

# UML : Black-Scholes application

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## Introduction

The subject of our project is to develop an application that estimates the prices process of an asset. As it is really specific, we decided to make the diagrams and requirements for the application itself but also for the environment in which it is used: the trading.

The estimating process of the application is based on the Black-Scholes model, which is a mathematical model of a financial market published by Fisher Black and Myron Scholes in 1973. It is currently used in all the financial markets.

We will present in a succession of six parts the requirements, the use case diagrams, the activity diagrams, the class diagrams, the state diagrams and the interactions diagrams.

## I – Requirements

### Trading

Trader is a person or entity that buys and sells financial instruments such as stocks or commodities. The system is especially for the deal of options. Traders can use the Black-Scholes application in order to simulate different options and find the perfect price that is described after.

### General

#### **TRA-GEN-001**

Calculating capability

An estimation of the option shall be provided thanks to Black-Scholes model.

#### **TRA-GEN-002**

Evaluating processing

The evaluation shall analyse the risk rate, the budget and the financial market state.

#### **TRA-GEN-003**

Confirmation processing

Both trader and customer shall confirm the deal.

### Coverage

#### **TRA-COV-001**

Trading coverage

The Black-Scholes function shall process the following types of parameters of option:

- Initial asset price
- Volatility
- Risk-free rate

#### **TRA-COV-002**

Options coverage

The trading system should use previous share prices of the option.

#### **TRA-COV-003**

Trading information coverage

The coverage area of trading information may define if the options are call or put (so to buy or to sell).

### Data

#### **TRA-DAT-001**

Data format

The trading system shall use prices as representation of options.

#### **TRA-DAT-002**

Dealing attribute

The trading system shall comprehend the attribute of dealing type.

#### **TRA-DAT-003**

Market conformity

The trading system should be call or put in the conformity of option market.

### Save

#### **TRA-SAV-001**

Trading saving transaction

The system shall capture the deal.

## Modelling

The Black-Scholes model is a mathematical model of a financial market. The system gives a theoretical estimate of the price of options. The relevance of the estimation is provided by calculated errors of parameters.

### General

#### **MOD-GEN-001**

Modelling capability

An estimation of the asset price shall be provided.

#### **MOD-GEN-002**

Modelling processing

The modelling function shall allow the acquisition, the creation and the calculation of information relative to the asset price.

### Coverage

#### **MOD-COV-001**

Modelling coverage

The modelling function shall process the following types of charts:

- Initial asset price:  $S(t)$
- Estimation of volatility :  $\hat{\sigma}(n)$
- Drift estimation :  $\hat{\theta}(t)$

#### **MOD-COV-002**

Modelling errors coverage

The modelling function shall calculate two errors related to the charts that indicate the relevance of the estimators.

#### **MOD-COV-003**

Modelling information coverage

The whole information may be described for the users. Actually, this page shall explain to the user the aim of the application.

### Data

#### **MOD-DAT-001**

Data format

The parameters *shall* be in in the right format and in the fixed intervals. Actually, each parameter shall be defined as a right format (e.g: the price shall be a float and the number of acquisitions shall be a integer).

#### **MOD-DAT-002**

Data size

To have a significant theoretical estimate of the price of options, both the number and the time of acquisition should be big numbers.

### Save

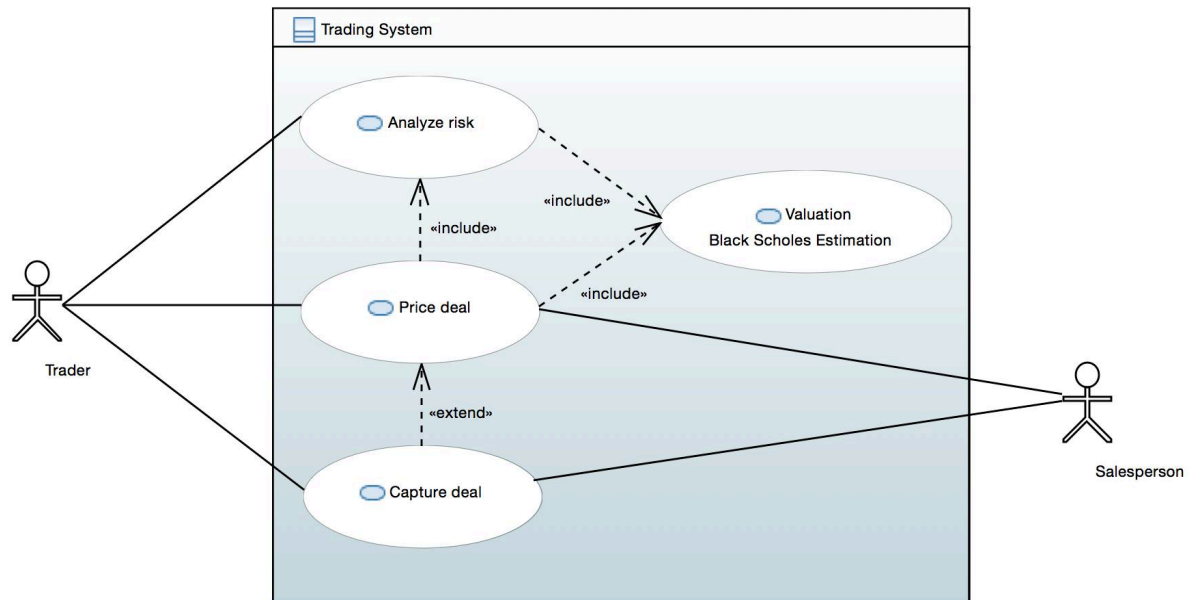
#### **MOD-SAV-001**

Modelling saving charts

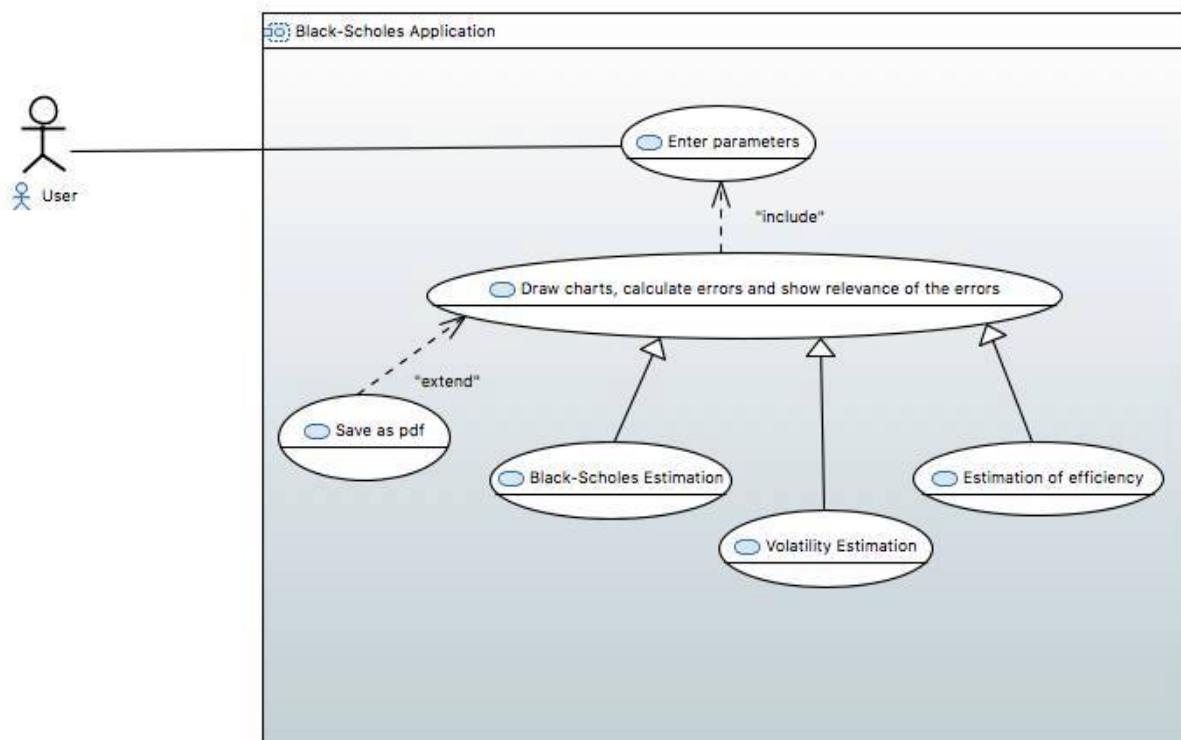
A global button will be displayed to export the three different charts as .pdf format.

## II – Use Case Diagrams

This use case diagram shows the usage of a trading system based on the Black-Scholes estimation. (*TRA-GEN-001*). The trader uses this system to estimate the price of the option and to analyze the risk rate (*TRA-GEN-002*).



In the second use case, we analyze our application's sub-functions that provide the Black-Scholes estimation. Traders can use the Black-Scholes application to simulate different options. The parameters given by the user shall be in the right format and in the fixed intervals (*MOD-DAT-001*), the bigger are the numbers, the more accurate the response will be (*MOD-DAT-002*). The application allows to draw three different charts (*MOD-COV-001*) and saves them as PDF (*MOD-SAV-001*).

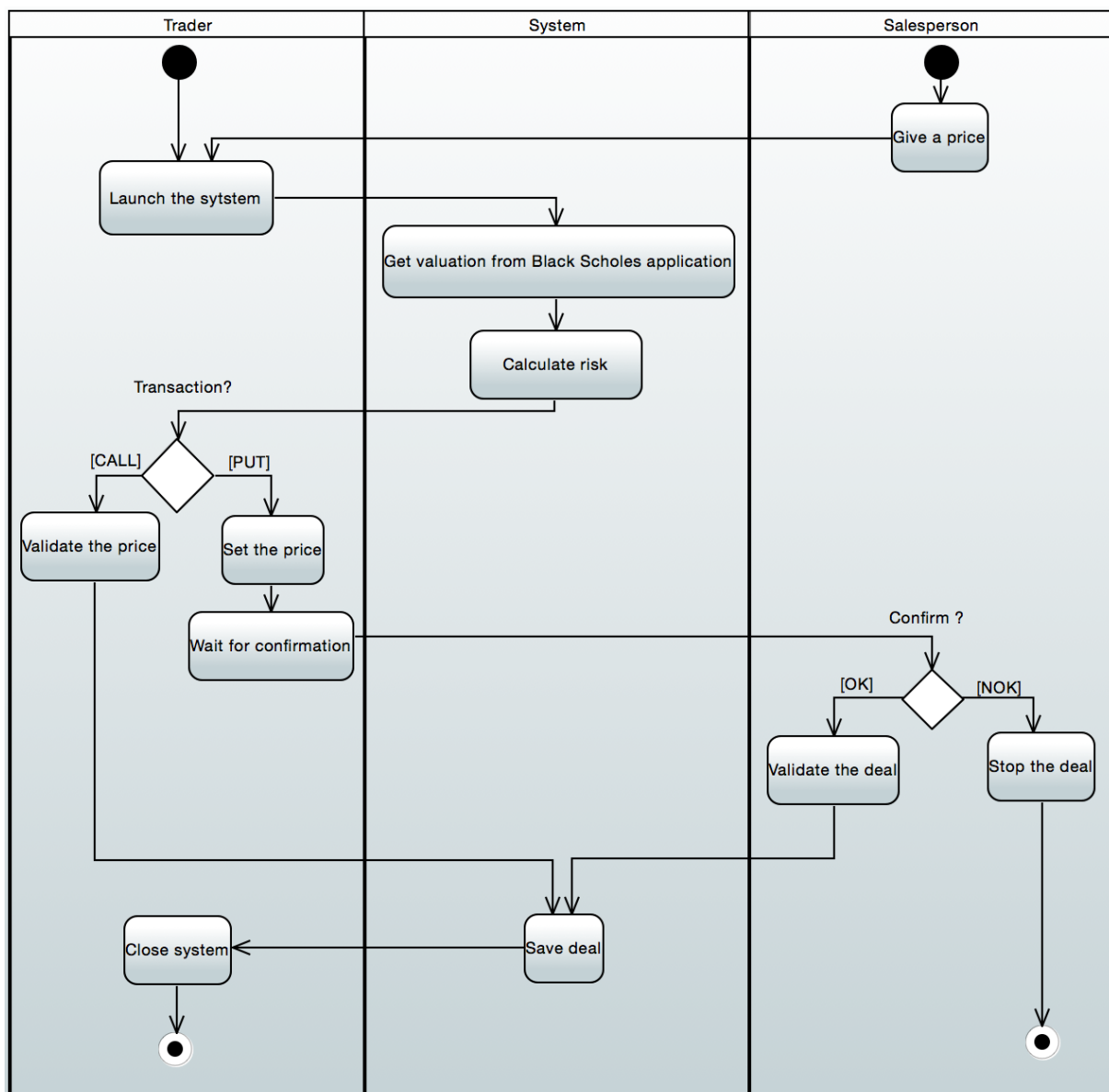


### III – Activity Diagrams

This Activity diagram (1) shows the utilization of a trading system by a trader that can both buy or sell an option to a salesperson.

The trader uses the system to estimate the price of the option thanks to the Black-Scholes model (TRA-GEN-001), this function is provided by our application (described in the second activity diagram). He is then able to analyze the risk rate, the budget and the financial market state (TRA-GEN-002).

In the case of a sale, the salesperson sets the price and the trader shall validate it. In the case of a purchase, the price is set by the trader and validated by the salesperson. In both situations, a confirmation is required (TRA-GEN-003). After validation, the deal is saved (TRAD-SAV-001).

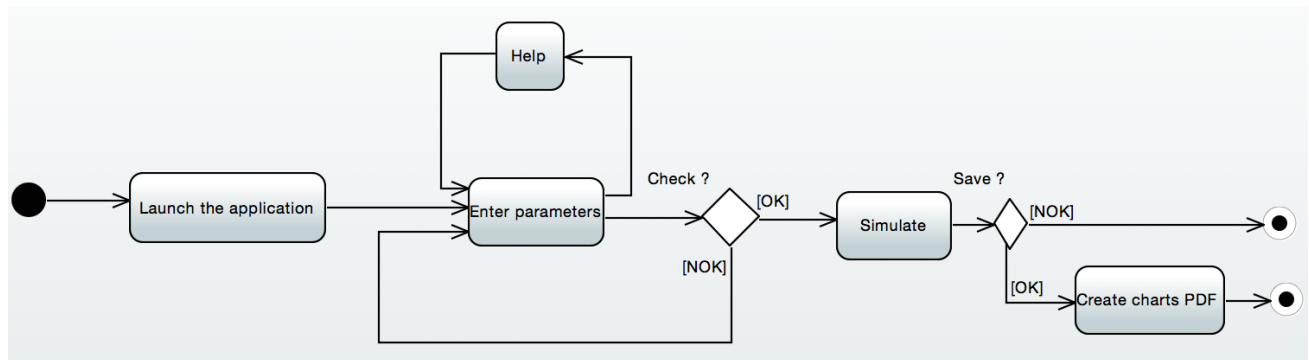


Activity Diagram 1

The second activity diagram introduces the utilization of our application. It gives a theoretical estimation of the options prices thanks to the Black-Scholes model. The user shall provide the initial price of asset (*MOD-GEN-001*) to obtain the model and the calculation of information relative to the asset price (*MOD-GEN-002*).

The user shall give parameters (*MOD-DAT-001*). Then the application draws three charts (*MOD-COV-001*) and saves them as PDF (*MOD-SAV-001*).

If the user needs help on the different parameters or the application, a “help” page is available (*MOD-COV-003*).

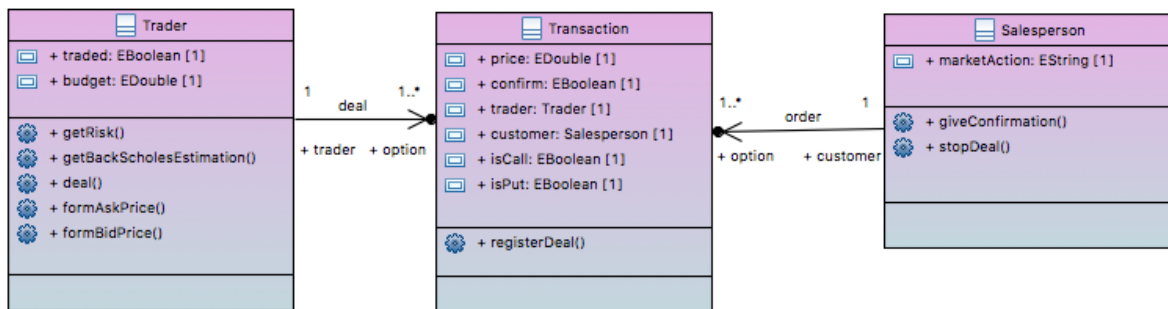


Activity Diagram 2



## IV - Class diagrams

First, we are going to analyse the structure of the system including the application and the application. The class diagram n°1 describes the relationship between the actors of the trading use case through a transaction class. A transaction can be instantiated in two types: a call or a put (*TRAD-COV-003*, *TRAD-DAT-003*). The whole information is set in the Transaction class (*TRAD-DAT-001*). Trader needs to manage a budget and find the best valuation of the transaction (*TRAD-GEN-002*). He uses different tools to obtain the best result as the Black-Scholes system in order to gain money (*TRAD-GEN-001*). The class diagram n°2 explains the first overview of the Black-Scholes application that the trader will calculate the optimal price. The last class diagram is the technical one.



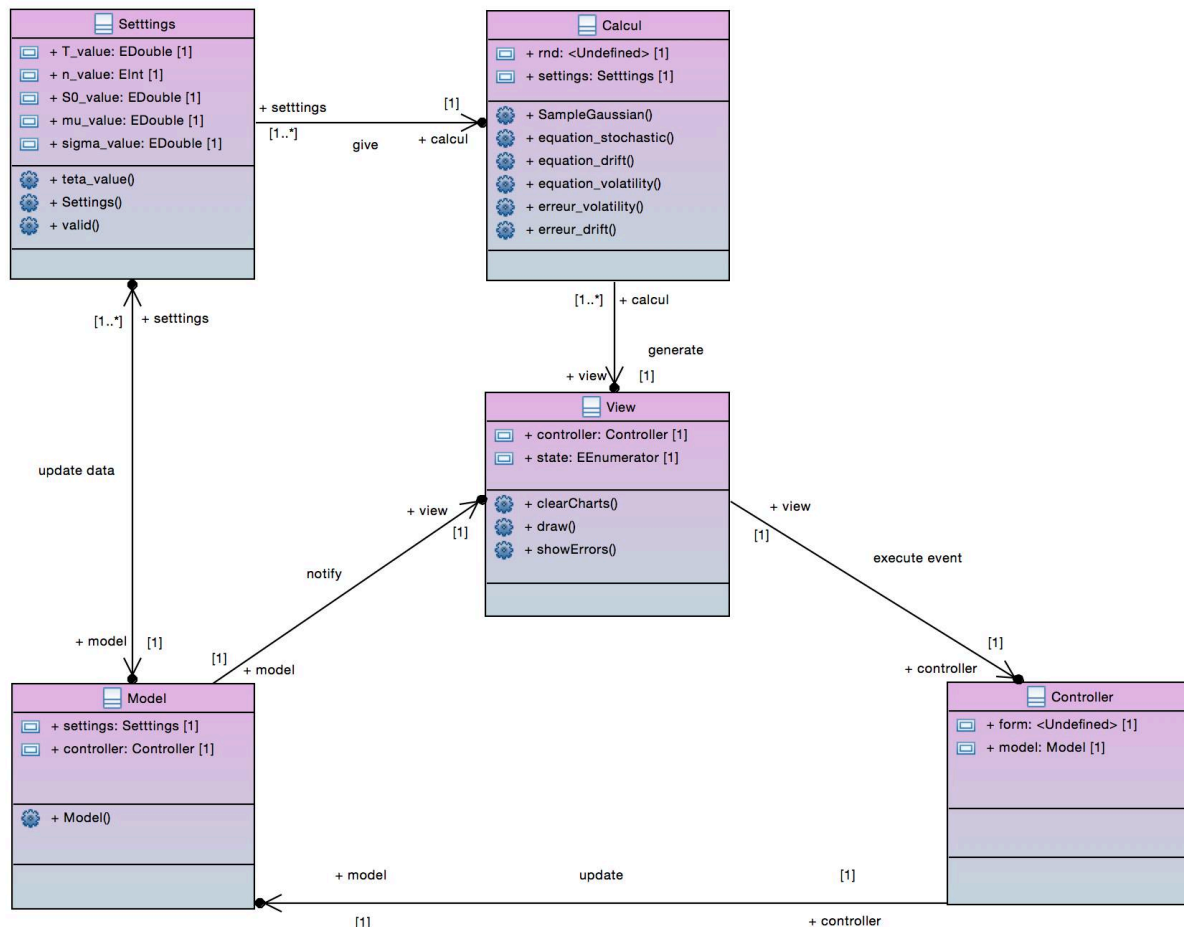
Class Diagram 1

The main goal of our application is showing through an interface to the user the simulation of the price of the option (*MOD-GEN-001*). The interface also indicates the estimations of option parameters (*MOD-GEN-002*). These estimations are relevant for the decision of the Trader as he can accept a deal or find the correct price (*MOD-COV-002*).



Class Diagram 2

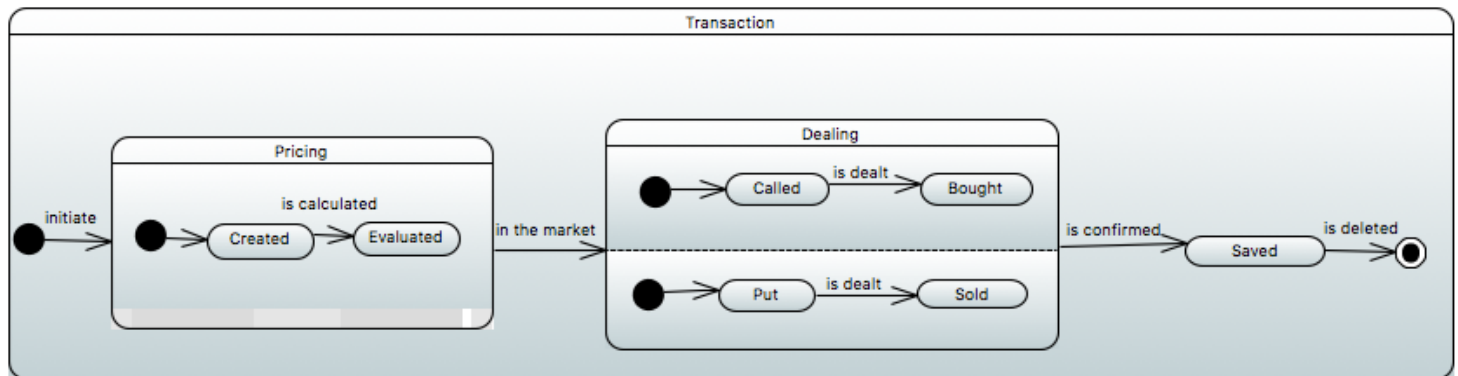
We can see the MVC architecture that is the process that links the application to users. To fit the transaction, the trader must enter settings (*MOD-DAT-001*). All the mathematical functions are grouped in a Calcul class and provided results for the view and so for the trader (*MOD-COV-001*).



Class Diagram 3

## V - State diagram

The state diagram 1 describes the behaviour of the trading system. The Black-Scholes application doesn't have real behaviours because it's only about generating values. The transaction state diagram includes different states when the trader and salesperson will interact (*TRAD-GEN-003*). Pricing is fully for the Trader in order to create the valuation of the dealing option (*TRAD-GEN-002*). The next step is divided between two regions that correspond to the options type possibilities (*TRAD-DAT-003*). Finally, the transaction is saved and deleted (*TRAD-SAV-001*).



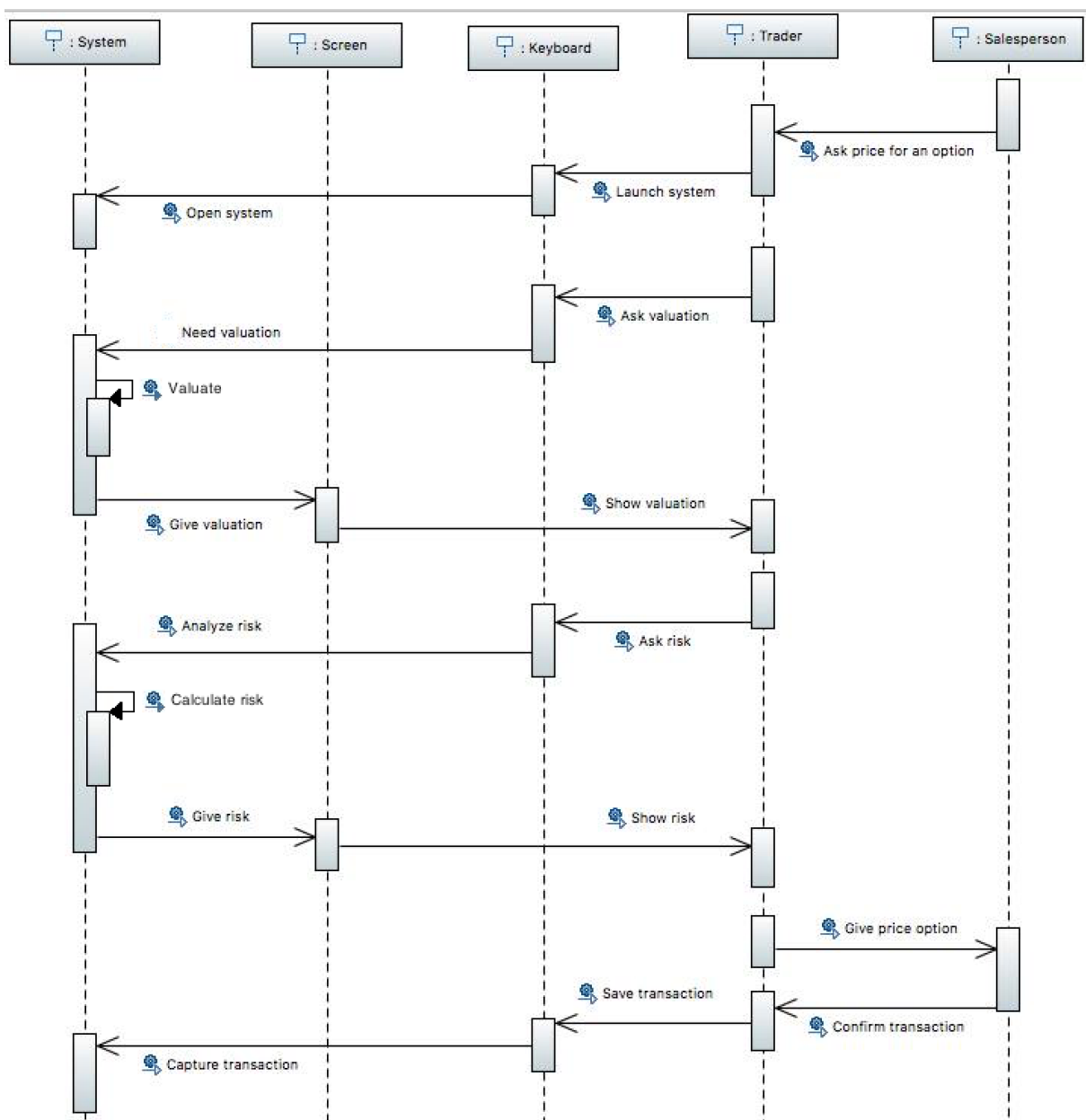
State Diagram 1

## VI - Sequence diagrams

The first sequence diagram shows the messages exchange during a purchase of an asset from a Salesperson to a trader that uses a trading system.

The salesperson asks the price for a specific action to the trader, then the trader analyses the risk rate, the budget and the financial market state thanks to the trading system (TRA-GEN-002) that are estimated with the Black-Scholes model.

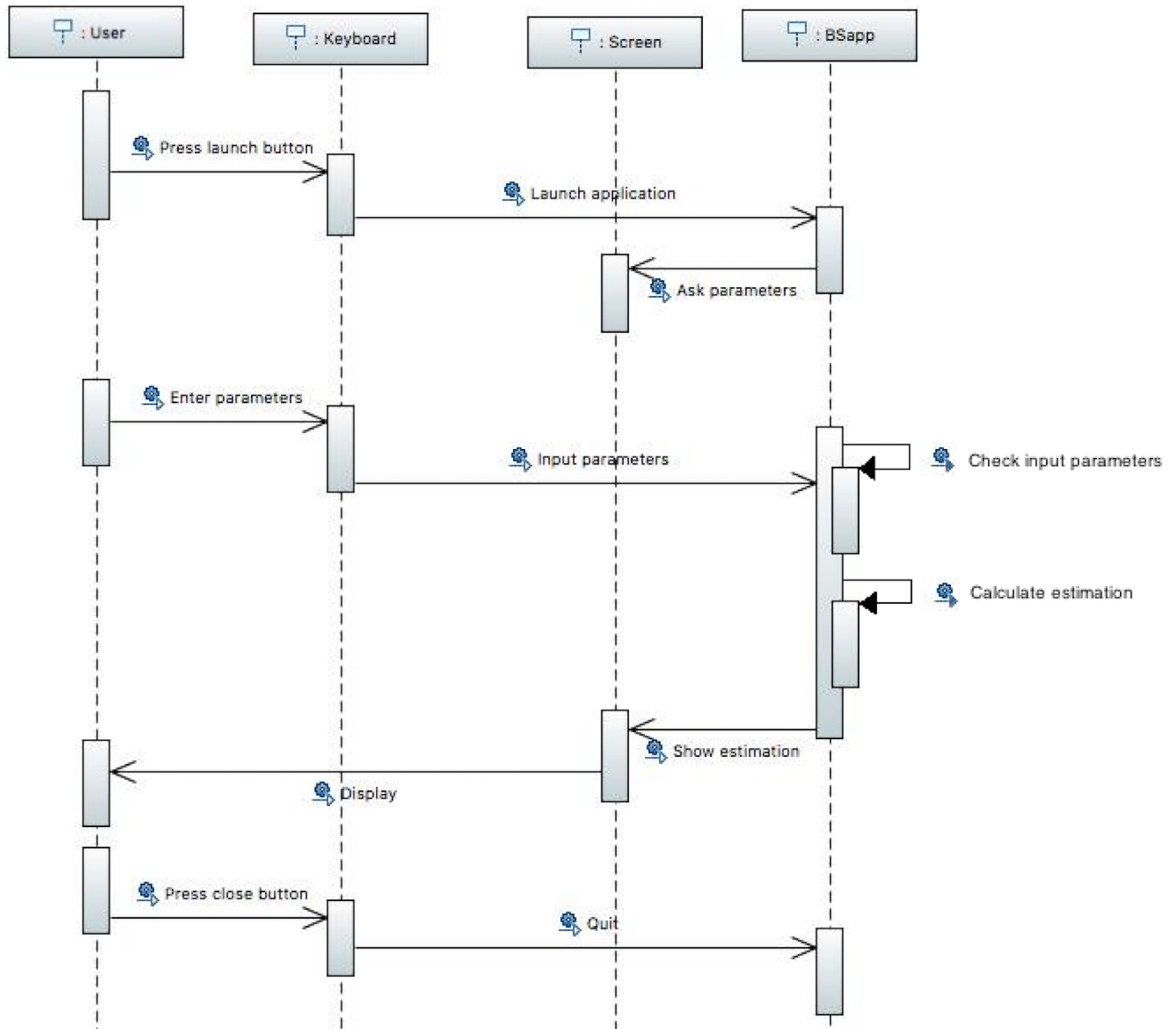
The system uses prices as representation of options (TRA-DAT-001), both trader and customer shall confirm the deal (TRA-GEN-003) then, the trader captures the deal (TRA-SAV-001).



Sequence Diagram 1

The second sequence diagram shows the messages exchange between our application and the user. The application shall provide an estimation of the asset (MOD-GEN-001) by allowing the acquisition, the creation and the information calculation (MOD-GEN-002).

The trader shall provide parameters in the right format and in the fixed intervals, a function that checks each parameter is defined as a right format (MOD-DAT-001).



Sequence Diagram 2

## Conclusion

To sum up, we can say that UML has been very useful to us in our design contexts. Thanks to its large type of features, as Use case diagrams, Activity diagrams, class diagrams, State diagrams, and Sequence diagrams, we were able to build our application in a structured and rigorous way.

Furthermore, we have been able to validate the different requirements which is a real great gain in the process of building our application.

Finally, our application estimates the pricing process of an asset, the final user could be a private or a professional like a trader.