Final Exam for UMU-54300 System och algoritmer för autonoma fordon, Winter 2022

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Please note:** Each multiple-choice question question is worth 1.5 pts, and has one and only one correct answer. If there is an option “All of the above”, and all the above options are correct, then you should choose it instead of one of the correct options.

1. In the high-profile fatal accidents by Tesla and Uber vehicles in 2016 and 2018, which module in the processing pipeline was faulty and caused the accidents?
2. Perception
3. Planning
4. Control
5. System supervisor

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. True or False: the AUTOSAR Adaptive Platform is intended to replace the AUTOSAR Classic Platform in future Automotive E/E Architectures.
2. True
3. False

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Which of the following V2X type is for communication with bicycle riders and pedestrians?
2. V2V
3. V2P
4. V2I
5. V2N

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Consider a feedforward Fully-Connected Neural Network with 10 neurons in the (i-1)-th layer, and 100 neurons in the i-th layer. What is the number of parameters (weights and biases) at the i-th layer, i.e., the number of edges connecting the (i-1)-th layer with the i-th layer?
2. 1000
3. 1100
4. 110
5. 111

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

(Number of params at i-th layer is , where is the number of neurons at the i-th layer. So it is (10+1)\*100=1100)

1. Consider a multi-class classification problem with 3 classes . For a given input image of **cat**, the SoftMax-based classifier returns a vector of probabilities for each of the 3 classes . What is the Cross-Entropy Loss?

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. The Cross-Entropy Loss for multi-class classification problems is:
2. Always greater than or equal to 0
3. Always less than or equal to 0
4. May be greater than or less than 0

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. With “same padding”in CNN, with input spatial dimension W1 x H1, stride S=1, filter size 5 x 5, what is the pad size?
2. 1
3. 2
4. 3
5. 4

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. With “same padding”in CNN, with input spatial dimension W1 x H1, stride S=1, filter size 5 x 5, what is the output spatial dimension?
2. (W1 +1) x (H1+1)
3. (W1 -1) x (H1-1)
4. W1 x H1
5. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C

1. A two-stage object detector, e.g., Faster R-CNN), is typically less accurate but more efficient than a one-stage object detector, e.g., YOLO or SSD.
2. True
3. False

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Consider the following object detection results, with the detected box shown in green and the ground-truth box shown in red. Which has a higher IOU (Intersection Over Union, IOU)?

Shape

Description automatically generated with low confidence

1. The left one
2. The right one

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Transposed Convolution can be used for:
2. Up-sampling, i.e., generate a larger image (in spatial dimension) from a smaller input image
3. Down-sampling, i.e., generate a smaller image (in spatial dimension) from a larger input image
4. Both
5. Neither

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. Which computer vision task requires the up-sampling operation?
2. Object detection
3. Segmentation
4. Classification

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. The Mean Average Precision (mAP) metric is used for:
2. Classification
3. Object detection
4. Segmentation

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Consider a given point in a two-dimensional space (x1, x2)=(1,1), its L2 distance to the origin (0, 0), is\_\_\_\_\_; its distance to the origin is\_\_\_\_\_.
2. 1.0,
3. , 1.0
4. 1.0, 1.0
5. ,

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Consider a given point in a two-dimensional space (x1, x2)=(1,1), it lies \_\_\_\_\_the L2 norm ball ; it lies \_\_\_\_\_the norm ball .
2. outside, outside
3. outside, inside
4. inside, outside
5. inside, inside

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. The Fast Gradient Sign Method (FGSM) algorithm for adversarial attacks:
2. takes one single large step in the gradient direction, followed by clipping to lie within the norm bound
3. takes many small steps in the gradient direction, followed by clipping to lie within the norm bound
4. All of the above
5. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. The Projected Gradient Descent (PGD) algorithm for adversarial attacks:
2. takes one single large step in the gradient direction, followed by clipping to lie within the norm bound
3. takes many small steps in the gradient direction, followed by clipping to lie within the norm bound
4. All of the above
5. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. A robust model obtained with Adversarial Training [Goodfellow et al., 2014] typically has a smoother loss surface than a non-robust model.
2. True
3. False

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. For which search algorithm is this true: at each node, expand all neighbor nodes at the present depth prior to moving on to the nodes at the next depth level.
2. Breadth-First Search (BFS)
3. Depth-First Search (DFS)
4. A\* search
5. Dijkstra’s algorithm

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A.

1. Which may be an *admissible heurstic* for A\* search, if we use a weighted graph to represent the road network, the objective is to minimize total travel time from start to goal, and the edge cost is travel time between two locations?
2. The Manhattan distance to the goal.
3. The straight-line distance to the goal.
4. The straight-line distance to the goal divided by the maximum speed limit.

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C.

1. Which module in the AD pipeline does Intel RSS (Responsibility-Sensitive Safety) address?
2. Perception.
3. Localization.
4. Planning.
5. Control.

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C

1. Consider the RSS rule for Safe Longitudinal Distance

Assume response time 𝜌=0, max and min deceleration , max acceleration ,:front vehicle speed (it is parked), rear ego-vehicle speed . What is ?

1. 100 m
2. 50 m
3. 10 m
4. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. Which of the following are rules of RSS?
2. Do not hit the car in front (safe longitudinal distance).
3. Do not cut-in recklessly (safe lateral distance).
4. Right-of-Way is given, not taken.
5. Be careful in areas with limited visibility.
6. If the vehicle can avoid a crash without causing another one, it must.
7. All of the above.
8. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

F

1. Which path planning algorithm(s) are guaranteed to find the optimal solution?
2. A\* algorithm
3. Rapidly-exploring Random Tree (RRT)
4. Probabilistic Roadmap (PRM)
5. All of them
6. None of them

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. Newton’s law (force equals mass times inertia) is useful in

A. Vehicle kinematics

B. Vehicle dynamics

C. Both

D. Neither

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. In the Kinematic Bicycle Model, \_\_\_\_\_ is part of the control input, \_\_\_\_\_ is part of the system state
2. steering angle, vehicle heading angle
3. vehicle heading angle, steering angle
4. Both
5. Neither

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. Which of the following are true for Model-Predictive Control (MPC)?
2. Predictive control with lookahead
3. Handles constraints explicitly
4. Applicable to both linear and nonlinear systems
5. Model-based: requires the system model
6. All of the above
7. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

E

1. Which of the following describes Classification and Regression in Supervised Learning?
2. Classification is for predict/classify discrete labels such as Male or Female, and Regression is used to predict continuous values such as price.
3. Regression is for predict/classify discrete labels such as Male or Female, and Classification is used to predict continuous values such as price.
4. Classification and Regression are both for predict/classify discrete labels such as Male or Female.
5. Classification and Regression are both used to predict continuous values such as price.

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. What are the characteristics of RL？
2. There is no supervisor, only a reward signal (may be sparse).
3. Feedback is delayed, not instantaneous.
4. Sequential data, not i.i.d. data.
5. All of the above
6. None of the above

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

D

1. A smaller discount factor in an MDP implies the agent is:
2. near-sighted: agent cares about short-term rewards more than long-term rewards.
3. far-sighted: agent cares about long-term rewards more than short-term rewards.

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A

1. What is the name of the function that map from (state, action) pair to the cumulative expected reward from it?
2. State value-function V(s)
3. Action value function Q(s,a)
4. Reward R
5. Return Gt

ANS: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B

1. (10 pts)
2. Consider a medical diagnosis test with the following metrics among 20 participants: True Positive TP=9, False Negative FN=1, False Positive FP=1, True Negative TN=9. Calculate precision, recall, F1 score, accuracy, False Positive Rate (FPR). Show the formulas and calculation process.

ANS:

precision=, recall==

accuracy=, FPR=

1. Repeat the calculation for TP=9, FN=1, FP=9, TN=1.

ANS:

precision=, recall==

accuracy=, FPR=

1. (10 pts)
2. Convolutional Neural Networks I

Input volume . filters () w. stride *,* no pad . Show the formulas and calculation process.

1. Calculate the dimensions of the output volume, including spatial size and depth.
2. Calculate the total number of parameters, including weights and biases.

ANS:

Each activation map:

Spatial size:

Depth:

Output volume:

No. params: each filter has params, so 32 filters add up to params

1. Repeat the calculation for: Input volume . filters () w. stride *,* pad .

ANS:

Each activation map:

Spatial size:

Depth:

Output volume:

No. params: each filter has params, so 32 filters add up to params