Exam 2018-08-27

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Contents

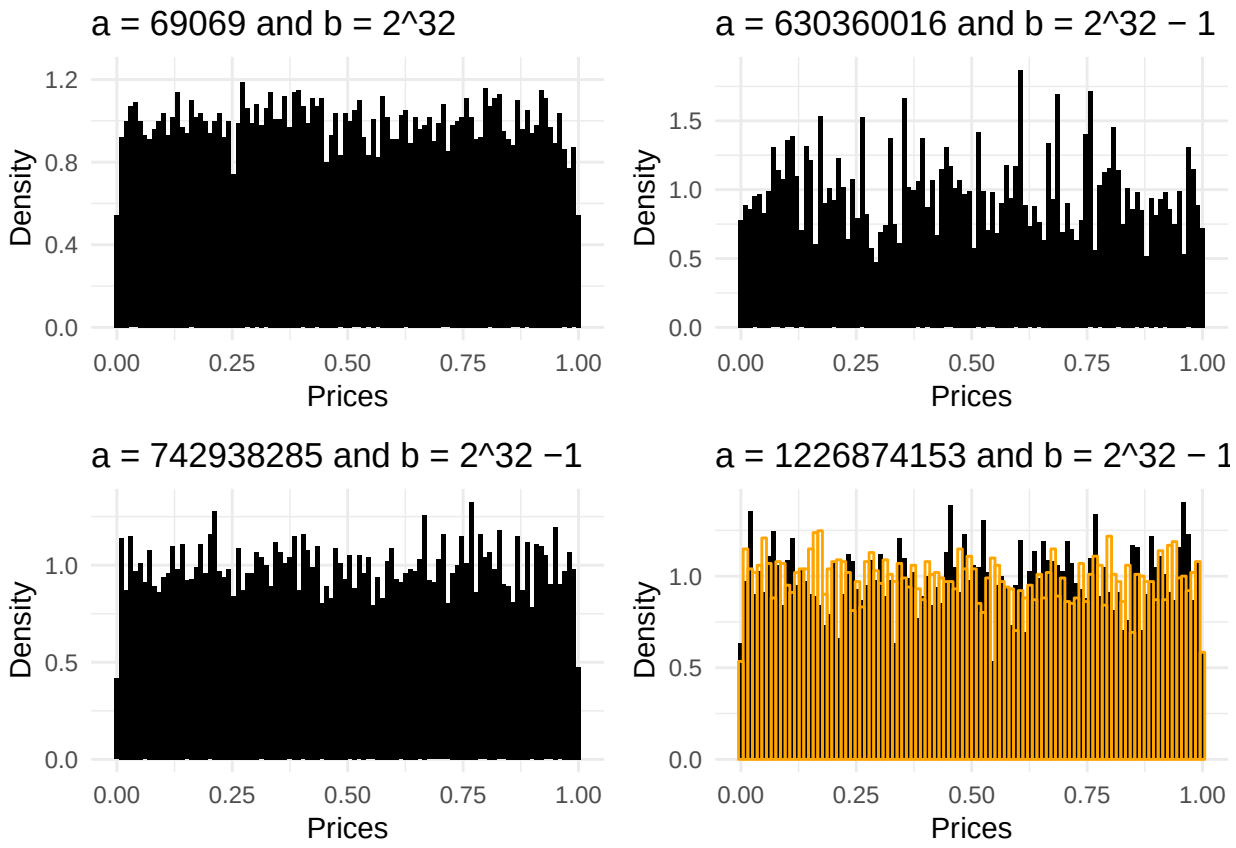
1 Assignment 1 (3 points)

1.1 Question 1.1

```
rng_runif = function(a, m, x_zero, nmax) {

  if (!(a >= 0 && a < m)) stop("a in [0, m) is required")
  if (nmax%%1 != 0) stop("nmax has to be an integer")

  storage = vector(mode = "numeric", length = nmax)
  storage[1] = x_zero

  for (i in 1:(nmax-1)) {
    storage[i+1] = ((a * storage[i]) %% m)
  }

  return(storage/m)
}
```

1.2 Question 1.2

```
prs_1 = rng_runif(69069, 2^32, 9999, 10000)
prs_2 = rng_runif(630360016, (2^32-1), 690690, 10000)
prs_3 = rng_runif(742938285, (2^32-1), 690690, 10000)
prs_4 = rng_runif(1226874153, (2^32-1), 690690, 10000)

unif_samples = runif(10000)
```




```
print(ks.test(x = prs_1, y = "punif"))
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  prs_1
## D = 0.010645, p-value = 0.2072
## alternative hypothesis: two-sided
```

```
print(ks.test(x = prs_2, y = "punif"))
```

```
## Warning in ks.test(x = prs_2, y = "punif"): ties should not be present for
## the Kolmogorov-Smirnov test
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  prs_2
## D = 0.018419, p-value = 0.002262
## alternative hypothesis: two-sided
```

```
print(ks.test(x = prs_3, y = "punif"))
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  prs_3
## D = 0.0063916, p-value = 0.8086
## alternative hypothesis: two-sided
```

```r
print(ks.test(x = prs_4, y = "punif"))
```

```
## Warning in ks.test(x = prs_4, y = "punif"): ties should not be present for
## the Kolmogorov-Smirnov test
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  prs_4
## D = 0.013235, p-value = 0.06018
## alternative hypothesis: two-sided
```

```r
print(ks.test(x = unif_samples_df, y = "punif"))
```

```
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  unif_samples_df
## D = 0.015937, p-value = 0.01245
## alternative hypothesis: two-sided
```

Answer: We see that the second and the last settings have a low-p value and have to be rejected at a significance level of $\alpha = 10\%$

- `a = 1` mod `p` for every prime divisor `p` of `m`
- `a = 1` mod `4` if `4` divides `m`
- `c` and m have to be relatively prime (no common divisirs bar 2)

In our case `c = 1`.

1.3 Question 1.3

```r
rng_rnorm = function(n, m, a) {

}
```

Skip.

2 Assignment 2

2.1 Question 2.1

2.2 Question 2.2

2.3 Question 2.3