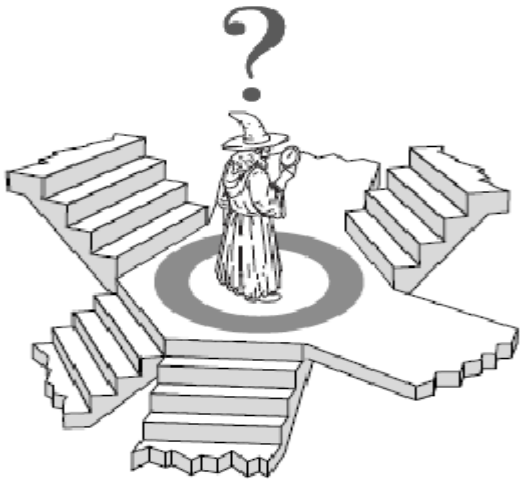


Problem Solving by Searching

Search Methods :

Local Search for Optimization Problems

Traveling Salesman Person

- Find the shortest Tour traversing all cities once.

Local Search Algorithms

2. Informed Search Strategies (Heuristic Search):

- A search strategy which searches the most promising branches of the state-space first can: (1) find a solution more quickly, (2) find solutions even when there is limited time available, (3) often find a better solution, since more profitable parts of the state-space can be examined, while ignoring the unprofitable parts.
- A search strategy which is better than another at identifying the most promising branches of a search-space is said to be more informed.

I. ***Hill climbing, Simulated Annealing, Tabu search.***

II. ***Best first search.***

III. ***Greedy search.***

IV. ***A* search.***

Local Search Algorithms

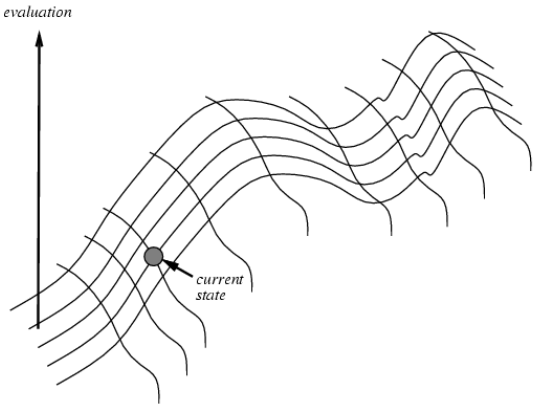
- Hill Climbing,
- Simulated Annealing,
- Tabu Search

Hill Climbing

- **"Like climbing Everest in thick fog with amnesia"**

- Hill climbing search algorithm (also known as greedy local search) uses a loop that continually moves in the direction of increasing values (that is uphill).

- It terminates when it reaches a peak where no neighbor has a higher value.



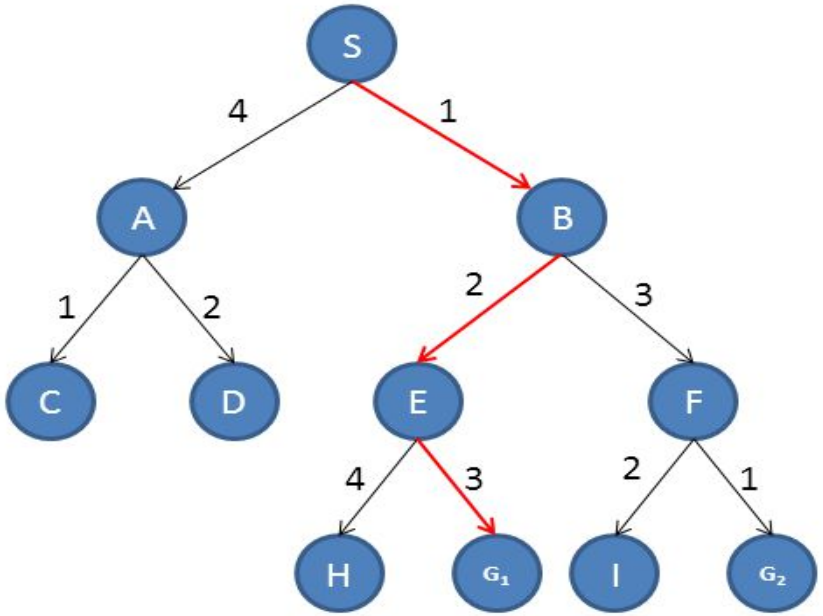
Hill Climbing Search

EXAMPLE on HILL-CLIMBING

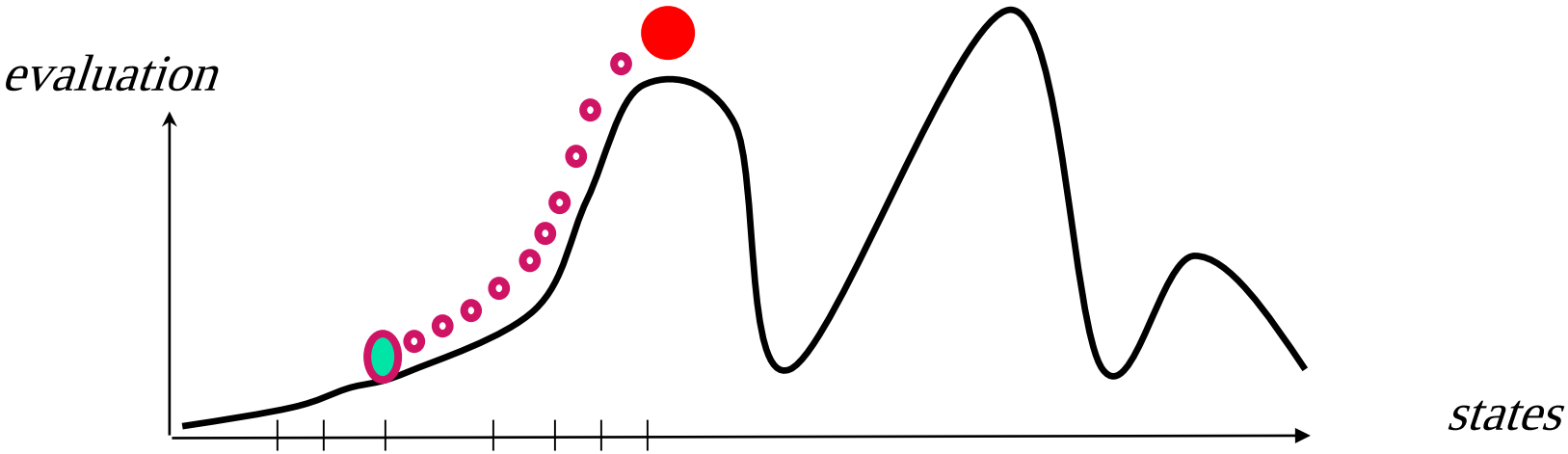
S → B → E → G1

SEARCH PATH = [S_0, B_1, E_2, $G1_3$]

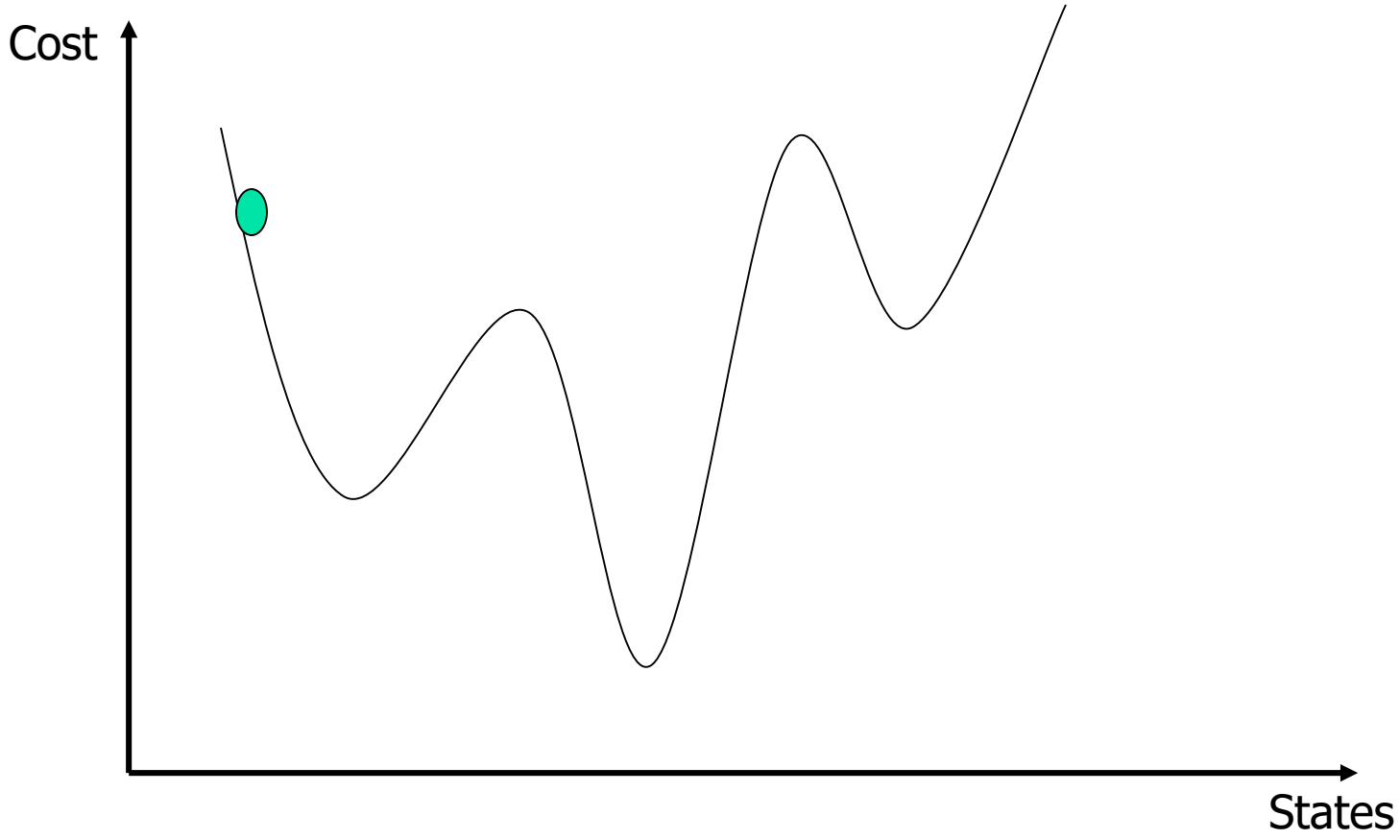
Cost = 1+2+3=6



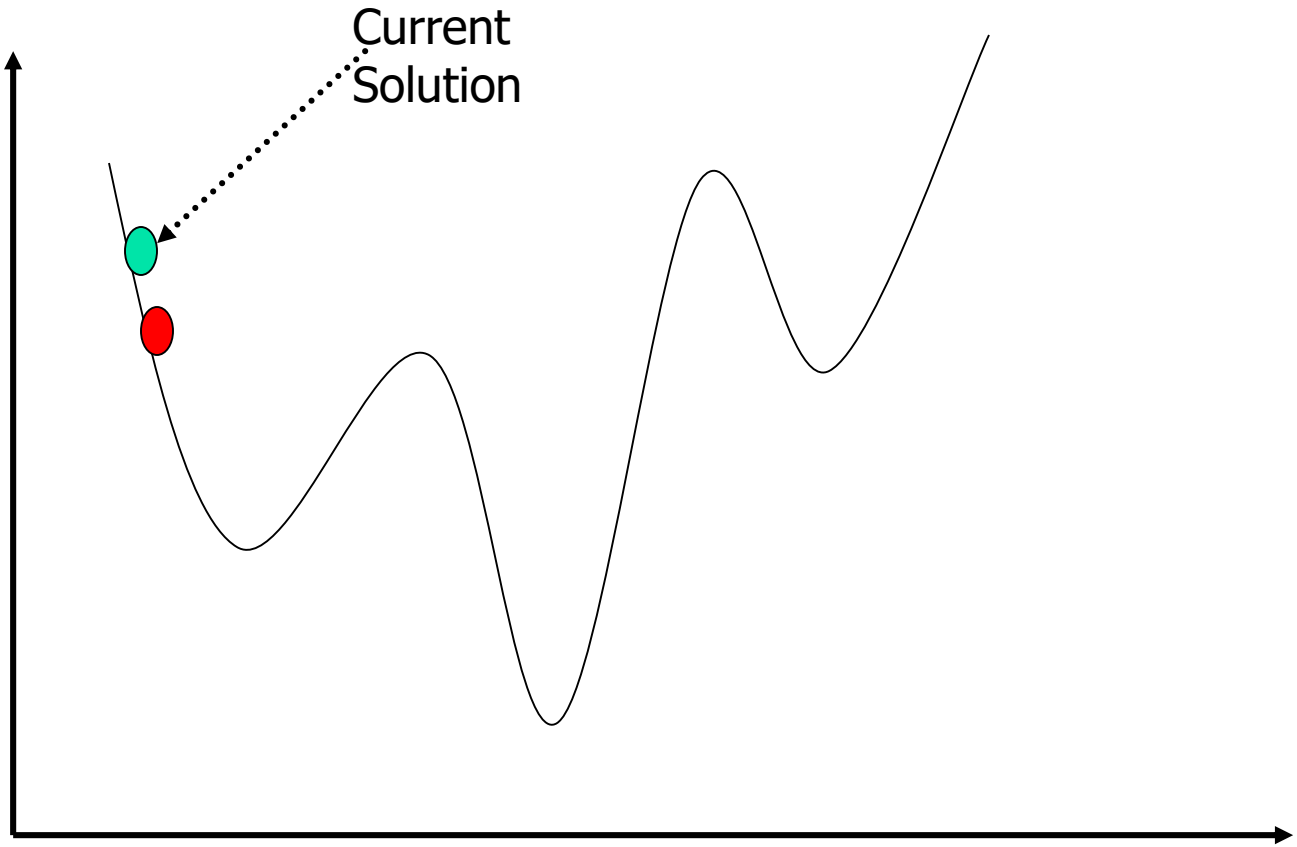
Hill Climbing



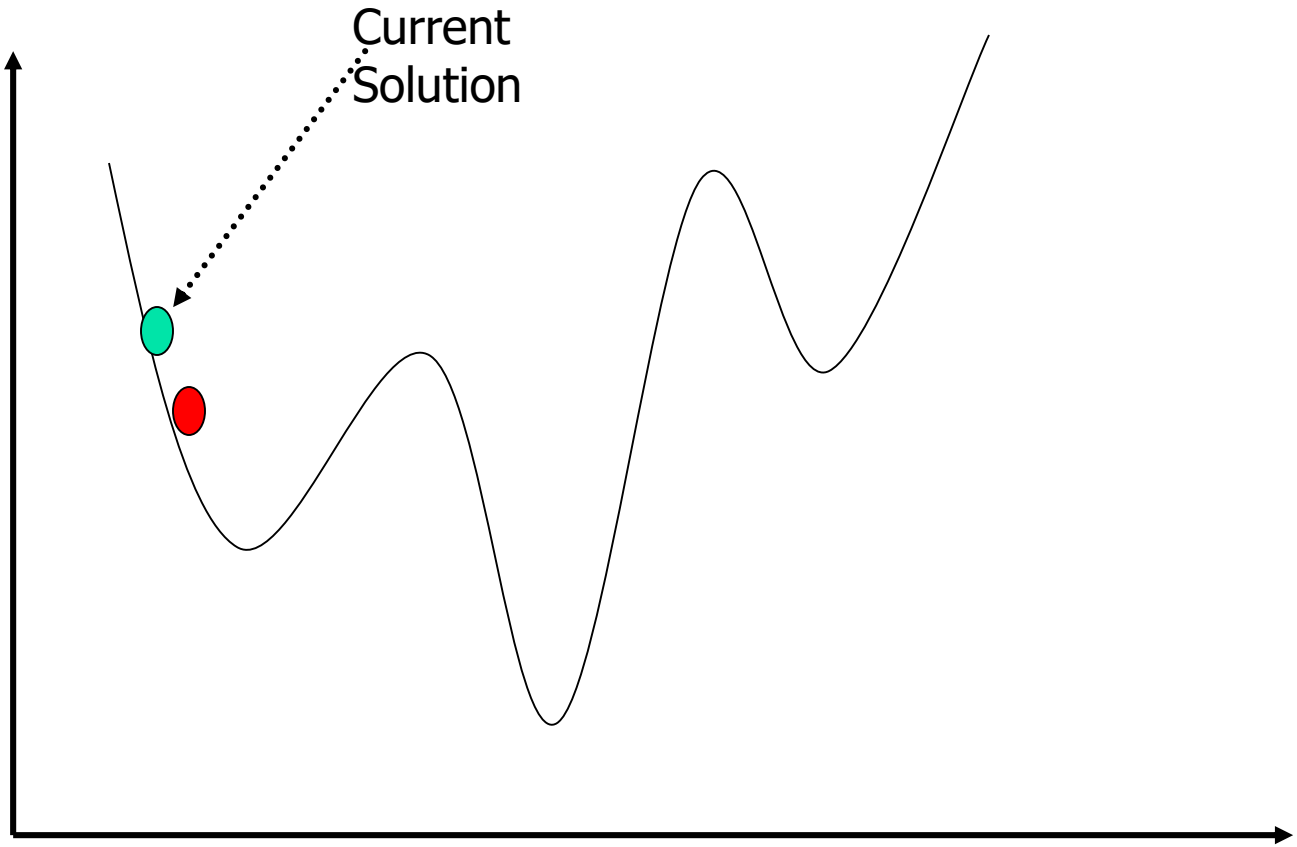
Hill Climbing in Action …



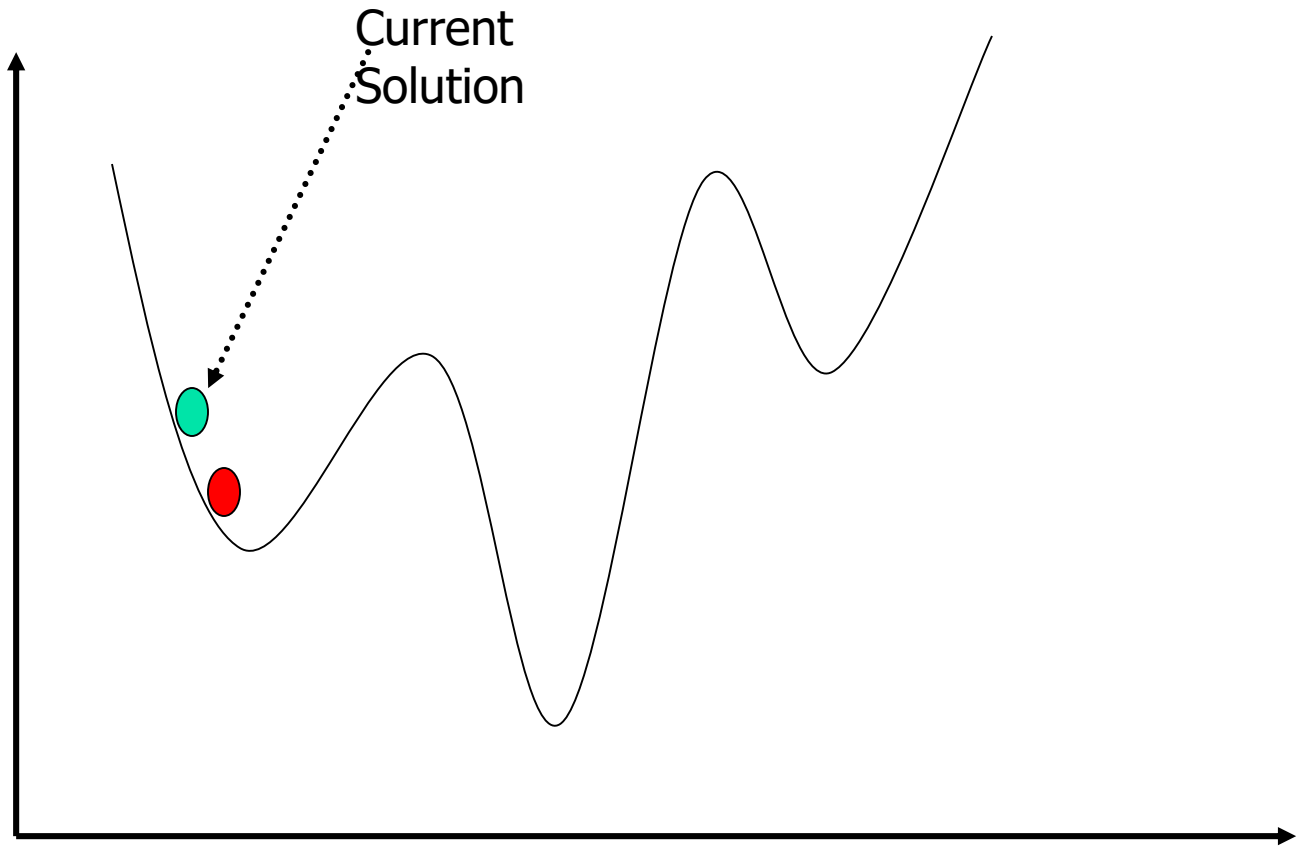
Hill Climbing



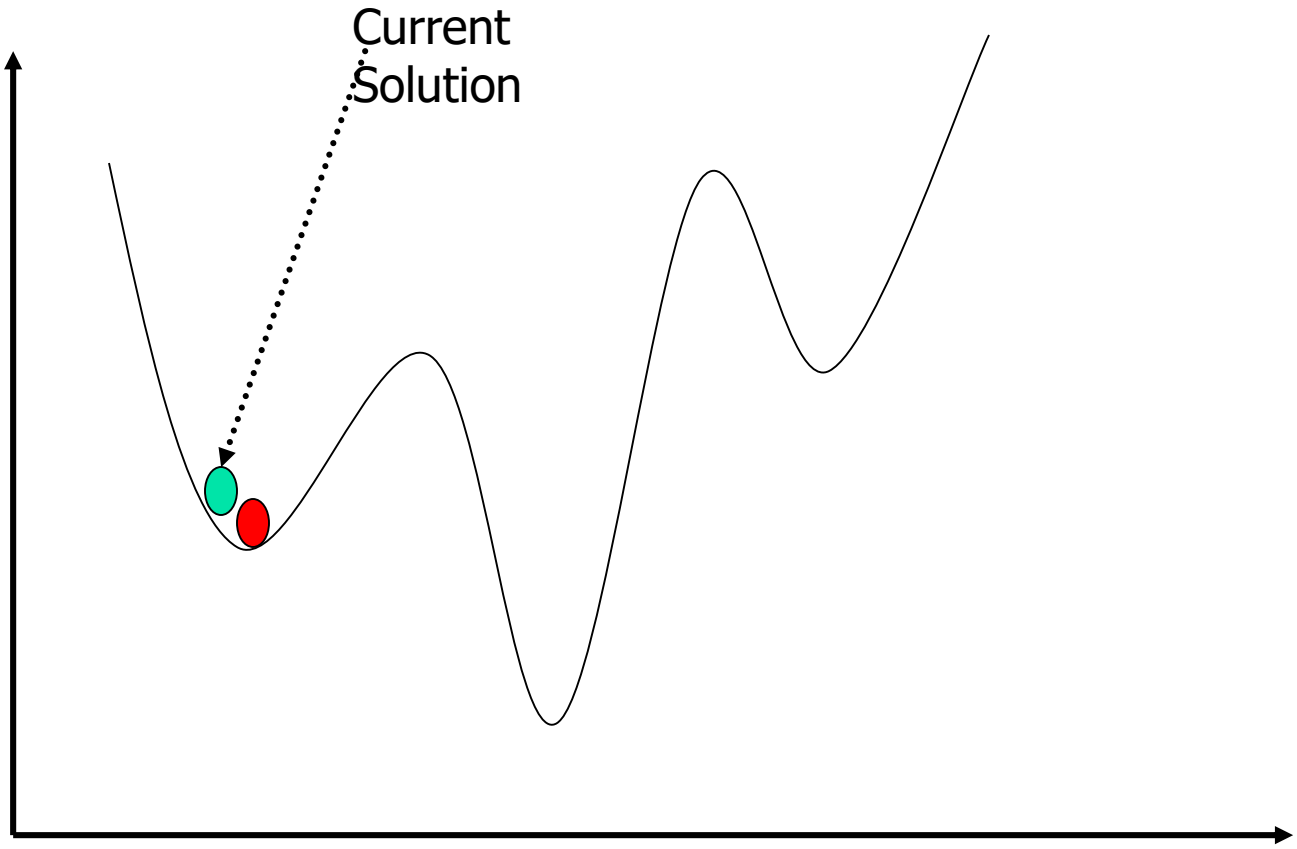
Hill Climbing



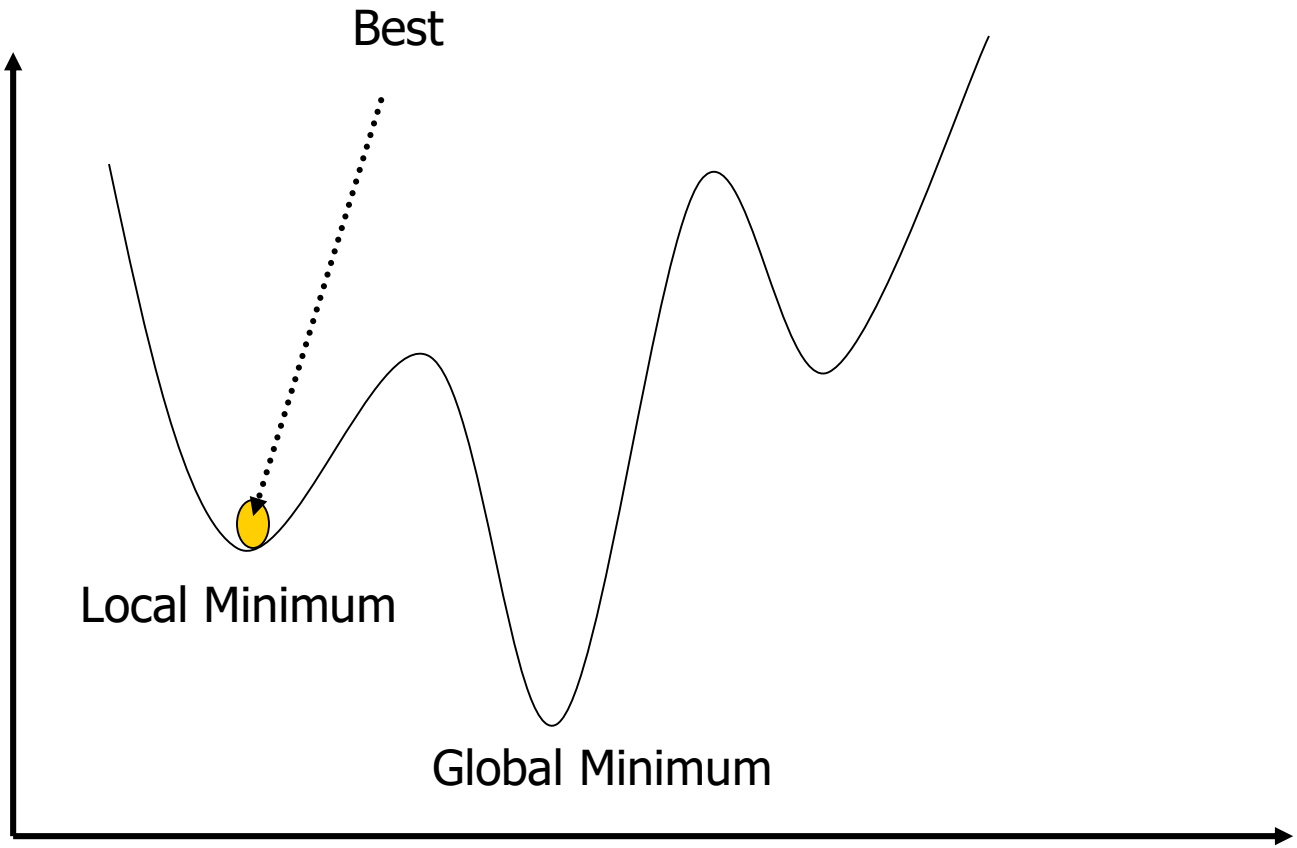
Hill Climbing



Hill Climbing

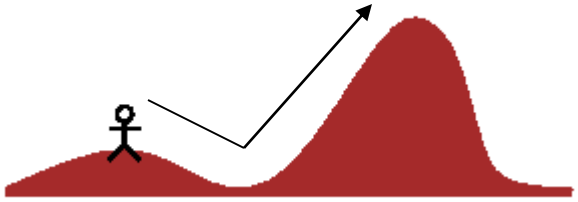


Hill Climbing

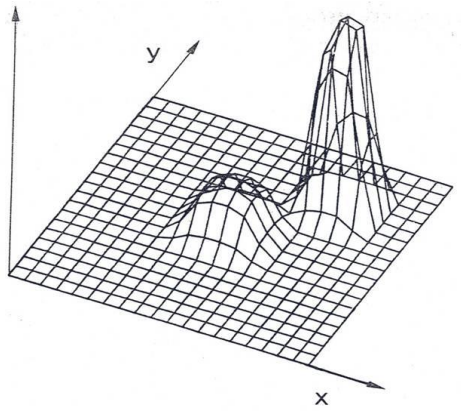


Issues

The Goal is to find GLOBAL



1. How to avoid LOCAL optima?
2. When to stop?
3. Climb downhill? When?



Simulated Annealing

- Key Idea: escape local maxima by allowing some "bad" moves but gradually decrease their frequency
- Take some uphill steps to escape the local minimum
- Instead of picking the best move, it picks a random move
- If the move improves the situation, it is executed. Otherwise, move with some probability less than 1.
- Physical analogy with the annealing process:
  - Allowing liquid to gradually cool until it freezes
- The heuristic value is the energy, E
- Temperature parameter, T, controls speed of convergence.

Simulated Annealing

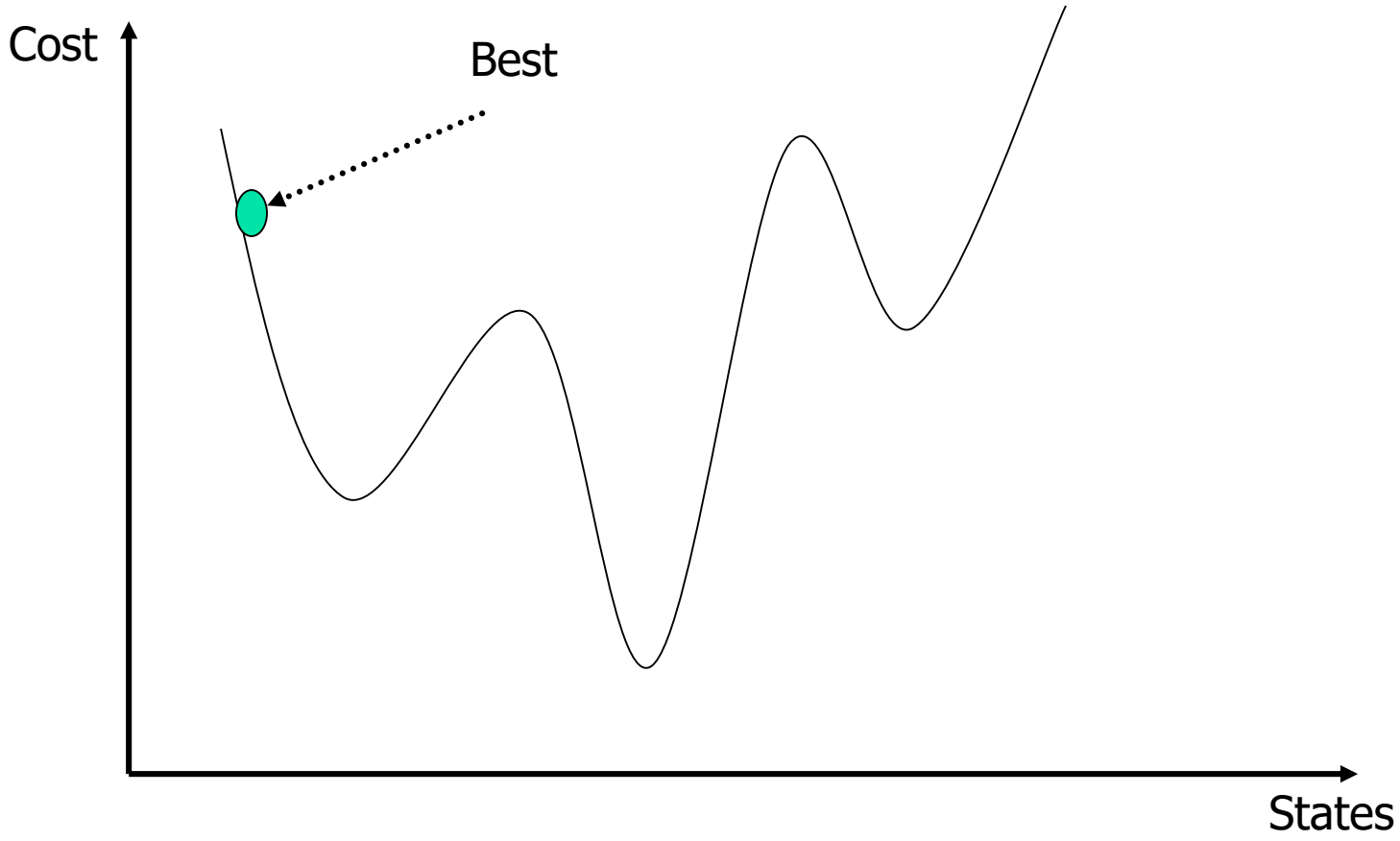
- **Basic inspiration**: What is annealing?

In metallurgy, annealing is the physical process used to temperature or harden metals or glass by heating them to a high temperature and then gradually cooling them, thus allowing the material to coalesce into a low energy crystalline state.

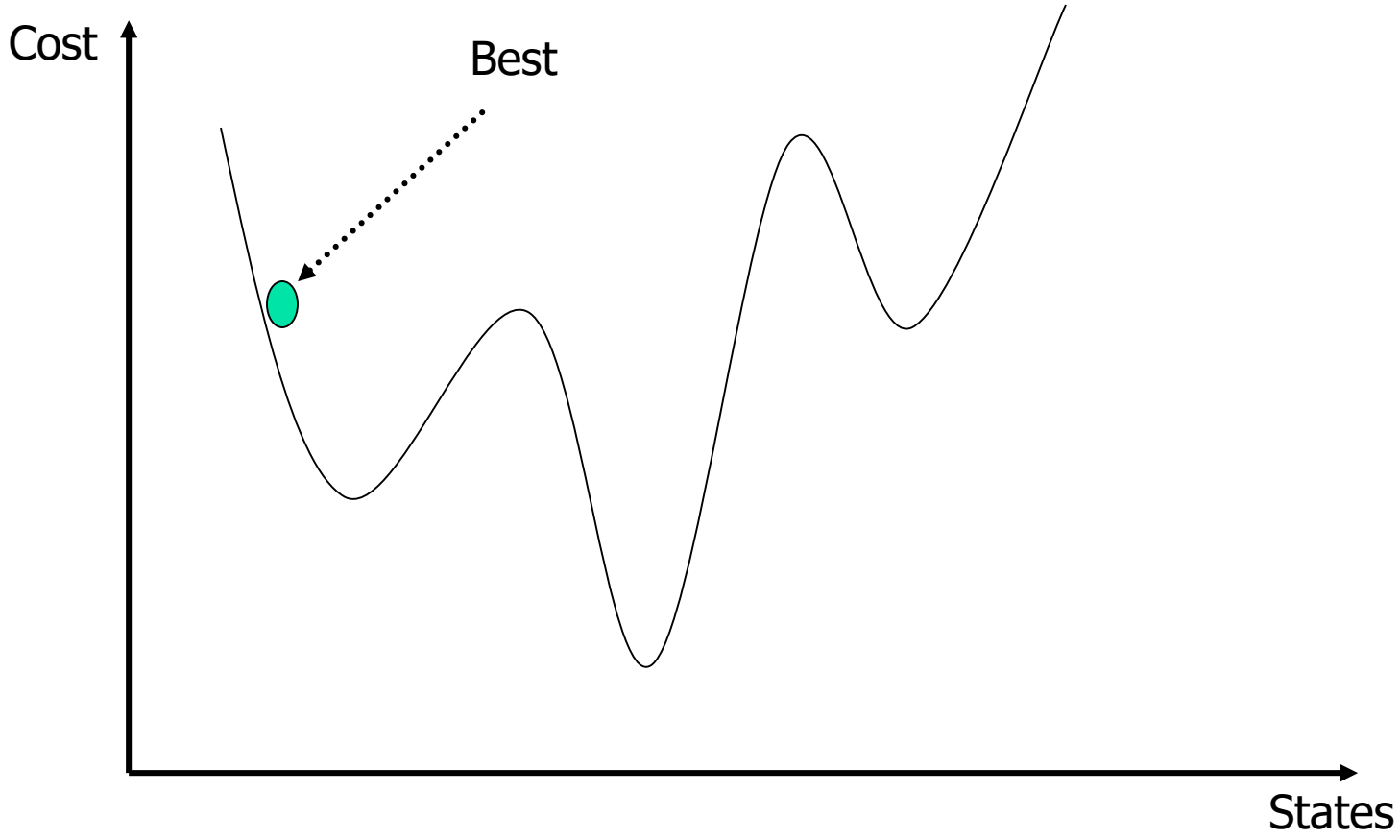
Heating then slowly cooling a substance to obtain a strong crystalline structure.

- **Key idea:** Simulated Annealing combines Hill Climbing with a random walk in some way that yields both efficiency and completeness.

Simulated Annealing in Action …



Simulated Annealing



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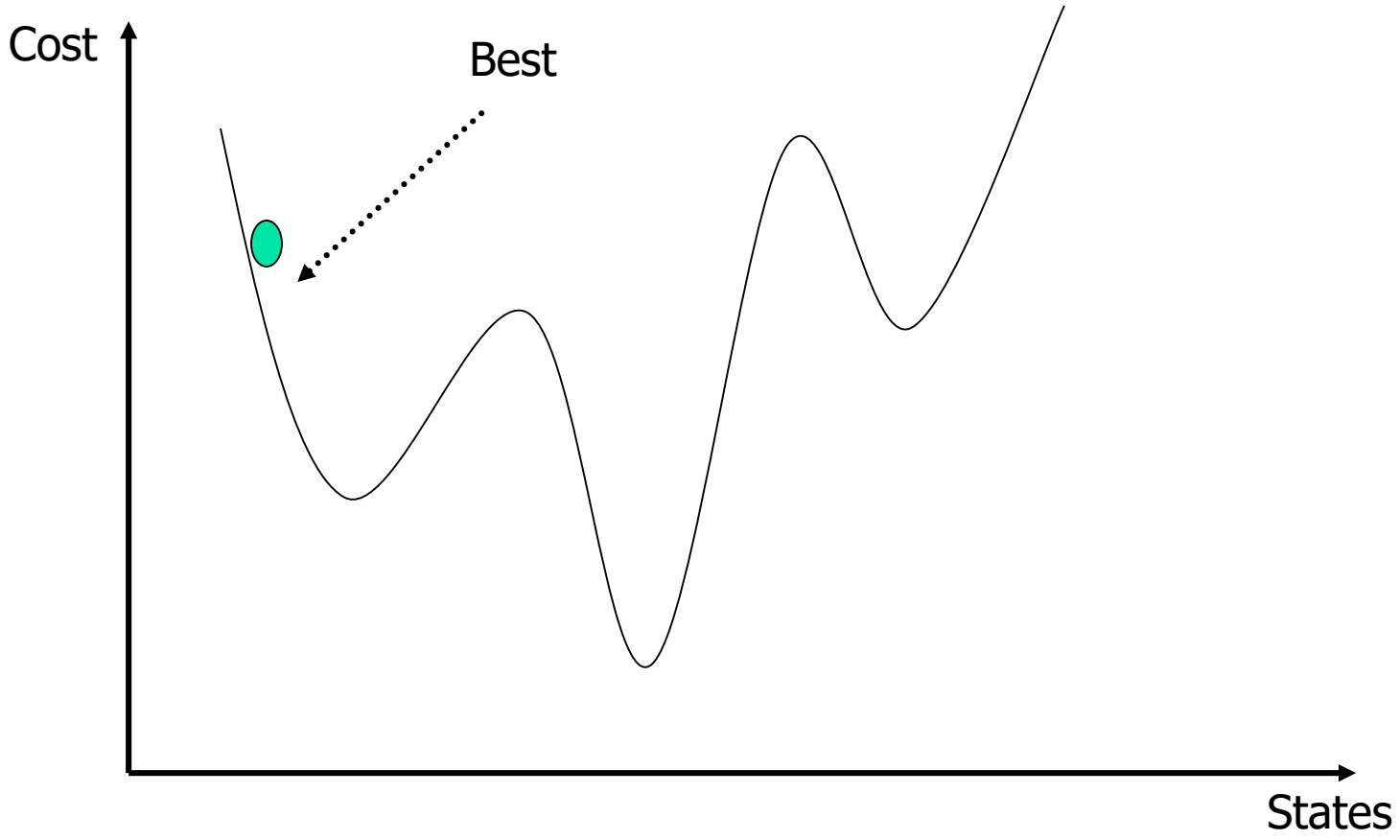

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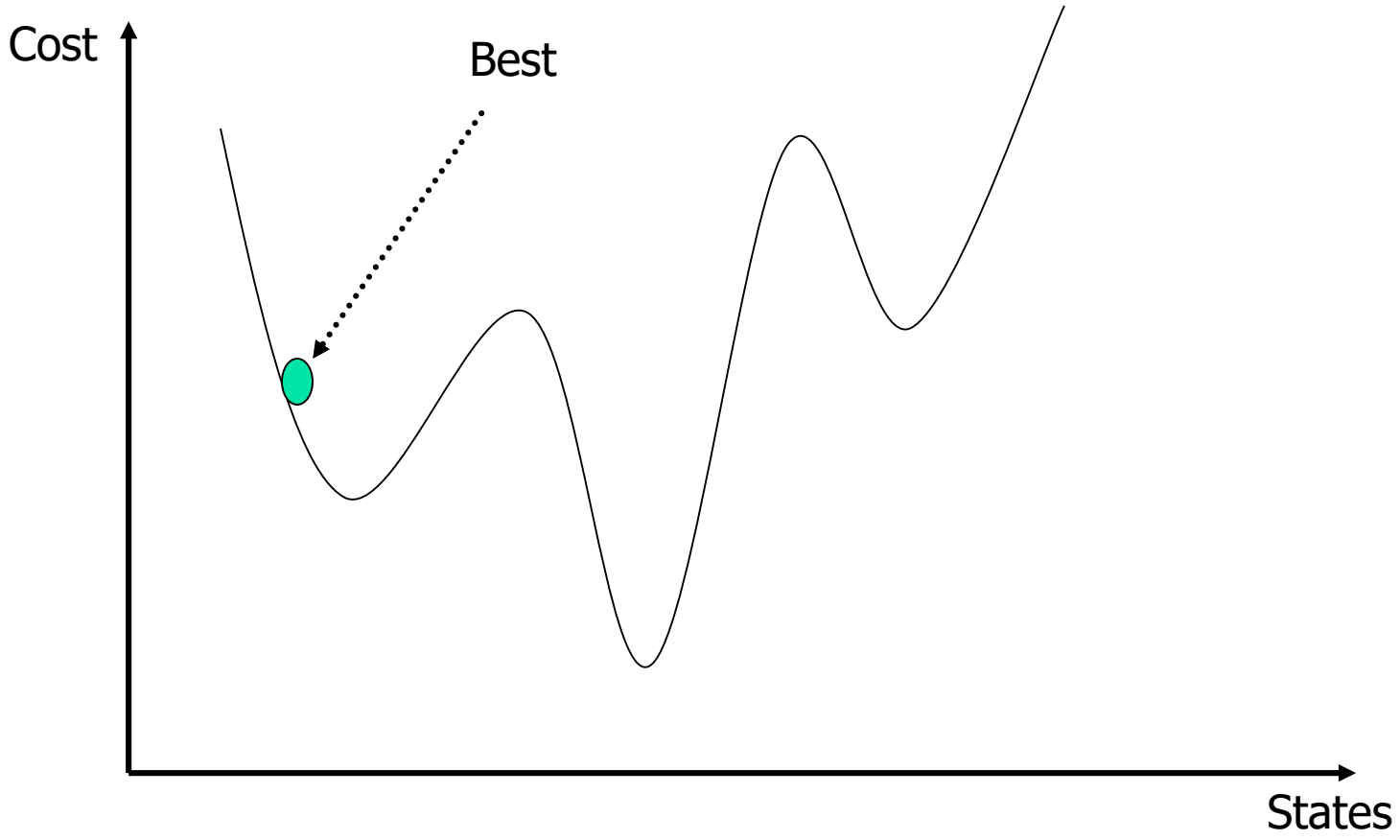

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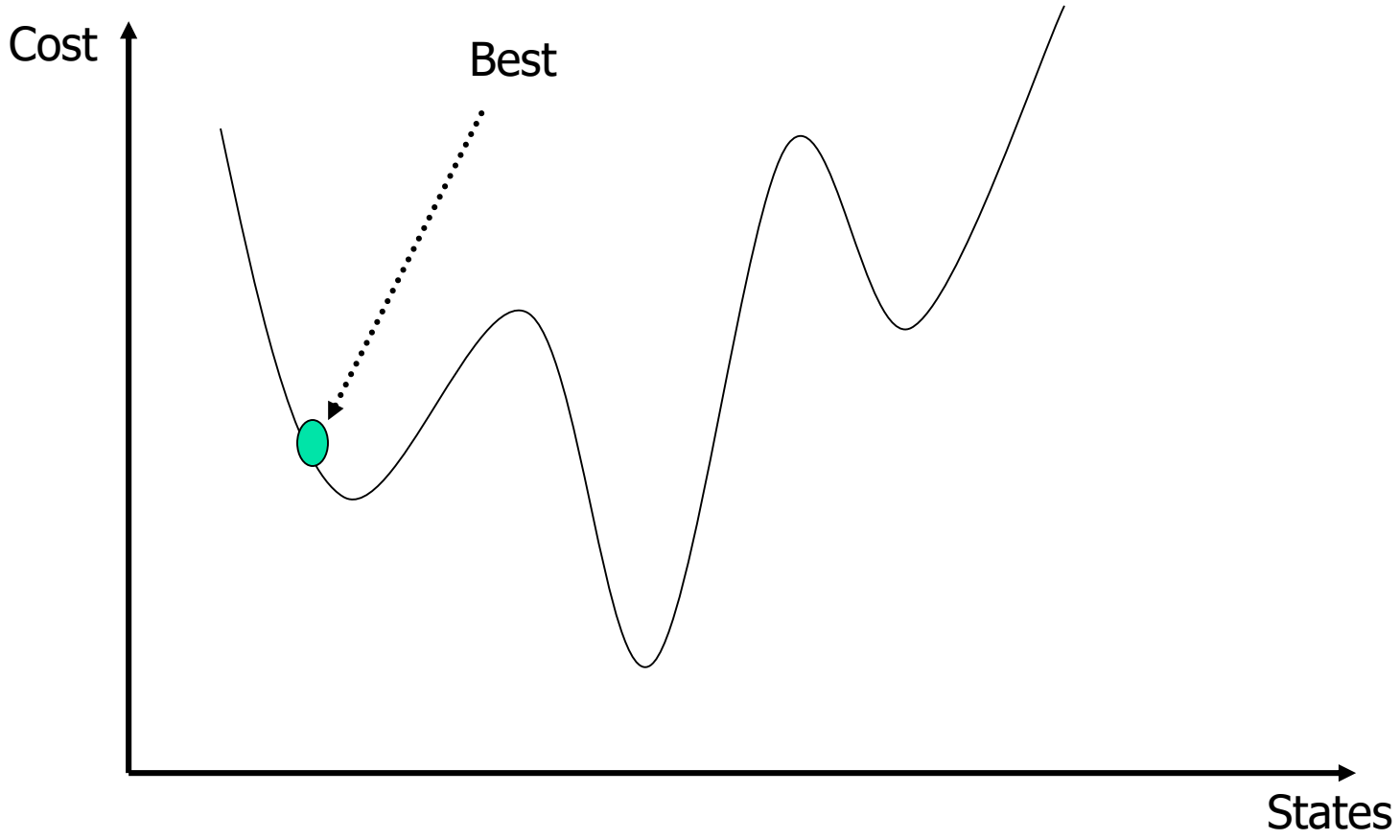

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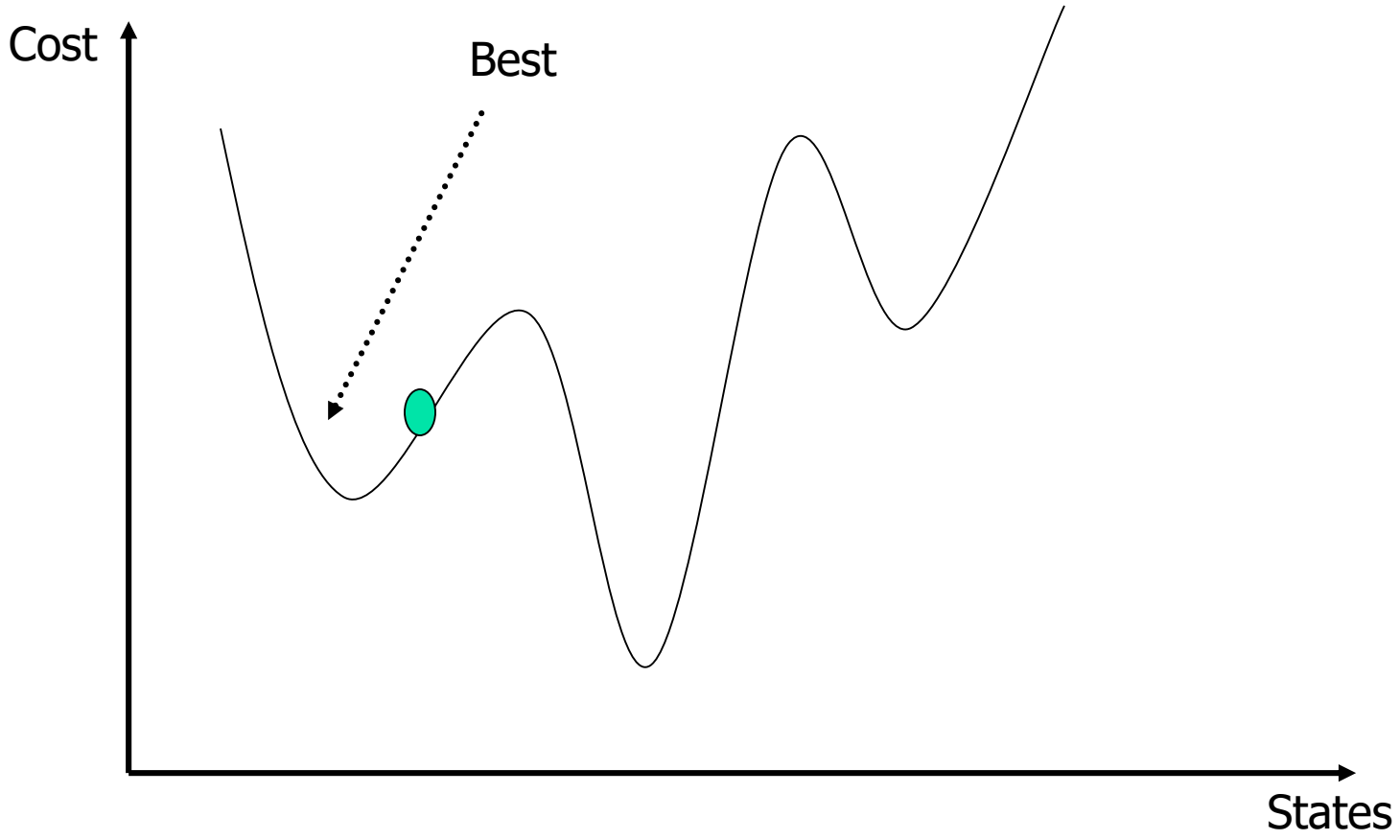

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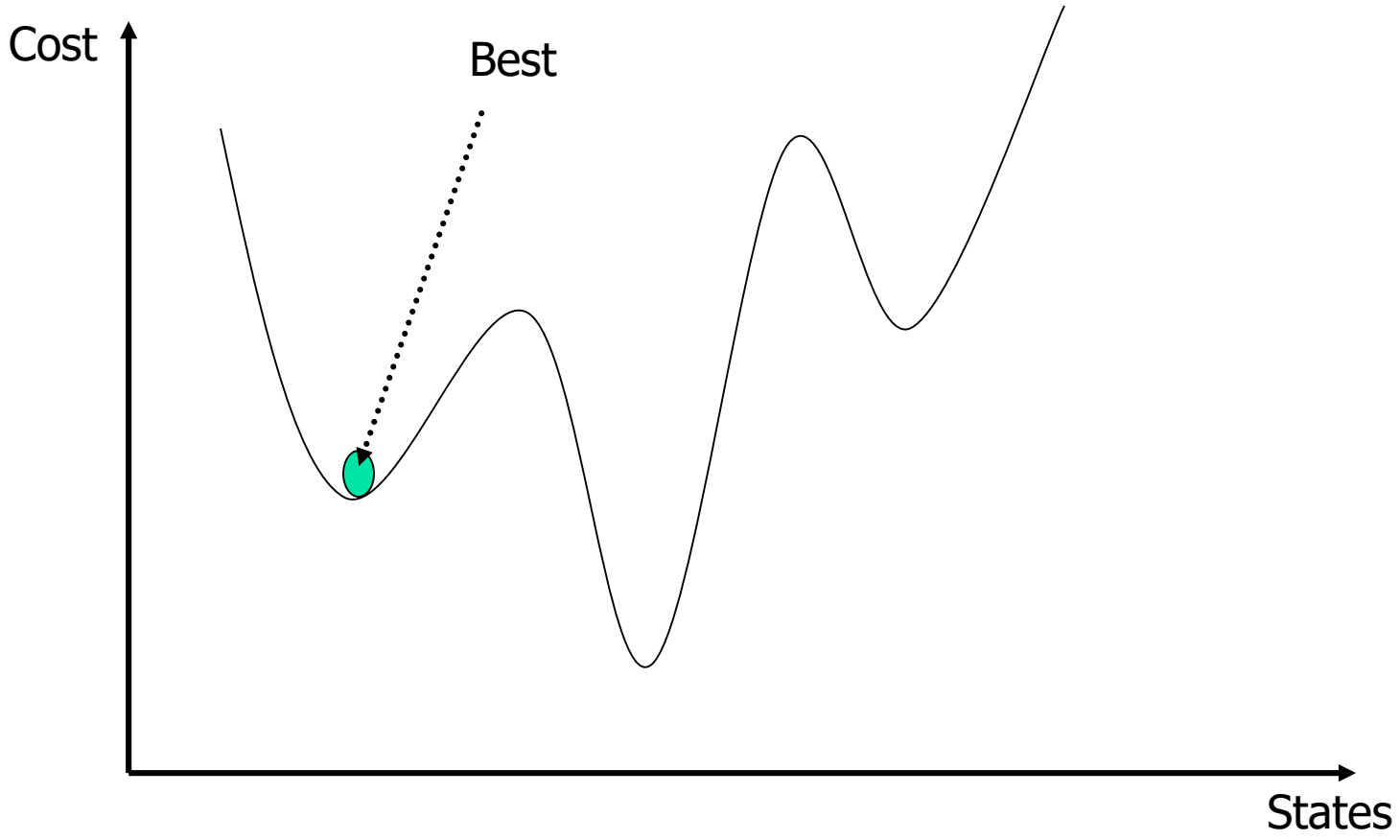

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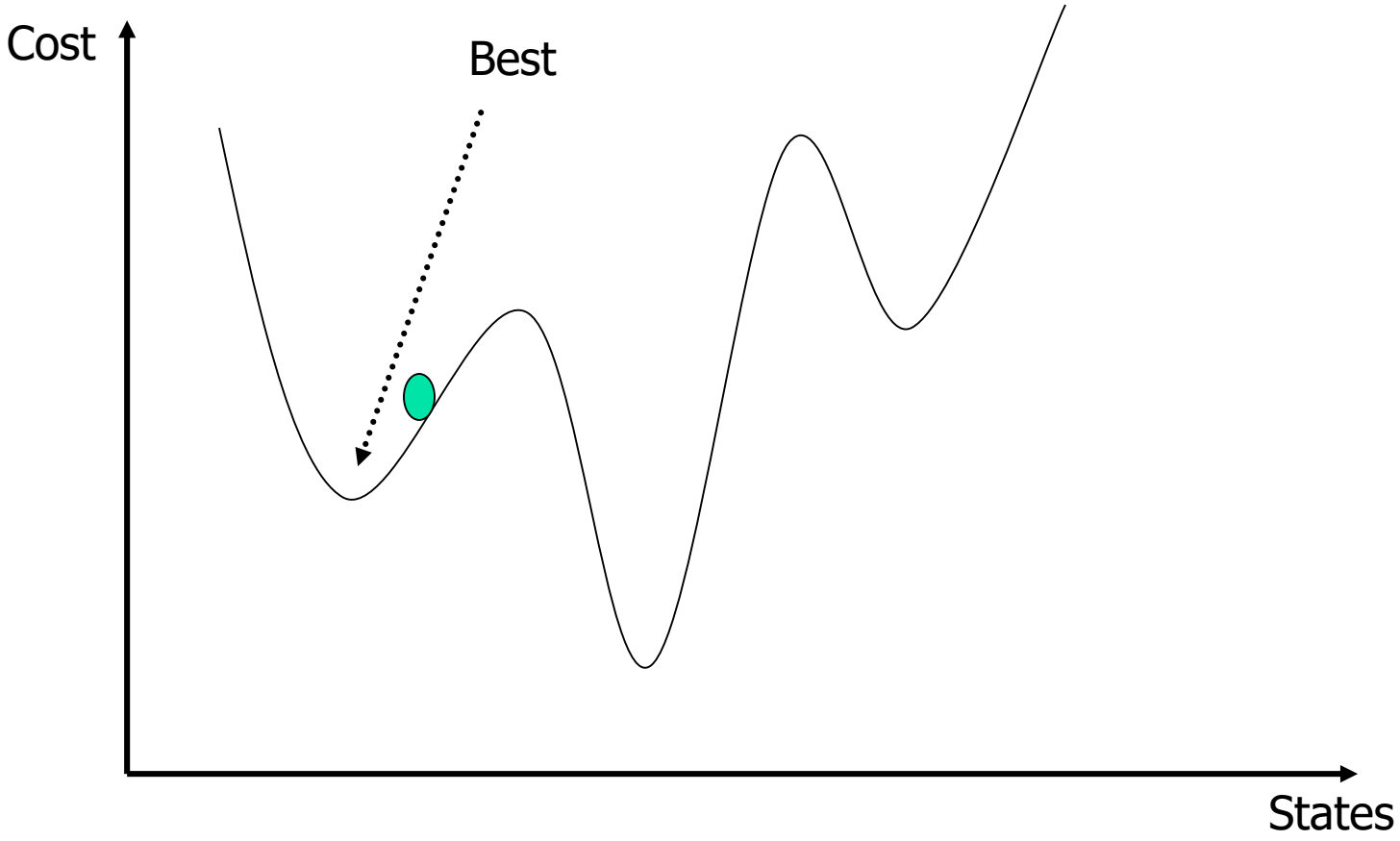

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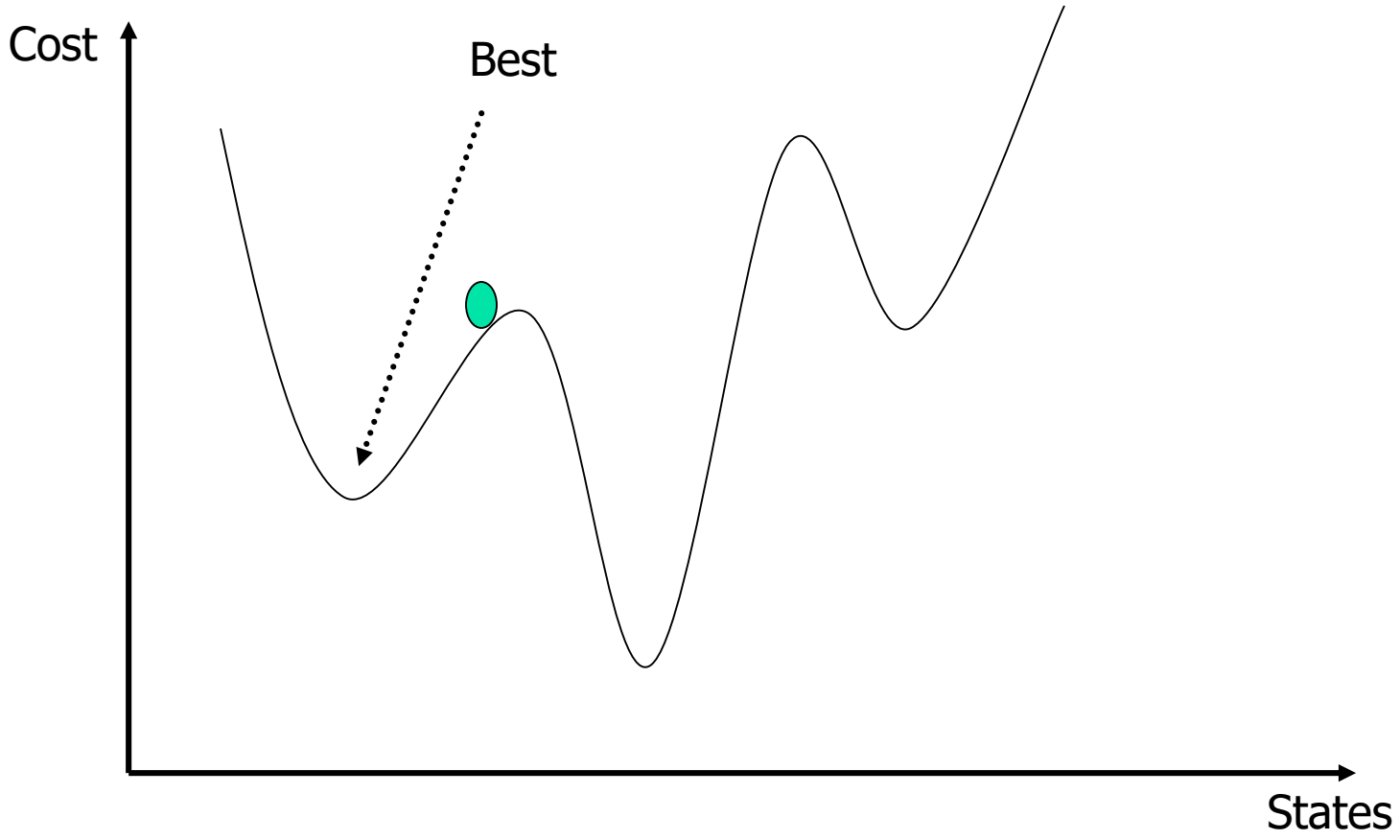

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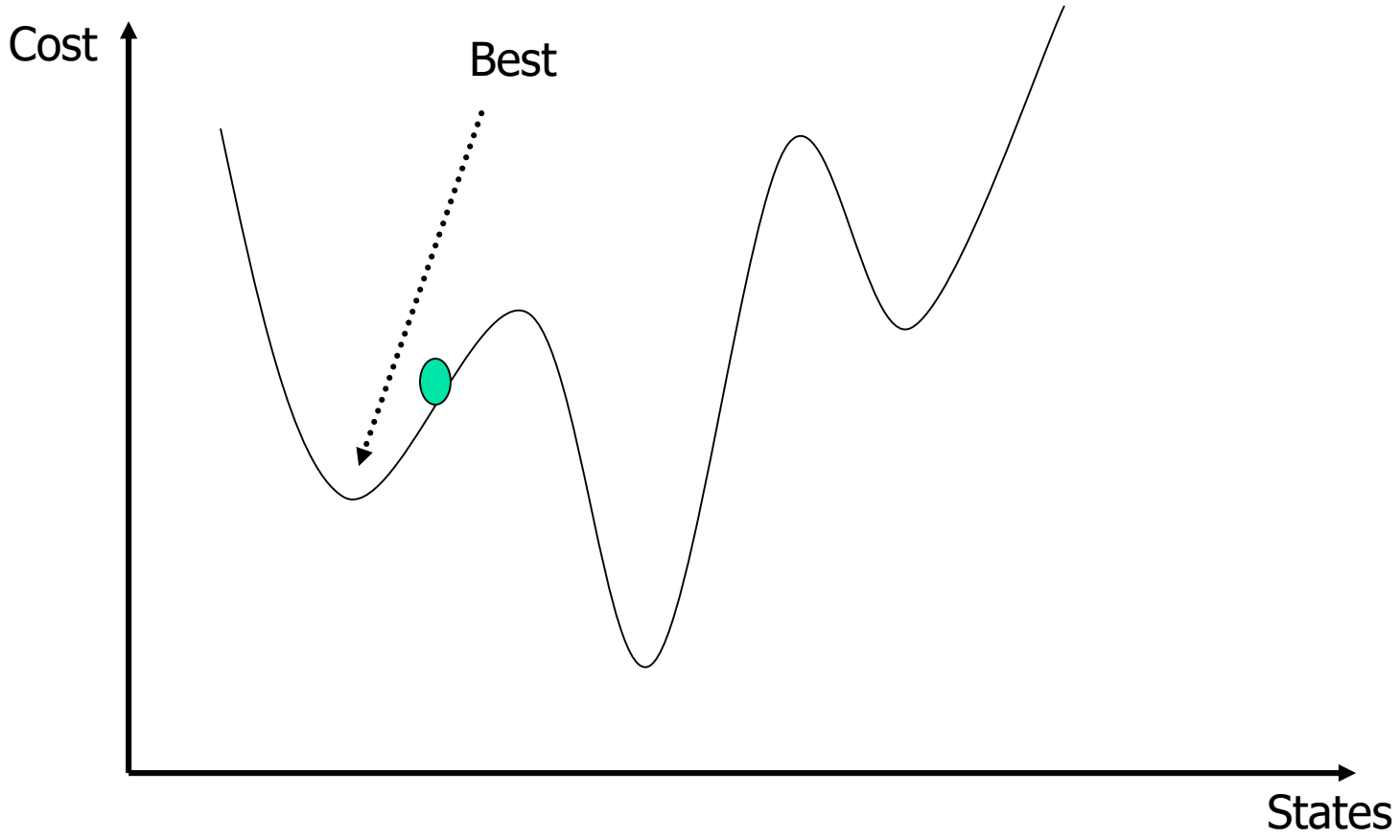

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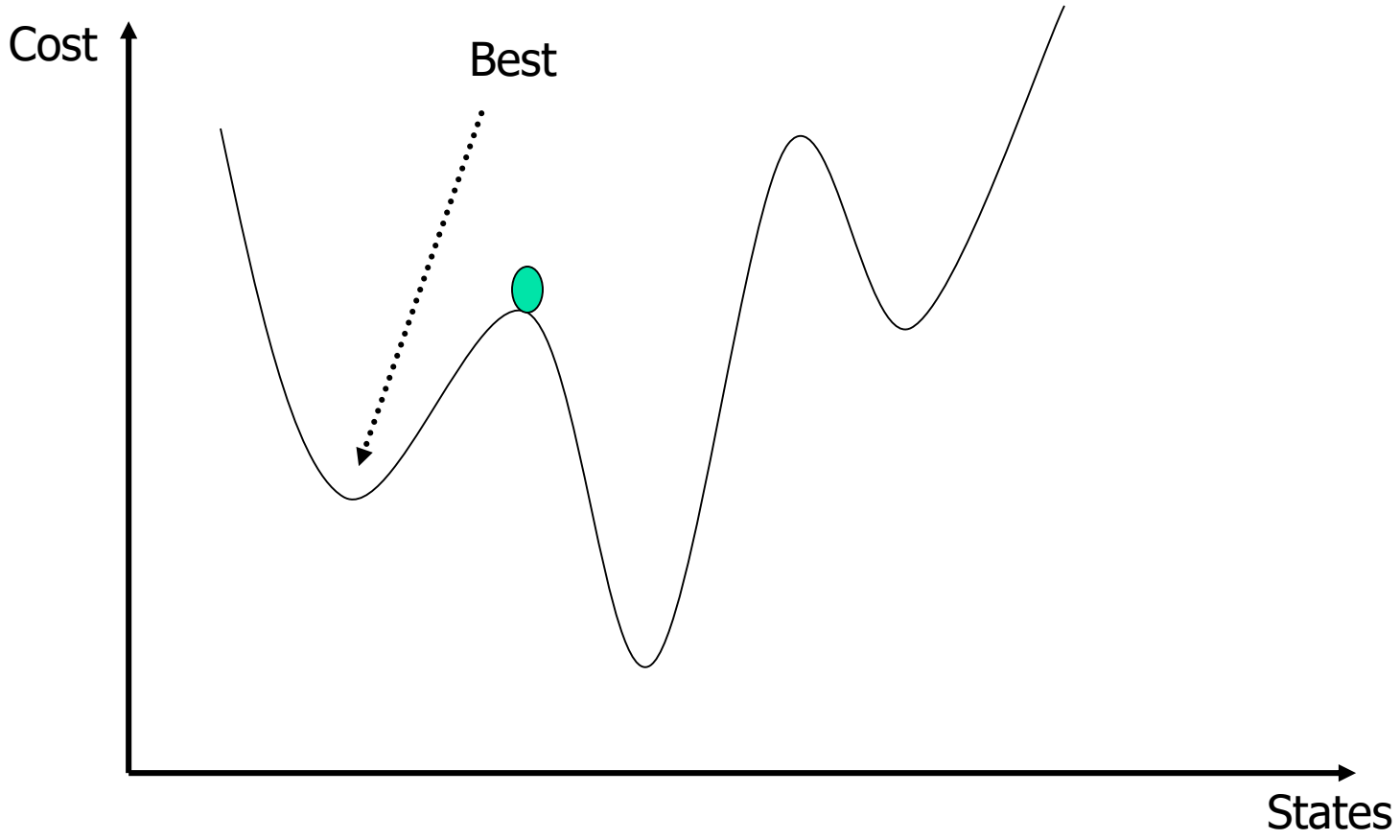

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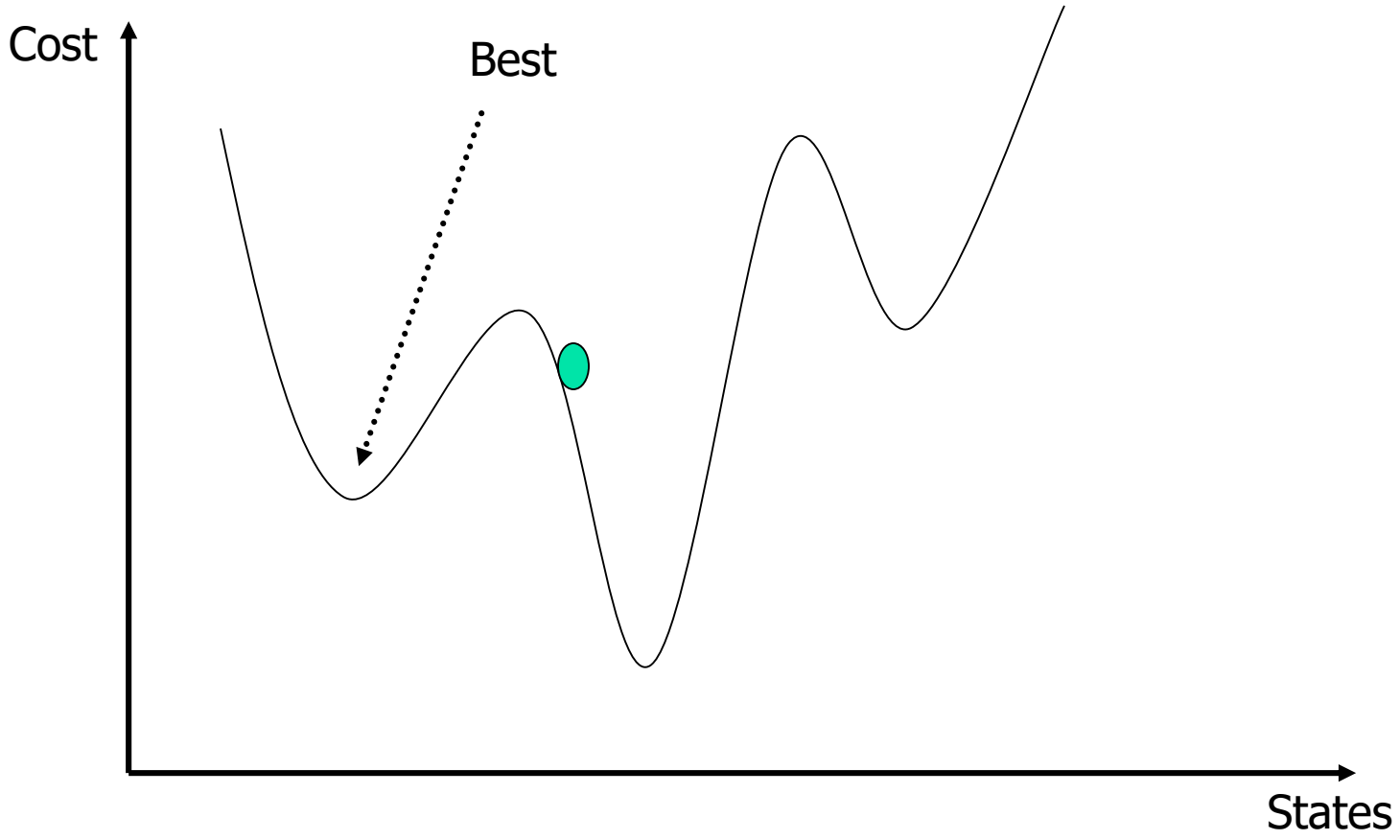

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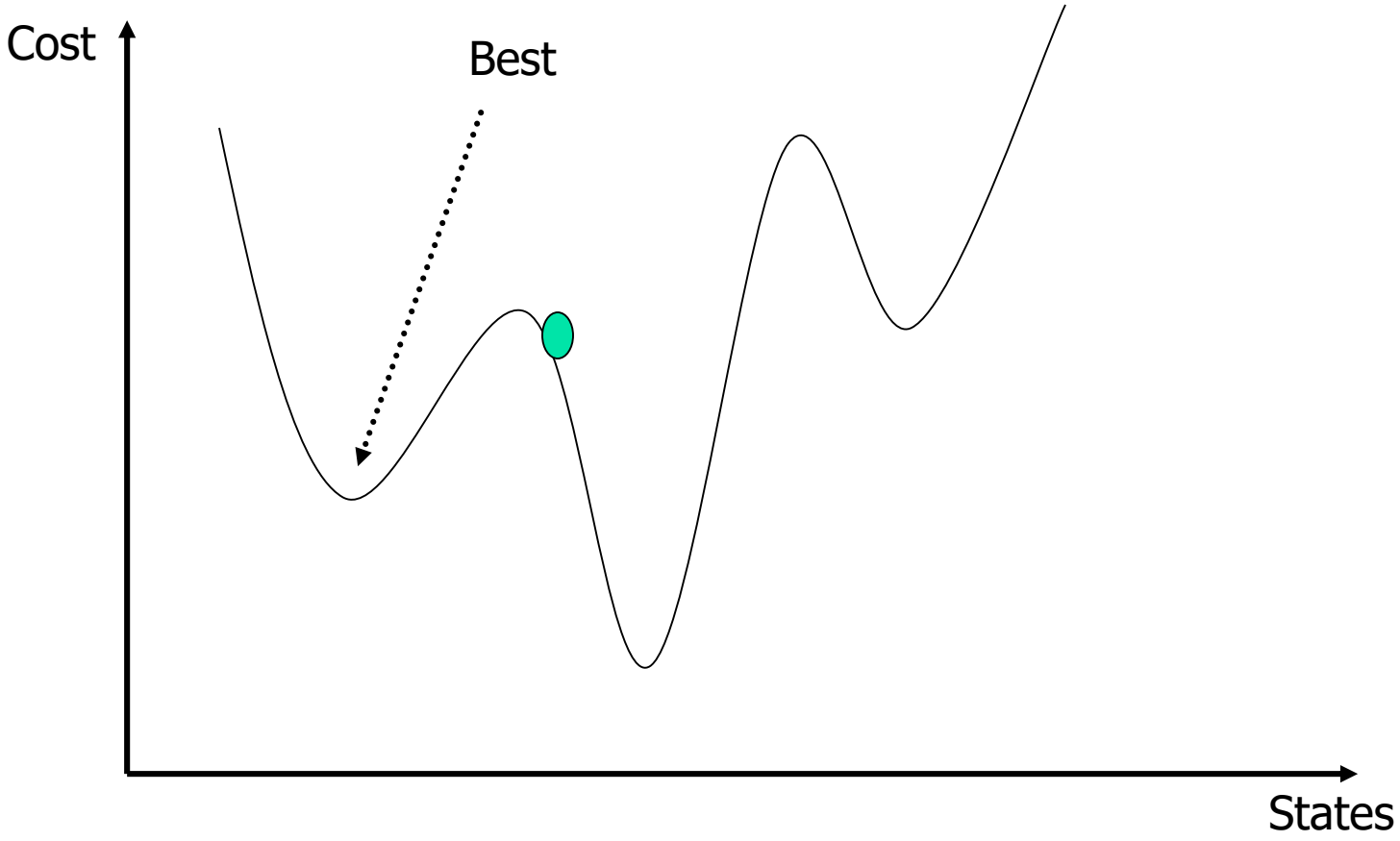

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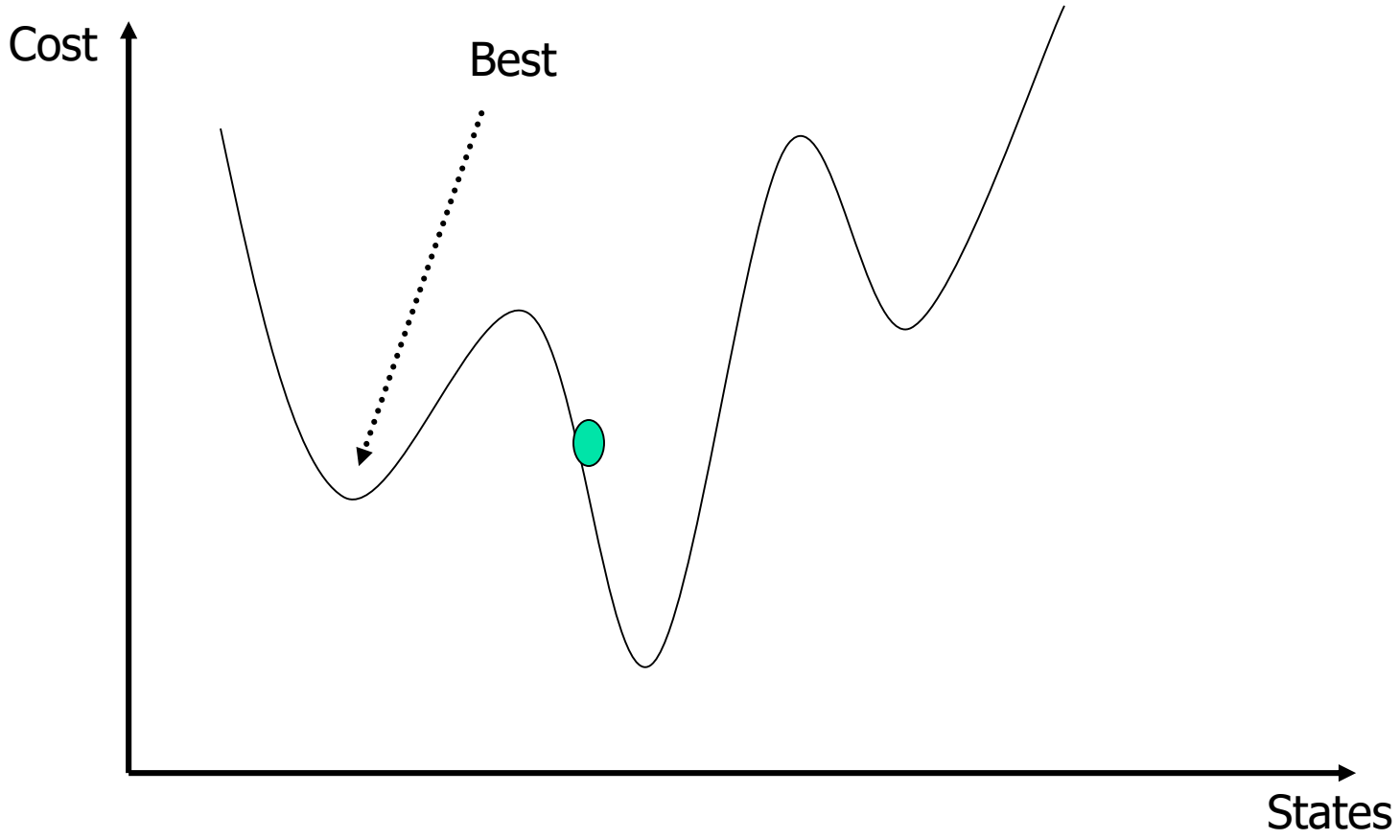

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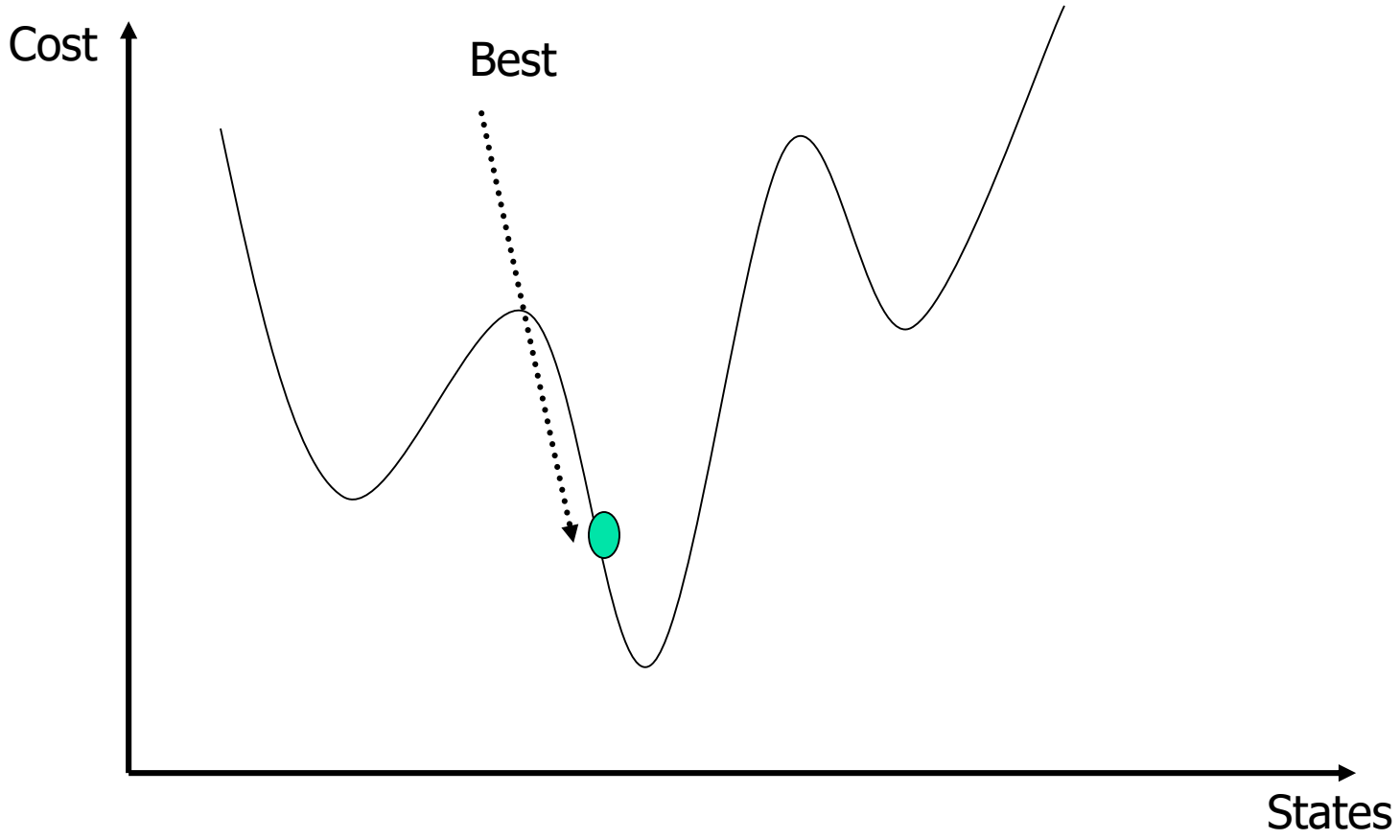

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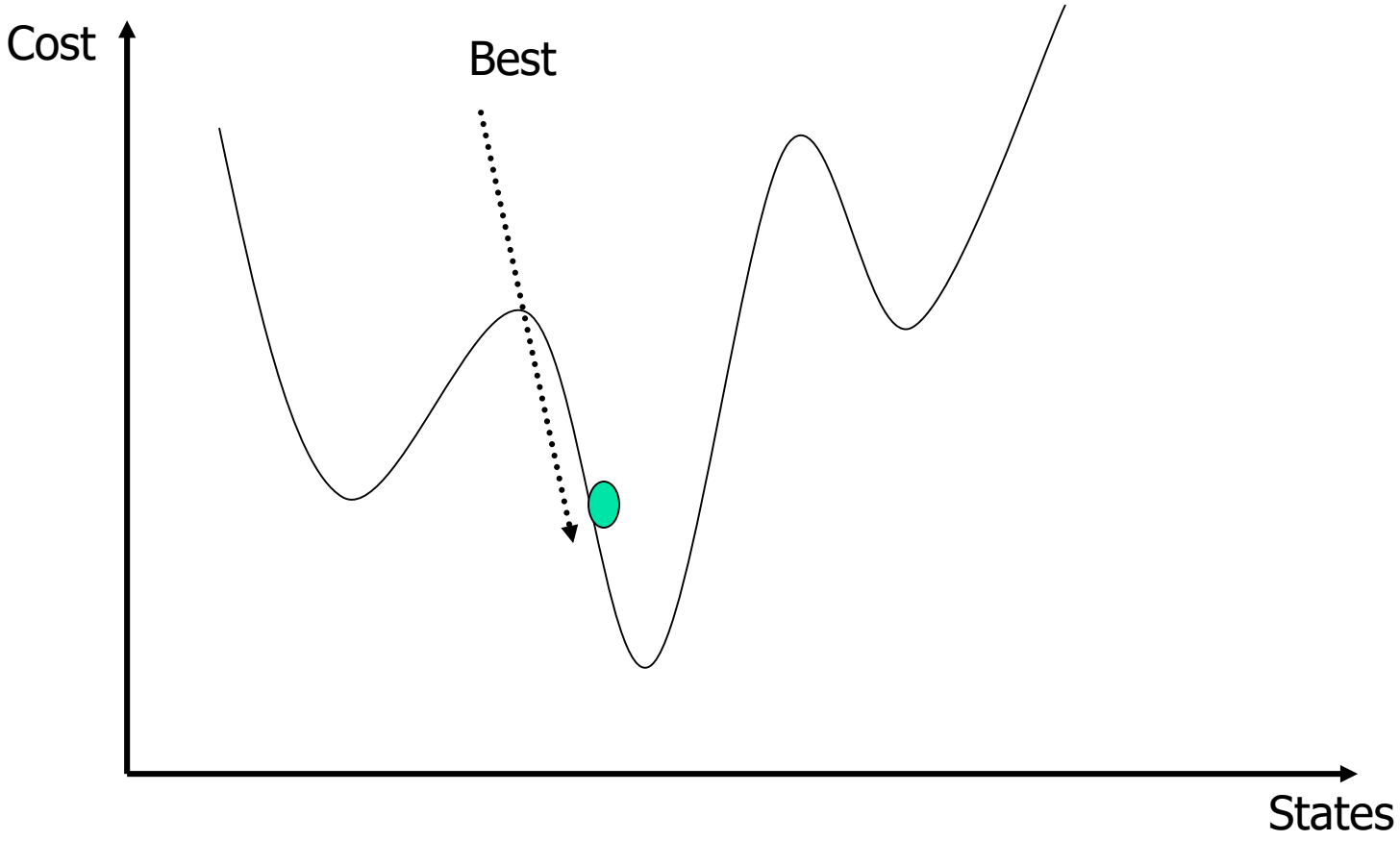

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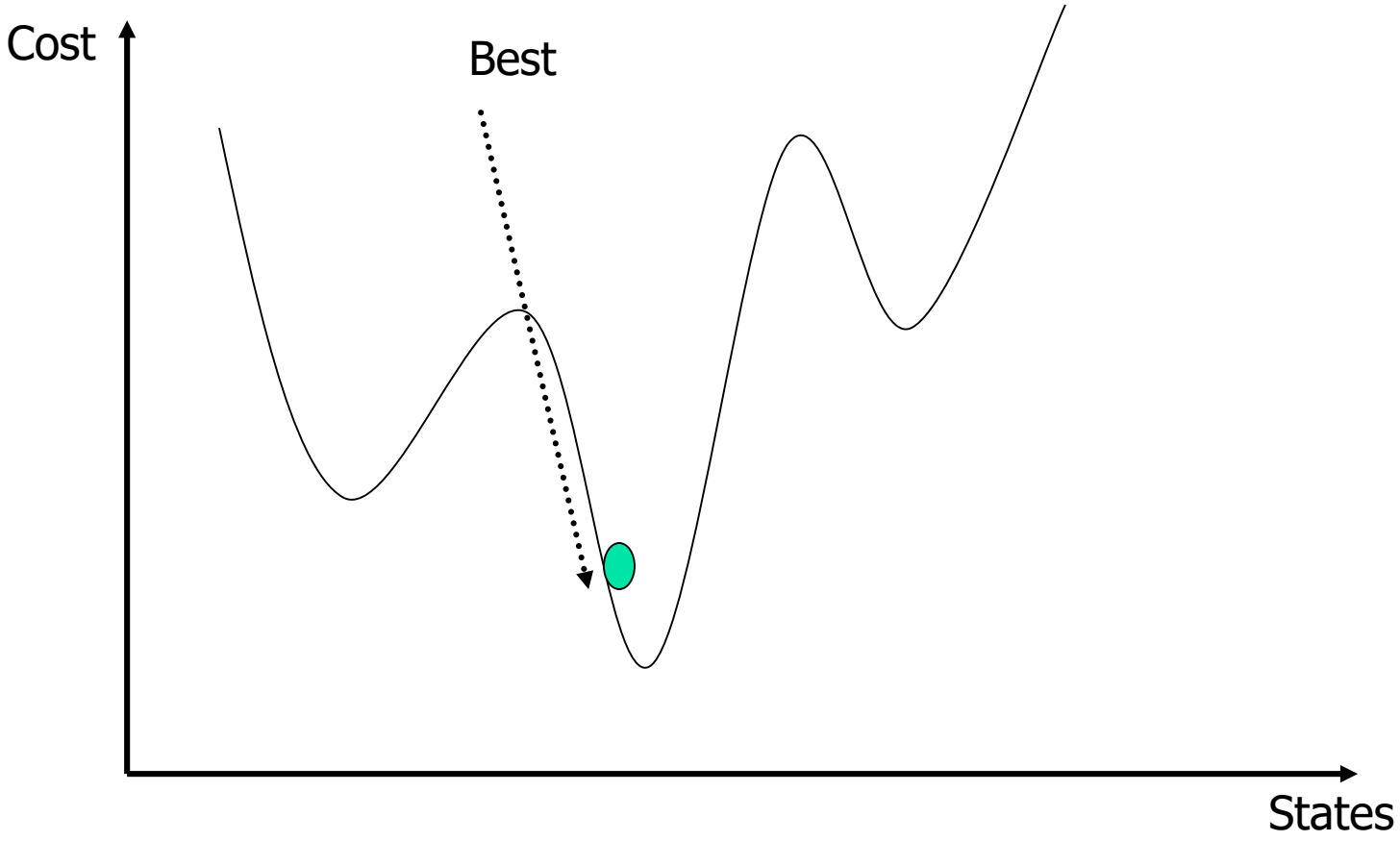

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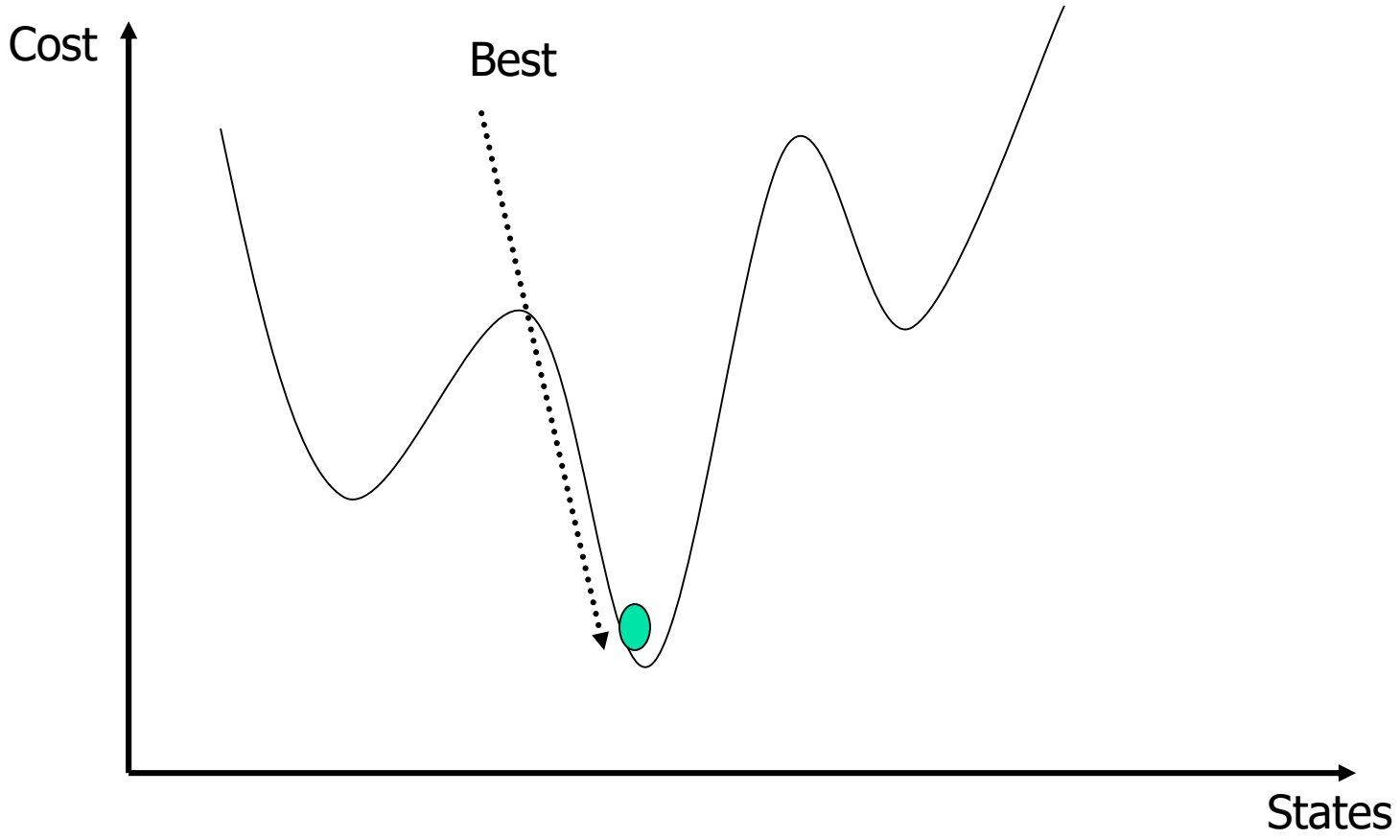

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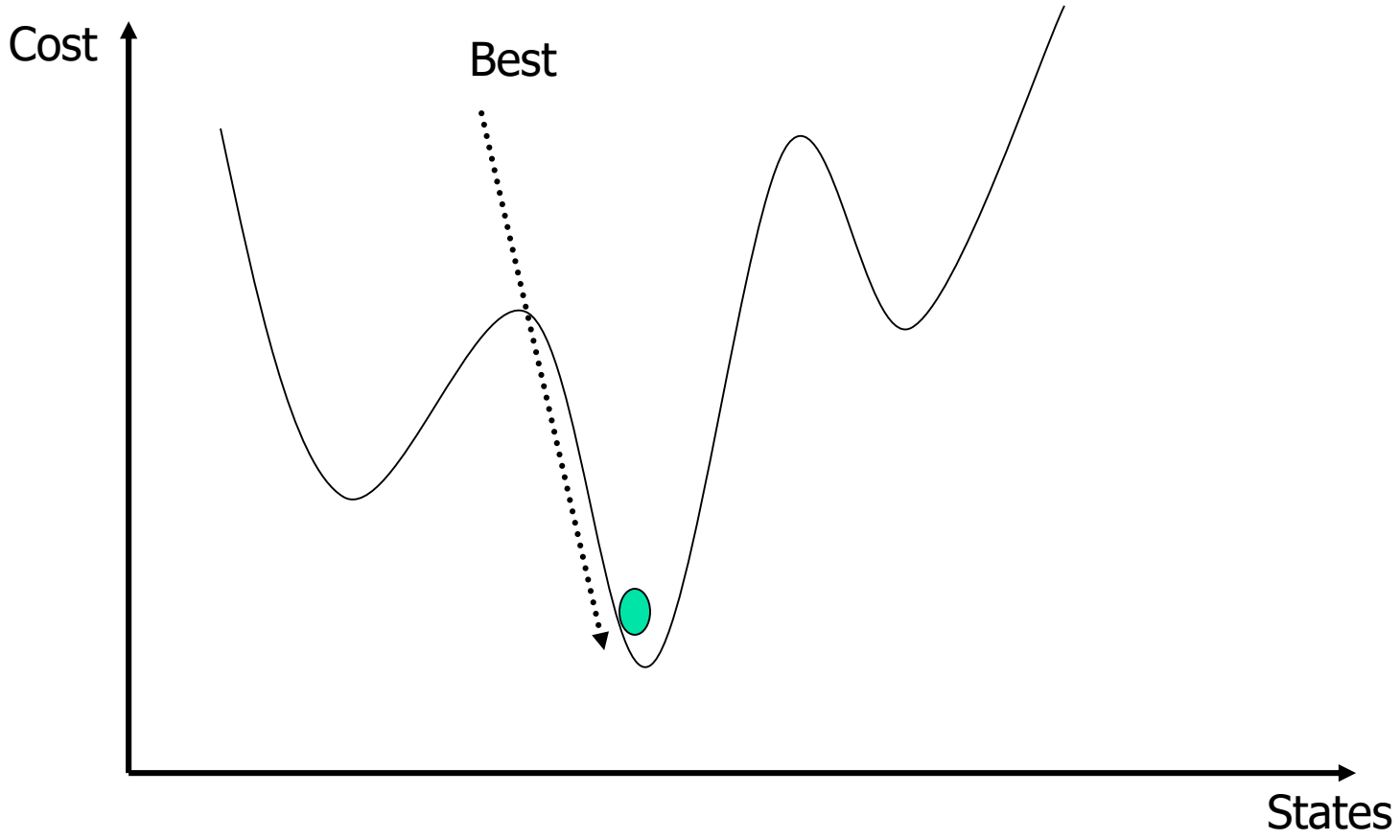

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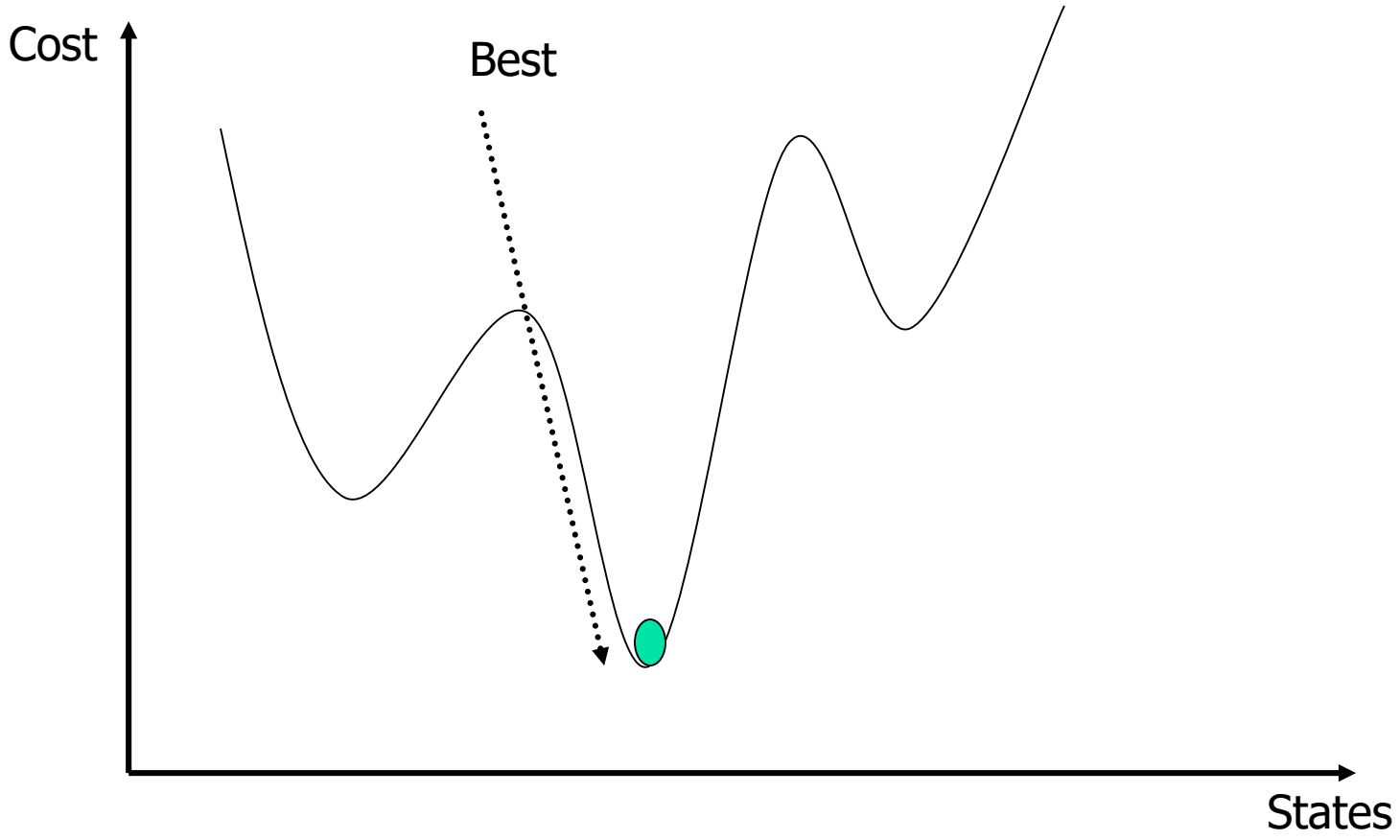

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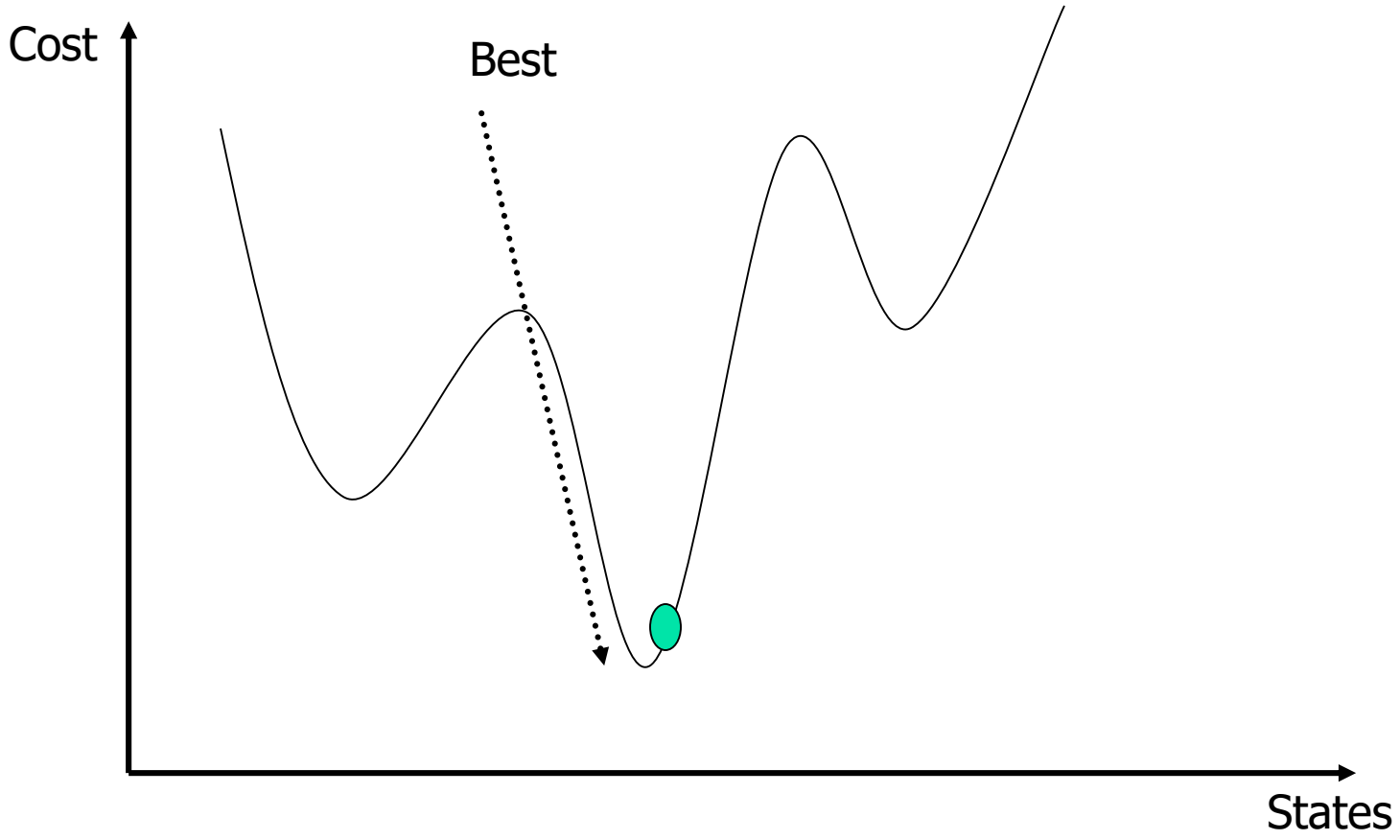

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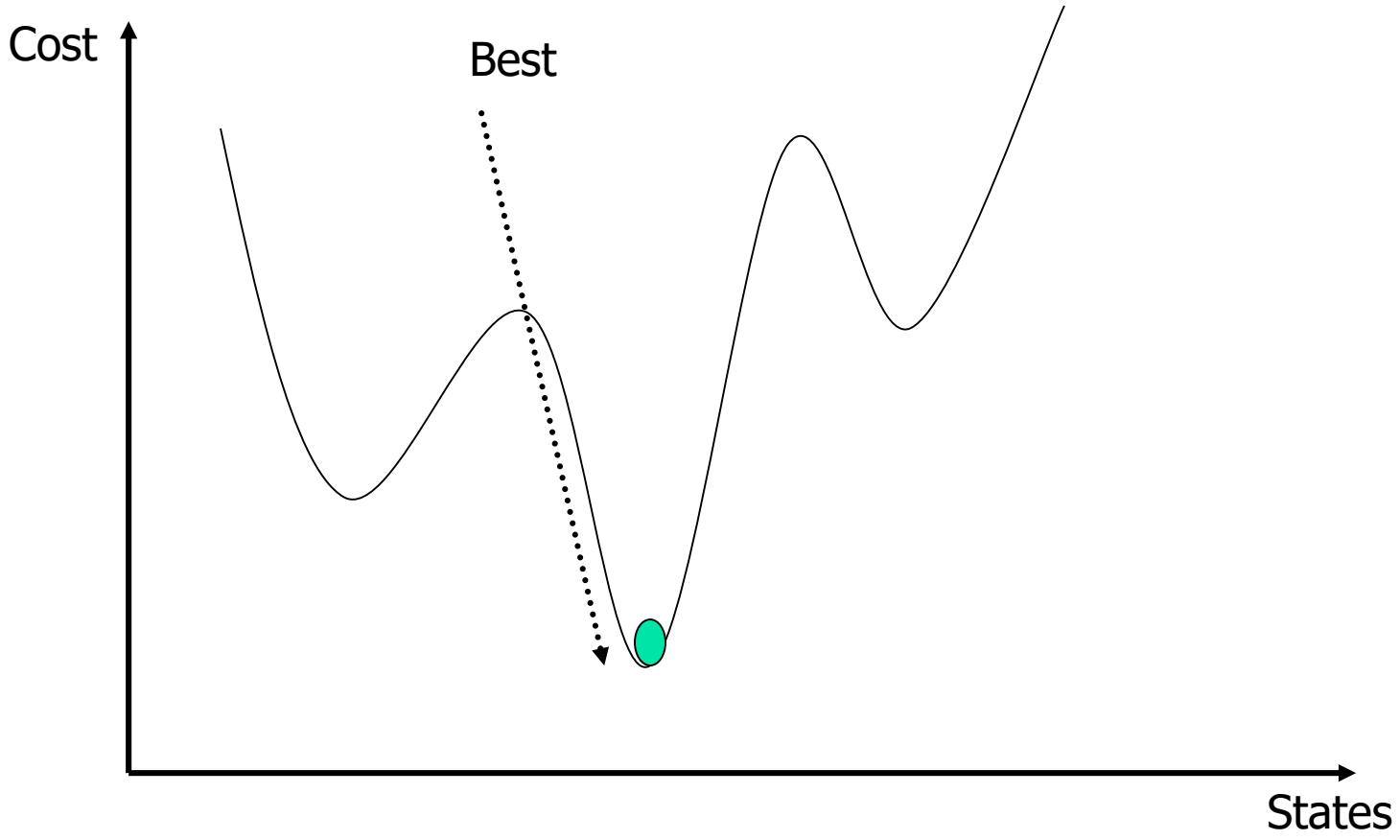

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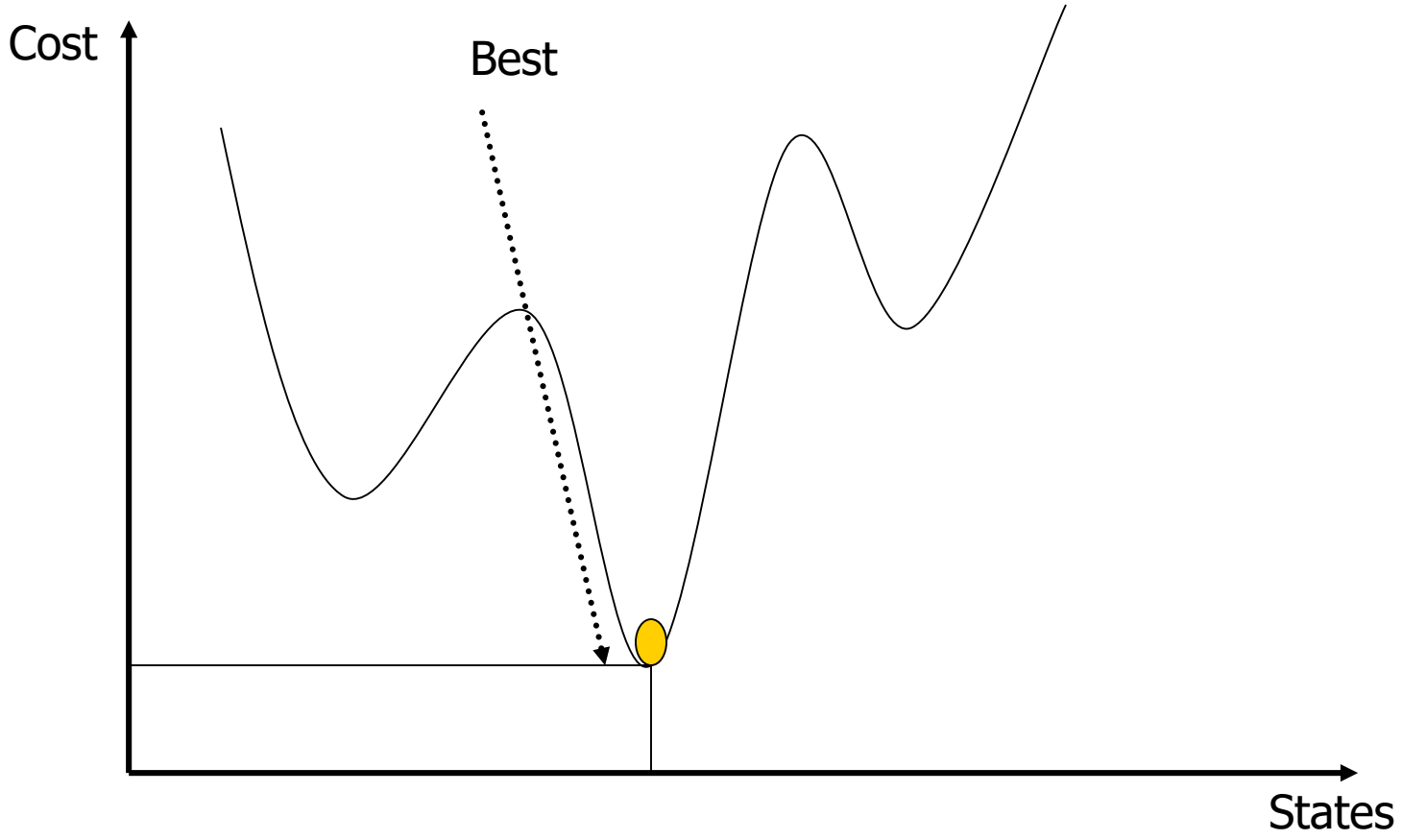
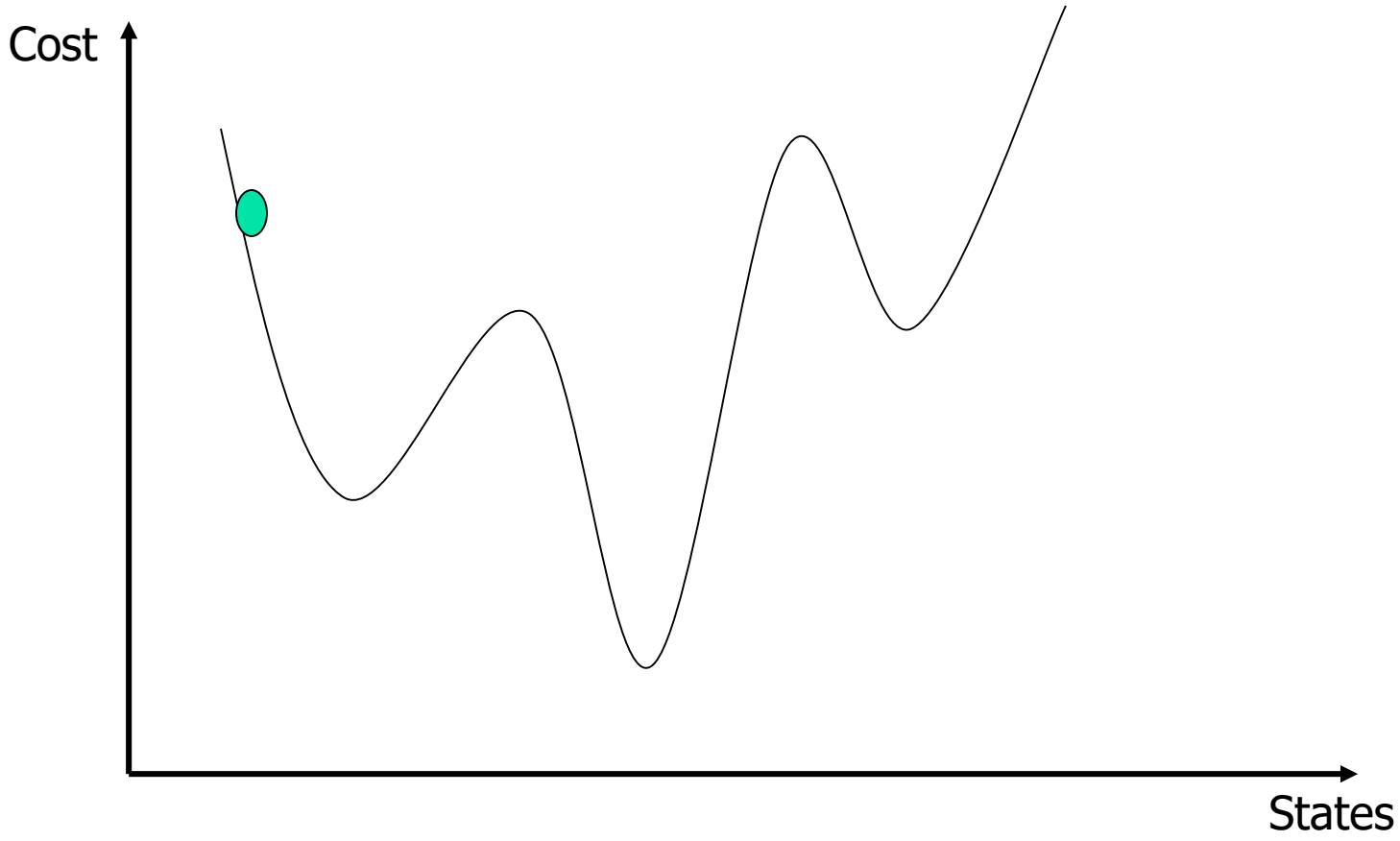


Tabu Search Algorithm

- Start with an initial feasible solution
- Initialize **Tabu** list
- Generate a **subset** of neighborhood and find the best solution from the generated ones
- If move is not in **Tabu list** then accept
- Repeat from 3 until **terminating condition**

Tabu Search: TS in Action …



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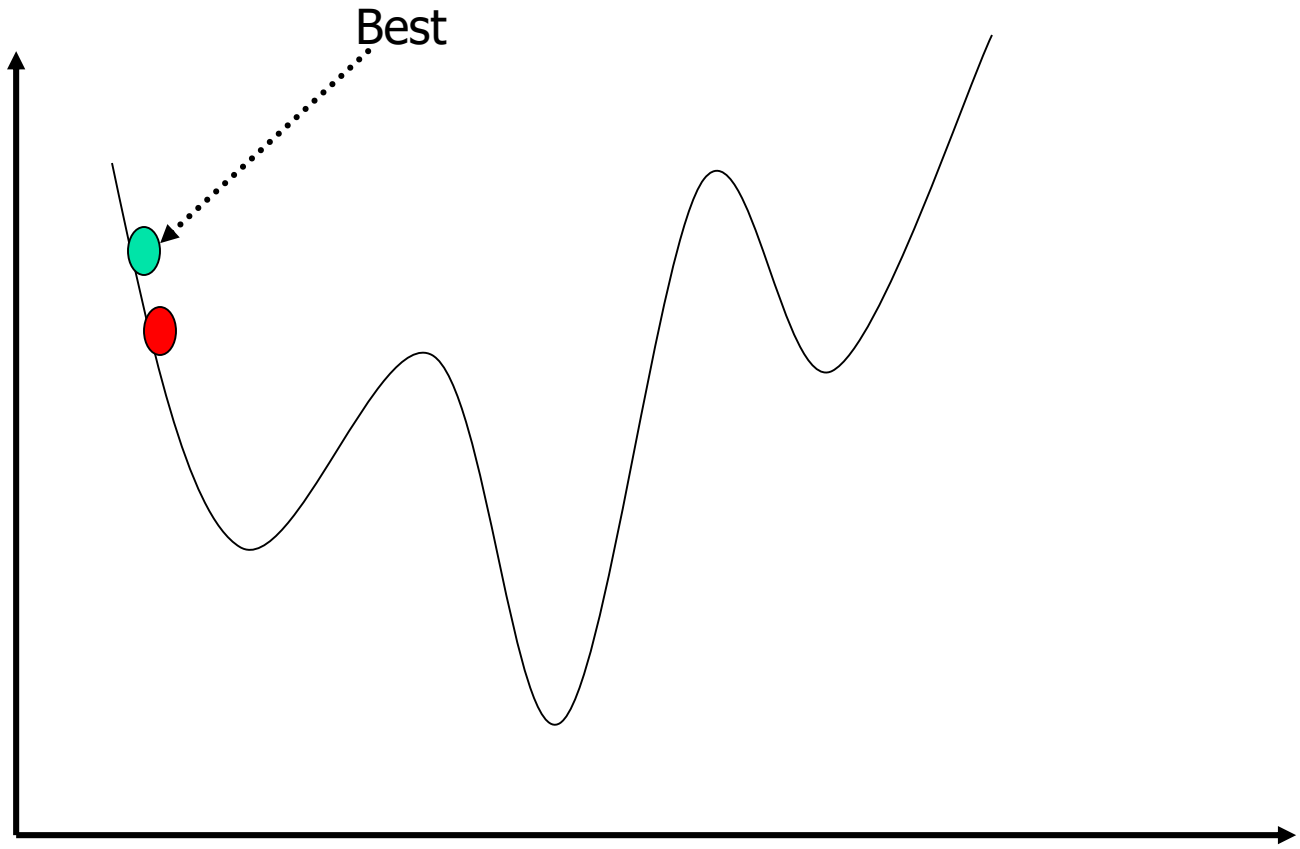

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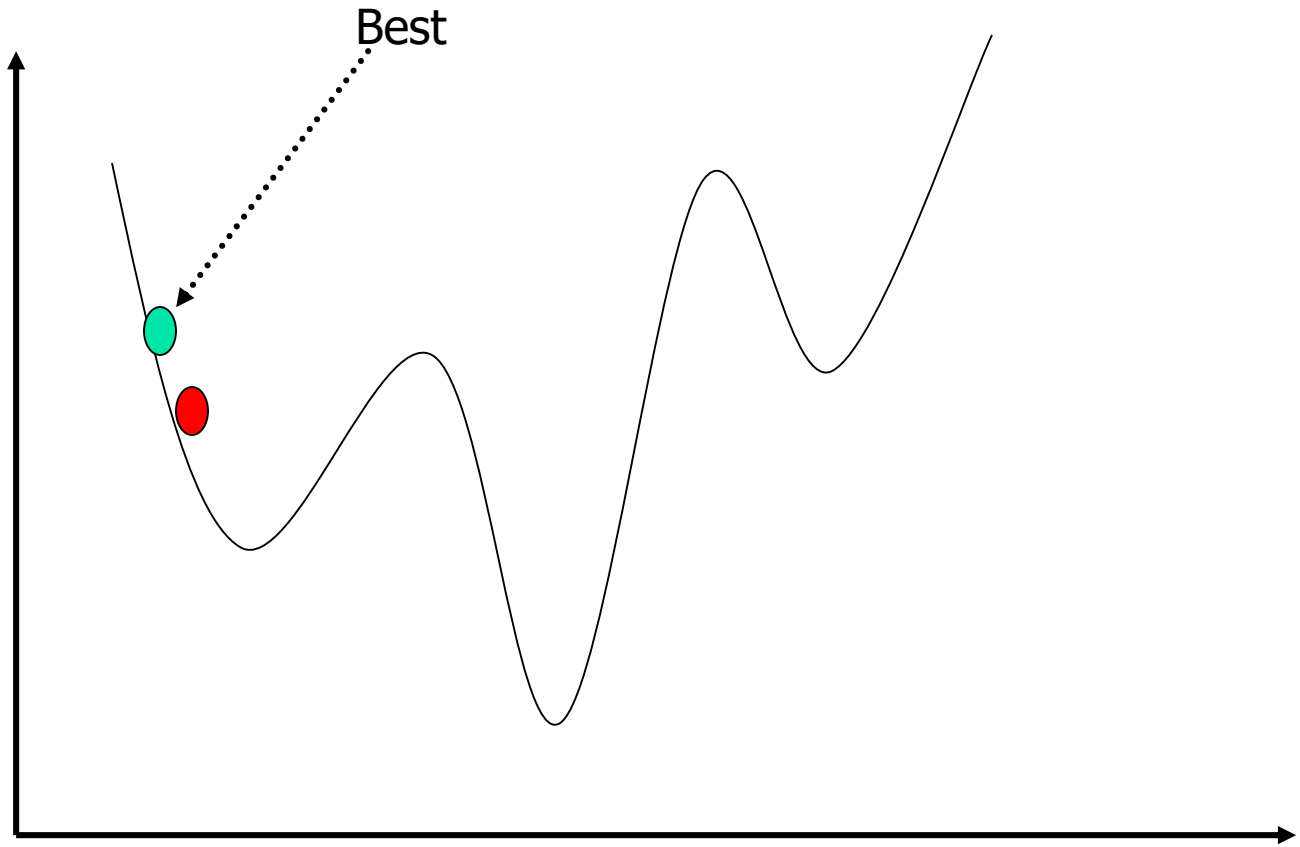

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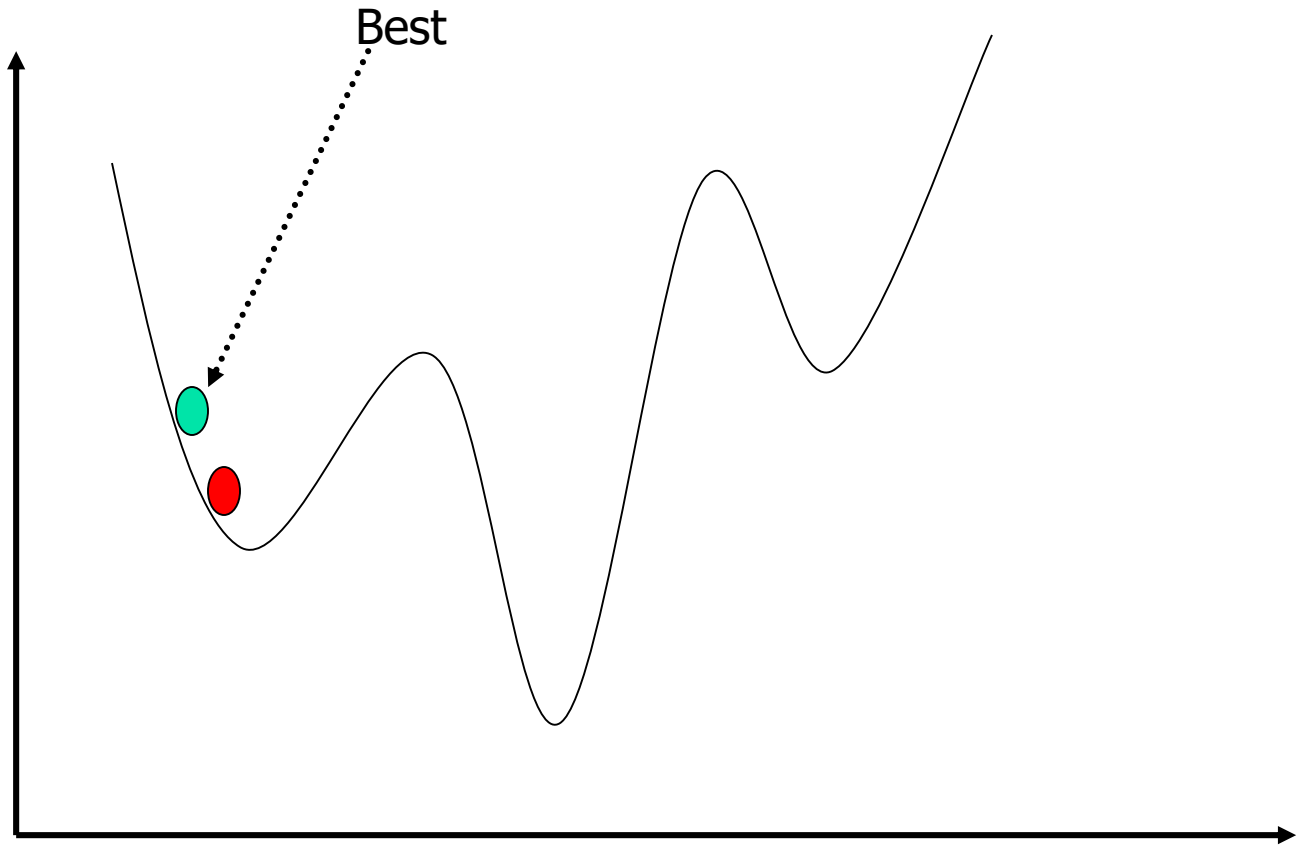

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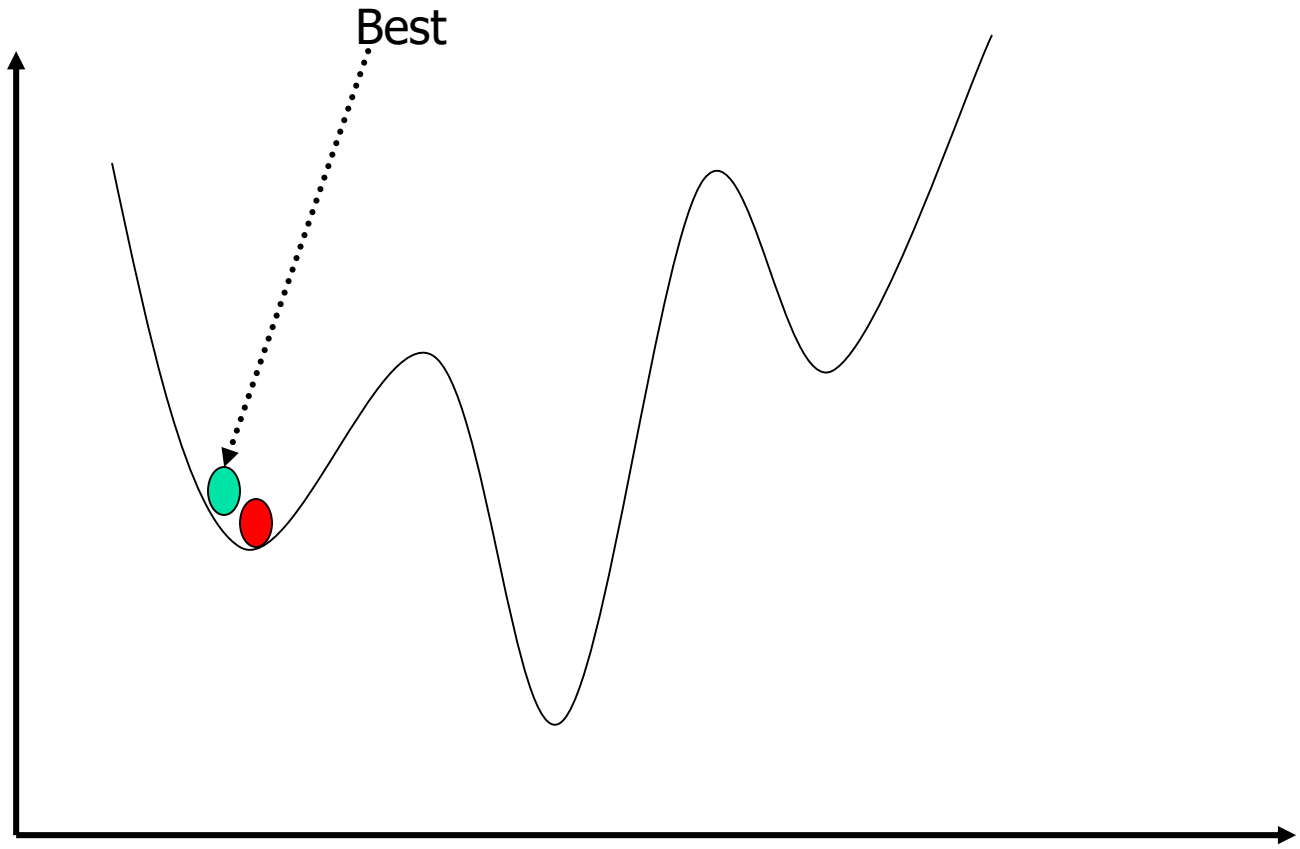

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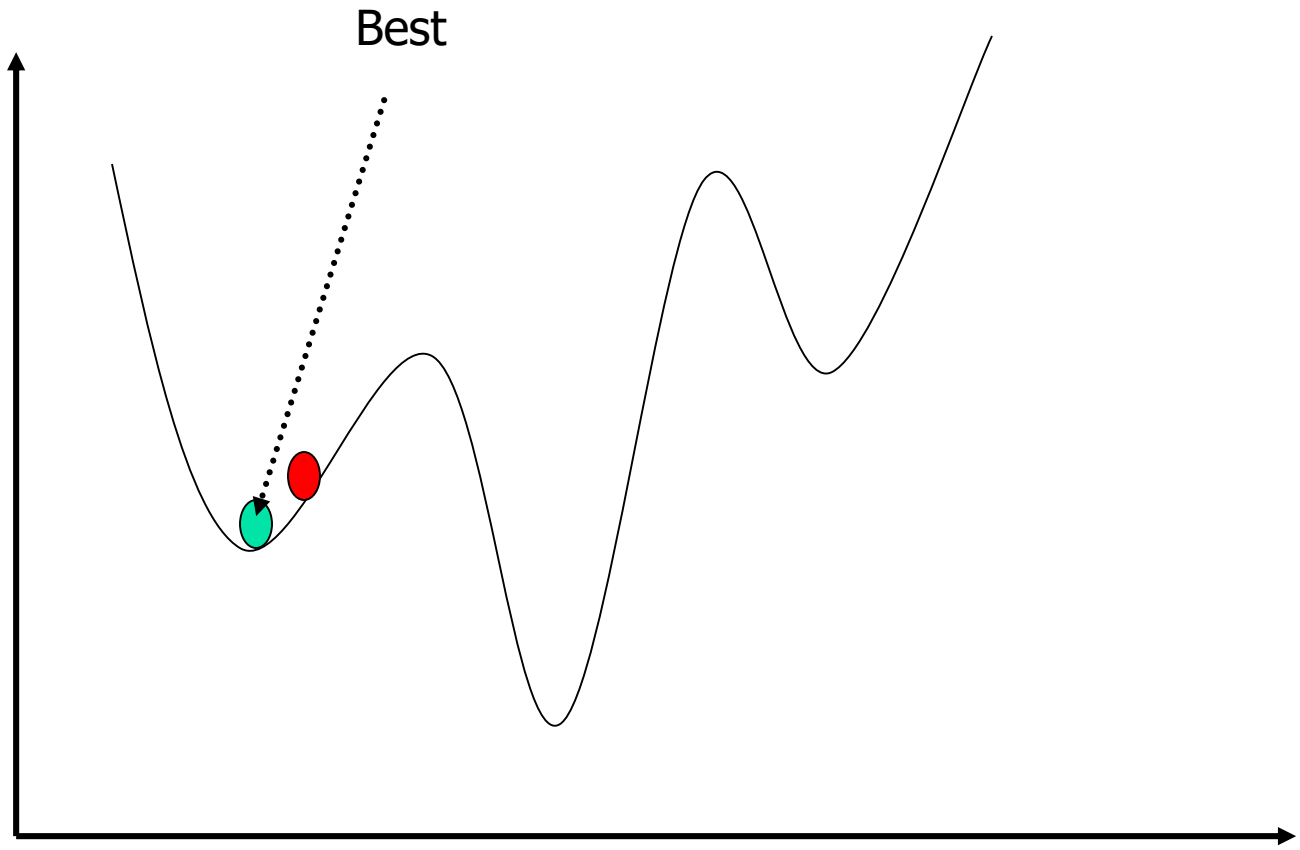

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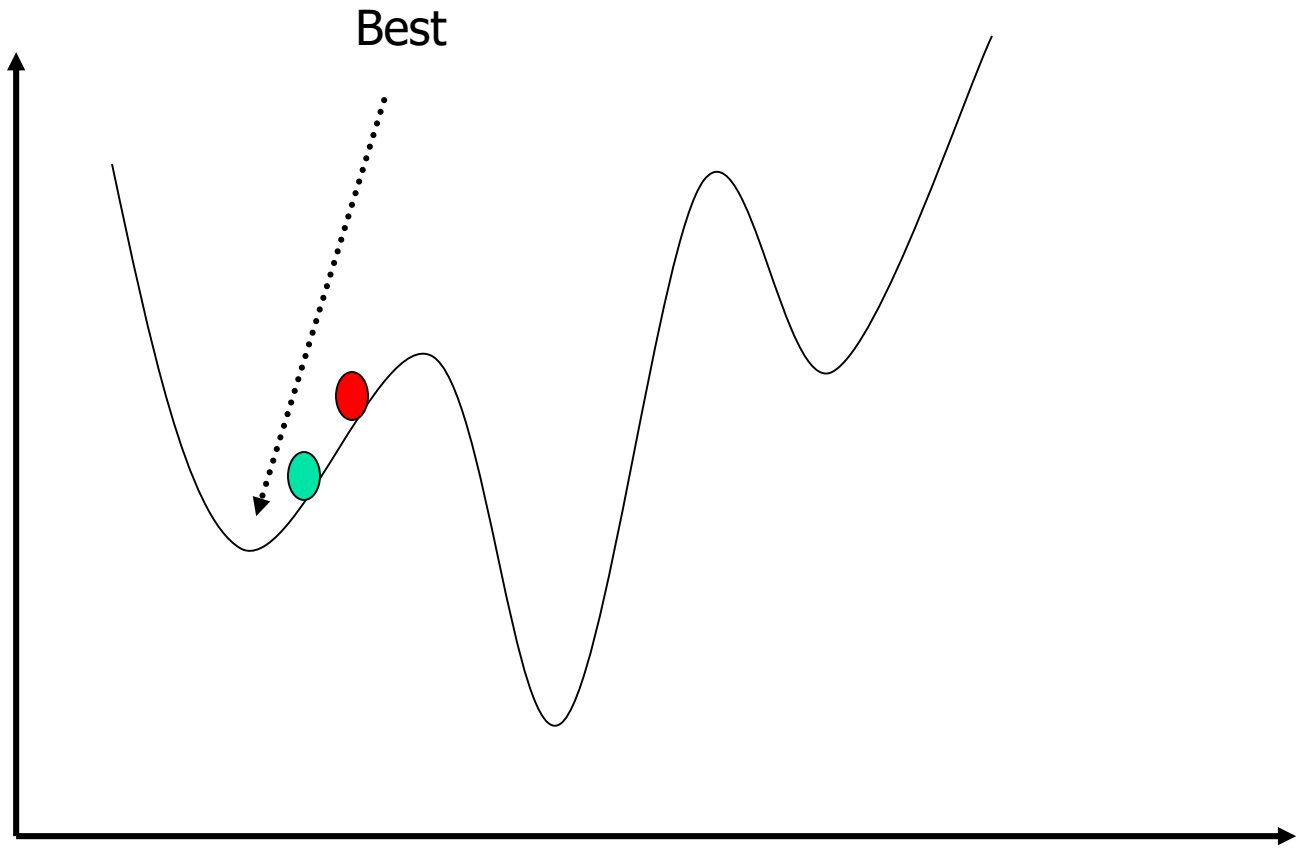

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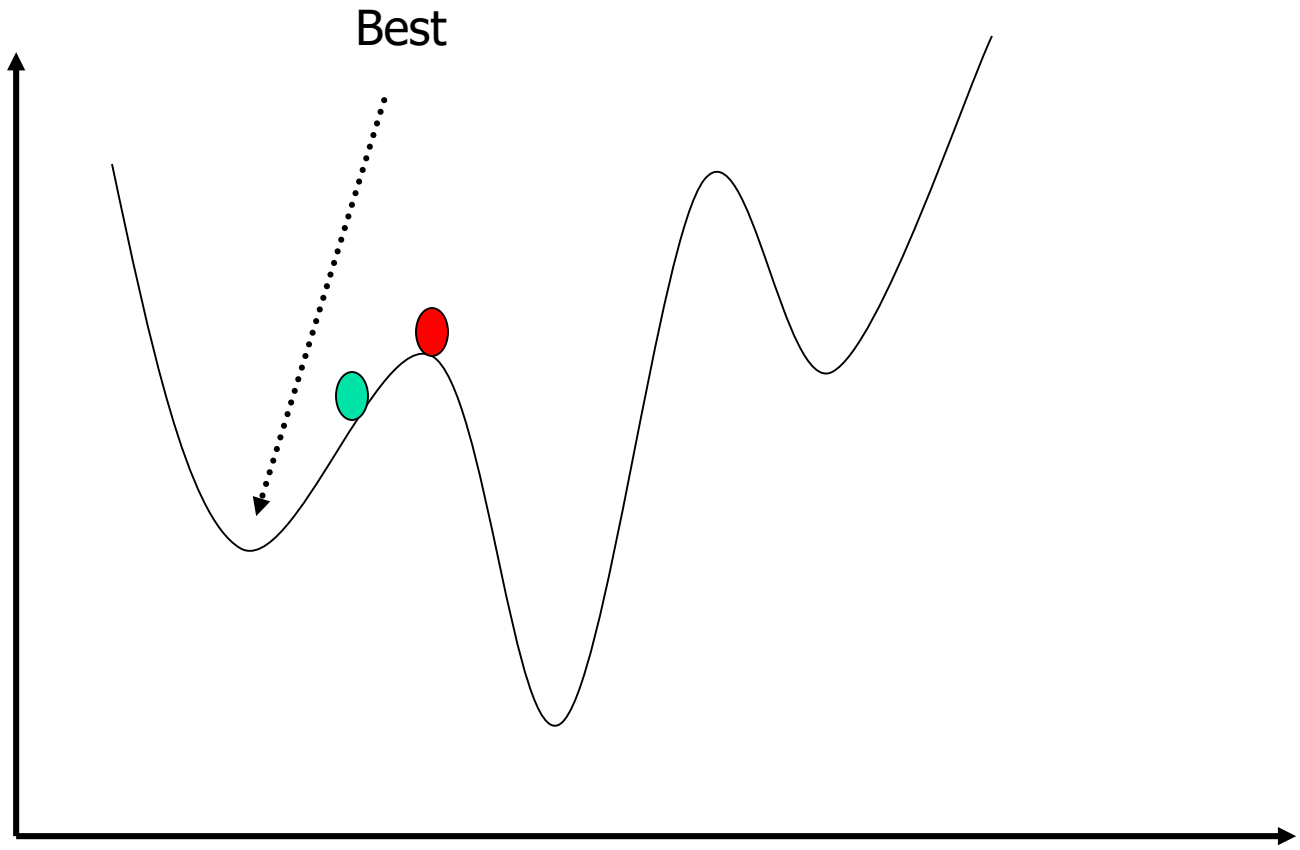

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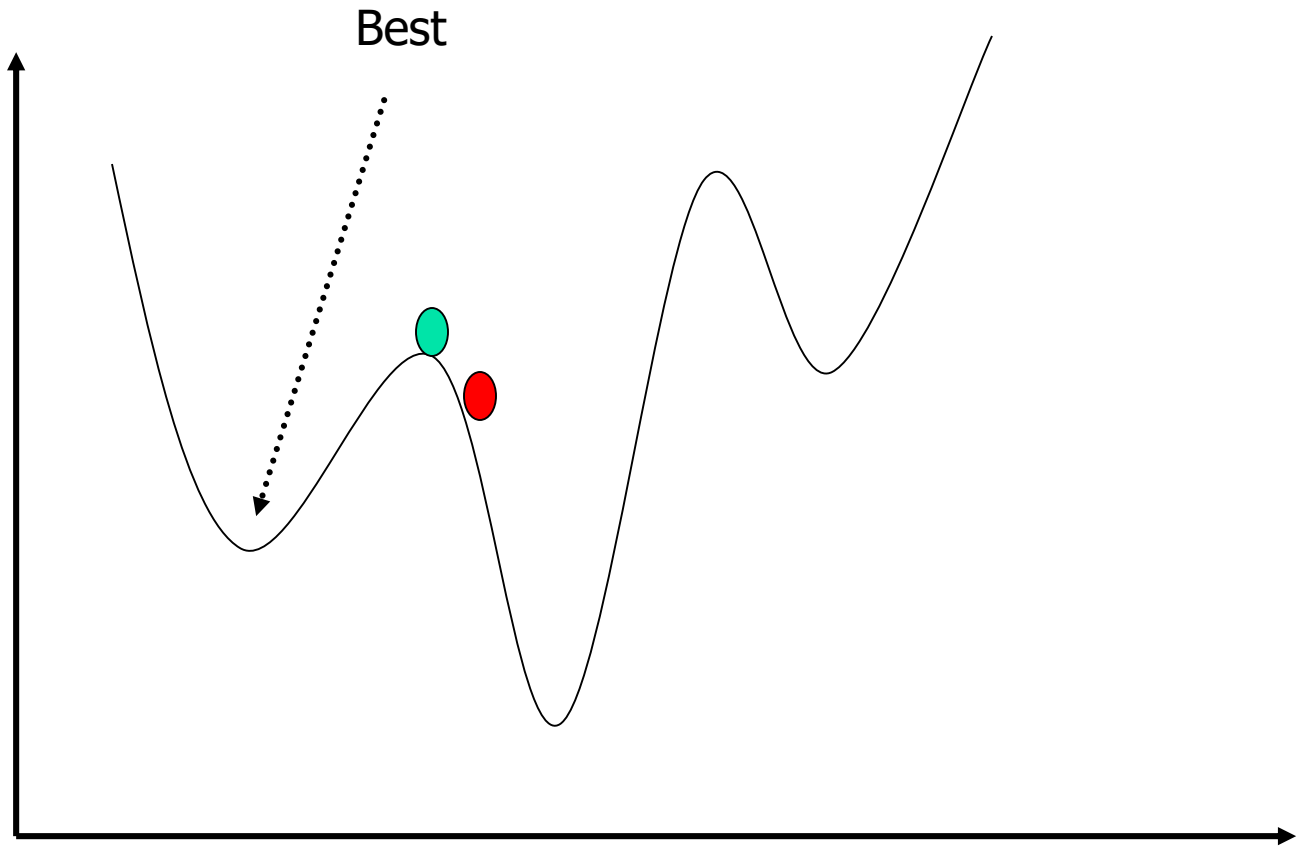

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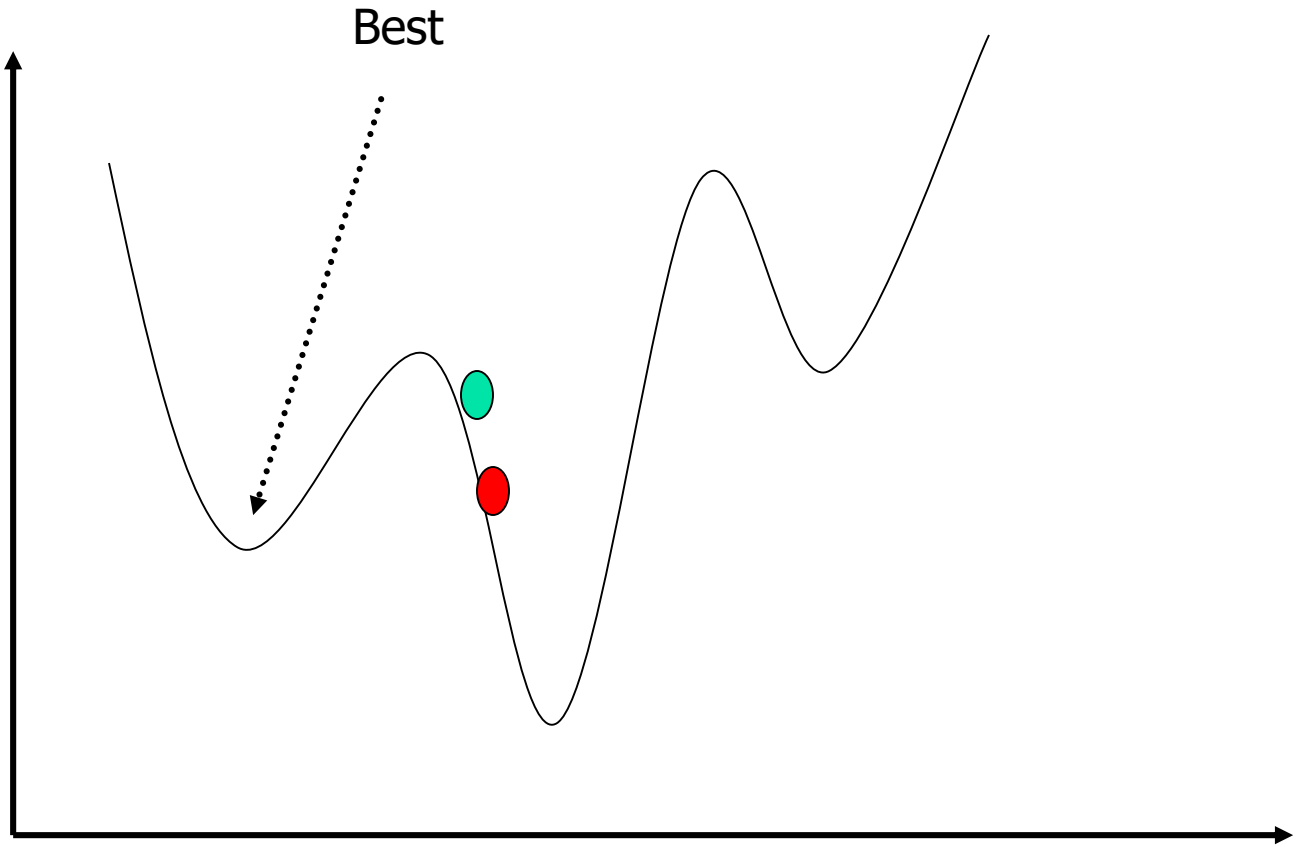

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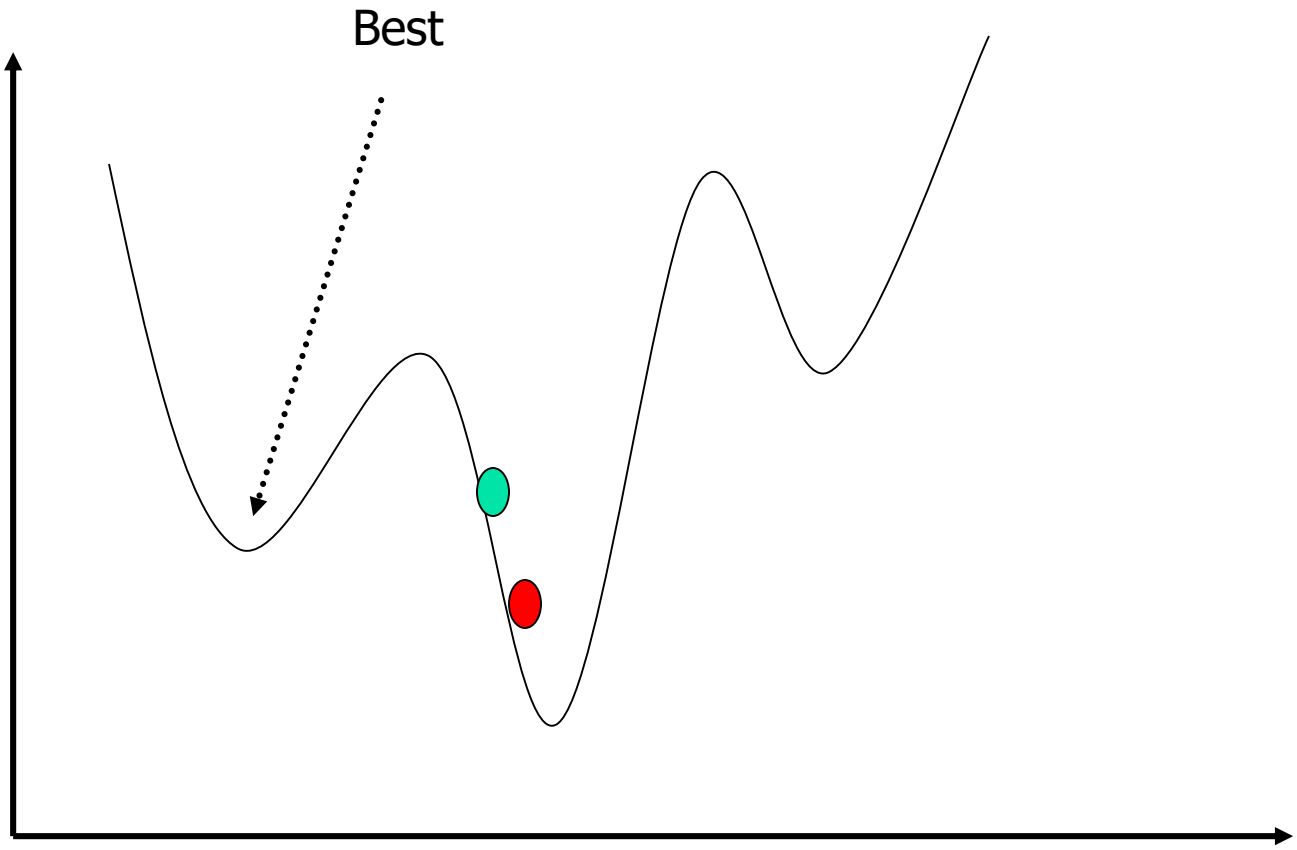

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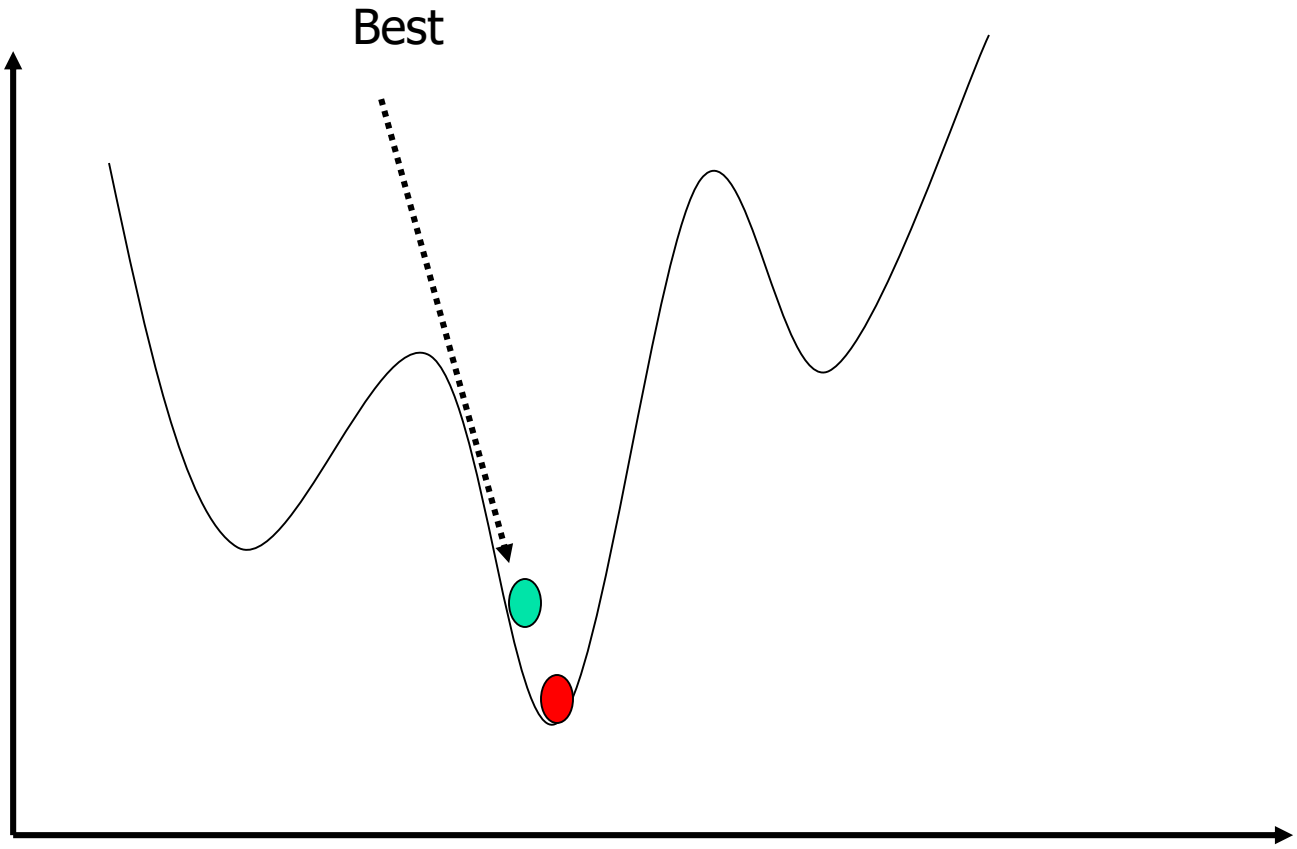

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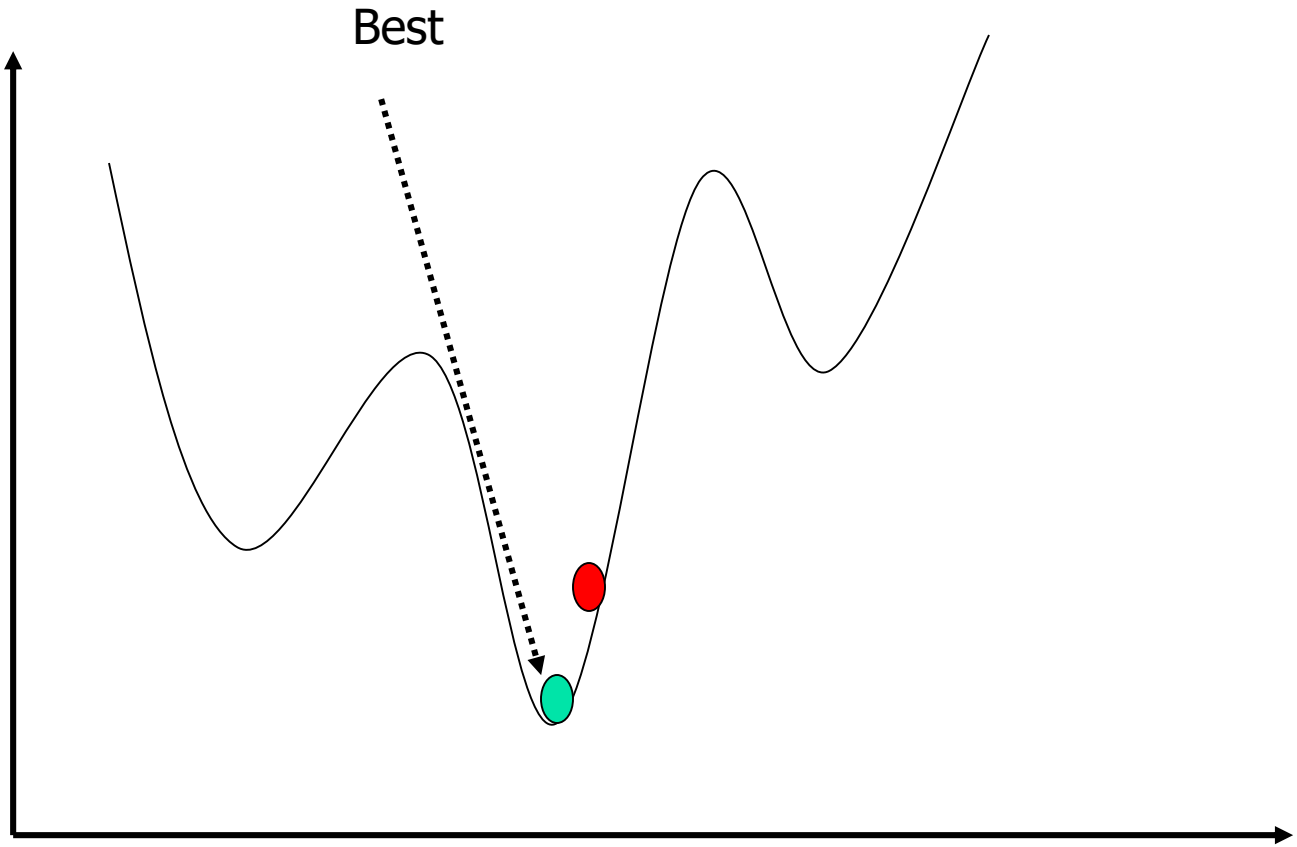

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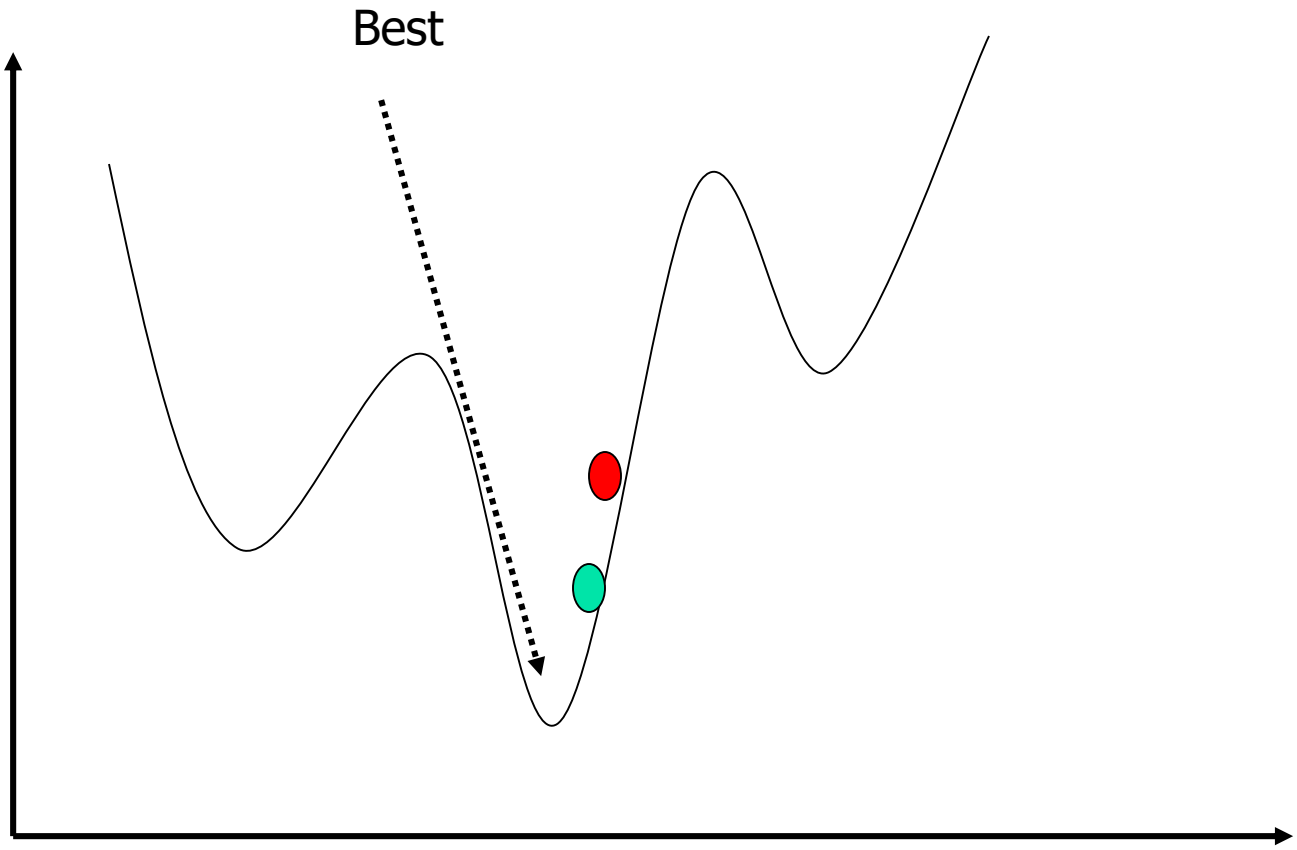

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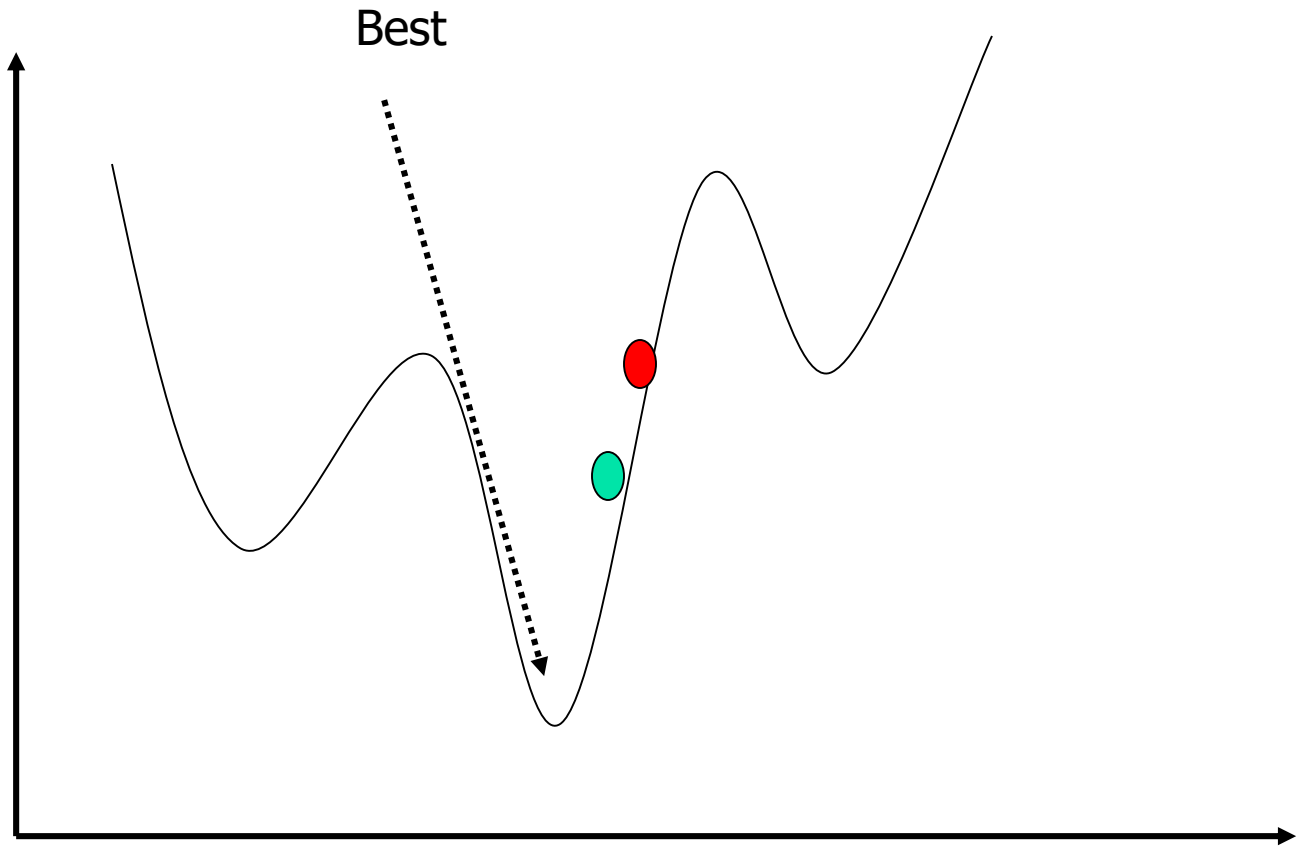

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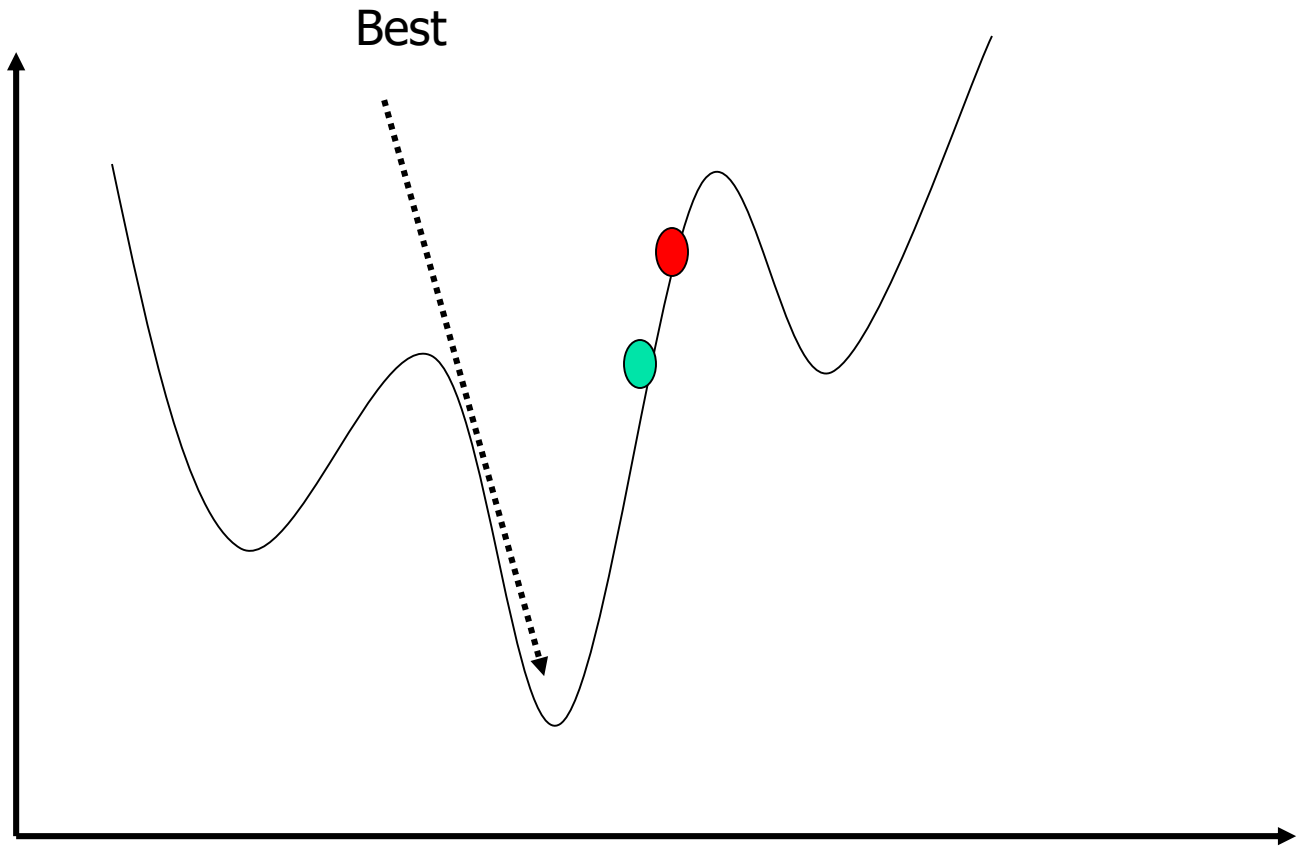

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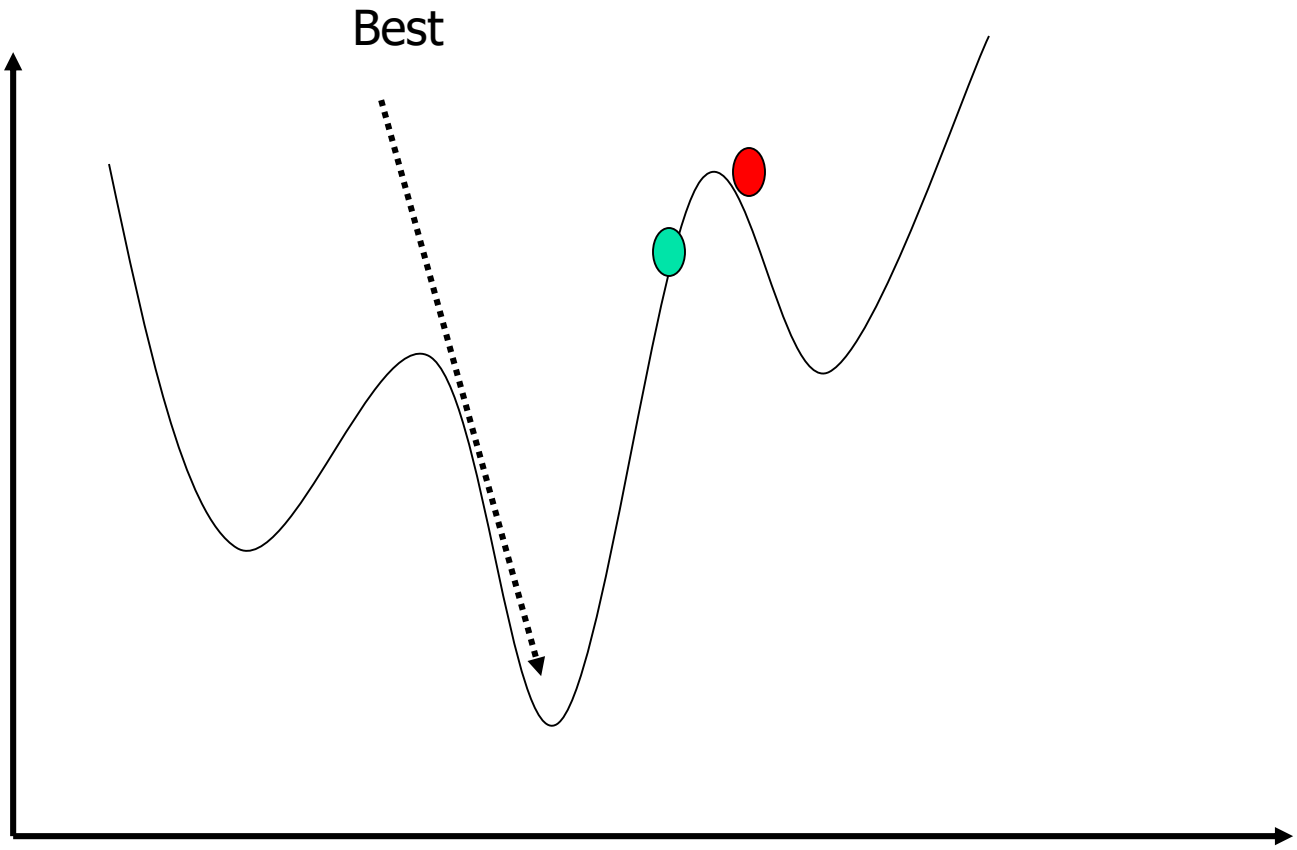

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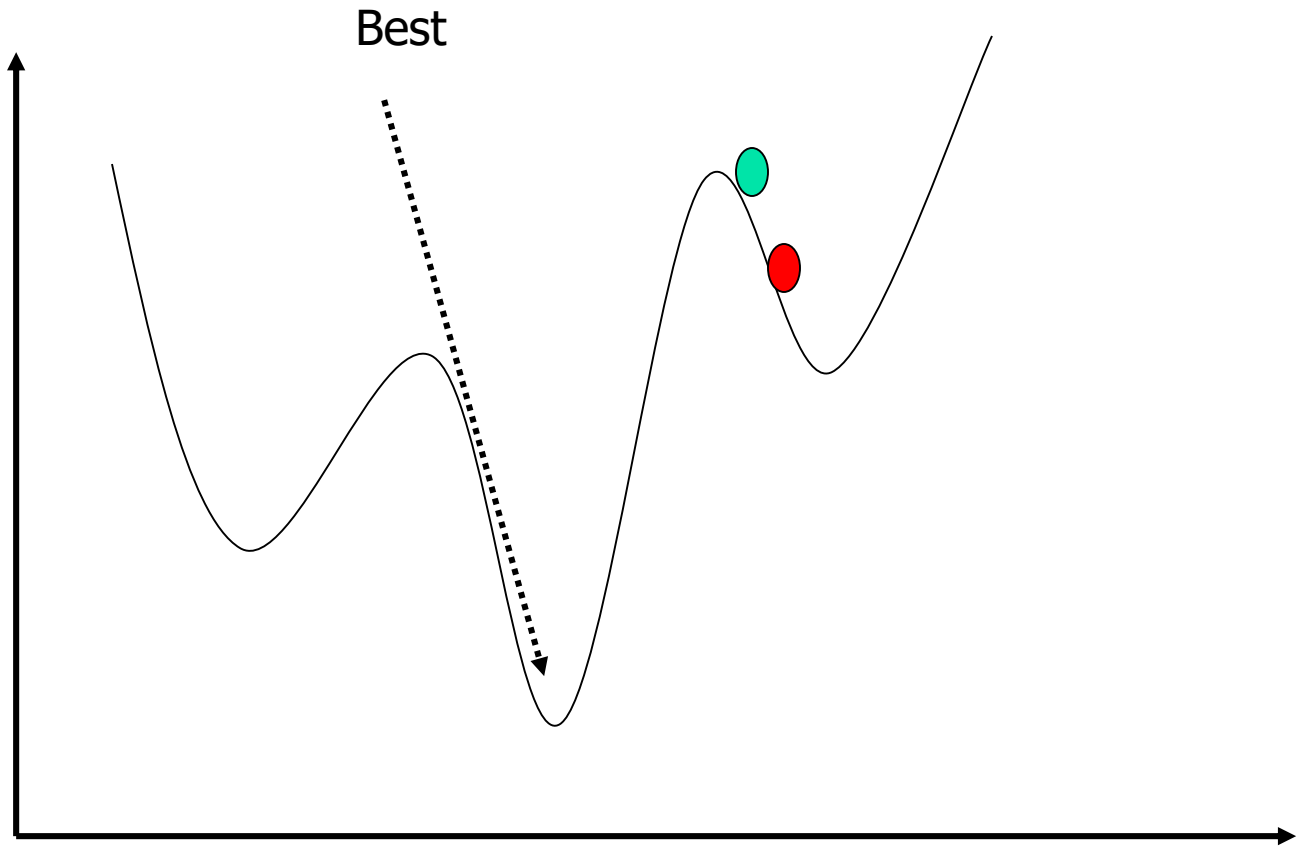

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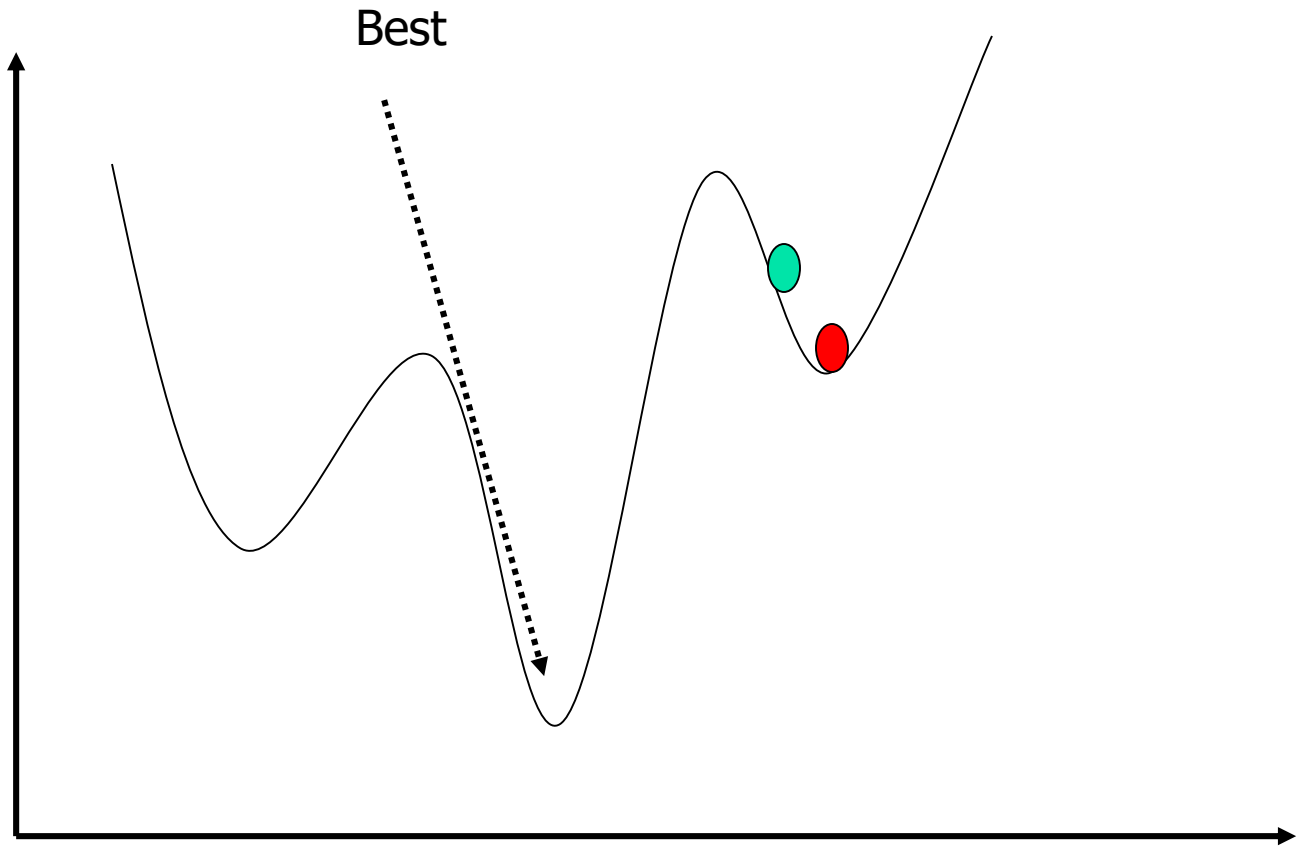

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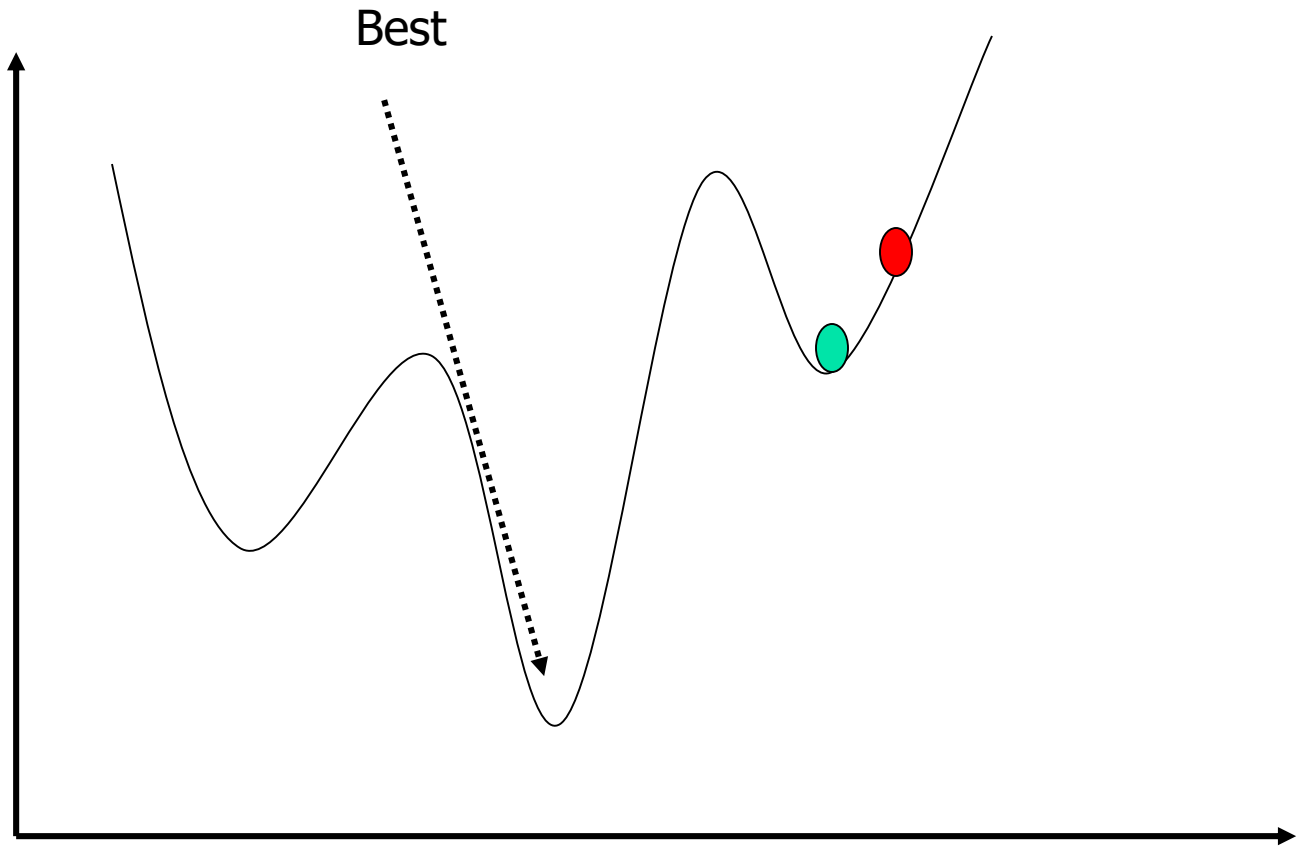

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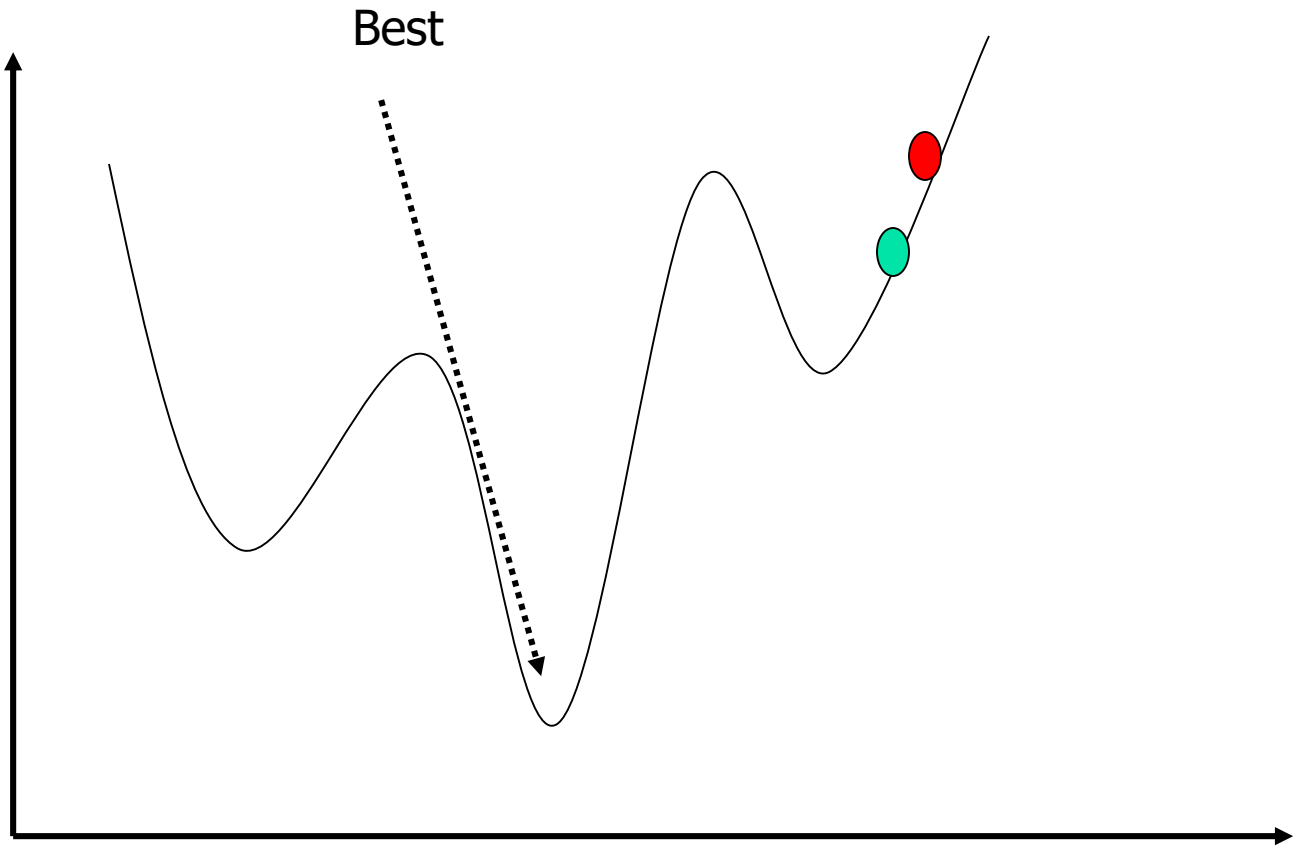

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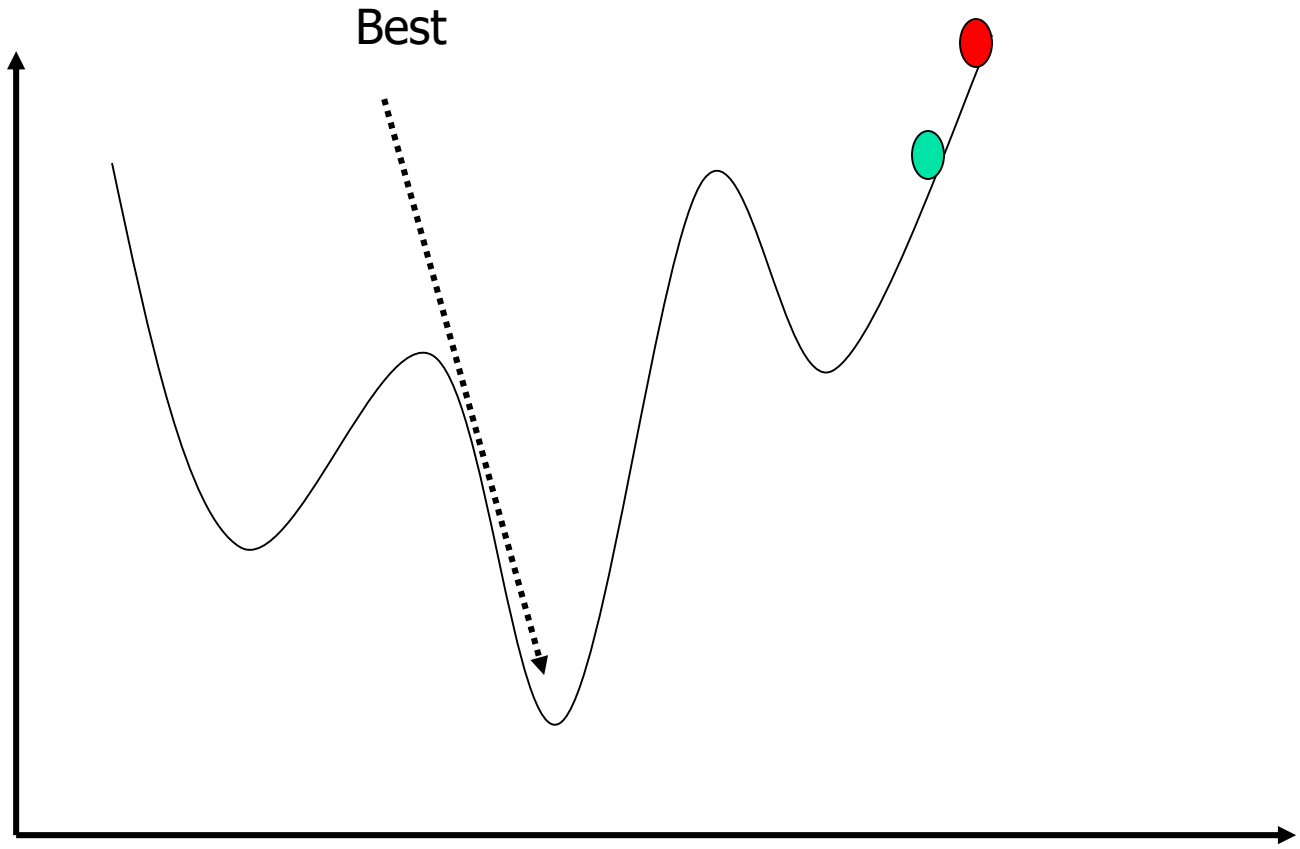

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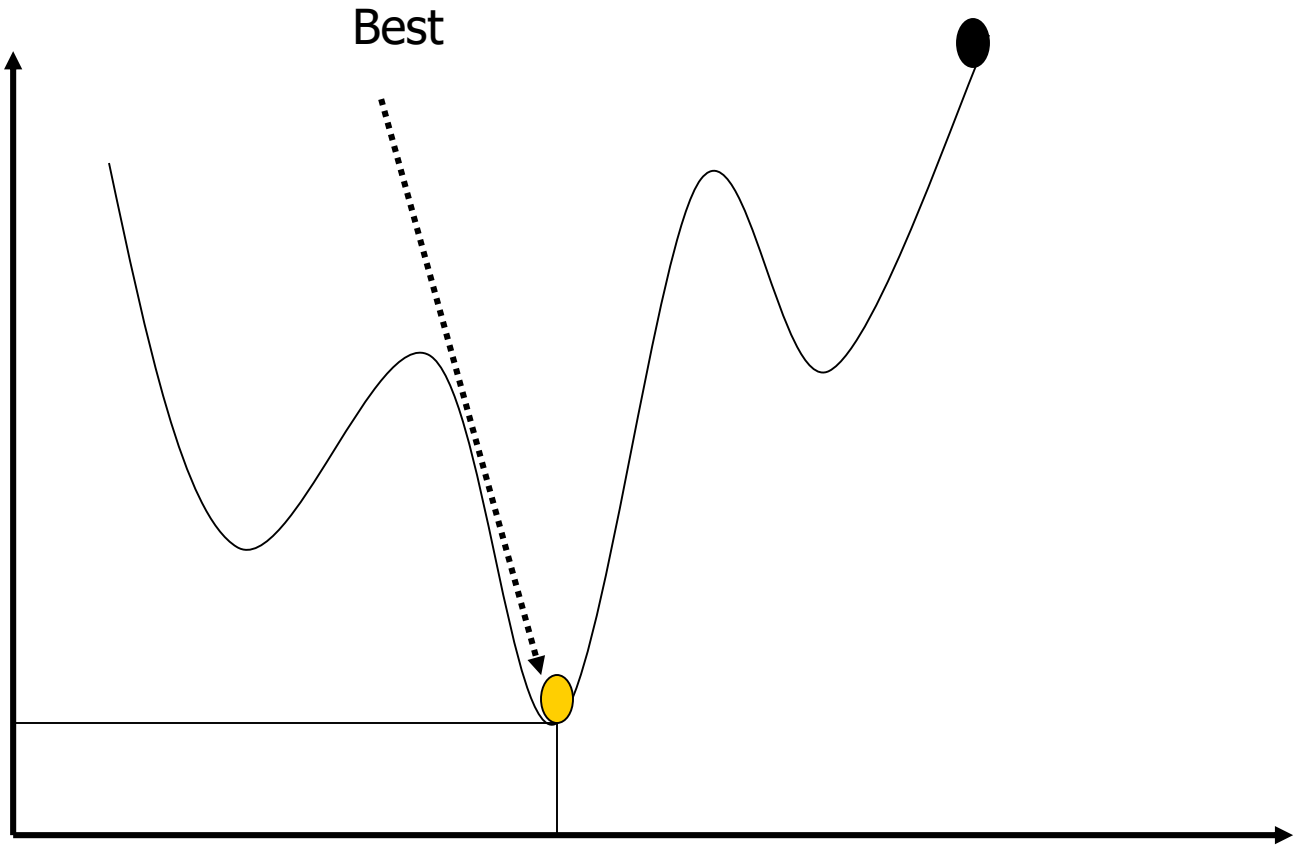

Summary

- Local search methods keep small number of nodes in memory. They are suitable for problems where the solution is the goal state itself and not the path.
- Hill climbing and simulated annealing are examples of local search algorithms.

References

Russell, S. J., Norvig, P., Canny, J. F., Malik, J. M., & Edwards, D. D. (2003). Artificial intelligence: a modern approach (Vol. 2). Upper Saddle River: Prentice hall.