CSIE 5452, Fall 2022: Quiz 2 Solution

Due at 3:30pm; Marked as Last Submission after 3:30pm; Gradescope Closed at 3:40pm

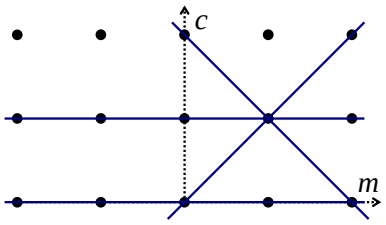
There are totally 50 points. You are expected to use X minutes for a question with X points. When you submit your solutions on Gradescope, please select the corresponding page(s) of each question.

1 Hough Transform (6pts)

Perform the Hough Transform between the (x, y)-space and the (m, c)-space, where $y = mx + c$. No explanation is required.

1. (4pts) Given $(0, 0), (0, 1), (1, 2), (-1, 0)$ in the (x, y)-space, draw their corresponding lines in the (m, c)-space.

   Answer:



2. (1pt) Write down the coordinates of the point which receives the most "votes" in the (m, c)-space.

   Answer: $(1, 1)$.

3. (1pt) Given the coordinates above in the (m, c)-space, write down the corresponding equation in the (x, y)-space.

   Answer: $y = x + 1$.

2 Short Answers: Non-Security (12pts)

1. (2pts) Regarding the sensing range, answer the *longest* and *shortest* ones among the following items: (1) automotive-use camera, (2) automotive-use radar, (3) automotive-use ultrasonic sensor. No explanation is required. No partial credit will be given.

   Answer: 1 and 3.

2. (2pts) Regarding the robustness against snow, fog, or rain, answer the *most* and *least* robust ones among the following items: (1) automotive-use camera (2) automotive-use radar, (3) automotive-use lidar. No explanation is required. No partial credit will be given.

   Answer: 2 and 1.

3. (4pts) For safety applications, does Dedicated Short Range Communications (DSRC) use the Internet Protocol (IP)? Answer "Yes" or "No" and explain the reason.

   Answer: No. The most relevant information is usually within 1 hop. Routing also results in additional overhead and increases the end-to-end delay.

4. (4pts) If a vehicle has the feature of object detection, explain (1) why the feature plus mapping can assist localization and (2) why the feature plus localization can assist mapping.

   Answer: When the vehicle detects an object and its relative coordinates, (1) if the map has the coordinates of the object, the vehicle can compute its own location; (2) if the vehicle has its own location, it can compute the coordinates of the object and then add or verify the object in the map.

3 Short Answers: Security (12pts)

1. (4pts) Regarding security key management, compared with the pair-wise key distribution, list one *advantage* and one *disadvantage* of the one-key-for-all key distribution.

   Answer: Only one message authentication code is needed for each message, but there are potential attacks between receivers.

2. (4pts) Regarding security key management, compared with the pair-wise key distribution, list one *advantage* and one *disadvantage* of the timed efficient stream loss tolerant authentication (TESLA).

   Answer: Only one message authentication code is needed for each message, but there is an authentication delay.

3. (4pts) The timing analysis in the early lectures computes the worst-case response time (R) of a message. With the timed efficient stream loss tolerant authentication (TESLA), is there any security concern if a sender releases a key right after an overestimated R? Answer "Yes" or "No" and explain the reason.

   Answer: No. A receiver still guarantees that a message is sent before the corresponding key is released.

4 Computation Tree Logic (8pts)

Algorithm 1: Pseudocode

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Input: x
y ← 2022 + (the last digit of your student ID number; 0 if it is an alphabet);
if x > 0 then
    for i ← 0 to x do
        if y is even then
            y ← y/2;
        else
            y ← y + 1;
        end
    end
end
```

Given the pseudocode where x, y, z are integers, determine whether the following properties are true or false. No explanation is required. No partial credit will be given.

1. (2pts) $\mathbf{AF}(y \leq 2)$.
2. (2pts) $\mathbf{EFAX}(y = 1)$.

Answer: F, T,

Ignore the pseudocode and let p, q be propositions. $\vee$ means "OR" in Boolean algebra.

3. (4pts) Decide the two properties are equivalent or not.

   - Property 1: $\mathbf{AF}(p \vee q)$.
   - Property 2: $\mathbf{AF}(p) \vee \mathbf{AF}(q)$.

   If yes, explain why they are equivalent; otherwise, draw a computation tree that satisfies one property but does not satisfy the other property.

Answer: No. An example is a computation tree with three nodes, where one leaf node satisfies p only and the other leaf node satisfies q only. It satisfies Property 1 but does not satisfy Property 2.

5 Weakly-Hard Constraints (12pts)

We use a weakly-hard constraint (m, k) to constrain the input of a system. A weakly-hard constraint (m, k) means that there are at most m bad events for any k consecutive events.

1. (4pts) If a system with $(m, k) = (1, 3)$ is unsafe, can it imply that the system with $(m, k) = (1, 2)$ is unsafe? If yes, prove it; otherwise, provide an example.

   Answer: Yes. The set of possible traces of $(m, k) = (1, 3)$ is a subset of the set of possible traces of $(m, k) = (1, 2)$, so an unsafe trace is still there with $(m, k) = (1, 2)$.

2. (4pts) If a system with $(m, k) = (1, 2)$ is safe, can it imply that the system with $(m, k) = (2, 10)$ is safe? If yes, prove it; otherwise, provide an example.

   Answer: No. Assume that 1 means a bad event and 0 means a good event. The verification of a system with $(m, k) = (1, 2)$ does not cover the trace 110000000, so it cannot imply that the system with $(m, k) = (2, 10)$ is safe.

3. (4pts) If a system with $(m, k) = (2, 10)$ is safe, can it imply that the system with $(m, k) = (1, 2)$ is safe? If yes, prove it; otherwise, provide an example.

   Answer: No. Assume that 1 means a bad event and 0 means a good event. The verification of a system with $(m, k) = (2, 10)$ does not cover the trace 1010101010, so it cannot imply that the system with $(m, k) = (1, 2)$ is safe.