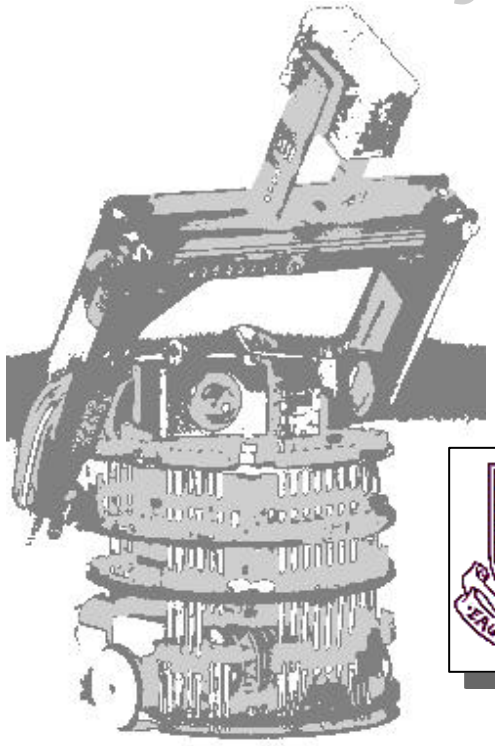
Autonomous construction of maps by miniature robots



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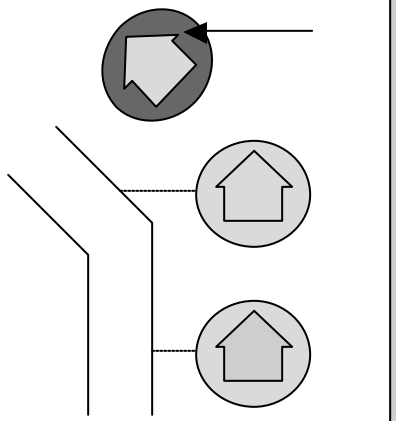
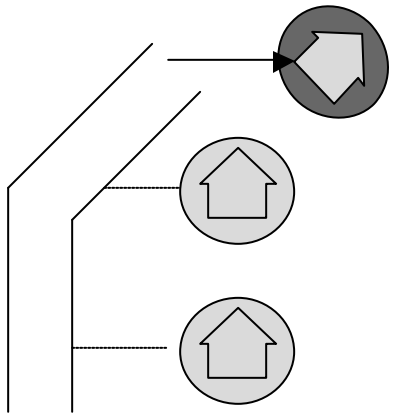
To follow a boundary :-

- Move forward continuously
- Turn left if boundary gets further away
- Turn right if boundary gets closer

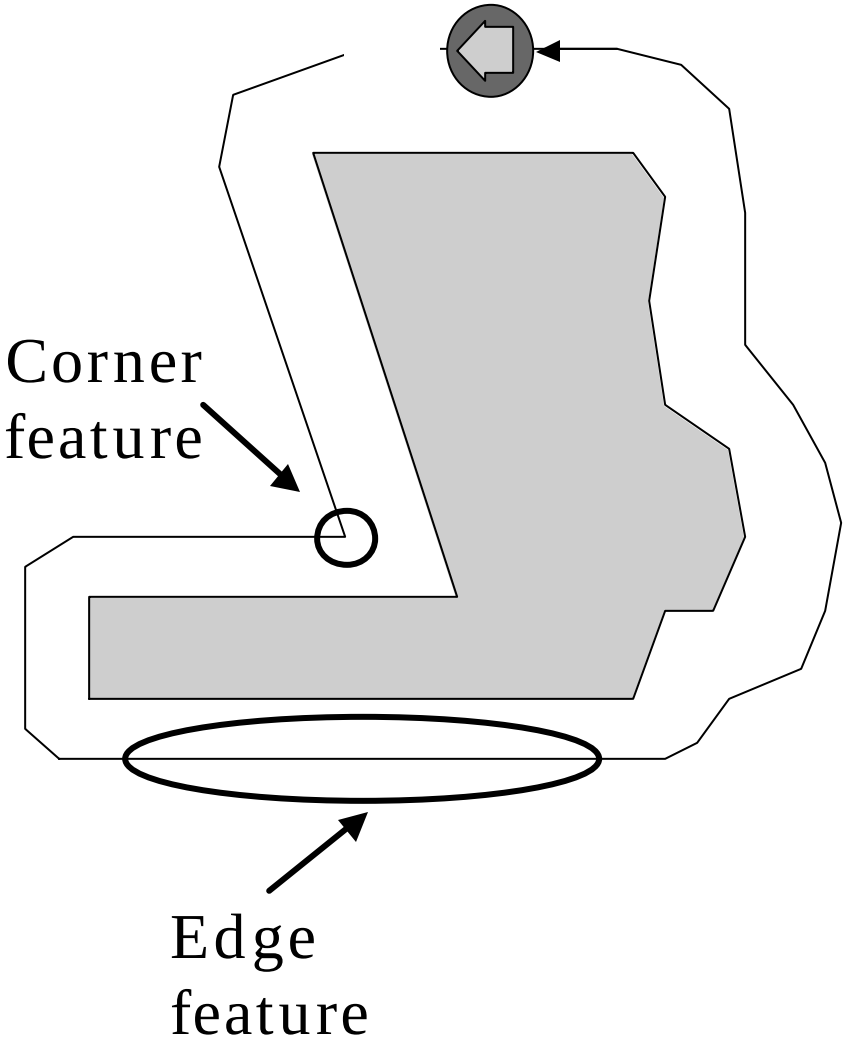
Move left



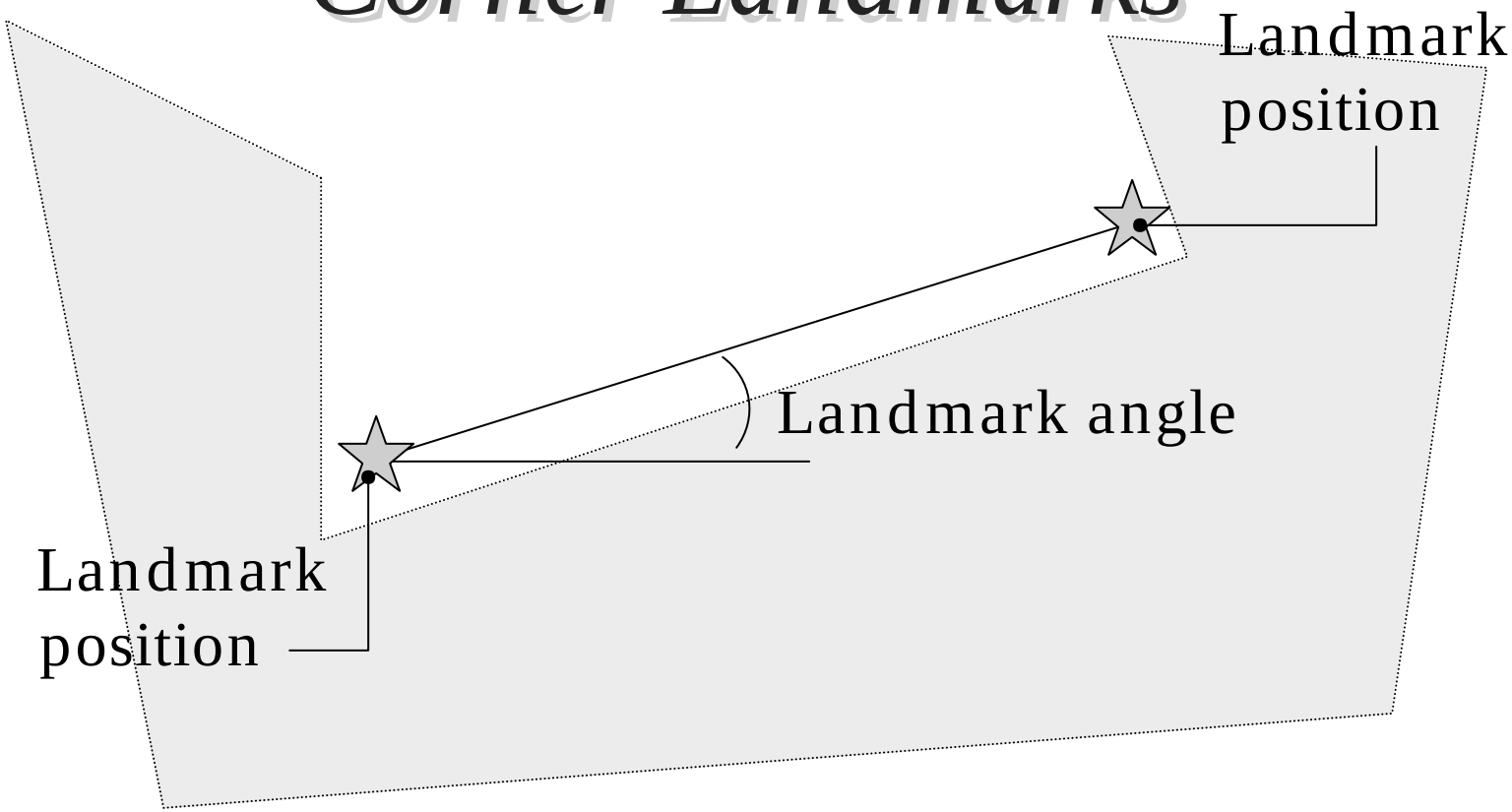
Move right



Robot's path traces the outline of the boundary

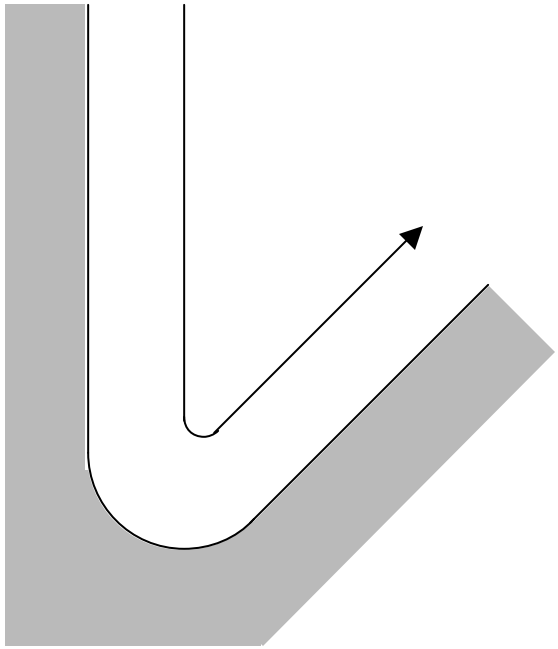


Corner Landmarks



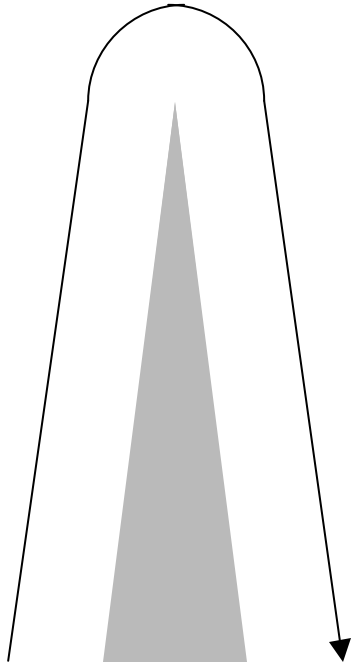
- Location of corners used to correct robot's position estimate
- Angle between pairs of corners allow corrections to direction estimate

Concave corner



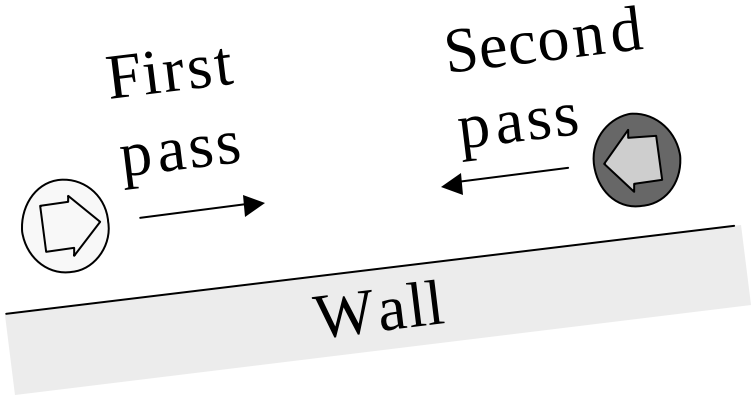
Robot turns more sharply than the curve itself, giving a well-defined landmark.

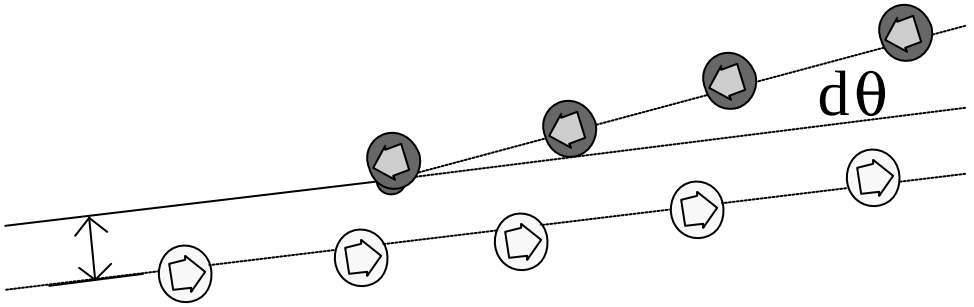
Convex corner

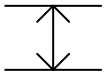


Robot cannot turn an arc with a radius less than the robot itself.

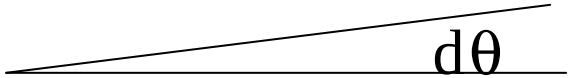
Straight-Edge Landmarks





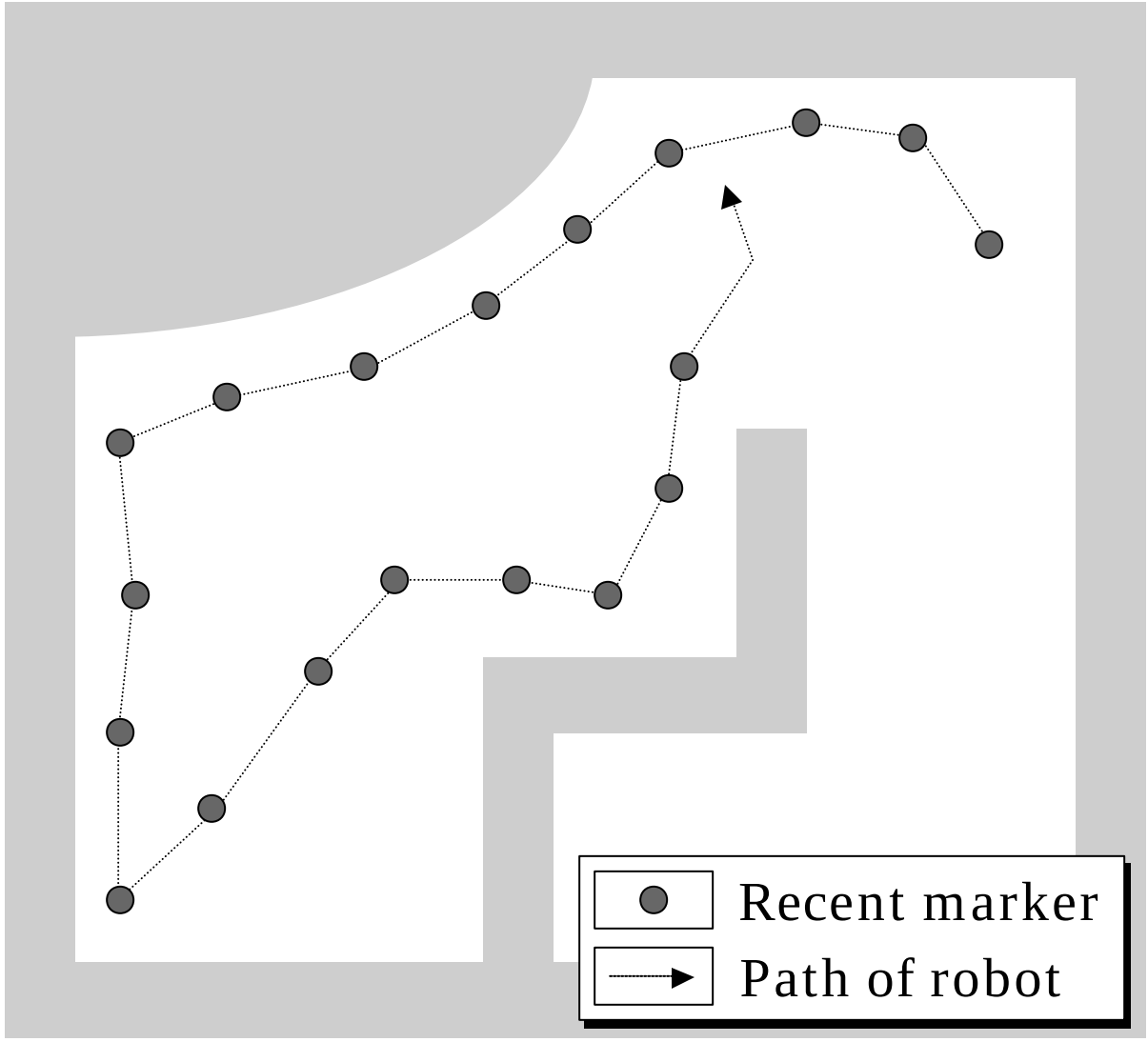


➪ Correction suggested by apparent edge position

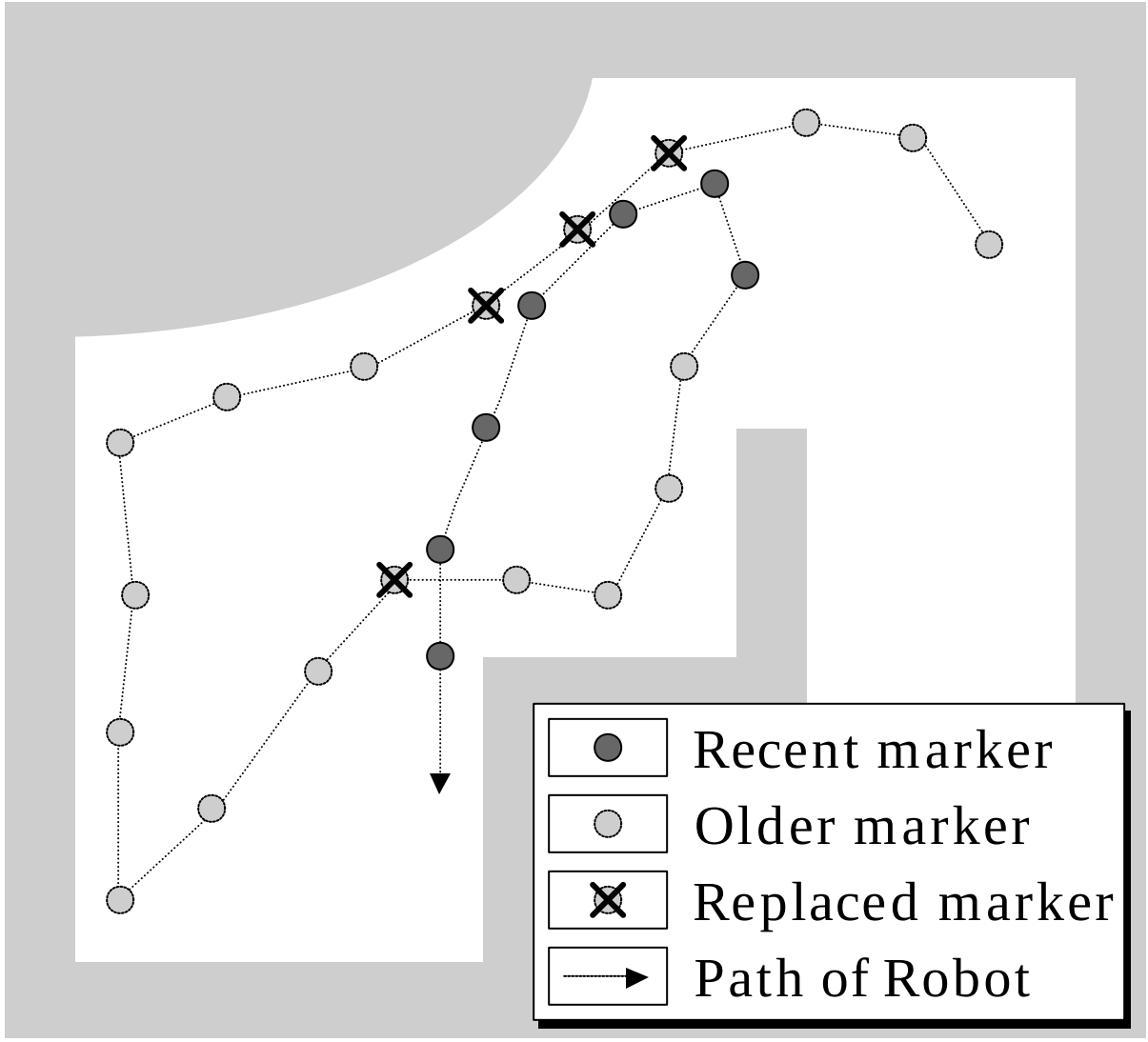


➪ Correction suggested by apparent direction of the edge

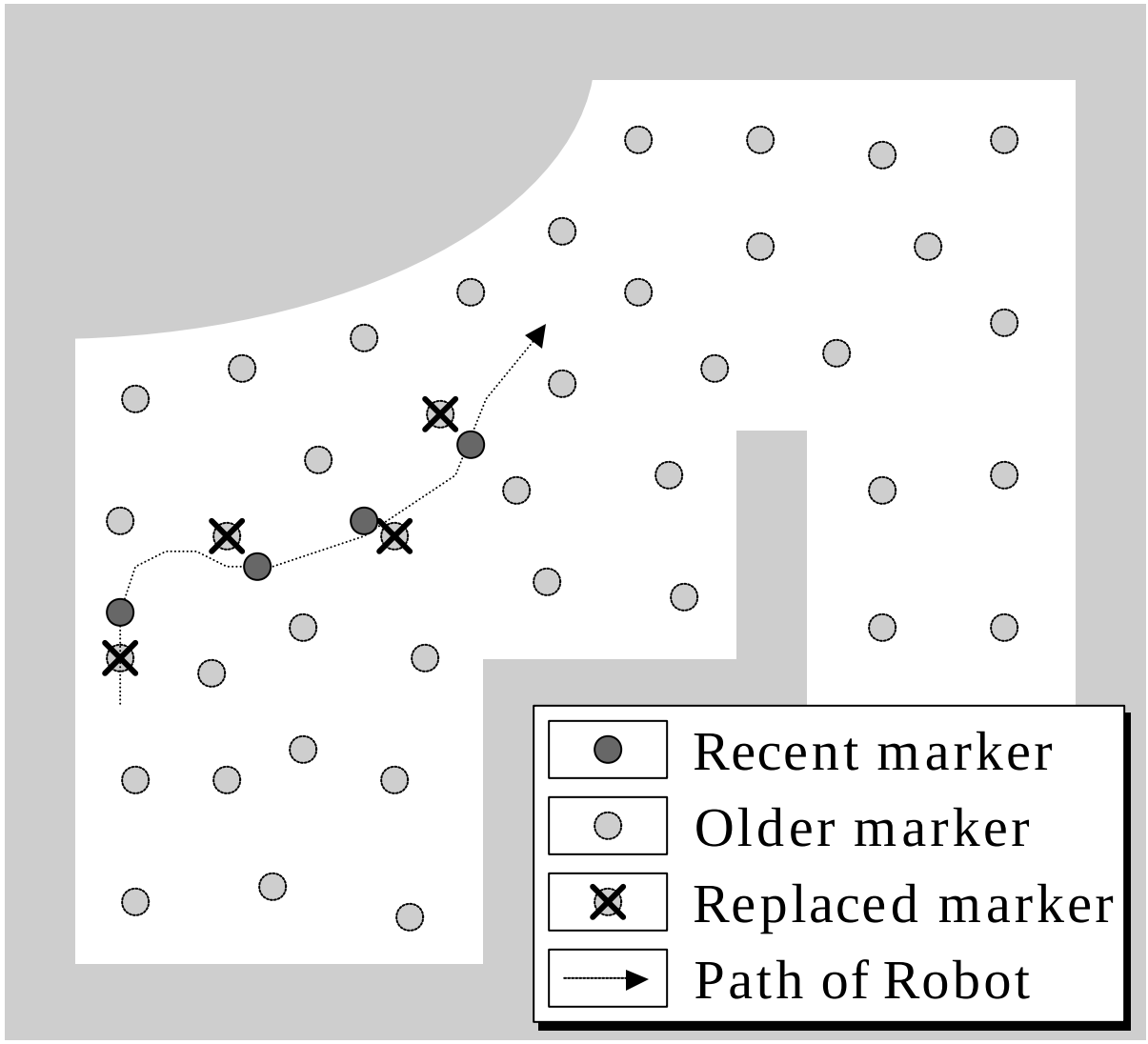
“Marker” representation scheme



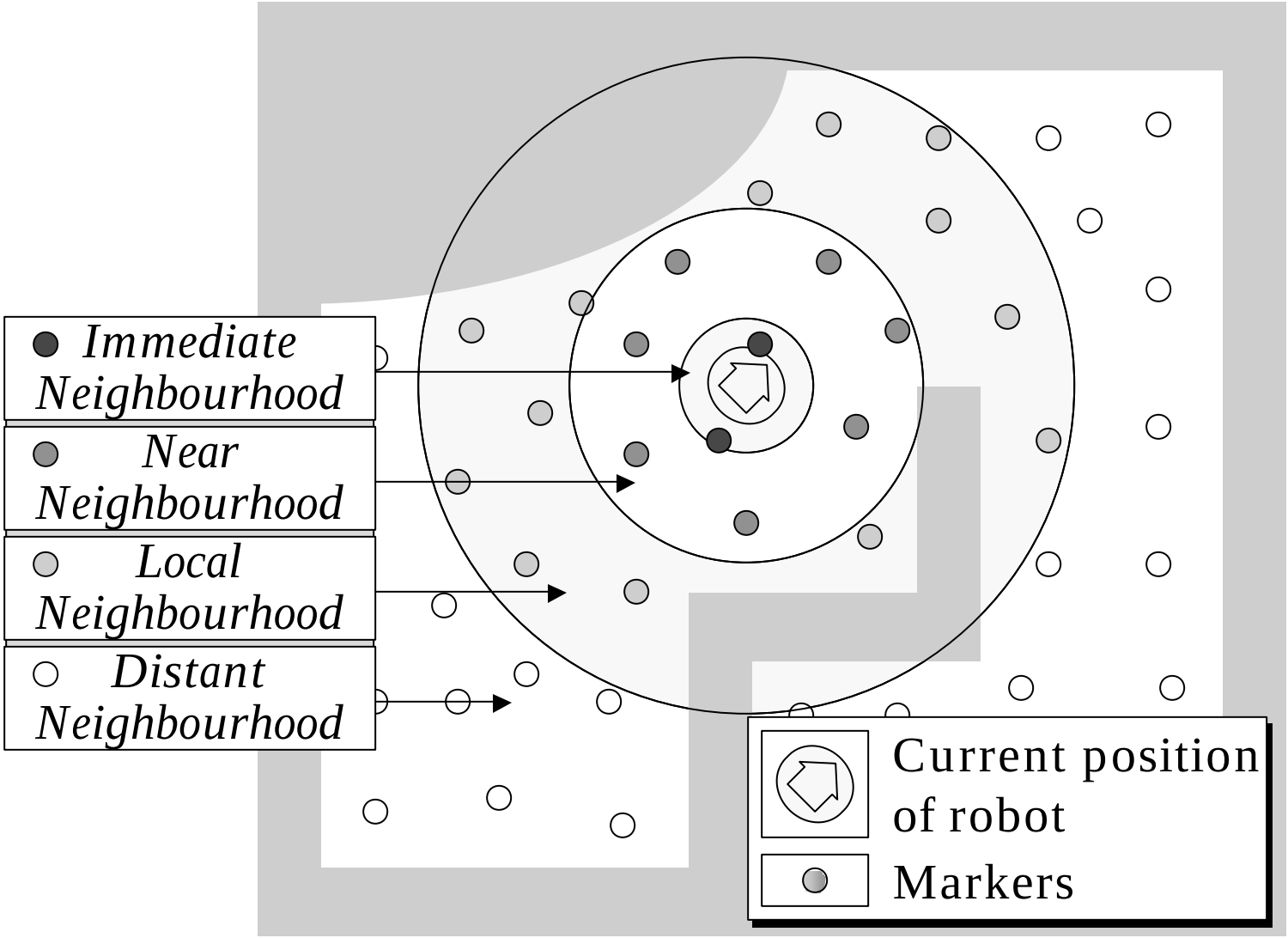
Updating markers

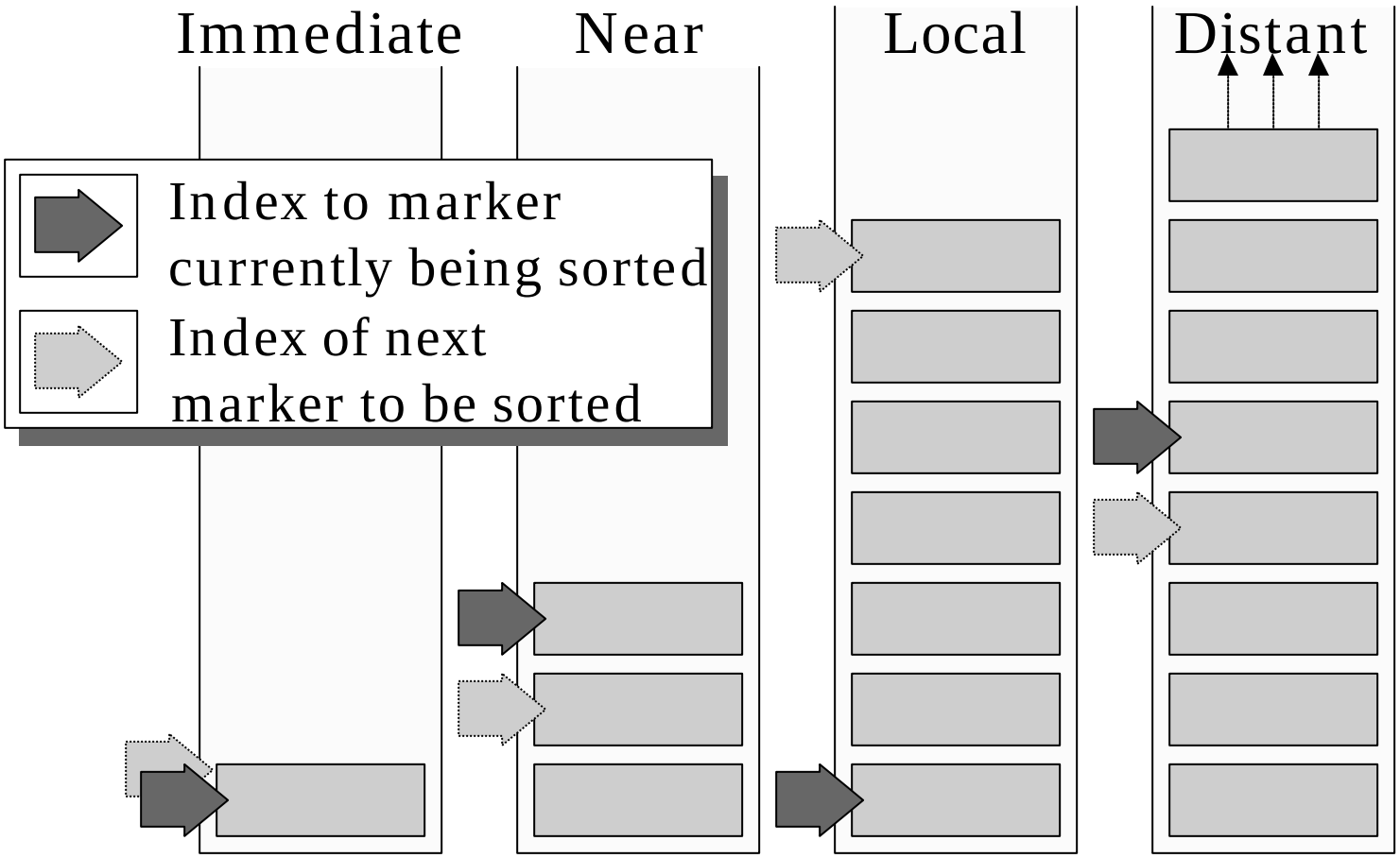


Map = collection of markers



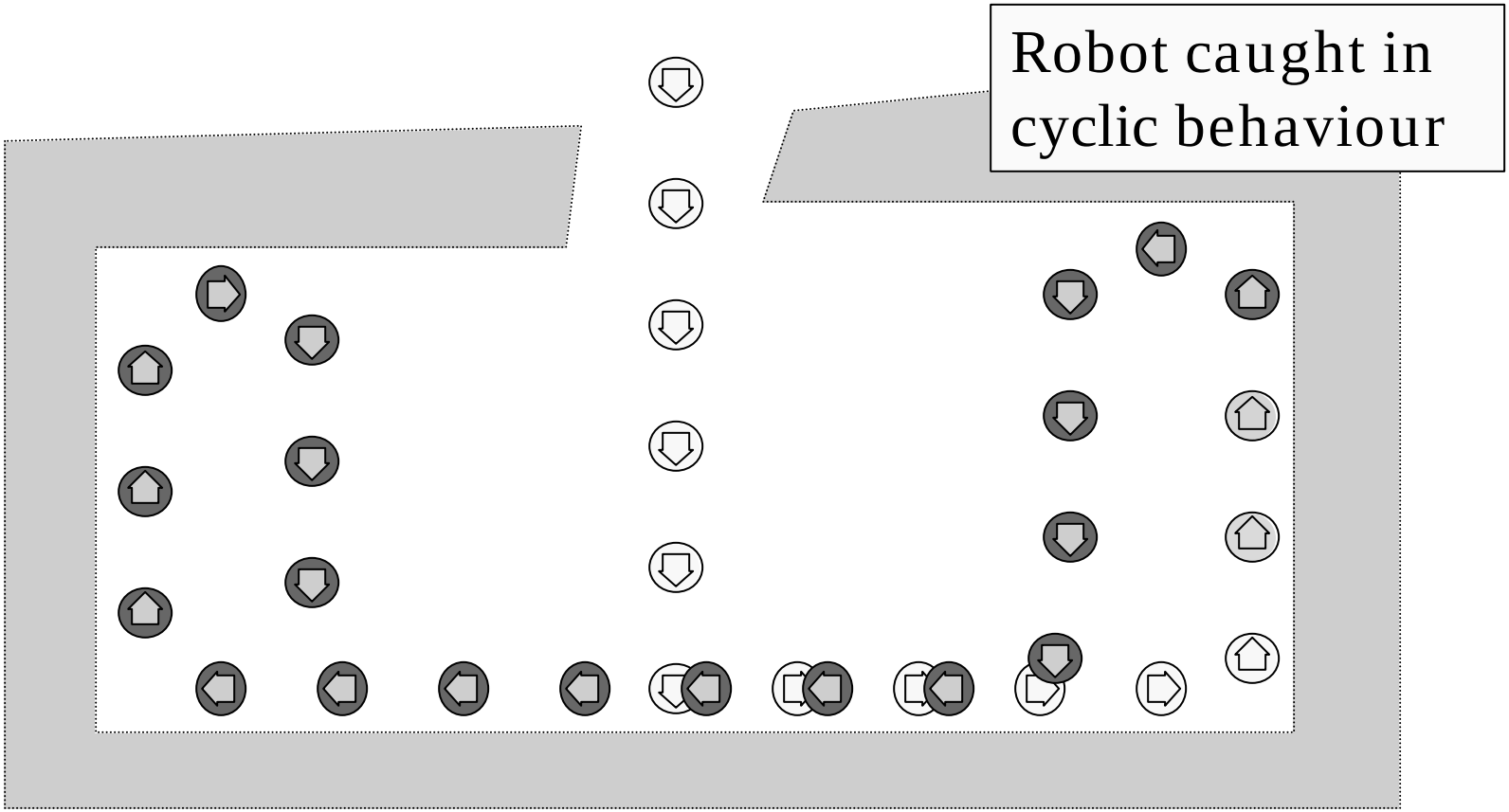
Neighbourhoods





In each cycle of the sorting process, one marker from each neighbourhood is examined and moved to another neighbourhood if appropriate.

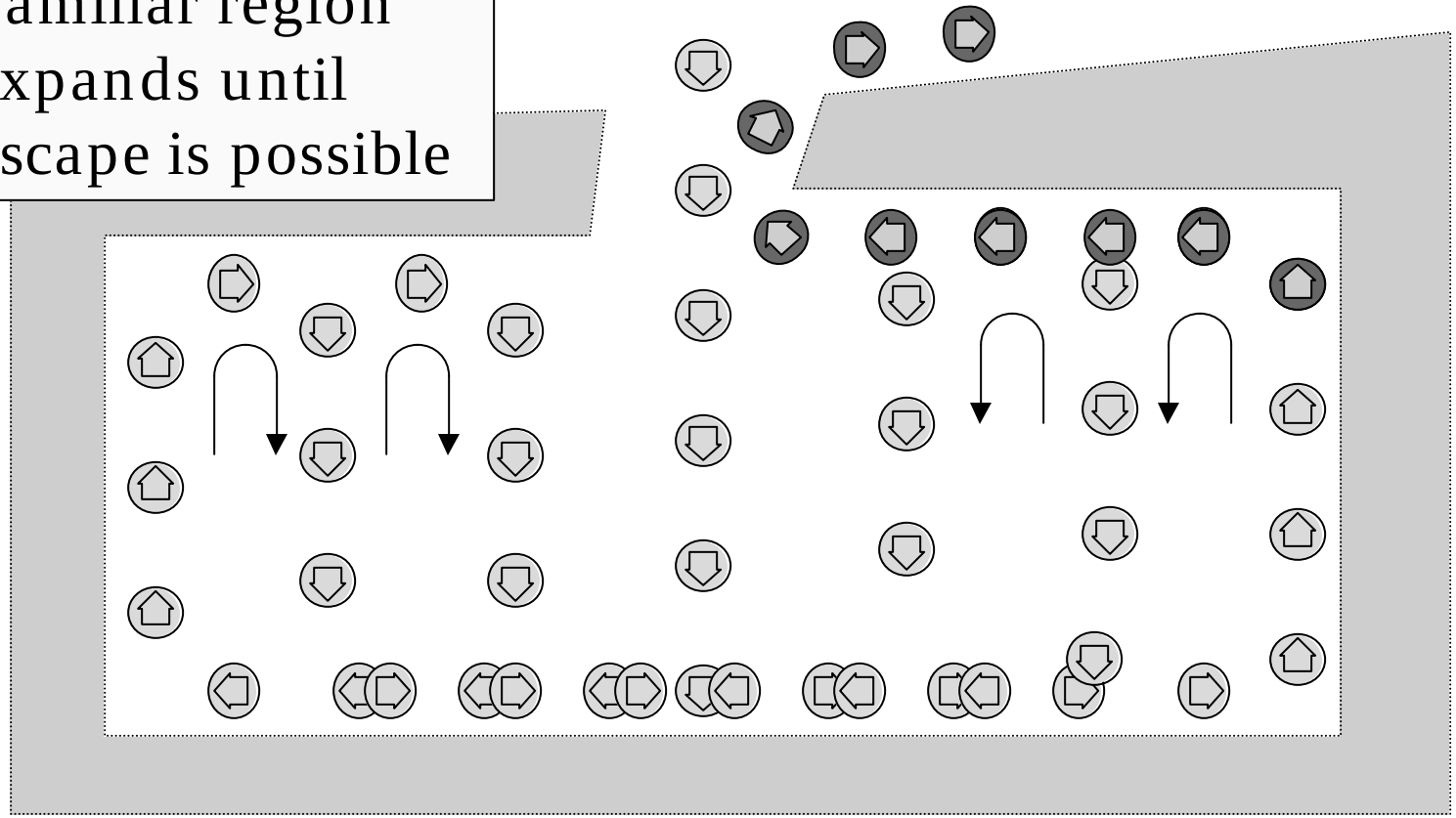
Cyclic behaviour



Robot shown trapped by an awkwardly shaped obstacle.

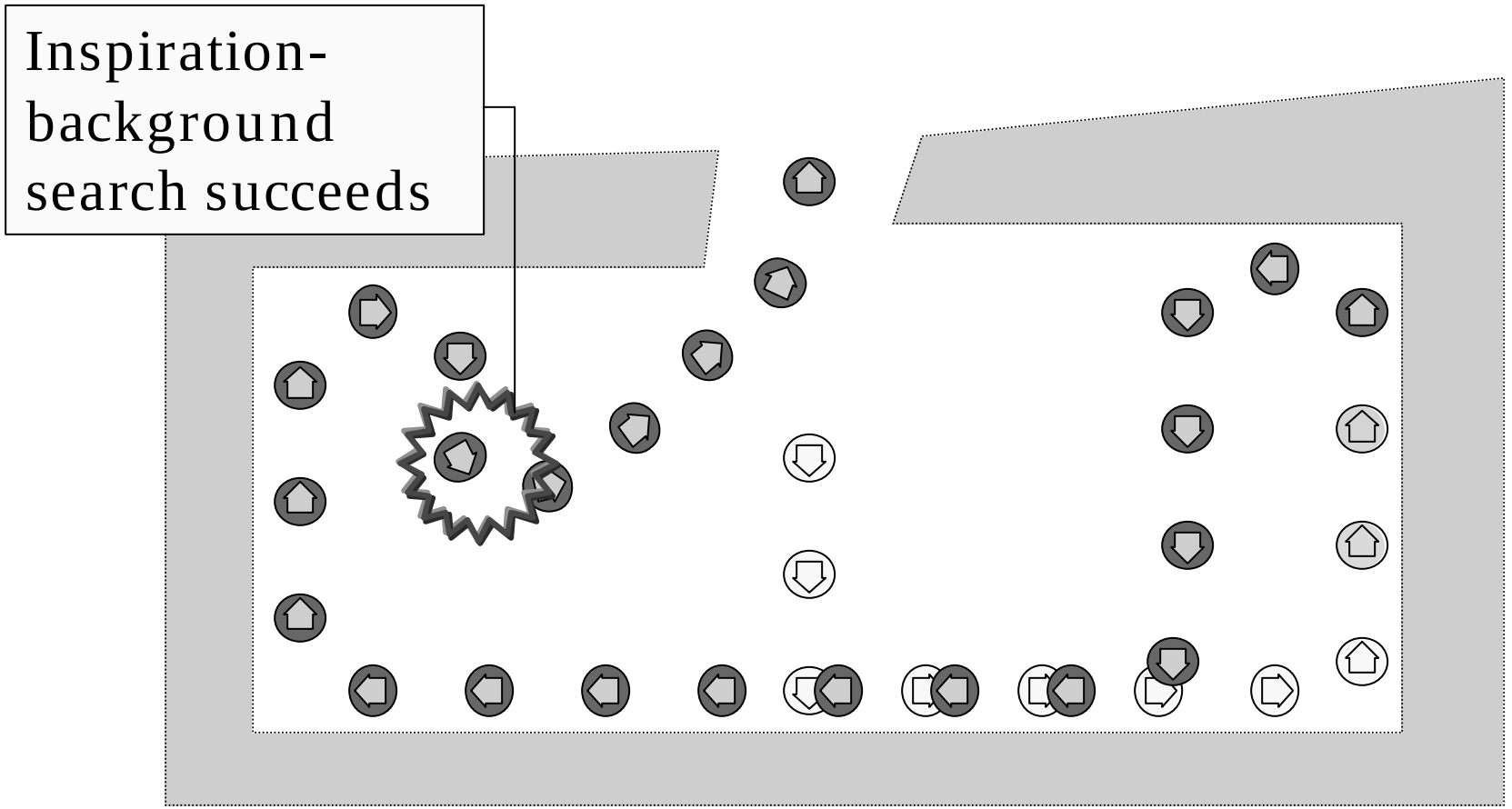
Use of familiarity

Familiar region expands until escape is possible



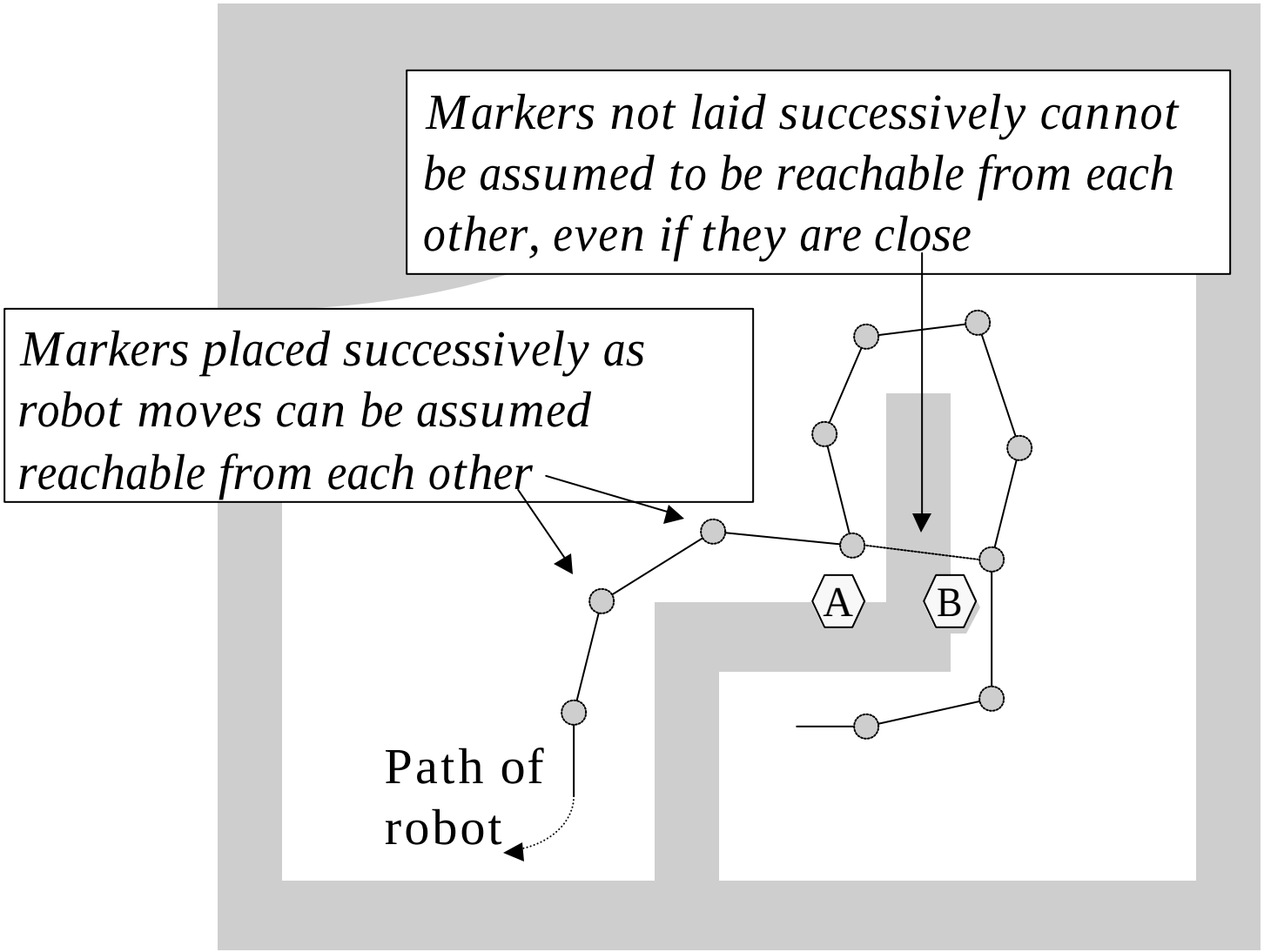
Robot uses “familiarity” sensor to escape from trap.

Use of background search



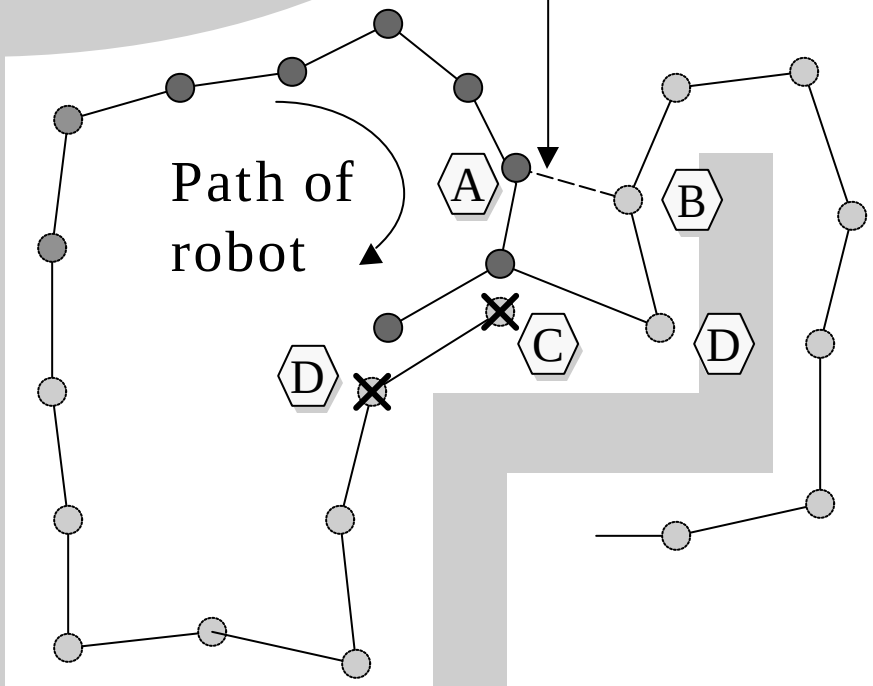
Use of familiarity can be combined with conventional search

Connectivity

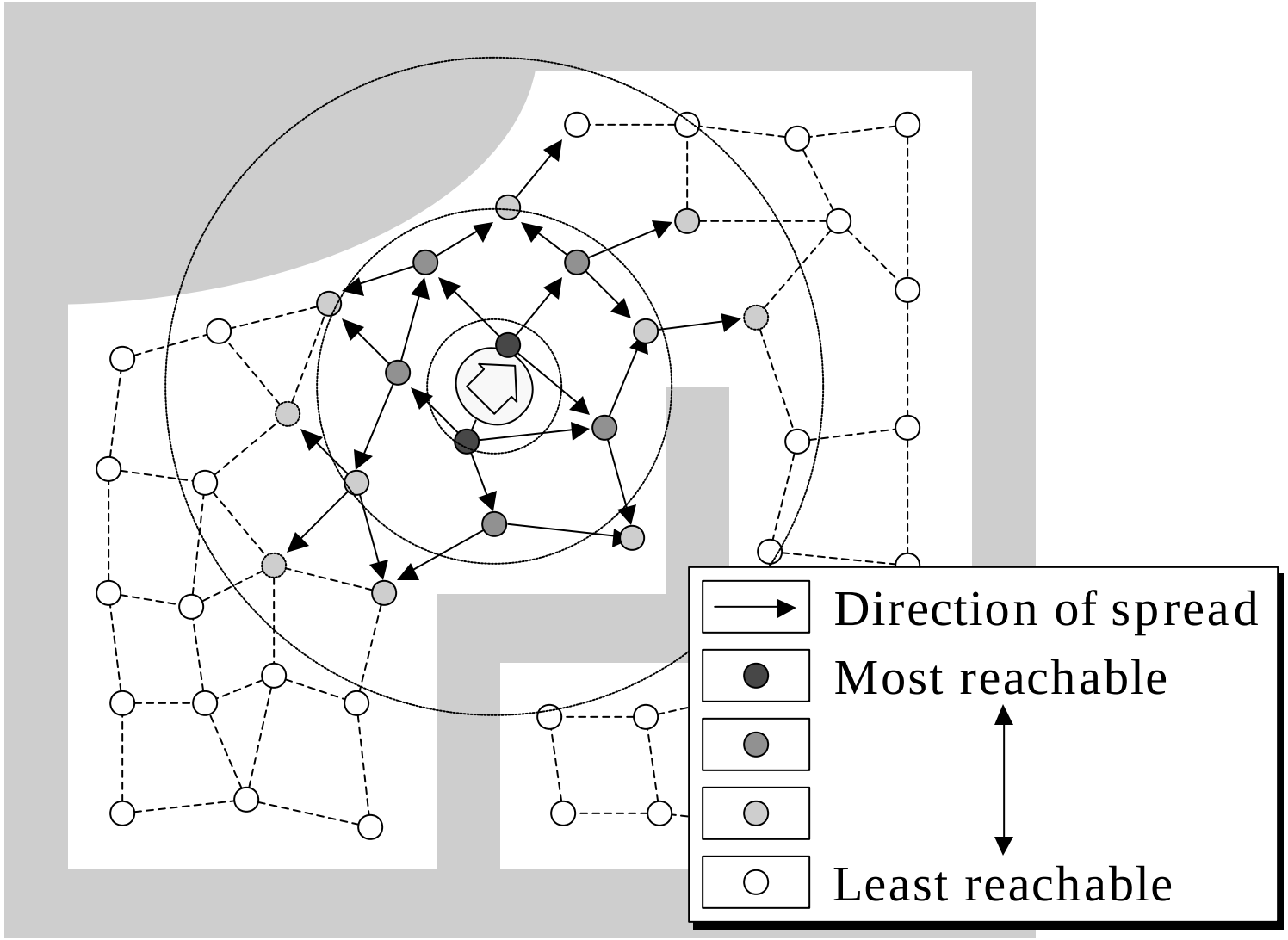


Deducing connectivity

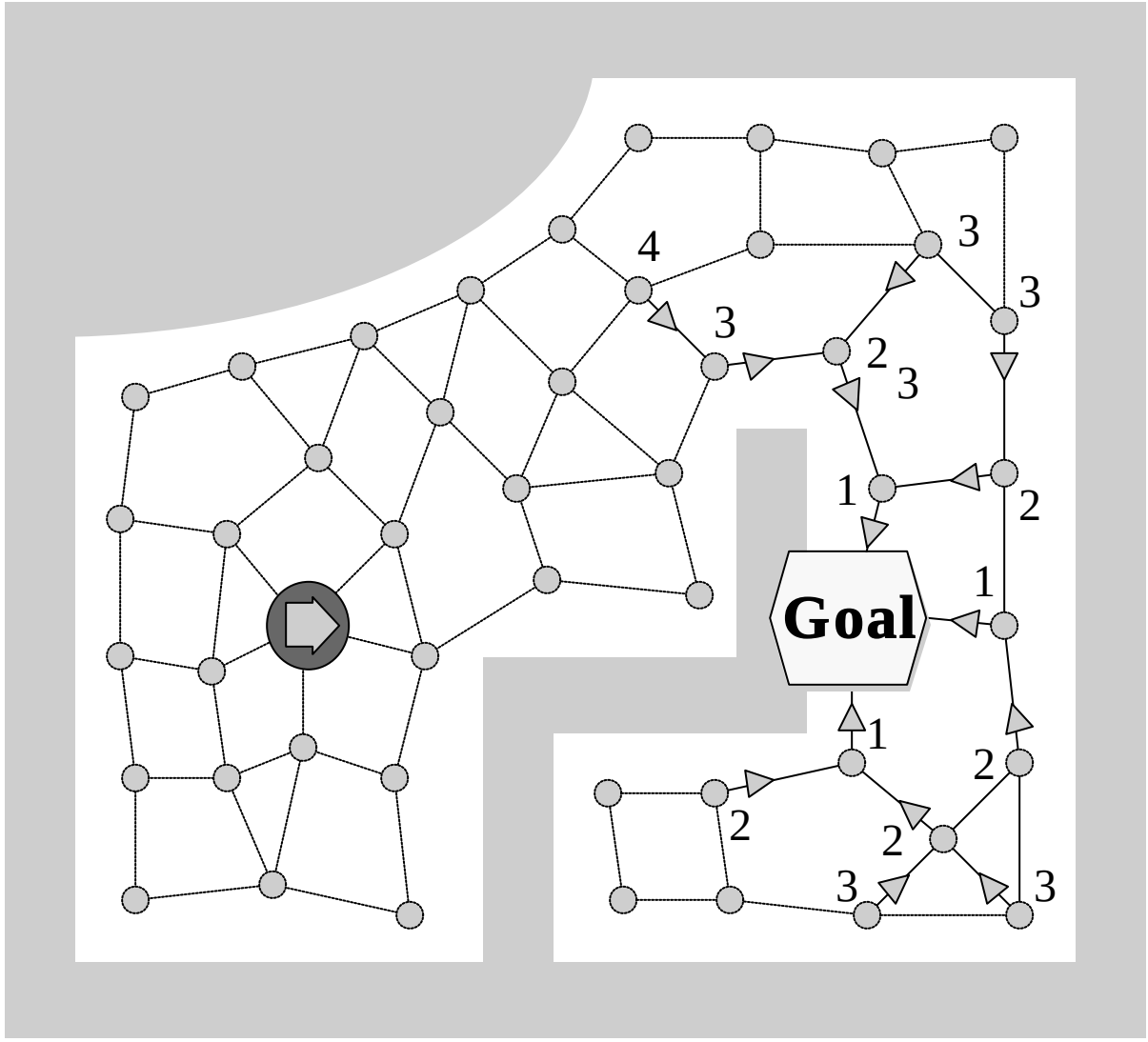
Markers close to each other can be deduced to be connected if a short path between them can be found through other connected markers



Updating connectivity



Using connectivity



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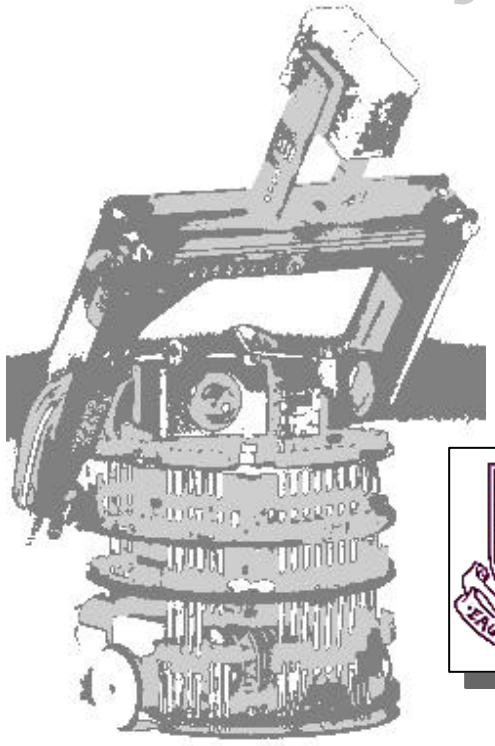

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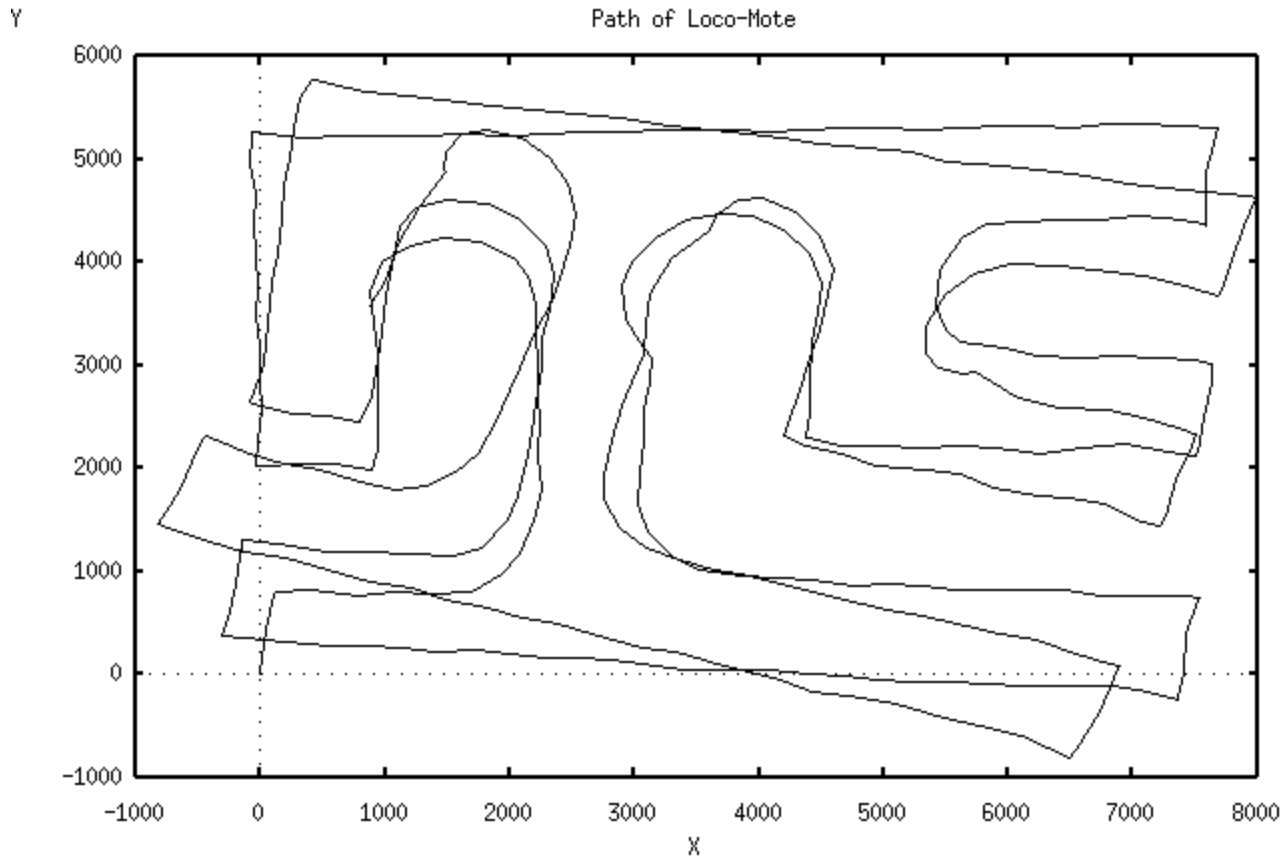
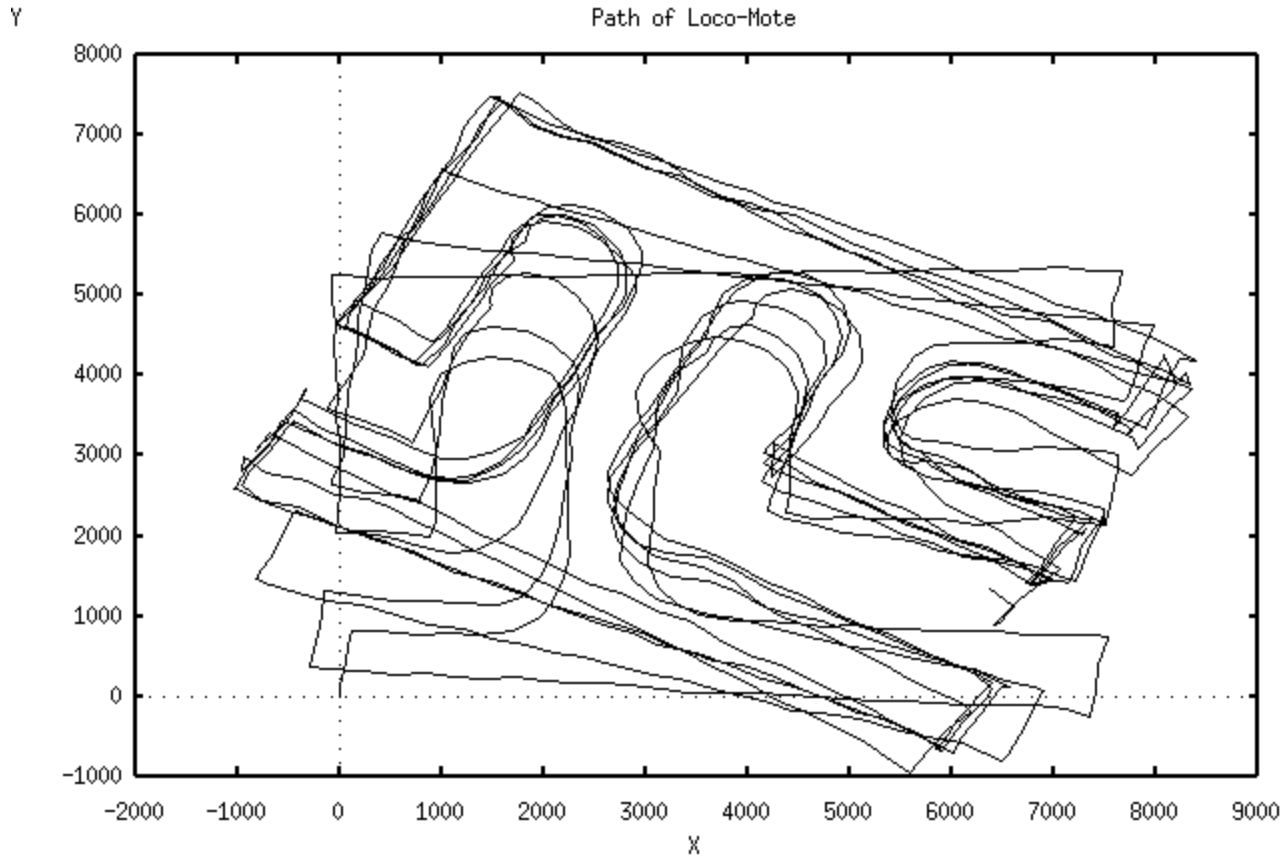
Effect of not using landmarks



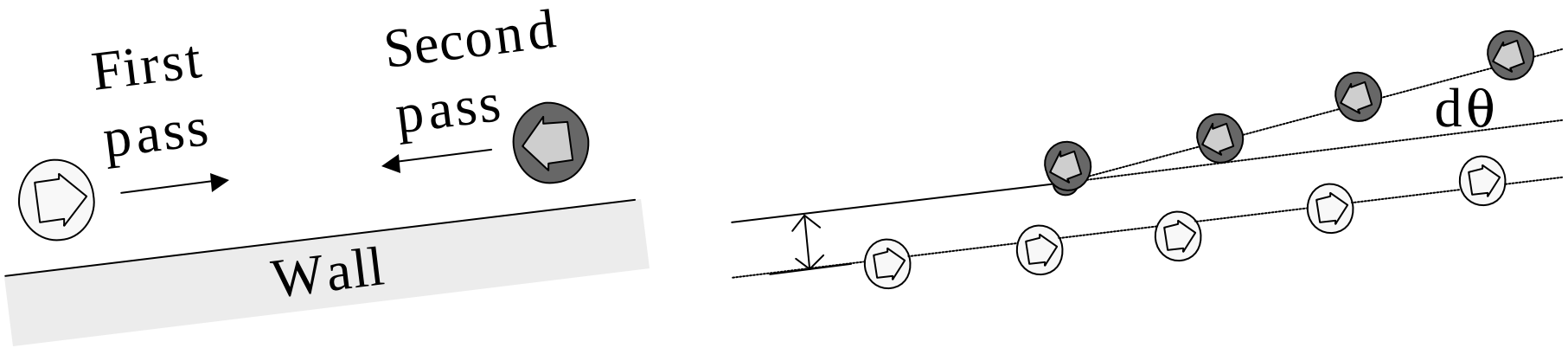
Effect of using landmarks

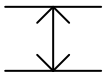


Conclusions

- Maps can be built by an autonomous robot even under very constrained conditions:
  - ⇨Without long-range sensors such as sonar or vision
  - ⇨With limited processing power
  - ⇨With limited memory
- Maps can be suitable for use by “behaviour-based” robots
  - ⇨No shared representation necessary
  - ⇨Don’t require extensive, time-extended computation

Straight-Edge Landmarks





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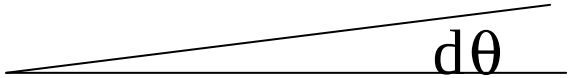

➪ Correction suggested by apparent direction of the edge