



U8.5 Ray casting the map

Mapping · University · about 35 min

Name _____

Class _____

Date _____

What this lesson is about

The forward model: given a map and a pose, what would the sensor read?

- Why it matters
- The cost, and what everybody does about it
- Doing it
- Unknown is not occupied

Questions

6 marks in all

1. What does this program print?

[1 mark]

```
CELL = 5.0
occupied_row = 6
y = 2.0
r = 0.0
while int((y + r) / CELL) < occupied_row:
    r += 1.0
surface = 33.0
print(r, surface - y)
```

2. A ray caster's predictions are consistently a few centimetres shorter than the real readings. Why?

[1 mark]

- ☐ A It stops on entering an occupied cell, so it reports the near edge of the cell rather than the surface inside it
- ☐ B The sensor adds a constant offset to every reading
- ☐ C The steps of 1 cm skip past thin walls
- ☐ D Unknown cells are being treated as blocked

3. A particle filter has 300 particles and uses 2 beams each, at 10 Hz, and each ray cast marches 150 steps. [1 mark]
How many grid lookups is that per second?

4. What does a likelihood field precompute, and what does it save?

[1 mark]

- ☐ A The distance from every cell to the nearest occupied cell, so scoring a beam is one lookup at its end point instead of a march
- ☐ B The ray cast from every cell in every direction, so no casting is needed at run time
- ☐ C The log odds of every cell, so the grid need not be stored
- ☐ D The frontier cells, so exploration is faster

5. A planner uses a ray cast to ask whether a straight route is safe. How should that caster treat unknown cells? [1 mark]
- ☐ A As blocked, so the robot never drives into a place it has not looked at
 - ☐ B As free, so it is only scored on evidence it has
 - ☐ C As occupied only if they are next to a known wall
 - ☐ D It makes no difference to the answer
6. Why can using two of the eight beams improve the estimate as well as the speed? [1 mark]
- ☐ A Neighbouring beams are correlated, and treating eight near-identical beams as independent makes the filter overconfident
 - ☐ B The outer beams are always less accurate than the inner ones
 - ☐ C Fewer beams mean less half-cell bias
 - ☐ D The weights underflow when more than two are multiplied

The task: predict a reading from the map

Standing at (100, 50), build a map from the scans. Then ray cast from a pose 20 cm behind the robot and print predicted: . Drive back 20 cm, measure, and print measured: and error: .

```
from bugbot import *
import math
connect()

CELL, W = 5.0, 40
L_OCC, L_FREE, L_MAX, FAR = 0.85, -0.4, 8.0, 170.0
START_X, START_Y = 100.0, 50.0
grid = [0.0] * (W * W)
```

Plan your program here, then type it in and press Run.



Do it on the robot

www.bugbotlab.com/learn/u8-5-ray-casting/

The simulator checks it and tells you when it passes. Nothing to install, no account.

Challenges

1. Cast rays at the eight angles `scan()` uses and compare the whole predicted fan with the real one.
2. Add a mode that treats unknown cells as blocked and see how much shorter the predictions get.
3. Time 1,000 casts. How many particles could you afford at 10 Hz?

