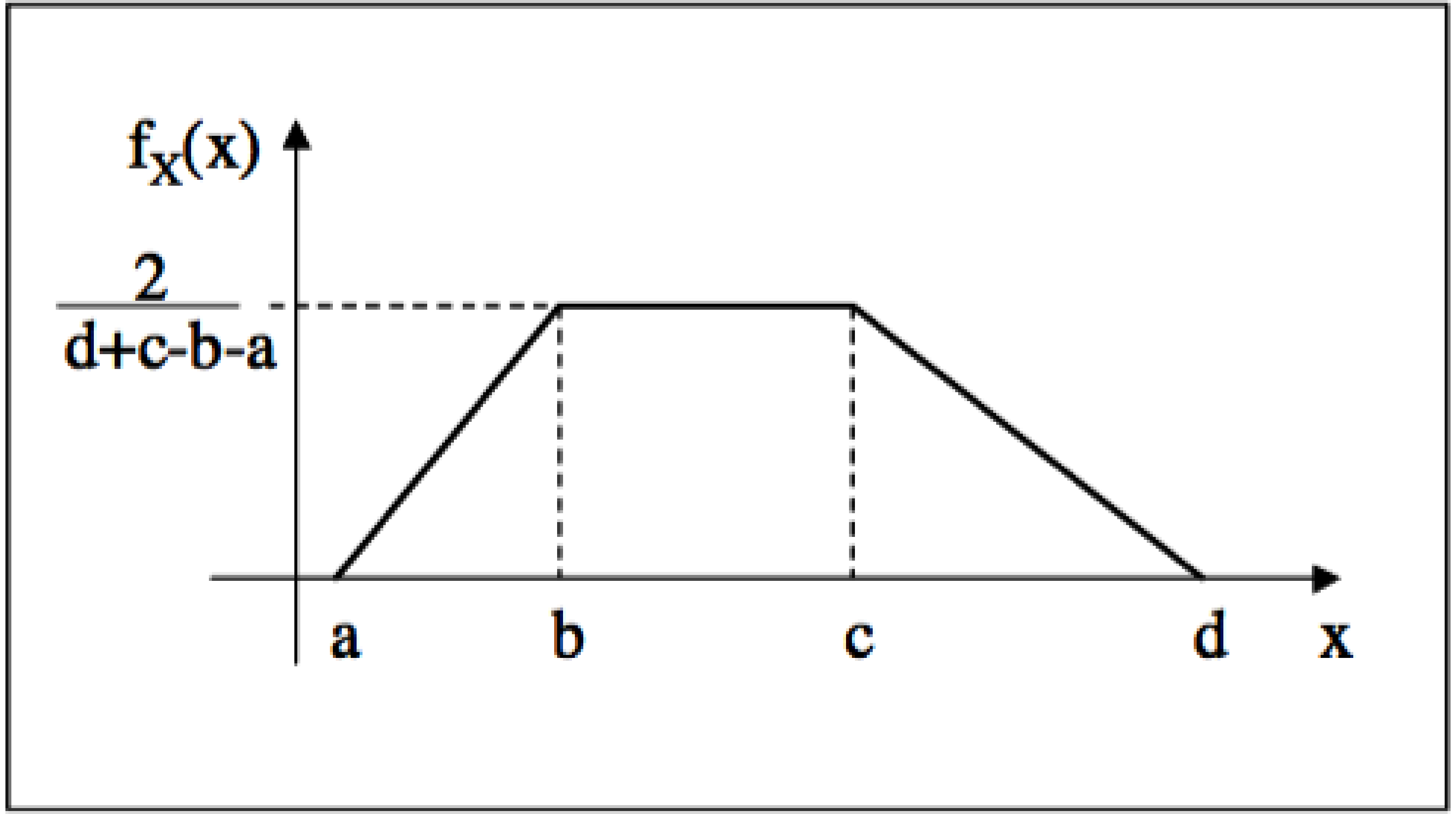


Figure 1. Probability Density Function of a Trapezoidal Distribution

$$U = \frac{2}{d+c-b-a}$$

if $b \le x < c \rightarrow U$

if $a \le x < b \rightarrow U \cdot \left(\frac{x-a}{b-a}\right)$

if $c \le x < d \rightarrow U \cdot \left(\frac{d-x}{d-c}\right)$

these give you a weight →

$$\boxed{\begin{array}{l} p(z \mid \text{free space}) \\ p(z \mid \text{tower}) \end{array}}$$

← create these 2 functions

Resampling Particles

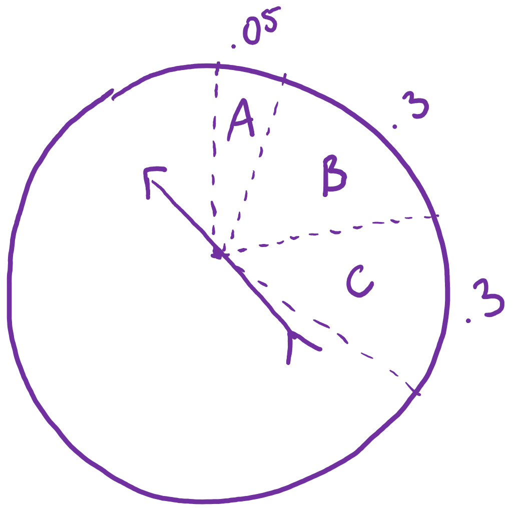
- Suppose 100 particles

	Particle #	Weight
A	1	.05
B	2	.3
C	3	.3
D	4	.05
E	5	.3
F	6	.05
G	7	.3
	⋮	

normalize so they sum to 1.0

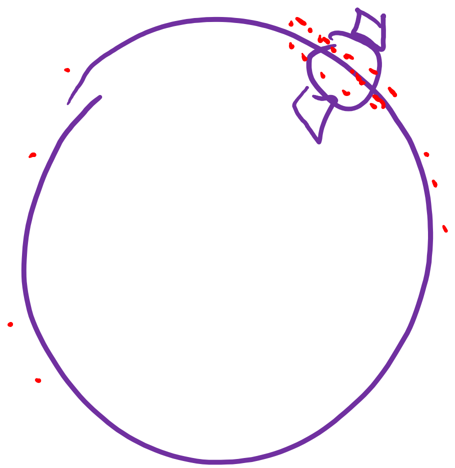
Resample to get 100 new particles

B
B
C
C
E
E
E
A



- throw in 5% random particles

Determining Robot Position



- as your robot drives, compute the standard deviation of the particles
- once the standard deviation is below a threshold, use the mean as the robot location

Monte Carlo Localization

knowing where your robot is

- Generate n particles

- take 1 sensor reading

- For each particle:
  - advance the particle (and add noise)
  - categorize the particles as: tower / free space
  - compute the weight of each particle
- Resample the particles