CS3243 Assignment 3

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3. i) h_1 = number of pallets left

h_1 is admissible

Even in the most optimal case where Pac-Man makes no wasted movements and eats 1 pallet per action, number of moves = number of pallets left
If there are any pallets left that are isolated or Pac-Man has to backtrack,
number of pallets left < number of actions Pac-Man makes

$h_1(n) \leq h^*(n)$ for all states n

ii) h_2 = number of pallets left + minimum among all Manhattan distances from each remaining pallet to current position of Pac-Man (closest pallet)

h_2 is inadmissible

counterexample: state where there is 1 pallet left 1 move away from Pac-Man

$h_2(n) = 1+1 > h^*(n) = 1$

There exists a state where h_2 overestimates path cost to goal

iii) h_3 = maximum among all Manhattan distances from each remaining pellet to current position of Pac-Man (furthest pallet)

h_3 is admissible

Manhattan distance is the minimum number of moves Pac-Man has to take to reach the pellet

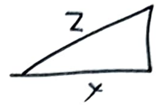
To even eat the pellet with the maximum manhattan distance, Pac-Man has to take the same amount of actions. The optimal case is when Pac-Man can eat all the other remaining pellets on the way to that furthest pellet without making moves in other directions except forward the furthest pellet. Else, $h_3(n) < h^*(n)$

Thus $h_3(n) \leq h^*(n)$ for all states n

iv) h_4 = average over all Euclidean distances from each remaining pellet to current position of Pac-Man

h_4 is admissible

Manhattan distance dominates Euclidean distance (due to $\triangle$ inequality ?)



$$z < x+y$$
$$z^2 = x^2 + y^2$$
$$< x^2 + 2xy + y^2$$
$$= (x+y)^2$$
$$z < x+y$$

since h_3 which is maximum of all manhattan distance is admissible, h_4 which is the average of all Euclidean distance which is $\leq$ maximum Euclidean distance will definitely be $\leq$ maximum manhattan distance

$$h_4(n) \leq h_3(n) \leq h^*(n) \text{ for all states } n$$

equality when 1 pellet remaining straight line from current position

4.

- h_3 dominates h_4 as proven in 3, iv) Manhattan distance $\geq$ Euclidean distance
- h_1 does not have dominance relationship with h_3 and h_4

  Proof by counterexample

  $h_1 < h_3, h_4$: 1 pellet remaining 2 steps away (straight line)
  $$h_1(n) = 1 < h_3(n), h_4(n) = 2$$

  $h_1 > h_3, h_4$: 2 pellets both 1 unit away from Pac-Man (above & below)
  $$h_1(n) = 2 > h_3(n) = h_4(n) = 1$$
  $$\frac{1+1}{2} = 1$$

- h_2 dominates h_1 since it also considers minimum manhattan distance apart from # pellets left

- h_2 does not have dominance relationship with h_3 and h_4

  Proof by counterexample

  $h_2 < h_3, h_4$: 2 pellets, 1 step away & 7 steps away
  $$h_2(n) = 2+1 < h_3(n) = 7$$
  $$< h_4(n) = \frac{1+7}{2} = 4$$

  $h_2 > h_3, h_4$: 2 pellets both 1 unit away from Pac-Man (above & below)
  $$h_2(n) = 2+1 > h_3(n) = h_4(n) = 1$$