COMS4701 Artificial Intelligence
HW1

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1 Problem I

1.1 Do a PEAS analysis of the Google Home.

Performance: Comfort, Efficiency/Connections to devices, Utility of suggestions, Implement of directions,.
Environment: Sounds/Noise from everywhere, User, WIFI, Linked devices, Unlinked devices, Online data, Personal data
Actuators: Speaker, Light signals, Google Assistant, Data management, Signal to linked devices,
Sensors: Microphone, GPS, Touch surface, Buttons

1.2 Describe the Google Home environment, using the classifications from lecture (classify based on observability, number of agents, deterministic/stochastic, and discrete/continuous).

Partially observable: Google home's sensors can not get full access to the complete state of the environment(e.g. the clear content of user's voic mixed with noises, the unknown status of linked devices and limited access to the personal data) at each point in time.
Stochastic: In stochastic environments, uncertainty about outcomes is modeled with probabilities. Google Home gives suggestions or answers but users may react unpredictable and when Google Home controls linked devices, the environment can be influenced by random factors(e.g. If we want Google Home to set the air-conditioner to certain temperature, the temperature can fluctuate based on many other temperature factors).
Dynamic: Some parts of environment (e.g. the position/link of devices, Wifi, time, light and noise) is changing while Google Home is deliberating.
Continuous: The answer/suggestions by google assistant can be unlimited in a form of NLP task and the implementations taken by Google Home when asked by users can also be continuous(e.g. temperature control, send voice message and recommendations).
Multi-agent: Google Home operates with human individuals and other smart devices authorized to control things in the environment.

2 Problem II

2.1 Whats the size of the state space in the N-puzzle game? Please justify. Remember the N-puzzle game contains $N = m^2 - 1$ tiles and one empty space.

The size of the state space in the N-puzzle game is $(N+1)!/2$.
JUSTIFY: For every j = 1, 2, ..., N, let N_j be the number of tiles T_i, $i < j$ that appears after T_j. Let N be the sum of all N_i and the row number of the empty tile T_0. THEN:

$$N = \sum_{i}^{15} N_i + row(T_0)$$

When the empty tile is moved horizontally, N doesn't change; when we move the empty tile vertically, N changes by an even quantity. So N mod 2 is invariant under any legal move of the empty tile.
We can conclude that the state space is split in two disconnected halves, one having N mod = 0 and the other having N mod 2 = 1, states of the same half can be reached by each other. For a goal state g to be reachable from state s, N_g and N_s should have the same parity and vice versa.
So only half of the possible state can be reached, that proves that The size of the state space in the N-puzzle game is $(N+1)!/2$.

3 Problem II

Let h1 and h2 be two admissible heuristics . Which of the following heuristics are admissible? Justify each answer.

3.1 (a)

$h(n) = min\{5 * h1(n), h2(n)\}$ is admissible.
Justify: $h(n) = min\{5 * h_1(n), h_2(n)\} \leq min\{+\infty, h_2(n)\} = h_2(n) \leq h^*(n)$
So $h(n) \leq h^*(n)$

3.2 (b)

$h(n) = max\{h1(n), h2(n)\}$ is admissible.
Justify: $h(n) = max\{h1(n), h2(n)\} \leq max\{h^*(n), h^*(n)\} = h^*(n)$
So $h(n) \leq h^*(n)$

3.3 (c)

$h(n) = w * h_1(n) + (1-w) * h_2(n), with 0 \leq w \leq 1$ is admissible.
Justify: $h(n) = w * h_1(n) + (1-w) * h_2(n) \leq w * h^*(n) + (1-w) * h^*(n) = h^*(n)$
So $h(n) \leq h^*(n)$

3.4 (d)

$h(n) = \frac{max\{2*h_1(n), h_2(n)\}}{2}$ is admissible.
Justify: $h(n) = \frac{max\{2*h_1(n), h_2(n)\}}{2} = max\{h_1(n), h_2(n)/2\} \leq max\{h^*(n), h^*(n)/2\} = h^*(n)$
So $h(n) \leq h^*(n)$