

Coconuts and Islanders

A) There are $N = 300$ inhabitants (natives, castaways, etc.) on the island, initially each receives $C = 15$ coconuts. The inhabitants play a game of paper-scissors-stone, the loser in a pair passes 1 coconut to the other person (if they have one). Pairs are chosen at random.

Perform a simulation of $T = 100000$ games and plot a histogram (probability density) as a function of the number of coconuts owned. Mark on the histogram the function (approximation of the distribution for $N, C \gg 1$)

$p(x) = 1/(1+C) * e^{-x/kT}$, where $kT = C + 0.5$.

B) Plot the number of people with zero coconuts as a function of the number of games (e.g., every 1000 games). Plot with a dashed line the value of $p(0) * N$.

All graphs should have a title, axis description, grid and be saved to a file.

An example solution to a similar problem can be found in “*Coconuts and Islanders: A Statistics-First Guide to the Boltzmann Distribution*” by Brian Zhang;

<https://doi.org/10.48550/arXiv.1904.04669>

For extra hints see below.

Example solution graphs are shown in Figure 1.

Hints on writing code:

```
N = 300; C = 15
```

```
x = np.ones(N) * C
```

```
l, j = np.random.choice(N, 2)
```

```
...
```

```
x[i] += -1
```

```
...
```

```
plt.hist(x, bins='auto', density=True, alpha=0.75)
```

```
plt.plot(xarr, yarr)
```

```
p = np.random.rand()    # single random value
```

```
p_arr = np.random.rand(100) # array of 100 random values
```

```
np.sum(x == 0)    # numer of zeros in array x
```

```
fig.set_size_inches(w, h)    # set the figure size in inches (width, height)
```

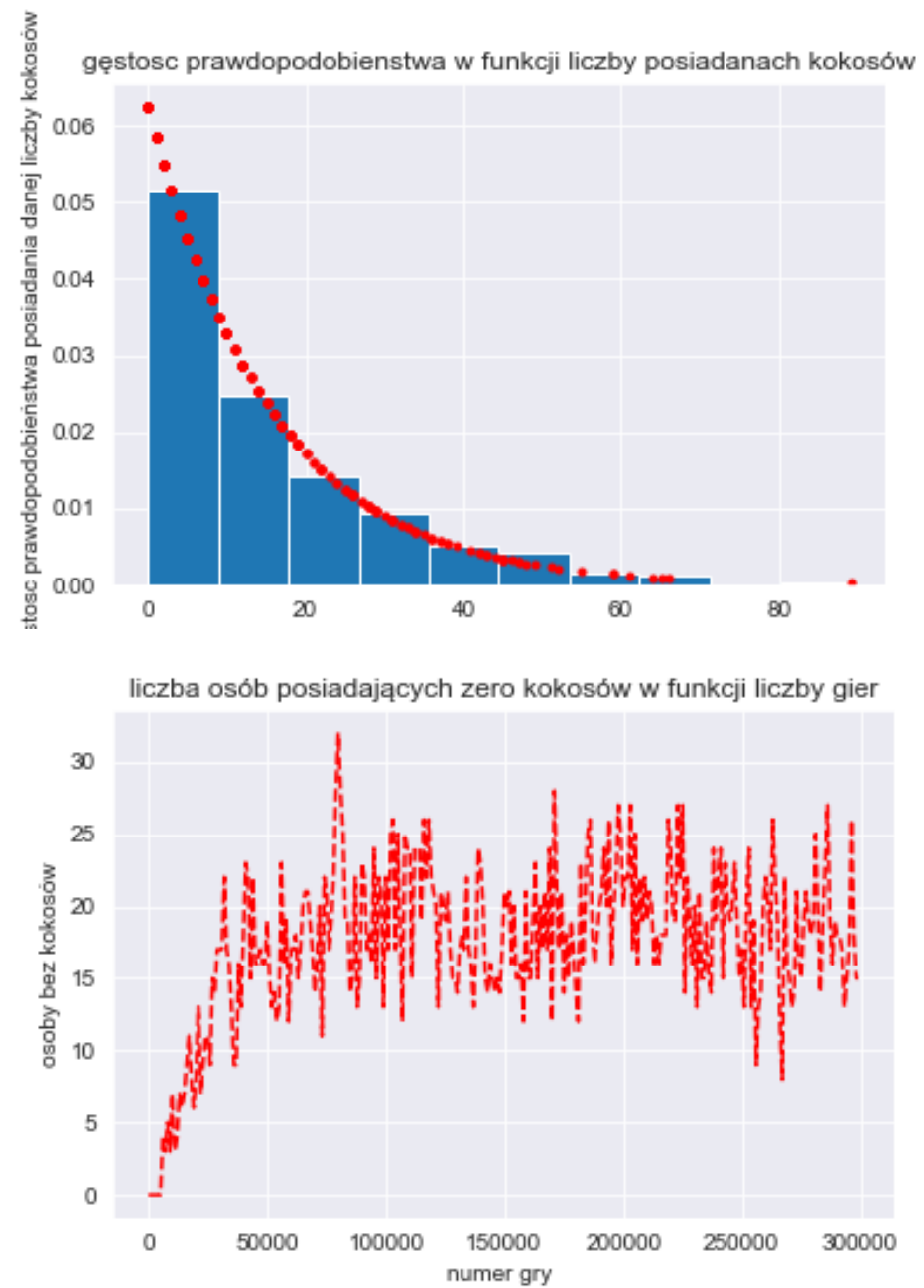


Figure 1. Example solution graphs

Additional materials on Boltzmann distribution:

- Ideologically the simplest illustration of Boltzmann decomposition (according to S.C. Zhang <https://arxiv.org/abs/1904.04669>)
- Physical model for the energy exchange between the particles of a gas we obtain, when we divide (in each collision) the sum of the possessed energy according to a random ratio
- numerous econo-physical models of wealth accumulation in the population: attempts to reconstruct the power-law distributions "Statistical mechanics, of money" <https://arxiv.org/abs/cond-mat/0001432>, <https://arxiv.org/abs/cond-mat/0004256>