ANSWER SHEET (DO NOT write in right hand column)

MODULE CODE:	COMP6212		Student ID:	31990401
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DLT is a digital system that allows users and systems to record transactions related to assets. A distributed universal technology stores information in multiple locations at any given time. The benefits of DLT related to digital currency development are:

Tamperproof

DLT forms trusted and secure systems where the consensus is based on the cryptography instead of any central authority (banks or central servers). Users have their own keys, and they can use them to make new transactions in the network. Creating a transaction means that new data are added in the network. By using DLT all data are stored in a public ledger and are accessible and visible at any time from anyone. Thus, no one can object to the transactions that have been made so far. Users have the ability to store, exchange transfer and monitor their currencies transaction without the involvement of any central authority.

Third party elimination

The traditional systems (banks) control the transactions and at the same time charge the users who make them with fees. In addition, the transactions may take a long time to complete. Thus, every time users want to make a transaction such as transferring an amount to another account, they will have to pay an additional cost which will end up in the bank. With the use of the DLT the intermediate entity is eliminated as the network relies on the P2P architecture. Transaction fees are significantly reduced as there is no central entity to participate in this process. As a result, users can make transactions and save money and time.

No central point of failure

DLT relies on a decentralized architecture. That means that there is no central server where users data are stored. However, traditional systems maintain a central server where all user's data are stored. Therefore, in a possible attack user's data can be leaked if the server found vulnerable. With DLT architecture all user's data are stores locally in user's devices. Thus, there is no fear that the server will be attacked, and the data will be leaked. Furthermore, if a central server goes out of order the whole network will be gone out of order. With DLT the whole network is running by all the participants. As a result, if one participant goes out of order the rest network will not be affected.

Anonymity

DLT uses cryptography to ensure that all the data will remain secure and anonymous. When a transaction is made the metadata of the transaction (sender, receiver, number of currencies to be moved) are encrypted with strong cryptographic algorithms. After that, they are stored publicly in the ledger of the network. Even the transactions are stored publicly and therefore are accessible and visible from anyone, they still remain anonymous because of their encryption. Thus, no one can identify the entity who made the transaction and reveal his/her identity.

The main problem with smart contract user's experience problems comes from the web. The most common problems that can be occurred are the following:

Non-consistent design of a digital wallet
In order to use a smart contract and its functionality we must enter in it a required amount of cryptocurrency. The problem is that different networks use different cryptocurrencies and therefore the type of the cryptocurrency the contract requires is specific. Although many cryptocurrencies are very common, smart contract accept only one type of cryptocurrency and thus require the user to have it in order to be able to use them. Furthermore, user interfaces (wallet applications) vary regarding their design and services and the capabilities they offer are different. As a result, if users decide to move to another wallet they must start from the beginning and familiarize with the new one and its functionalities.

Cryptocurrency knowledge required
Smart contracts operate under decentralized networks meaning that there is no third party (such as banks) in order for the transactions to be preceded. That means that each user needs to know detailed information regarding their wallet, transactions, keys and addresses.
Poor payment network. All of these, however, require technical knowledge and therefore in order for a user to be able to understand them, his technical training is required. For example, users need to know how much time a transaction takes to be completed, their private keys, their addresses (if they have multiple addresses) the transaction fees and so on so forth. Also, even for making a simple transaction user need to make some effort by downloading and setting their wallet application.

Poor payment network
Although cryptocurrencies aim to eliminate third parties and reduce transaction fees, at the moment the average transaction fee is higher than a traditional centralized payment service (PayPal). Another very big problem is that although cryptocurrencies are now widely used, it is rare to come across commercial companies that accept cryptocurrency payments. Cryptocurrency payments are mainly supported online level, thus limiting their use.

Lack of regulations
Unfortunately, cryptocurrencies are not protected by any legal regulation and so there are no regulations regarding their legal use. Thus, hackers with this situation in mind, try to approach users without technical knowledge in order to steal their personal data (private keys) and therefore their cryptocurrencies. At this point we should mention that a user without knowledge can send his cryptocurrencies to the wrong address of another wallet and thus lose them. As a result, many users take advantage of the fact that the system is not legally supported and take advantage of this situation by acting illegally to their advantage

All the above are the main problems related to the web. But another noteworthy problem is the fact that all systems are different and therefore their mode of operation is different. For example, a smart contract in Ethereum may have a different fee than a smart contract in a Hyperledger network (which is actually free). If a Hyperledger user is unaware of this technical detail and tries to use an Ethereum smart contract, he/she will spend his/her cryptocurrencies without knowing it.

Smart contracts make a network functional, so minimal designing is very important for the following reasons:

Functions scope reduction
A network can use data and services from other networks. This means that smart contracts work with smart contracts from other networks to burn some functionalities. Thus, since these functions are based on another network, we do not need to rewrite the code for this function, and therefore reducing the volume and complexity of the smart contract.

Straightforward concerns addressing
Smart contracts are small programs that they act on their own. They do not rely on any central server but the code itself. Thus, minimalist design is very important because it gives contracts the opportunity to give more efficient solutions to problems faster.

Clarity regarding the contract logic
A smart contract that has been designed with minimalism reveals more easily the reason for which it has been designed. The logic of its functionality is fully understood and specific and thus does not need unnecessary functions.

Defense to non-trivial consequences
By following a minimalist architecture when implementing a smart contract, we give it more security in case of non-trivial consequences. Thus, if a problem or threat is observed, it will be easier to locate the problem in a minimalist code than in a complex and messy code

In order to “future proofing” a smart contract we have to ensure the following three:

Data discoverability
Data discoverability refers to the ability of a user (simple user or developer) to identify the type of data and how they are managed by the smart contract.

Real time events
Real time events are a kind of alert that occurs whenever a state changes. For example, if a user decides to make a transaction an event must be occurred and notify him that the smart contract was activated, and the transaction has been made successfully.

Access to states inspection and event listening
Users should be able to access the various state changes. If the functionality of a contract changes, all users should have access to the contract to be informed of new changes. They should also be notified by an appropriate event regarding any changes that happened.

Coloured coins is a concept designed on the top of the Bitcoin blockchain (all the relevant advantages of Bitcoin apply) in order to create a new set of information regarding the coins that have been exchanged. Coloured coins usage can give a colour (something like a label) to each Bitcoin, so it can effectively turn it into a token which can be used representing anything (stocks, assets, etc.). Thus, coloured coins is a distributed management infrastructure layered on the top of the Bitcoin blockchain which allows individuals and companies to issue different asset classes.

Example 1
A supermarket decides that if the customer buys certain products, he will get a coloured coin in exchange. Then, if the customer manages to collect 20 colored coins, he will be able the next time he visits the supermarket to use the colored coins and buy these products for free.

Example 2
The council of Southampton decides that every Sunday if drivers use the public parking for more than an hour, they will receive 5 coloured coins. 5 coloured coins correspond to one hour, so the next time they want to park their car in a public parking they will be able to use their coloured coins and park their car for one hour free of charge.

Advantages

Emotion's minimization: Automatic trading minimizes emotions during the trading process. Reducing emotions, traders are more able to stick with a trading plan and follow it. As long as transactions are automatically executed, traders don't have a dilemma whether to hesitate or not the trade. *Example: A trader holds a stock and plans to sell it when it gets 20% profit. In case this target is met during the investor's session with general positive trends, the stock may go above the initial trader goal. Thus, the trader may want to keep the stock even the goal is reached in order to gain even more, and as a result increase the risk level. By using automatic trading technique this risk does not exist.*

Performing further testing (Backtesting): Backtesting uses historical data and apply trading rules on them in order to determine the viability of the idea. In automatic trading all rules must be determined clearly form the beginning and therefore computers are not able to "guess" what they have to do. Traders can use these set of rules as historical data and apply them in test models before they apply them in a real trading.
Example: Long term investors are not interested in short term fluctuations. Thus, they can use historical data in order to evaluate the real value of a stock.

Trading preserving: As mentioned before all rules are determined from the beginning. Therefore, transactions are executed automatically even in volatile markets. Lack of preserving is a very often phenomenon because of the trading fear or the money loss. However, automatic trading follows specific rules and plans no matter what.
Example: If a trader wants to make an order and buy 100 shares will not be incorrectly entered as an order to sell 1000 shares.

Faster order entries: As long as computers are able to respond to the different market conditions and changes, automated systems can make orders when all the trading requirements are met. When a position is entered all the other order are made at the same time automatically including protective stop losses and profit targets. Markets can move quickly and it's unwanted to hit the stop-loss level. Automatic trading can prevent such a situation.
Example: When a specific stock price hits the goal, the selling process is done immediately, the profit target is achieved, and money loss is prevented.

Diversifying trading: Automated trading gives the opportunity to the trader to exchange different accounts or different strategies at the same time. This situation can spread the risk in different instruments and create a hedge against losing position.
Example: Traders can create a class of stocks from different markets capitalizing on different trends and minimizing the risk level of negative trend on one or another market.

Disadvantages

Functional failures
Automatic trading is performed by machines that are vulnerable to errors and failures. Depending on the trading platform, a trade order could be stored in a client's computer instead of a server.
Example: In case that a computer lost the internet connection, the order will be unable to be sent in the market with any consequence that might have.

System monitoring and maintenance
Sometimes an automated order will be unable to executed because of a software failure. That means that the system needs to be monitored and maintained by a technical team in order to avoid these issues.
Example: The company should spend money for a technical team if they want to support the automatic trading mechanism.

Unreasonable optimization
Over optimization refers to the excessive curve fitting that produces a trading plan in real time trading. Sometime traders assume that a plan should have absolute profit or should never face a drawdown. As a result, the plan is not realistic and completely fails when they apply it in real time trading.
Example: A pharma company has a stable trend for the last 5 years. However, this year this company acquire another pharma company, and this has a positive impact to its financials that is not captured in the historical data. Thus, the historical data are not robust enough and any plan based on them will be over optimized and unrealistic.

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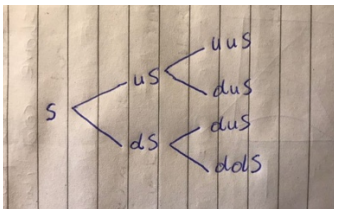
A binomial-lattice model is used to value derivatives which are actually economical instruments in that their price is related to an asset such as a stock. Such a model uses a binomial tree in order to present the different paths of the price. A binomial tree represents the possible prices in different times.

The binomial-lattice model says that there are two states

1. One state goes up (by a factor u)
2. One state goes down (by a factor d)

and each state will lead only to other states



We should also make the following assumptions:

1. All values are positive (> 0)
2. Paths are independent
3. Model can be constructed in a spreadsheet
4. For stock prices we assume intervals of time (t), months, quarters and years
5. Volatility is constant

Single period

For a single period, we can determine the stock price which is based on historical data as

$$P = \alpha e^{\beta t}$$

Then we can take the logarithm of this value $\ln(P) = \ln \alpha + rt$, where r is the average rate of growth. Next, we can calculate the growth of the stock price in a single period (year) with some variance $\sigma^2 T$

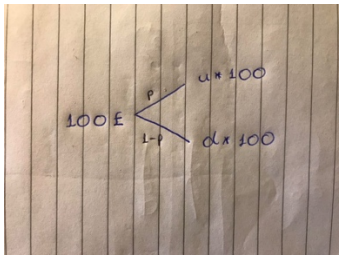
$$\ln(P) = \ln \alpha + rt \pm \sigma\sqrt{t}$$

Notice that volatility σ is one standard deviation. If the period, we want to calculate is not a whole year then we have

$$\sigma\sqrt{\frac{t}{n}}$$

Thus, up (u) is $e^{\sigma\sqrt{t}}$ (volatility) and down (d)= 1/u. We can calculate the probability of up by using the Brownian motion:

$$p = \frac{e^{rt} - d}{u - d}$$



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Multiple years

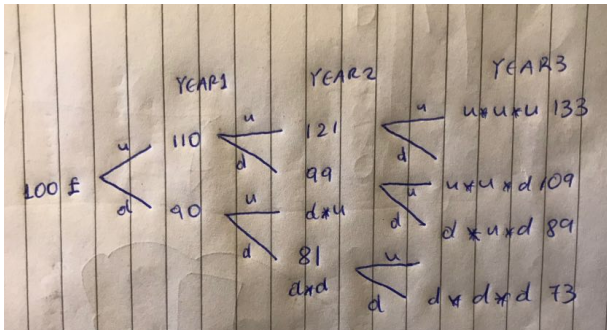
For multiple years we build again a tree with the u, d, and p factors. The difference is that a multiple year model is like a single year model stepwise repeated. We have also made the assumption that the model arbitrage free (d<r<u).

Forward moving

We can now work by moving forward in order to calculate the value of the stock in some years. So, let's assume that we have a stock which costs 100 pounds and has also a volatility of 10% per year. We want to calculate its value in three years.

u = $e^{\sigma\sqrt{t}}$ → u= $e^{+0.1\sqrt{1}}$=1.1

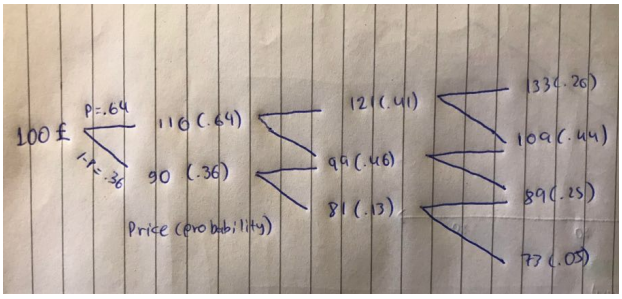
d= 1/u or $e^{-0.1\sqrt{1}}$=0.9



Backyard moving

Now we can work by moving backyard and calculate the price depending on the strike price and the type of option.

The expected value is either a value or zero Call E(p)=max (S-K, 0), where S is the stock price and K is the strike price Put E(p) = max (K-S, 0).



The Greek letter are used to determine some functions in order to measure the volatility of a price. Those Greek letters are also called “risk sensitivities” and are used to the following functions.

Delta (δ, Δ)
Delta function measures the sensitivity of a specific stock. More specifically, it measures the sensitivity of the option price if there is a change in the underlying price of this stock. Delta function can be determined as

delta = $\Delta = \frac{\partial C}{\partial S} = \Phi\ (d_i)$

We can also use Delta function to perform a hedging meaning that periodically we can rebalance the portfolio to get a delta of zero.

Gamma (γ, Γ)
By using the gamma function, we can measure the sensitivity of the delta function. That means that we can measure how much will the call price delta change if the underlying stock price changes. Gamma function can be determined as

gamma = $\Gamma = \frac{\partial^2 C}{\partial S^2} = \frac{\Phi\ (d_i)}{\sigma S_t \sqrt{T}}$

and is the same for puts.

Vega (κ, Κ)
Vega function measures the sensitivity of the volatility. In particular is the measurement of an option's price sensitivity to changes in the volatility of the underlying stock. If an option contract's price changes in reaction to a 1% change in the implied volatility of the underlying asset, the Vega function represents the amount of this change. Vega function can be determined as

vega = $\frac{\partial C}{\partial S} = S_t \sqrt{T} \Phi\ (d_i)$

and is the same for puts and calls.

Theta (θ, Θ)

Theta function measures the rate of decline in the value of an option due to the passage of time. Theta function acts differently for puts and calls.

For calls, the rate of decline is calculated by theta by using the following equation

$$\Theta(\text{call}) = -\frac{S_0 N'(d_1)\sigma}{2\sqrt{T}} - rKTe^{-rT}N(d_2)$$

where $N'(x) = \frac{1}{\sqrt{2\Pi}} e^{\frac{y^2}{2}}$

On the other for puts, the rate of decline is calculated by theta by using the following equation

$$\Theta(\text{call}) = -\frac{S_0 N'(d_1)\sigma}{2\sqrt{T}} + rKTe^{-rT}N(-d_2)$$

where $N(-d_2)$ = 1- $N(d_2)$, and the theta of a put exceeds the theta of a corresponding call by

$$rKTe^{-rT}$$

Rho (ρ, P)

Rho function is used to measure the sensitives of the options to the change in the risk-free rate of interest. Again, Rho function acts differently for puts and calls.

For calls, the sensitive of the options is calculated by theta by using the following equation

$$\text{rho} = \rho = \frac{\partial C}{\partial r} = KTe^{-rT}N(d_2)$$

On the other for puts, the sensitive of the options is calculated by theta by using the following equation

$$\text{rho} = \rho = \frac{\partial P}{\partial r} = -KTe^{-rT}N(-d_2)$$

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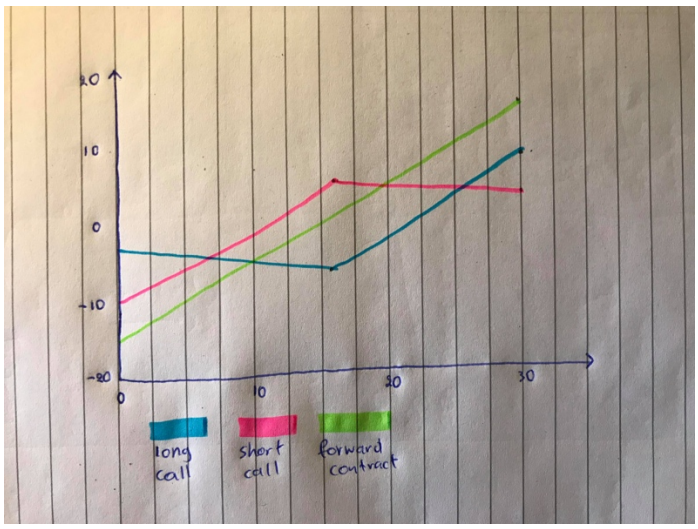
Putt-Call parity says that if someone is holding a short put and a long call of the same class, the returning will be the same as holding one forward contract on the same asset with the same expiration date and a forward price equal to the option's strike price. Therefore, putt-call parity is a relationship between put and call options. If put and call prices diverge and their relations is about to be broken, then we have an arbitrage opportunity. That means that the traders can gain money without risk.

Example

Consider we are selling a put option for the XCORP stock where the expiration date, the strike price and the option cost are the same. After that we receive 5 pounds for writing the option. Now we are unable to exercise or not the option since we don't own it. The legal buyer has bought the right, but he is not committed to sell us the XCORP at the strike price. That means that we must make the dealt whatever the XCORP price is. If XCORP trading costs 10 pounds per year, the buyer will sell the stock for 15 pounds. We have already gained 5 pounds for selling the put option while the buyer has spent 5 pounds to buy it. If the XCORP stock costs 15 pound or more, we have gained 5 pounds since the other party will not be able to exercise the option. If XCORP price costs below 10 pounds we will lose up to 10 pounds if the price becomes 0.

We can see the profit of the loss in the diagram below. If we add the profit or loss on the long call, we make or lose what we would have if we had agreed on a forward contract for XCORP which would cost 15 pounds and expires in one year. If the stock costs less than 15 pounds we lose our money. However, if they are going for more, we have profit.



Fundamental analysis

Fundamental analysis is a method which is used to measure the stock's intrinsic value by examining economic and financial factors. In fundamental we need to evaluate the value of a stock and to do so we use public data related to the company we want to analyze (state of the economy, management team etc.). The main goal is to arrive at a number that we then can compare with the stock process. Then we can take decisions regarding this number. For example, if the number is higher than the stock price the company is undervalued, so we are able to buy. However, if the number is lower than the stock price the company is overvalued, and we have to sell.

Fundamental analysis is used when we have to deal with qualitative and quantitative data. When we say quantitative data we mean financial statements like assets, profits, etc. that we can measure with precision. On the other hand, qualitative data include the quality of a company's key executive, its brand name, the patents and the technology which is used. By performing fundamental analysis, we mainly focus on the following:

- Business model: identify if there's more behind the current model
- Competitive advantage: looking for things that the company has and its competitors not
- Management: locking if the CVs have been buying sell stock lately
- Corporate governance: investigate the system of the company, if they follow any standards and if the stakeholders are happy

Technical analysis

Technical analysis is a trading discipline which is used to evaluate investments and identify trading opportunities by analysing statistical trends. Technical analysis says that all the fundamentals are factored into the price

There are 4 popular forms of technical analysis:

- Simple moving averages
- Support and resistance
- Trend lines
- Momentum and based indicators

Difference

Fundamental and technical analysis differ regarding the predicting stock pricing. On the one hand, fundamental analysis evaluates securities by attempting to measure the intrinsic value of a stock. On the other hand, technical analysis is related to the stock's price and volume. However, both methods are used for researching and forecasting future trends in stock prices.

Variance - Risk

Variance is used to measure the risk of a single asset. If the returns are spread out over the last few years, then the risk is high. Variance is actually used to measure the risk of volatility of the return.

$$\sigma^2 = \frac{\sum_{i-1}^{N}(r_i - \mu)^2}{N}$$

That means for the population r = return, N = number of years, μ is the average. For a sample it is S and the N-1 in the denominator. The total variance is a combination of systemic risk and non-systematic risk. Systematic risk refers to inflection, natural disasters, political uncertainty, etc. Non-systematic risk refers to a particular asset or industry such as regulation changes, new technology, etc.

Covariance

It is very often that traders are interested in more than one asset in their portfolio. When performing a portfolio analysis, we want to know how assets vary in relation to each other. Covariance is used to measure how assets are moved together. Although covariance has a range (-inf, +inf) it is very difficult to have get results by a high score. What we can get is the direction of the movement. That means that covariance is positive when the variables show similar behaviour and when the variables show different behaviour.

Correlation

Correlation is used to measure the linear relationship between two assets. The Beta value has a range [-1, +1]. +1 is a perfect positive correlation between two assets. The returns of the two assets move together. 0 means that there is no correlation between the two assets. Finally, -1 means that there is perfect negative correlation between the two assets. The returns of the two assets move in opposite directions.

Correlation and covariance

Covariance and correlation primarily assets the relationship between variables. The closest analogy to the relationship between them is the relationship between the variance and standard deviation. Both correlation and covariance are indicators of the relationship between two variables by indicating whether the variables are positively or negatively related.

Covariance and correlation are linked with the following formula:

$Cov(R_i, R_j) = \rho(R_i, R_j) * \sigma R_i * \sigma R_j$

Were:

Ri = Return on asset i

Rj = Return on asset j

Cov (Ri, Rj) = Covariance of returns on assets i and j

ρ(Ri, Rj) = Correlation between two returns

σRi = standard deviation of returns of asset i

σRj = standard deviation of returns of asset j

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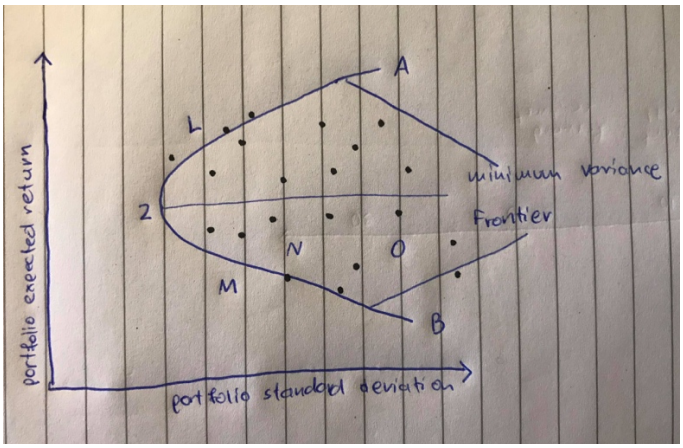
The Effective Frontier a set of optimal portfolios that they offer the highest expected return for a determined level of risk or the lowest risk for a given level of expected return. All the portfolios that are below the effective frontier are not considered as optimal because they don't offer enough returns for the given risk level. All the portfolios that are located on the right side of the effective frontier are not optimal because they have higher risk level for the determined rate of return.

Diagram explanation



When using a portfolio there are no risk-free assets and also a portfolio has a variance for a given level of return. Thus, if we consider all the above, we can determine a minimum variance frontier where M, N and O give the same return, but M has less variance. On the left side of the graph is the expected return which has also an expected risk (x axis).

The Effective Frontier is the portion of the graph above the global maximum variance. That means that this portfolio will give the highest returns for a given risk level. Conservative investors will aim for a spot on the left side of the efficient frontier because it has low return and low risk, while aggressive investors will aim for the right side of the efficient frontier because it has high return and high risk. If a portfolio falls below the efficient frontier, then it is inefficient and therefore the investors are exposed to too much risk for the specified return or, conversely, provides too low a return for the specified risk.

Selection of portfolio based on the efficient frontier

As we mentioned before portfolios that are below the effective frontier are not considered as optimal because they don't offer enough returns for the given risk level. Furthermore, portfolios the portfolios that are located on the right side of the effective frontier are not optimal because they have higher risk level for the determined rate of return. Thus, if we want to select an optimal portfolio, we have to select one which is not located above or on the right side of the efficient frontier.

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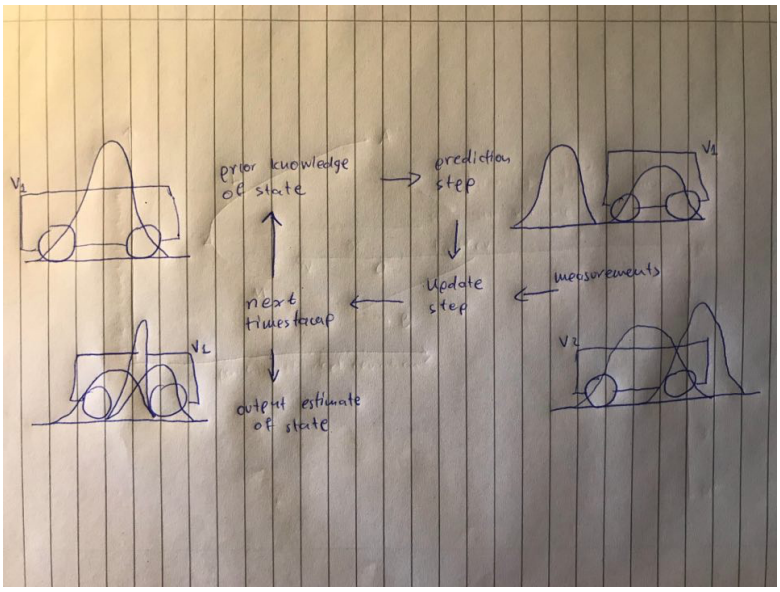
In stock price prediction a Kalman filter is used for filtering out noise from data as finance data seems to contain a portion of noise in them. The Kalman filter, is a minimizing algorithm which updates the state estimate when information arrives, which enables for processing application in real-time. Kalman filter is widely applicable to applications that make linearity assumptions, and it infers that at every step the posterior density is Gaussian and a parametrized covariance.

The following diagram show how the Kalman filter works:



The Kalman filter is a process that recursively estimates the coefficients of the model represented by a vector θ based on the values of the previous day's coefficients, an uncertainty matrix adjusted every day, and some tuning parameters that model the error.