PHOT 110: Introduction to programming

Lecture 16: exercises on Numpy arrays

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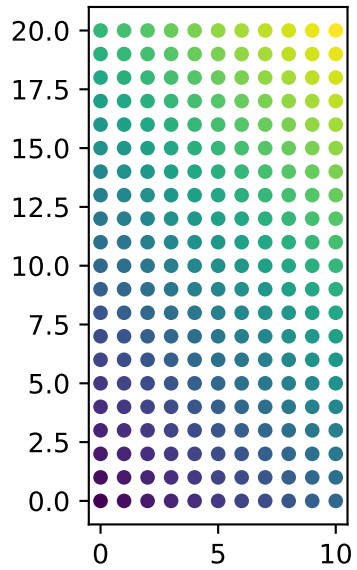
Exercises on Numpy arrays

Exercise 1: 2D domains

Use Numpy's `arange()` function to create two intervals containing integers with e.g. $x \in [0, 10]$ and $y \in [0, 20]$, and make a 2D domain of them using the `xx, yy = np.meshgrid(x, y)` function. Plot the coordinates thus created using a scatter plot (`plt.scatter(xx, yy)`).

The plot should similar to the following:



Exercise 2: 2D arrays

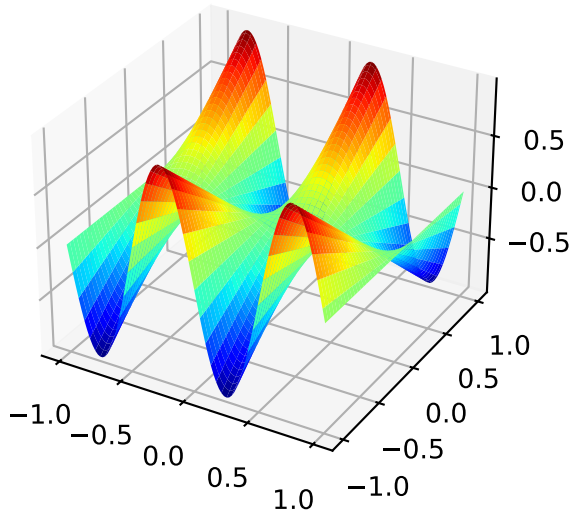
Use a 2D domain/interval using the `np.meshgrid` command such as in exercise 1, but using `np.linspace()` for the intervals with $x \in [-1, 1]$ and $y \in [-1, 1]$ at a finer grid, and plot the function for that domain:

$$z = f(x, y) = y \sin(2\pi\, x)$$

For the plot use

```
fig, ax = plt.subplots(subplot_kw={"projection": "3d"})
ax.plot_surface(xx, yy, zz, cmap=cm.jet)
plt.show()
```

The output should be similar as below:



Exercise 3: Solve a system of equations

Solve the following system of equations in x, y, and z:

$$\begin{cases} x + y = 0 \\ x + y + z = 5 \\ 2x - z = -2 \end{cases}$$

by converting it to a matrix equation:

$$\begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0 \\ 5 \\ -2 \end{pmatrix}$$

And then multiplying both sides of the equation by the inverse matrix from the left.

$$\begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix}^{-1} \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix}^{-1} \begin{pmatrix} 0 \\ 5 \\ -2 \end{pmatrix}$$

$$\Rightarrow \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 2 & 0 & -1 \end{pmatrix}^{-1} \begin{pmatrix} 0 \\ 5 \\ -2 \end{pmatrix}$$

Thereby calculate and print the values for x, y, and z. Verify by hand whether this is indeed a solution.