

**Exercise 1**

Consider a LIBOR market model scenario for dates  $T_0 = 0 < T_1 < \dots < T_n$ , and let the dynamics of the LIBOR rate  $L(T_i, T_{i+1}; t)$  for  $i = 0, \dots, n-1$  be driven by  $n$  correlated Brownian motions  $W^i$ ,  $i = 1, \dots, n$ , with exponentially decaying correlations

$$\rho_{i,j} = \exp(-a|T_i - T_j|), \quad a > 0, \quad 1 \leq i, j \leq n. \quad (1)$$

Factor reduction is performed in the `Finmath` library by the method

```
factorReduction(double[] [] correlationMatrix, int numberOfFactors)
```

in the class `net.finmath.functions.linearAlgebra`. This method takes as arguments the original correlation matrix  $R = (\rho_{i,j})_{0 \leq i,j \leq n}$  and the number of most relevant factors the user wants to take into account, and returns the matrix  $F^r$  defined at page 648 of the script. You can find a class

```
com.andreamazzon.handout12.FactorReductionExponentialDecay
```

which uses the latter method in order to test the impact of factor reduction, depending on the correlation decay parameter  $a$  in (1).

Read the class, and complete the methods when asked.

Also write a test class where you construct an object of type `FactorReductionExponentialDecay` with a semi-annual tenor discretization going up to 10 years, call the method

```
getErrorFromFactorReduction(double corrDecay, int numberOfFactors)
```

and print the value it returns, for a fixed value `numberOfFactors = 2` and letting `corrDecay` run from 0 to 1. Try to figure out what do you expect before looking at the results: the difference will increase or decrease when `corrDecay` increases?

**Exercise 2**

Change where needed the method `createLIBORMarketModel` of

```
com.andreamazzon.handout9.LIBORMarketModelConstructionWithDynamicsAndMeasureSpecification
```

in such a way that you can give it the number of factors you want to simulate.

Calling this modified method, repeat the tests you can find in

```
com.andreamazzon.handout7.LMMDigitalCapletTest
```

considering now only 4 factors. Compare the average error in the prices of the digital caplets with respect to the one we get without factor reduction. Do you expect it to change or remain the same?