



Course : Image Processing for Earth Observation

Mid term examination

First Name :

Last Name :

SCIPER Number:

Course of study :

The mid-term is composed of 7 questions. **Please answer all the questions.** Motivate your answers and report your calculations where applicable.

The length of the answer boxes is not proportional to the expected length of the answer. You can use the back of the sheets to write if really you need more, but we prefer concise answers.

You can use all the material provided during the course.

Good luck!

Lausanne, 10.12.2021

Question 1 (2 points)

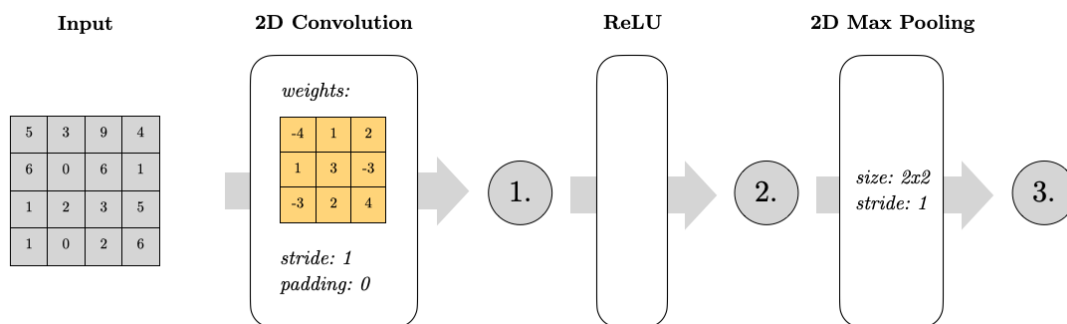
You are working in an NGO and have been contacted by concerned citizens about habitat loss of the critically endangered mountain gorillas in Rwanda. The country is not only home to the Volcanoes National Park, where the majority of mountain gorillas live, but also to a thriving human population, which performs increasingly expansive agricultural practices in the surroundings of the park.

In this context, you have been asked to estimate whether and by how much the mountain gorillas' habitat in the area has been affected. For long-term conservation purposes, the enquirers are particularly interested in changes in habitat area over the last three to four decades.

Sketch how you would design your processing pipeline, including data acquisition, design and deployment. You have a very limited budget.

Question 2 (1.5 points)

You are provided an image with pixel values and a CNN with three layers and indicated parameters:



Calculate and draw the outputs of each of the CNN's layers (1., 2. and 3. In the figure). Explicit your calculations.

Blank area for drawing the outputs of the CNN layers (1., 2. and 3.).

Question 3 (1.5 points)

Which sensor would you use for which application? Complete the table below.

Task	Sensor	Why?
Monitor floods status during a storm		
Monitoring parking usage of large supermarkets		
Detect ripe tomatoes in fields for precision harvesting		
Map aerosols over Northern America		
Monitor deforestation		

Question 4 (1 point)

The code below is supposed to train an AlexNet deep CNN on the ImageNet dataset in PyTorch:

```
import torch
from torch.utils.data import DataLoader
import torchvision

dataLoader = DataLoader(
    torchvision.datasets.ImageNet('/data/imageNet')
)
model = torchvision.models.AlexNet(num_classes=1000)
optim = torch.optim.SGD(model.parameters(), lr=1e-3)
criterion = torch.nn.CrossEntropyLoss()

for (data, labels) in dataLoader:
    pred = model(data.cuda())
    labels_pred = pred.argmax(1)
    loss = criterion(labels_pred, labels)
    loss.backward()
    optim.step()

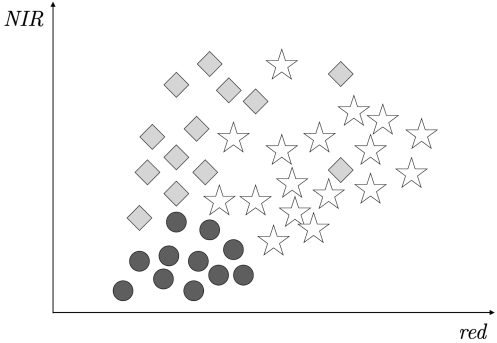
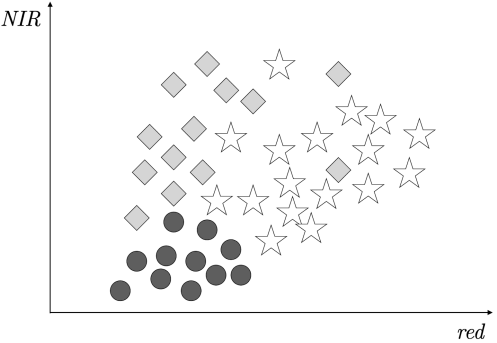
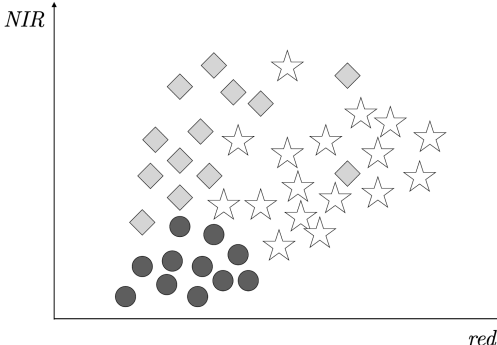
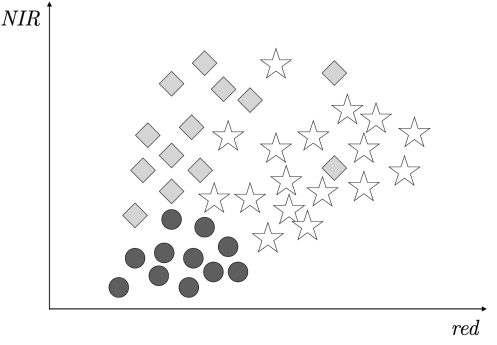
# print overall accuracy
print(torch.mean((labels_pred == labels).float()).item())
```

Unfortunately, three errors have made it into this code snippet. Please identify two of those errors and explain what problem they would cause.

You can assume the ImageNet dataset to be properly downloaded and configured under /data/imageNet.

Question 5 (1.5 points)

Given a set of data points and their intensity values in red and near-infrared as follows, draw the decision boundaries for the indicated classifiers:

	
Decision tree of depth 1	Random forest with 500 trees
	
Decision tree of depth 2	k-Nearest Neighbours with $k = 1$

Can you identify the types of land cover classes if we assume these pixel values come from a satellite image? Assume both axes are shown from 0 to the maximal radiometric resolution.

- Diamonds:
- Circles:
- Stars:

Question 6 (2 points)

You are given 100 aerial images over a residential area like the one shown below:



They are 0.5m resolution, orthorectified images with four bands: red, green, blue and near-infrared.

You have been asked to map all building footprints. Your predecessor on the project already started labelling a few, but could only annotate eight (8) such images with polygons due to time restrictions.

Design a plan to get from the status quo to the required output, detailing the intermediate steps as much as possible. Also indicate what performance metrics you plan on using.

Question 7 (1.5 points)

TearWallsApart Inc. is a company that builds thermal cameras, which are used to automatically detect faults in façades. You are given the task to build a classifier that detects if a wall is about to crack. Missing many would be a catastrophe for the people living in the house.

With that in mind, you try various classifiers and come up with the following confusion matrices and overall accuracy scores. By using only this information, which classifier do you choose? Motivate your answer in your own words.

Classifier 1		PREDICTED			
		Good as new	Under stress	About to crack	Cracks visible
TRUE	Good as new	5000	0	0	100
	Under stress	100	5000	0	0
	About to crack	2000	500	700	300
	Cracks visible	0	100	0	1200

Overall accuracy: 79.33%

Classifier 2		PREDICTED			
		Good as new	Under stress	About to crack	Cracks visible
TRUE	Good as new	5000	0	0	100
	Under stress	300	3700	1100	0
	About to crack	100	600	2200	600
	Cracks visible	0	100	600	600

Overall accuracy: 76.67 %

Classifier 3		PREDICTED			
		Good as new	Under stress	About to crack	Cracks visible
TRUE	Good as new	4700	300	0	100
	Under stress	300	4400	400	0
	About to crack	200	1200	2100	0
	Cracks visible	0	500	0	800

Overall accuracy: 80.00 %