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Quick Answer

This page offers Uncodemy's NumPy data analysis guide as a PDF download. NumPy provides fast arrays and vectorised mathematics, and it sits underneath pandas and many other analysis libraries. The guide covers arrays, indexing, vectorised operations, broadcasting, statistics and random numbers, with small examples you can run as they are.

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Why NumPy matters

NumPy supplies the ndarray, a grid of values of one type stored compactly in memory. Because operations run over whole arrays in optimised compiled code, they are far faster than Python loops, and the code is shorter and easier to read. Almost every Python data library is built on NumPy arrays, including pandas, SciPy and scikit-learn. As an analyst you may use NumPy directly for numeric calculations, simulation and statistics, and you will meet it indirectly every time you use pandas. Understanding it helps you write faster code and understand the behaviour of the tools built on top of it.

Creating arrays

Arrays can be built from lists or generated with helper functions.

```
import numpy as np

a = np.array([12, 15, 11, 18, 20, 14])
zeros = np.zeros(3)
steps = np.arange(0, 10, 2)          # 0, 2, 4, 6, 8
grid = np.linspace(0, 1, 5)         # 5 evenly spaced values
matrix = np.array([[1, 2, 3], [4, 5, 6]])

print(a.shape, a.dtype, matrix.shape)
```

Vectorised operations

Arithmetic applies to every element at once; there is no need for a loop.

```
prices = np.array([100.0, 250.0, 80.0, 400.0])
qty = np.array([3, 1, 5, 2])

revenue = prices * qty              # element by element
print(revenue)                     # [300. 250. 400. 800.]
print(revenue.sum(), revenue.mean())
print((revenue > 300))             # boolean array
print(revenue[revenue > 300])      # boolean filtering
```

Indexing and slicing at a glance

Goal	Syntax	Meaning
One element	a[2]	Third element (indexing starts at 0)
A range	a[1:4]	Elements 1, 2 and 3
From the end	a[-2:]	The last two elements
A row of a matrix	m[0, :]	First row, all columns
A column of a matrix	m[:, 1]	All rows, second column
By condition	a[a > 15]	Elements greater than 15

Statistics with NumPy

NumPy includes the descriptive statistics that analysts use every day: mean, median, standard deviation, variance, minimum, maximum and percentiles. For two-dimensional arrays you can specify an axis so that the calculation runs down columns or across rows. Remember that the default standard deviation in NumPy is the population version; set ddof to 1 for the sample standard deviation, which is what most analysis uses. It is a small detail that explains why two tools sometimes disagree in the third decimal place.

Descriptive statistics and the axis argument

Column-wise and row-wise summaries of a small matrix of monthly sales for three products.

```
sales = np.array([[120, 135, 150],
                  [ 90,  85, 100],
                  [200, 210, 190]])  # rows = products, columns = months

print(sales.sum(axis=0))           # total per month
print(sales.mean(axis=1))          # average per product
print(np.median(sales), np.percentile(sales, 90))
print(sales.std(ddof=1))           # sample standard deviation
```

Broadcasting

Broadcasting lets NumPy combine arrays of different shapes by stretching the smaller one along the missing dimension, without copying data. Adding a single number to an array is the simple case. A more useful case is subtracting each column's mean from a matrix to centre the data, or dividing each row by its total to get shares. The rule is that dimensions are compared from the right and must be equal or one of them must be one. When shapes do not fit you receive a clear error that tells you the shapes, which is the signal to reshape or add an axis.

Broadcasting examples

Centre each column and turn each row into percentage shares.

```
centered = sales - sales.mean(axis=0)          # subtract column means
```

```
shares = sales / sales.sum(axis=1, keepdims=True) # row shares
print(centered.round(1))
print((shares * 100).round(1))
```

Random numbers for simulation

A seeded generator gives repeatable results, useful for testing ideas such as a simple simulation of daily orders.

```
rng = np.random.default_rng(seed=42)
daily_orders = rng.poisson(lam=20, size=30) # 30 days, average 20 orders
print(daily_orders.mean(), daily_orders.std(ddof=1))
```

NumPy and pandas together

- A pandas column is backed by a NumPy array; `df['x'].to_numpy()` returns it.
- NumPy functions such as `np.log` and `np.where` work directly on pandas columns.
- `np.where(condition, a, b)` is a fast vectorised if-else for creating columns.
- Missing values appear as NaN, and functions such as `np.nanmean` ignore them.

Common NumPy mistakes

- **Using Python loops** where a vectorised operation would be shorter and faster.
- **Confusing a view and a copy:** slicing returns a view, so changing it changes the original.
- **Integer division surprises** and mixed dtypes.
- **Ignoring NaN:** most functions return NaN if any element is NaN.

When to reach for NumPy directly

In day-to-day analysis you will usually work in pandas, but a few tasks are cleaner in plain NumPy. Simulations with random numbers, matrix calculations, fast element-wise functions and anything involving arrays of more than two dimensions are examples. It is also useful for checking a calculation independently: compute the same total with NumPy and with pandas and confirm they agree. Treat NumPy as the engine under the hood that you can open when needed.

NumPy functions worth memorising

Function	What it does
<code>np.where(cond, a, b)</code>	Choose a or b element by element
<code>np.cumsum(x)</code>	Running total
<code>np.diff(x)</code>	Difference between consecutive elements
<code>np.unique(x, return_counts=True)</code>	Distinct values and how often each appears
<code>np.corrcoef(x, y)</code>	Correlation matrix of two variables
<code>np.round(x, 2)</code>	Round to a number of decimals

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Frequently Asked Questions

What is NumPy used for?

NumPy provides fast arrays and vectorised numerical operations, and it underlies pandas, SciPy and many other data libraries.

What is vectorisation?

Applying an operation to a whole array at once instead of looping element by element, which is faster and shorter.

What is broadcasting in NumPy?

Broadcasting lets arrays of different shapes be combined by stretching the smaller one along missing dimensions when shapes are compatible.

Is NumPy needed if I use pandas?

You can start with pandas alone, but NumPy knowledge helps you understand pandas behaviour and write faster numeric code.

Why does NumPy standard deviation differ from my spreadsheet?

NumPy uses the population formula by default. Set `ddof=1` to get the sample standard deviation used by most spreadsheets.

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