

AY: 2024-2025
MIDTERM | AI-ECUE322
Nov. 2024

M2-S3: Dept. of Electrical Engineering
Teacher: A. Mhamdi
Time Limit: 1h

This document contains 6 pages numbered from 1/6 to 6/6. As soon as it is handed over to you, make sure it is complete. The 2 tasks are independent and can be treated in the order that suits you.

The following rules apply:

- ❶ A handwritten double-sided A4 sheet is permitted.
- ❷ Any electronic material, except basic calculator, is prohibited.
- ❸ Mysterious or unsupported answers will not receive full credit.
- ❹ Round results to the nearest thousandth (i.e., third digit after the decimal point).
- ❺ Task N^o2: Each correct answer will grant a mark with no negative scoring.

Task N^o1

⌚ 25mn | (8½ points)

The code that follows is provided for reference.



```

1  using Flux # v0.14.25
2
3  model = Chain(
4      Conv((5, 5), 3 => 32, relu),
5      MaxPool((2, 2)),
6      Conv((3, 3), 32 => 32, relu),
7      MaxPool((2, 2)),
8      Conv((3, 3), 32 => 16, relu),
9      MaxPool((2, 2)),
10     Flux.flatten,
11     Dense(fc => 32, relu),
12     Dense(32 => 32, relu),
13     Dense(32 => 10),
14     softmax
15 )

```

- (a) ($5\frac{1}{2}$ points) A 320×240 rgb colored image serves as the model's input. If we feed the model a tiny batch of four samples at a time, find the size of the output at each layer.

```
Chain(
  Conv((5, 5), 3 => 32, relu),      # (316, 236, 32, 4)
  MaxPool((2, 2)),                  # (158, 118, 32, 4)
  Conv((3, 3), 32 => 32, relu),      # (156, 116, 32, 4)
  MaxPool((2, 2)),                  # (78, 58, 32, 4)
  Conv((3, 3), 32 => 16, relu),      # (76, 56, 16, 4)
  MaxPool((2, 2)),                  # (38, 28, 16, 4)
  Flux.flatten,                     # (17024, 4)
  Dense(17024 => 32, relu),          # (32, 4)
  Dense(32 => 32, relu),             # (32, 4)
  Dense(32 => 10),                  # (10, 4)
  softmax                           # (10, 4)
)
```

- (b) (3 points) Determine how many parameters each layer is updating.

```
Chain(
  Conv((5, 5), 3 => 32, relu),      # 2_432 parameters
  MaxPool((2, 2)),
  Conv((3, 3), 32 => 32, relu),      # 9_248 parameters
  MaxPool((2, 2)),
  Conv((3, 3), 32 => 16, relu),      # 4_624 parameters
  MaxPool((2, 2)),
  Flux.flatten,
  Dense(17024 => 32, relu),          # 544_800 parameters
  Dense(32 => 32, relu),             # 1_056 parameters
  Dense(32 => 10),                   # 330 parameters
  softmax,
) # Total: 12 arrays, 562_490 parameters, 2.147 MiB.
```

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ANSWER SHEET

Task N°2

⌚ 35mn | (11½ points)

(a) (1 point) What will be the output of the following code?



```

1  abstract type Shape end
2  struct Circle <: Shape
3      radius::Float64
4  end
5  struct Rectangle <: Shape
6      length::Float64
7      width::Float64
8  end
9  describe(shape::Shape) = "An unknown shape"
10 function describe(shape::Circle)
11     return "A circle: $(shape.radius)"
12 end
13 function describe(shape::Rectangle)
14     return "A rectangle: $(shape.length) x $(shape.width)"
15 end
16 function describe(shape::Shape, detailed::Bool)
17     return detailed ? describe(shape) : "A generic shape"
18 end
19 c = Circle(5.0); r = Rectangle(4.0, 6.0)
20 print(describe(c, true));
21 print(describe(r, false));
22 print(describe(Shape))
    
```

DO NOT WRITE ANYTHING HERE

✂

- ☐ A circle: 5.0 A generic shape An unknown shape
 - ✓ A circle: 5.0 A generic shape Error
 - ☐ A circle: 5.0 A generic shape An unknown shape
 - ☐ A circle: 5.0 A rectangle: 4.0 x 6.0 An unknown shape
 - ☐ Error A generic shape An unknown shape
- (b) (1 point) How can you define a mutable composite type in Julia?
- ☐ Using the struct keyword.
 - ✓ Using the mutable struct keyword.
 - ☐ Using the mutable type keyword.
 - ☐ Using the composite struct keyword.
- (c) (1/2 point) What is the primary feature of multiple dispatch in Julia?
- ☐ Functions are selected based on the type of the first argument only.
 - ☐ Functions can operate on arguments of different types but ignore their order.
 - ✓ Functions are dynamically dispatched based on the types of all arguments.
 - ☐ Functions can only be dispatched at compile time.
- (d) (1/2 point) One step of “_____” propagation on a computational graph yields derivative of final output variable.
- ☐ forward
 - ✓ backward
- (e) (1 point) Would structured or unstructured data have features such as pixel values or individual words?
- ☐ Structured data.
 - ✓ Unstructured data.
- (f) (1/2 point) What is the objective of gradient descent in Machine Learning.
- ☐ Maximizing loss function.
 - ✓ Minimizing loss function.
 - ☐ Imputing missing values.
- (g) (1/2 point) What does the learning rate η control in gradient descent?
- ✓ Step size of updates.
 - ☐ Dataset size.
 - ☐ Feature scaling.
 - ☐ Model complexity.



- (h) ($\frac{1}{2}$ point) What is the role of pooling layers (e.g., max pooling, average pooling) in a CNN?
- ☐ To increase the spatial resolution of the feature maps.
 - ☒ To reduce the spatial resolution of the feature maps and reduce the number of parameters.
 - ☐ To apply non-linear transformations to the feature maps.
 - ☐ To concatenate feature maps from different layers.
- (i) ($\frac{1}{2}$ point) What is the primary goal of a variational encoder in a VAE architecture?
- ☐ To reconstruct the input data exactly.
 - ☒ To learn a probabilistic representation of the input data.
 - ☐ To classify the input data into predefined categories.
 - ☐ To generate new samples from the input data distribution.
- (j) ($\frac{1}{2}$ point) What is the purpose of the KL-divergence loss function in a VAE?
- ☒ To regularize the latent space by encouraging the encoder to produce a distribution that is close to a standard normal distribution.
 - ☐ To minimize the difference between the input data and the reconstructed output.
 - ☐ To maximize the similarity between the input data and the reconstructed output.
 - ☐ To optimize the decoder's ability to generate novel samples.
- (k) ($\frac{1}{2}$ point) What is the purpose of visualizing the latent space in a VAE?
- ☐ To identify the most important features in the input data.
 - ☐ To evaluate the quality of the reconstructed output.
 - ☒ To understand the structure and relationships between the latent dimensions.
 - ☐ To optimize the hyperparameters of the model.
- (l) ($\frac{1}{2}$ point) What is Git?
- ☐ A centralized version control system.
 - ☒ A distributed version control system.
 - ☐ A cloud-based version control system.
 - ☐ A local file management system.
- (m) ($\frac{1}{2}$ point) What is the primary purpose of Git?
- ☐ To manage large-scale projects.

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- ✓ To track changes in code.
- ☐ To collaborate with team members.
- ☐ To backup files.
- (n) (1/2 point) Which command creates an empty Git repository in a specified directory?
- ✓ git init ☐ git clone ☐ git branch ☐ git tag
- (o) (1/2 point) Which command pulls new changes from a remote repository?
- ☐ git push ✓ git pull ☐ git fetch ☐ git merge
- (p) (1/2 point) What is the purpose of the .git directory?
- ☐ To store committed files.
- ☐ To track changes in code.
- ☐ To manage branches.
- ✓ To store metadata and object database.
- (q) (1/2 point) What are instances of Docker images that can be run using the Docker run command?
- ☐ Hub ✓ Container ☐ File ☐ Cloud
- (r) (1/2 point) Which command is used to manage running containers?
- ☐ docker create
- ☐ docker run
- ✓ docker stop
- ☐ docker rm
- (s) (1/2 point) What is used to create a Docker image?
- ✓ Dockerfile ☐ Docker Hub ☐ Docker Engine ☐ Docker Swarm
- (t) (1/2 point) Which command is used to list all Docker images on the system?
- ✓ docker images
- ☐ docker ps
- ☐ docker run
- ☐ docker rm