# Assignment 3

**Ex 1**

The bigcity.csv dataset contains the population of 49 American cities in 1920 (u) and in 1930 (x). Let's assume that cities are a random sample and that we are observing the couple (U, X), the parameter that we want to estimate is theta = E(X)/E(U), where E(.) is the expected value operator.

- Propose an estimator for theta and produce the estimate based on the sample
- Estimate with the bootstrap the bias and the standard error of the estimate of the previous point
- Get a bootstrap confidence interval for theta, 0.90 confidence level

**Ex 2**

Consider the Weibull distribution:

$$F(y) = 1 - \exp\{-(y/\mu)^{\alpha}\}$$

(for y > 0, otherwise F(y) = 0).

- use the Inverse Transform Method to generate pseudo-random values from this distribution, given alpha and mu
- plot the results, comparing them with the theoretical distribution of a Weibull

**Ex 3**

Using what already did during the Lecture 6, generalize the EM algorithm in order to estimate also the standard deviations of the two Normal densities of the mixture.

**Ex 4**

Consider the distribution X, with density:

$$f(x;\delta) = \begin{cases} \frac{\delta}{x\sqrt{2\pi}} \cosh\{\delta \log(2x)\} \exp\{-\sinh\{\delta \log(2x)\}^2/2\}), & \text{per } x > 0 \\ 0, & \text{altrimenti} \end{cases}$$

- implement a function to compute f(x, delta) and plot it with delta = 1.5
- Implement a function to simulate from X using the Acceptance Rejection sampling, using an Exponential distribution (with lambda = 1) as proposal
- Generate a sample using your function and, with these data, estimate E(X^2). Using the bootstrap, give a measure of precision of your estimate.