SMC2017: Preparatory exercises

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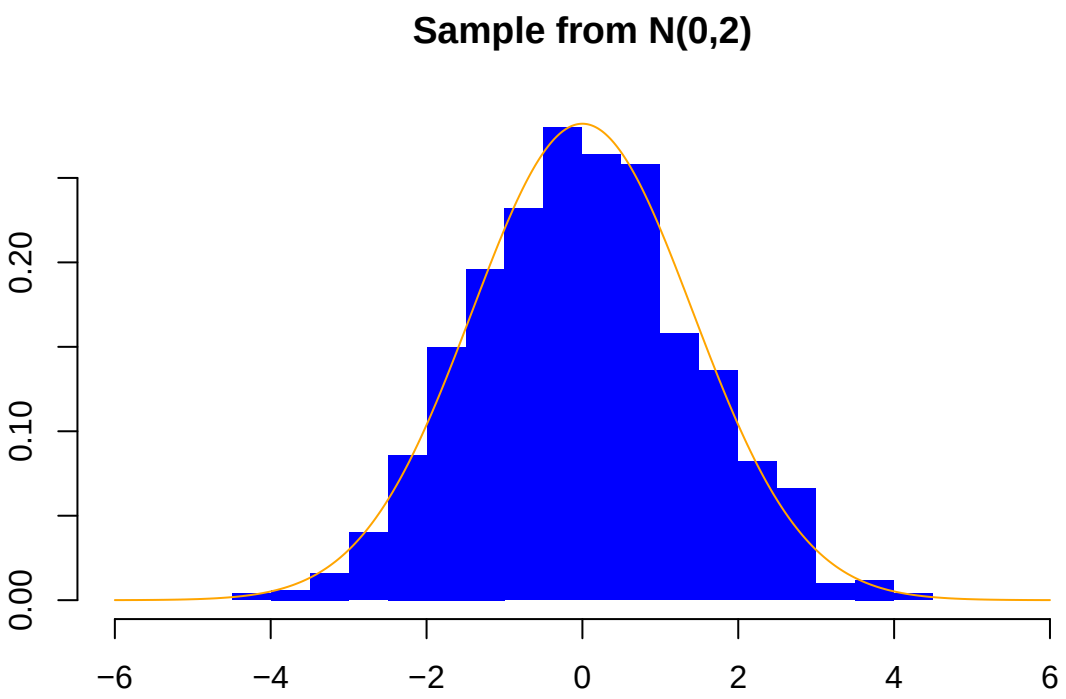
This document provides solution for the proparatory problems set given at http://www.it.uu.se/research/systems_and_control/education/2017/smc/schedule/SMC2017_preparatory.pdf.

P.1 Random number generation basics

(a) Sample 1000 random numbers from N(0,2)

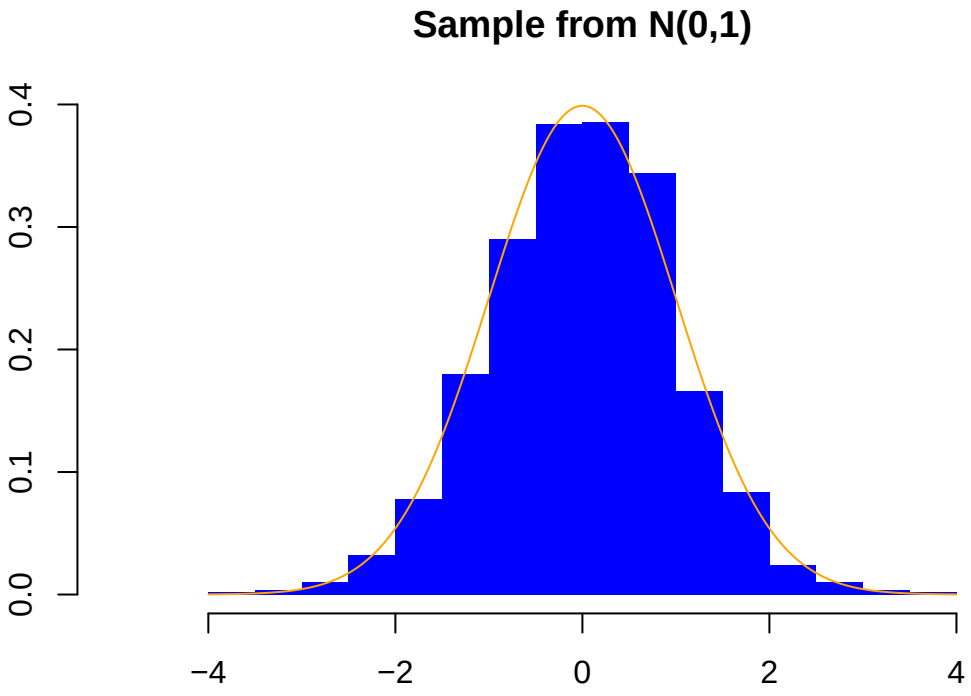
```
norm_data <- rnorm(1000, mean = 0, sd = sqrt(2))
x <- seq(-6, 6, length = 1000)
y <- dnorm(x, mean = 0, sd = sqrt(2))
#Plot the generated samples and the density function.
h <- hist(norm_data, breaks = 20, probability = TRUE,
          xlim = c(-6,6), col = "blue", lty = "blank",
         main = "Sample from N(0,2)", xlab = "", ylab = "")
lines(x, y,  type = "l", col = "orange")
```



(b) Inverse transform sampling, from N(0,1) using U(0,1)

```
unif_data <- runif(1000, 0, 1)
norm_data <- qnorm(unif_data, mean = 0, sd = 1) #transformed sample
x <- seq(-4, 4, length = 1000)
y <- dnorm(x, mean = 0, sd = 1)
#Plot a histogram of the transformed samples and the density function.
h <- hist(norm_data, breaks = 20, probability = TRUE,
```

```
          xlim = c(-5,5), col = "blue", lty = "blank",
          main = "Sample from N(0,1)", xlab = "", ylab = "")
lines(x, y,  type = "l", col = "orange")
```



(c) Affine transform

Sample 1000 numbers from N(2,10) by first drawing from N(0,1) and then make the appropriate linear transformation.

```
z <- rnorm(1000, 0, 1)
x <- z*sqrt(10) + 2
# Calculate the variance of the transformed sample to check if the affine transform was chosen right.
print(var(x))
```

```
## [1] 9.881122
```

(d) Setting the random seed in R.

```
set.seed(2018)
print(rnorm(5))
```

```
## [1] -0.42298398 -1.54987816 -0.06442932  0.27088135  1.73528367
```

```
set.seed(2018)
print(rnorm(5))
```

```
## [1] -0.42298398 -1.54987816 -0.06442932  0.27088135  1.73528367
```

P.2 Estimation of pi: Assume a unit circle inside a square of side 2.

We draw n pairs of samples from (unif[-1,1], unif[-1,1]) and count the number of occurances of the points inside the unit circle. The probability of hitting inside the circle is $\frac{\pi}{4}$.

```r
x1 <- runif(1000, -1, 1)
x2 <- runif(1000, -1, 1)
m <- sum(x1^2 + x2^2 <= 1)
pi <-  m/1000 * 4
print(pi)
```

```
## [1] 3.172
```

P.3 Analytical manipulation of Gaussian densitie

See folder exercises_on_paper.