Project 3 Solution

Q1.1

(1) What is the error of Markov Localization given different motion sigmas? Report the error here.

- Motion sigma = 1.0
  - 1.189016505454354
- Motion sigma = 2.0
  - 1.276154135554610 9
- Motion sigma = 3.0
  - 1.4540758499693573

Any result with increasing error is correct. Error should be within range of 1-2

Q1.1

(2) What is the running time of Markov Localization at Motion sigma = 1.0? Report using wall time in seconds.

15.6 s

Any answer within 8-20 range would be correct

Some students might have faster or slower results, it would be acceptable if their Q1.1 is right.

Q1.2

Please provide an explanation for your observations. How does changing motion sigma affect trajectory error and sample(probability) distribution as observed in the generated slide shows?

Higher sigma higher error.

probability distribution would spread wider around the robot.

Anything close will get full credit

Some students may conclude differently. Look at their Q1.1 answer. If their description here matches their data, then give full credit.

Q2.1

How changing motion sigma affect error of localization? Report the error here.

- Motion sigma = 1.0
  - 11.673446022161055
- Motion sigma = 2.0
  - 11.929004663546566
- Motion sigma = 3.0
  - 12.180808313494742

Any result with increasing error is correct. Error should be within range of 8-15

Q2.2

Please provide an explanation for your observations. Does changing motion sigma in particle filtering have similar effects on trajectory error and sample distribution as Markov localization? Why or why not?

Effect is similar.

Motion model is the same, except that one is continuous one is discrete.

Anything close will get full credit

Some students may conclude differently. Look at their Q2.1 answer. If their description here matches their data, then give full credit.

Q2.3 (1)

How changing sample size affect the running time of localization? Report using wall time in seconds.

- Sample size = 500
  - 1.46 s
- Sample size = 1000
  - 3.2 s
- Sample size = 2000
  - 5.89 s
- Sample size = 5000
  - 14.3 s
- Sample size = 10000
  - 30.6 s

As long as the student gets increasing running time give full credit

Q2.3 (2)

How changing sample size affect the error of localization? Report the error here.

- Sample size = 500
  - 11.673446022161055
- Sample size = 1000
  - 9.970697835735868
- Sample size = 2000
  - 9.668558815239804
- Sample size = 5000
  - 9.511905984933506
- Sample size = 10000
  - 9.708168842373482

Any result within ±2 range would be correct.

Q2.4

Please provide an explanation for your observations. How does changing sample size affect running time and error?

Sample size larger = running time longer, error smaller.

Some students may conclude differently. Look at their Q2.3 answer. If their description here matches their data, then give full credit.

Q2.5 (1)

- Describe the initial distribution of the samples and the generated slide show for each distribution.

  Multimodal: centered around multiple points

  Node-centered: centered around single point

  Uniform: All over the map

  Anything close will get full credit, describe how results in slideshow appear

Q2.5 (2)

- How changing initial distribution affect the error of localization? Report the error output here.
- Uniform distribution
  - 11.673446022161055
- Node-centered distribution
  - 0.7535694264198065
- Multi-modal distribution
  - 5.853751308825285

Any result within ±1 range would be correct.

Q2.6

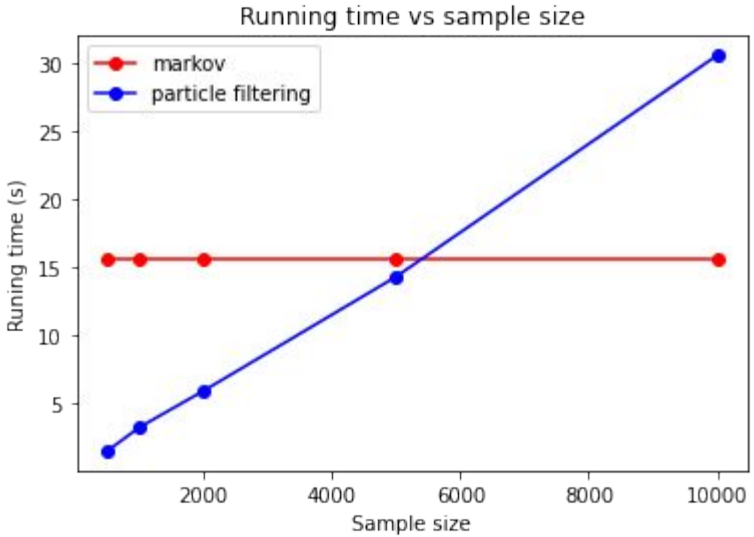
How does changing sample initialization affect the functionality of Monte Carlo Localization? How will unbalanced initialization (such as multimodal distribution) affect the localization process and sample distribution? Support your answer with the observations you found above.

The more randomly distributed the samples are initialized, the larger the average error along the trajectory. Unbalanced initialization will have higher error than node-centric initialization but still lower than randomly uniform initialization.

Anything close will get full credit

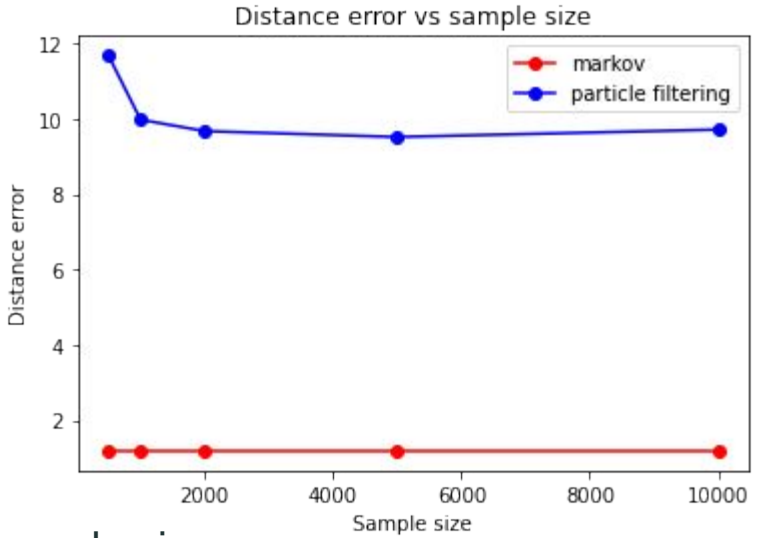
Q3.1

Any graph close to the shape and point locations will get full credits (no need to show legend and dots)
Check if the two lines cross close to sample size = 5000



- Include your graph here.
- Explain the correlation between running time and sample size.
  - Running time should increase as sample size increases, as the algorithm must take into account more points when performing calculations.
- At approximately which sample size will the running time of Monte Carlo localization reach that of Markov localization?
  - 5000 (Or any answer close to 5000)

Q3.2



Any graph close to the shape and point locations will get full credits (no need to show legend and dots)

- Include your graph here.
- Explain the correlation between error and sample size.
  - Theoretically, the error should decrease as sample size increases (Some students may mention the error going up after decreasing, please give full credits for this kind of answer as well.)
- How does the error of the two algorithms compare?
  - Based on the observations, markov localization has much smaller error.
- At approximately what sample size is the error of Particle Filtering similar to that of Markov localization?
  - None as in the settings of this particular assignment.

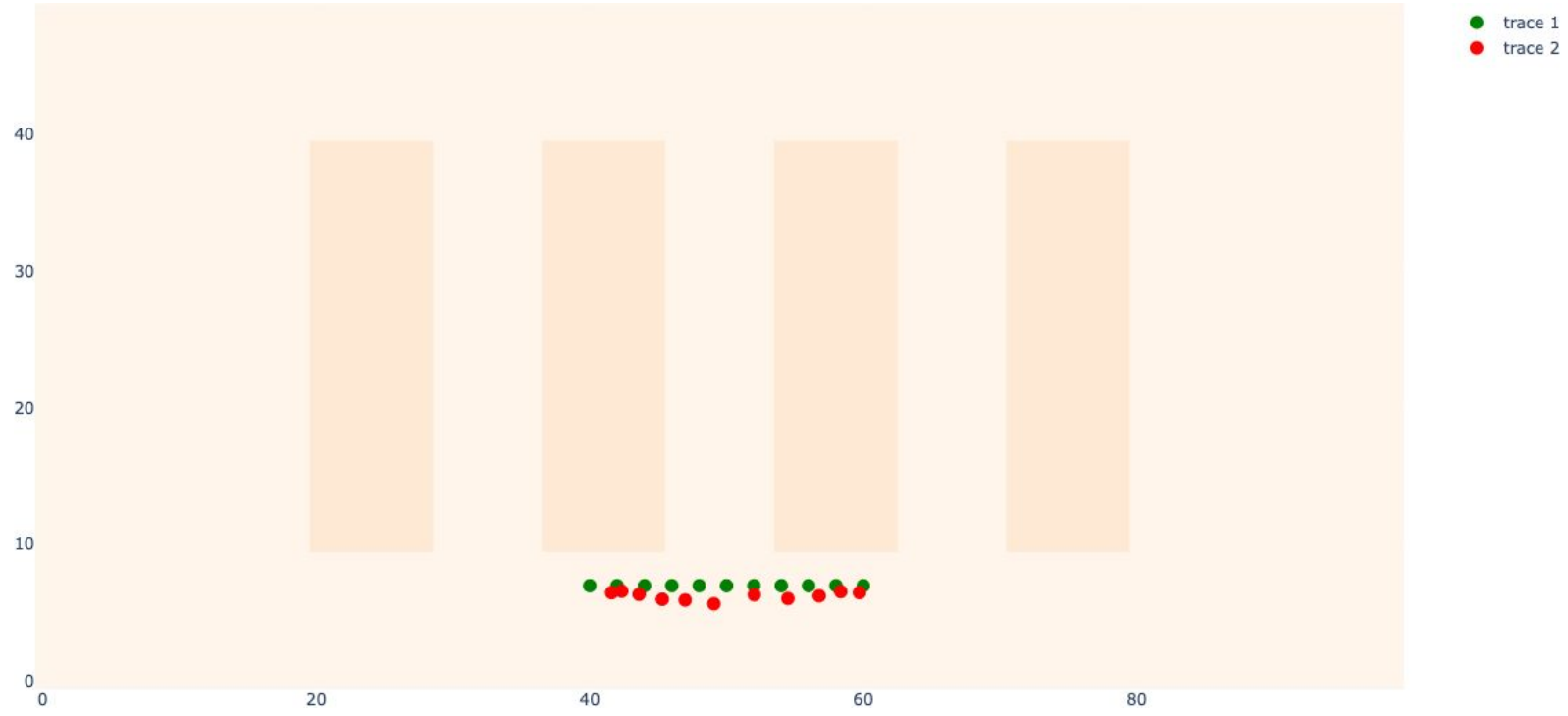
Q3.3

Explain under what configuration (sample size etc.) you would prefer Monte Carlo localization over Markov localization and vice versa?

Answer should mention trade-off between running time and accuracy to get full credit.

(Accurate -> Markov Localization; Fast -> Particle Filtering)

Q4.1



Q4.2