

# 11.16.3.2

EE24BTECH11001 - Aditya Tripathy

## Question:

A coin is tossed twice, what is the probability that atleast one tail occurs?

## Solution:

The sample space is

$$\Omega = [HH, HT, TH, TT] \quad (0.1)$$

Assuming equally likely outcomes,

$$\Pr(\omega \in \Omega) = \frac{1}{4} \quad (0.2)$$

Define a discrete random variable  $X$  = number of tails in the sequence.

$$\Pr(X \geq 1) = 1 - \Pr(X < 1) \quad (0.3)$$

$$= 1 - \frac{1}{4} = \frac{3}{4} \quad (0.4)$$

## Simulation:

To run a simulation we need to generate random numbers with uniform probability, which is done as shown below(Algorithm taken from OpenSSL's random\_uniform.c):

- 1) Generate 32 bits of entropy using /dev/urandom.
- 2) Treat this as a fixed point number in the range [0, 1)
- 3) Scale this to desired range using fixed point multiplication and treat as 64bit number(upper 32 bits integer and rest as fractional part)
- 4) Return the integer part of the fixed point numbers

The following shows how the relative frequency reaches true probability with increasing number of trials of the event.

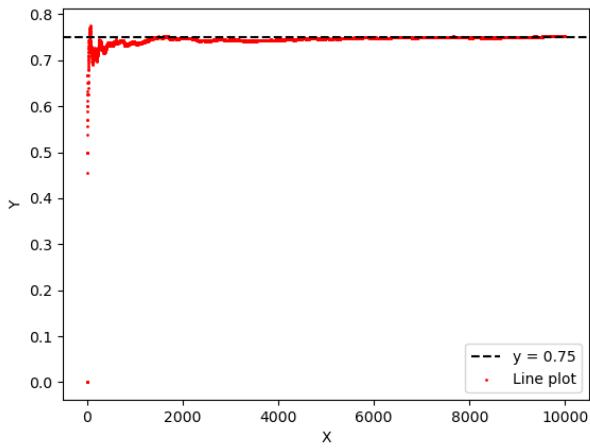


Fig. 4.1: Relative Frequency tends to True Probability