Python and Maths Basics

Exercise 1 : Converting between model function space and the loss landscape

Consider the loss $l_2(c, y(\mathbf{x}))$ as defined in the homework sheet for the point $(4, 6)$.

(a) By looking at the model function space (the 2D coordinate system in which the model function is represented as a straight line), intuitively explain why $l_2 = 0$ holds for a set of more than one instance of model parameters.

(b) Show through calculations that $l_2 = 0$ is a straight line in the loss landscape.

(c) To what structure does this correspond in the function space? Plot and try to show your conjecture using calculations. Hint: Compute $y(4)$ and $\frac{\partial y}{\partial x}$.

Exercise 2 : Advanced model functions

What if we want to fit a parabola instead of a straight line?

(a) Define the model function.

(b) How can we find $(\mathbf{x}, c)$, given the points to fit through (e.g., $(4, 6), (-1, -3), (5, 10)$)? Hint: Write the model function as a vector dot product $\mathbf{w}^T \cdot \mathbf{x}$.

(c) Vaguely describe the loss landscape.

Exercise 3 : Gradient descent and loss functions

Consider the general case, but you might want to check back on the loss landscape plot in the homework exercise.

(a) In which direction does the gradient point?

(b) In which direction does the negative gradient point?

(c) Why does that help in the context of a loss landscape?

Exercise 4 : Limits of LMS

(a) What happens to the loss landscape in further iterations of the LMS algorithm?

(b) Why is that a problem?

(c) What could be the solution?