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Report

Question 1

Pacman's belief's on ghost position is updated based on the Pacman's sensors. In addition, pacman has also the knowledge about the ways that the ghosts may move (ghost may not move across walls, if there is a wall in the right side ghost can not move to the right etc.). Based on this extra information, it updates it's belief in elapse time method. **That is to say Pacman doesnt directly observe the ghost, so the actions will not impact the Pacman's beliefs.** So, overtime the beliefs of the Pacman reflects to the places in the board. His beliefs are mainly effected by the valid moves that ghost can choose, and noisy sensors readings and the distribution of those sensor readings. First ghost chooses it's actions randomly so every place that ghost can move has equal probability because the sensor readings comes from those random places. However second ghost is the go South agent. It's sensor readings mainly/dominantly come from South so, the Pacman has stronger belief in the South side of the board.

Question 2

In the first case, Pacman is unable to move and he should trust his sensor readings since Pacman can't directly observe the ghosts. Indeed,it should be emphasized that, the Pacman can't move, and the belief at every position on the map is updated after every sensor reading which comes from the same spot. Based on the sensor readings coming from the same spot since the Pacman is unable to move, the ghost can be in four points in the board which are equally distributed. That is to say since the Pacman is in the center, the sensor readings produce beliefs which are symmetric so sensors work in a symmetrical manner. In the second case, the pacman is able to move and can locate the sensor readings in different locations. Since the pacman gets sensor readings from various locations in case 2, Pacman was able to locate the ghost correctly.

Question 3

The particles get re-initilized when the probabilities of the particles become too low. That can be interpreted as, they get re-initilized when the uncertainty accumulates. So, If the particles in the board stops providing accurate information about the location of the ghosts then, they get re-initilized.

It help, since it can provide more information about ghost's location, and more particles means more accuracy, but it has drawbacks in terms of computation and memory. With more particles uncertainty may accumulate harder but I would prefer using better sensors.

Question 4

For exact inference case, the probabilities of the particles are more accurate, and converges to the true location of the ghost. In Question 2 and 3 (which uses exact inference), the final belief distributions are result of Markov Decision Process, which can be said that conditional, and joint distributions are used. However in the case of approximate inference (Question 5,6) the belief about the ghost location is based on the sampling instead of using probability distributions. Approximate inference uses less complicated representation and samples based on the sensor readings, and the positions that ghost can move while computing the belief distribution.However, this method risks the conditions that affects the ghost's position by sampling (sampling puts some randomness in the process) . In addition, 5000 particles are provides good experimental results for the computation of the beliefs and the accuracy. The more particles means more accuracy so 5000 particles are enough for getting good accurate results.

Question 5

During the calculation of the weights, I took account the current belief state, and the emission probabilities. For every particles and for every ghost I weighted each particle by the likelihood of the observation conditioned on the sample.

Mathematically weights are represented as this calculation:

$$P(E_1^a \mid G_1^a) * P(E_1^b \mid G_1^b)$$

Later, during elapse time method, for every particle and for every ghost I calculated the new position distribution and sampled in proportion to their weights.