Unknown environment

Environment is one of several
Let \( E = \{ e_1, e_2, \ldots, e_n \} \)
\[ X = \mathbb{Z} \times \mathbb{Z} \times D \times E \]

Here, \( X(\tau k) \) gives set of possible positions, directions, environments

Move while reducing the size of \( X(\tau k) \)

Cannot distinguish between translated or rotated copies of the "same" environment

\[
\begin{array}{c|c}
\downarrow & \leftarrow \\
\hline
\uparrow & \rightarrow \\
\end{array}
\] (no compass)
We can even let $E$ be infinite.

Example: $E$ is the set of all finite, connected sets of white tiles.

Problem: Mapping and localization at the same time (SLAM).

Let $\text{Maps} = \text{Pow}(\mathbb{Z} \times \mathbb{Z} \times D \times E)$

Represent a set in $\text{Maps}$ by recording the current local configuration, and the "status" of each tile in $\mathbb{Z} \times \mathbb{Z}$.

- white $\rightarrow$ name then
- black $\rightarrow$ name then
- unknown

$(0, 0, N)$
Some state space
\[ X = \mathbb{Z} \times \mathbb{Z} \times D \times E \]

Different task (Blum, Kozen, 1978)

There may be a treasure on one of the white tiles.

Additional sensor: Binary treasure detector.

Need to visit every tile

Systematic search:
- Spiralizing outward
- Breadth first
- Depth first

- Takes time and space linear in number of white tiles

\[ O(n) \quad n = \# \text{ of white tiles} \]

Can we solve the problem with less space?
Make a derived F-space that keeps track of

1) lattice - # of tiles in the local N direction (O(lgn) bits)
2) orientation (local) (2 bits)

Sec. 12.3.1
Localization in a Given Polygon

**Sensors:** Compass - no orientation problems

Visibility - perfect depth mapping \( \Rightarrow y: S' \rightarrow [0, \infty) \)

Sensor

\( X = \mathbb{R}^2 \)

Inside of each region, the set of visible edges (partial or full) remains the same.

Divide environment into convex regions

Ilcinkas TCS?
H(y) = 4 possible positions

Χ(??)?