AI

Intro

{ thinking humanly / rationally
| Acting humanly / rationally

1940 – 1950 → 1950 – 1970 → 1970 – 1990 → 1990 – Present

gestation of AI — McCulloch & Pitts, Turing's
early Enthusiasm
Knowledge based AI — AI winter
Neutral Network — Data + ML — spring

Agents and Evironment → Search Agents → Logical – → Learning ~ → Probabilistic – → Decision → Ethical AI → AI Application.

Search Agents { uninformed: BFS. DFS. UCS
informed: Greedy. A*

Adversarial Search: Game. Minimax. α-β stochastic
Constraints Satisfaction (CSP): problem formalization. back-tracking, arc-consistency

Logical Agents: syntax + semantic; $KB \vDash \alpha$;

ML: Data segmentation / clustering
unsupervised learning clustering. k-means, association rules
↳ Binary classification.
classification, K nearest neighbor perception neutal network linear regression
(perceive. think. act)

Agent

rational Agent: maximize a performance measure.
{ perceiving its environment through sensors
Acting upon that environment through actuators

PEAS { Performance (function): safety ...
Evironment: roads ...
Actuator: steering ...
Sensor: camera. GPS

Envir-Types:
Fully/Partially observation: sensor give all state of enviro
Deterministic (stochastic): completely determined by action. (stochastic: probability)
Static (dynamic): envir is unchanged while agent deliberating
Discrete (continuous): a limited number of distinct action.
Known (Unknown): have knowledge of environment.
Number of Agents: ( )

Agent Types { Simple reflex: base on current state
Model-based: evolves indepently from the agents/agent affect the world.
Goal-based
Utility-based. measure agents by a utility function/performance.

Agent's organizations: Atomic representation → search
Factored ~ → CSP
Structured ~

Reflex —— States —— Variable —— Logic → High-level Intelligence

AI search

Initial state:
states (space): (search space) → abstract configuration by tree or graph [Explored / Frontier (fringe) / Unexplored
Actions:
Transition model: action → result
Goal test:
Path cost:

Uninformed Agents

BFS. DFS DLS IDS. UCS. (b: branches; d: depth of solution; m: maxi depth)

BFS: Complete: yes (if b is finite)
queue FIFO
Time: $O(b^d)$
Space: $O(b^{d+1})$
Optimal: yes

DFS: Complete: no (fail in infinite depth spaces)
fringe: stack ~~FILO~~ LIFO
Time: $O(b^m)$
Space: $O(bm)$
Optimal: no

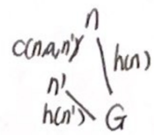
Depth-Limited Search (depth-limit L)
- Complete: no
- Time: $O(b^L)$
- Space: $O(bL)$
- Optimal: no

Iterative-Deepening Search.
- DLS with increasing limits
- Complete: yes
- Time: $O(b^d)$
- Space: $O(bd)$
- Optimal: yes. if step cost is 1.

1. start with random state. (Current)
2. $T = T_{max}$
3. when $T \neq 0$.
   - select a neighbor (n)
   - $\Delta h = h(c) - h(n)$
   - if $\Delta h \le 0$. $c = n$.
     else accept with prob. $\propto e^{(-\frac{\Delta h}{T})}$
   - decrease T. (exponential decay)

Uniform-Cost Search
- Complete: yes. if cost is finite.
- Time: $O(b^{C^*/\epsilon})$ C^*: cost of optimal solution) ϵ: Every action costs at least ϵ.
- Space: $O(b^{C^*/\epsilon})$
- Optimal: Yes

- Admissible $\forall n,\ h(n) \le h^*(n)$
- Consistency $\forall n,\ h(n) \le C(n,a,n') + h(n')$ $\underline{n' = succ(n)} \rightarrow A^*$



Informed Search

Greedy search
heuristic $h(n)$ estimate S to G
↳ from n to goal

A^* search
heuristic. $h(n) + g(n) = f(n)$
- $h(n)$: est n to goal
- $g(n)$: reach n.

complete ✓
Optimal ✓
Space. $O(b^d)$

trade off between. heuristic. Accuracy and Computational Cost.

Local Search

- Current state
- Move only to neighbor of that node.
- X search tree
- ✓ little memory
- ✓ good solution in continuous or large state space

⇒
- Hill climbing (greedy local search): local optima. only look for immediate goal
  ↳ sideway moves, Random start, Stochastic
- Simulated annealing (see 右上)
- Local beam search: maintain k state when $\underline{hc}$.
- Genetic algorithm: slow to converge.

AR Search

I: item → itemset
Transaction dataset $D = \{(tid, X_{tid}) / tid \in T, X_{tid} \subseteq I\}$ (T ← ID)
Size of Lattice itemset: $2^{|I|}$ (bottleneck. too many data. hard to search)

Apriori-Algor: BFS search layer +1

Frequency: $freq(X) = |t(X)|$
Support: $supp(X) = \frac{|t(X)|}{|D|} \ge MinSupp$
Mining Freq Itemset:
$F = \{X \subseteq I \mid supp(X) \ge MinSupp\}$.
Conf: $l-c \rightarrow c$
$conf(C(l-c) \rightarrow c) = \frac{supp(l)}{supp(l-c)} \ge Min\ Conf$
Minimum Confidence threshold

CSP

{variable. domains Constraints.
backtracking search. (DFS)
arc consistency

- MRV: ~~max~~ remain value
- LCV: least constraint value
- FC: one step further. (not detect unassigned)

Node, arc, Path {consistency. (trans)

complexity (AC) n: varia. d: domainsize.
$O(n^2d^3)$ if sub. $O(\frac{n}{c} d^c)$ (c → varia per subproblem)

$O(nd^2)$ (n → node)
↑
tree-structure (DAC)

Adversarial Search

- Initial state
- Players
- Actions
- ~~Transactions~~ Transition
- Terminal test
- Utility function

Minimax (optimal and complete)
DFS time and space.
α-β Pruning. $\{\alpha = -\infty$ (update max), $\beta = +\infty$ ($\sim$ min)
when $\alpha \ge \beta$. pruning {worst $O(b^m)$, ideal $O(b^{m/2})$
real time → eval(s) replace utility