## 1 Intensity-level entropy

Given a discrete random variable X with support  $\mathfrak{X}$ , the *Shannon entropy* is

$$H = \sum_{x \in \mathcal{X}} -P(x) \ln P(x).$$

The *intensity-level entropy* is the Shannon entropy of the empirical distribution of intensity values.

```
import numpy as np
    def shannon_entropy(h):
        """The Shannon entropy in bits"""
        return -sum(p*np.log2(p) if p > 0 else 0 for p in h)
    def intensity_distribution(data):
        """The intensity distribution of 8-bit `data`."""
        hist, _ = np.histogram(data, bins=range(256+1), density=True)
        return hist
    def intensity_entropy(data):
        """The intensity-level entropy of 8-bit image data"""
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        return shannon_entropy(intensity_distribution(data))
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    def intensity_expected(f, data):
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        """The intensity-distribution expected value of `f`."""
        return sum(p*f(p) for p in intensity_distribution(data))
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```