Numerical Exercises
- part 2 -

Assist. Prof. Mirela Popa

Maastricht University | Department of Advanced Computing Sciences

Exercise 1

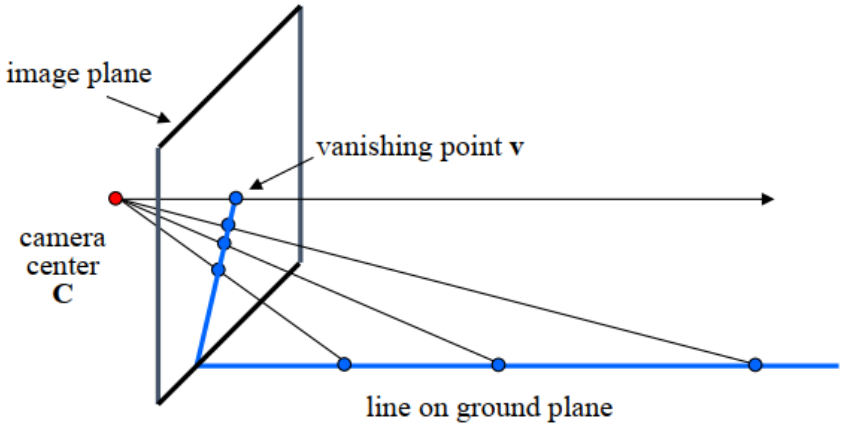
(a) Which parameters are important for optimizing a CNN architecture?
(b) How would you incorporate more learning objectives in your CNN architecture?
(c) When is indicated to use a deep architecture (many layers) and when not?

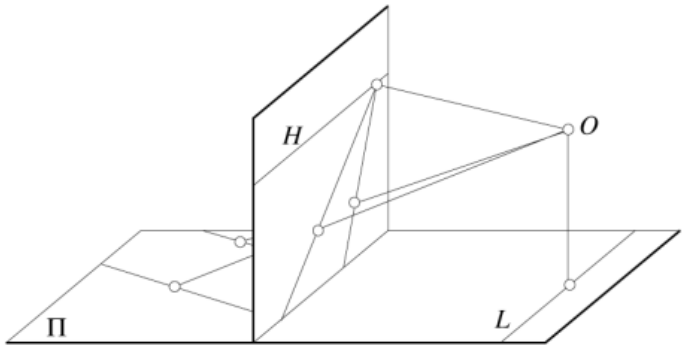
Exercise 2 - Autoencoders

a) Can the hidden layer size be larger than the input layer size, in the case of an Autoencoder model?
b) Which effect has this condition on the general learning task?
c) Is there any method to optimize the learning process in this case?

Exercise 3

Vanishing points





Prove Algebraically that the projections of two parallel lines lying in some plane Π appear to converge on a horizon line *H* formed by the intersection of the image plane with the plane parallel to Π and passing through the pinhole.

This is called the **Vanishing Point**

- projection of a point at infinity

Exercise 4 – Epipolar Geometry

a) How is the Fundamental matrix related to pairs of corresponding points in two images?
b) How are the fundamental matrices, F going from image I to I' and F', going from I' to I, related?
c) How are the epipoles related to the fundamental matrices?
d) What is the effect of applying the fundamental matrix to a point?
e) How can you determine the epipolar line l' passing through a point x'?

Exercise 5 – Epipolar Geometry

- Which are the properties of the skew symmetric matrix $\mathbf{[e']_x}$?
- How to compute the transpose?
- Does it have a null vector?

Exercise 6 – Fundamental Matrix for Parallel Cameras

Compute the fundamental matrix for a parallel camera stereo rig. What does the fundamental matrix tell about the relationship between the projections of the same 3D point on the image plane when the camera is placed at different locations?

Exercise 7

Suppose the fundamental matrix is given by

$$F = \begin{bmatrix} 0.5 & 0.3 & 0.2 \\ -0.1 & 1 & 0.2 \\ 10 & 30 & 100 \end{bmatrix}$$

Given the pixel coordinates (100, 100) on the left image, find the epipolar line in the right image. Similarly, given the pixel (100, 100) on the right image, find the epipolar line in the left image.