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Grokking the Object Oriented Design Interview

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Design an Online Stock Brokerage System

Let's design an Online Stock Brokerage System.

We'll cover the following

- System Requirements
- Usecase diagram
- Class diagram
- Activity diagrams
- Code

An Online Stock Brokerage System facilitates its users the trade (i.e. buying and selling) of stocks online. It allows clients to keep track of and execute their transactions, and shows performance charts of the different stocks in their portfolios. It also provides security for their transactions and alerts them to pre-defined levels of changes in stocks, without the use of any middlemen.

The online stock brokerage system automates traditional stock trading using computers and the internet, making the transaction faster and cheaper. This system also gives speedier access to stock reports, current market trends, and real-time stock prices.

System Requirements

We will focus on the following set of requirements while designing the online stock brokerage system:

1. Any user of our system should be able to buy and sell stocks.
2. Any user can have multiple watchlists containing multiple stock quotes.
3. Users should be able to place stock trade orders of the following types: 1) market, 2) limit, 3) stop loss and, 4) stop limit.
4. Users can have multiple 'lots' of a stock. This means that if a user has bought a stock multiple times, the system should be able to differentiate between different lots of the same stock.
5. The system should be able to generate reports for quarterly updates and yearly tax statements.
6. Users should be able to deposit and withdraw money either via check, wire, or electronic bank transfer.
7. The system should be able to send notifications whenever trade orders are executed.

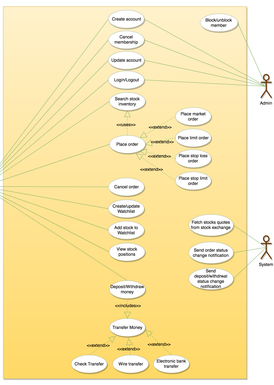
Usecase diagram

We have three main Actors in our system:

- **Admin:** Mainly responsible for administrative functions like blocking or unblocking members.
- **Member:** All members can search the stock inventory, as well as buy and sell stocks. Members can have multiple watchlists containing multiple stock quotes.
- **System:** Mainly responsible for sending notifications for stock orders and periodically fetching stock quotes from the stock exchange.

Here are the top use cases of the Stock Brokerage System:

- **Register new account/Cancel membership:** To add a new member or cancel the membership of an existing member.
- **Add/Remove/Edit watchlist:** To add, remove or modify a watchlist.
- **Search stock inventory:** To search for stocks by their symbols.
- **Place order:** To place a buy or sell order on the stock exchange.
- **Cancel order:** Cancel an already placed order.
- **Deposit/Withdraw money:** Members can deposit or withdraw money via check, wire or electronic bank transfer.

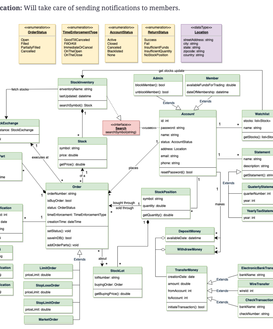


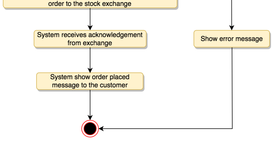
Use case diagram for Stock Brokerage System

Class diagram

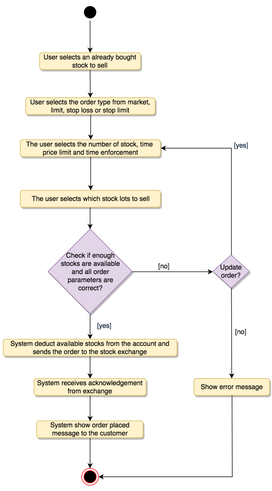
Here are the main classes of our Online Stock Brokerage System:

- **Account:** Consists of the member's name, address, e-mail, phone, total funds, funds that are available for trading, etc. We'll have two types of accounts in the system: one will be a general member, and the other will be an Admin. The Account class will also contain all the stocks the member is holding.
- **StockExchange:** The stockbroker system will fetch all stocks and their current prices from the stock exchange. StockExchange will be a singleton class encapsulating all interactions with the stock exchange. This class will also be used to place stock trading orders on the stock exchange.
- **Stock:** The basic building block of the system. Every stock will have a symbol, current trading price, etc.
- **StockInventory:** This class will fetch and maintain the latest stock prices from the StockExchange. All system components will read the most recent stock prices from this class.
- **Watchlist:** A watchlist will contain a list of stocks that the member wants to follow.
- **Order:** Members can place stock trading orders whenever they would like to sell or buy stock positions. The system would support multiple types of orders:
  - **Market Order:** Market order will enable users to buy or sell stocks immediately at the current market price.
  - **Limit Order:** Limit orders will allow a user to set a price at which they want to buy or sell a stock.
  - **Stop Loss Order:** An order to buy or sell once the stock reaches a certain price.
  - **Stop Limit Order:** The stop-limit order will be executed at a specified price or better after a given stop price has been reached. Once the stop price is reached, the stop-limit order becomes a limit order to buy or sell at the limit price or better.
- **OrderPart:** An order could be fulfilled in multiple parts. For example, a market order to buy 100 stocks could have one part containing 70 stocks at $10 and another part with 30 stocks at $10.05.
- **StockLot:** Any member can buy multiple lots of the same stock at different times. This class will represent these individual lots. For example, the user could have purchased 100 shares of AAPL yesterday and 50 more stocks of AAPL today. While selling, users will be able to select which lot they want to sell first.
- **StockPosition:** This class will contain all the stocks that the user holds.
- **Statement:** All members will have reports for quarterly updates and yearly tax statements.
- **DepositMoney & WithdrawMoney:** Members will be able to move money through check, wire or electronic bank transfers.
- **Notification:** Will take care of sending notifications to members.


OrderStatus
OrderTypeCancelled
OrderTypeFilled
OrderTypeNew
OrderTypePartiallyFilled
OrderTypeCanceled
OrderSide
Buy
Sell
ShortSell
ShortCover
AssetClass
Equity
Option
Future
Forex
Crypto
Commodity
Index
AssetStatus
Active
Inactive
Canceled
Expired
Delisted
Suspended
Unknown
RetainStatus
Business
Day
IntuitionPrivateIndividual
IntuitionPrivateInstitutional
Location
street/address string
city string
state string
zipcode string
country string
StockExchange
exchangeUpdate: StockExchange
isOpen(): bool
OrderPart
price: double
quantity: double
executed: datetime
Stock
symbol: string
price: double
getPrice(): double
StockInventory
inventoryItem: string
lastUpdated: datetime
searchSymbol(): Stock
Search
searchSymbol(symbol: string)
Admin
blockMember(): bool
unblockMember(): bool
Member
evaluateFundsForTrading: double
cancelMembership: datetime
Account
id: int
password: string
name: string
address: AddressStreet
address: Location
email: string
phone: string
totalPassword(): bool
Watchlist
stocks: StockStocks
name: string
getStocks(): bool
Statement
name: string
description: string
getStatement(): string
QuarterlyStatement
quarterNumber: int
year: int
YearlyTaxStatement
year: int
Order
orderNumber: string
isBuyOrder: bool
status: OrderStatus
timeInforcement: TimeInforcementType
creationTime: dateTime
setStatus(): void
setAmt(int): void
addOrderPart(): void
StockPosition
symbol: string
quantity: double
getQuantity(): double
DepositMoney
availableFunds: datetime
WithdrawMoney
TransferMoney
creditNumber: int
amount: double
fromAccount: int
toAccount: int
initiateTransaction(): bool
ElectronicBankTransfer
bankName: string
WireTransfer
swift: int
CheckTransaction
bankName: string
checkNumber: string
Notification
notificationId: int
createdOn: date
content: string
send(): bool
SMS
phone: string
EmailNotification
email: string
PushNotification
email: string
LimitOrder
priceLimit: double
StopLossOrder
priceLimit: double
StopLimitOrder
priceLimit: double
MarketOrder
BlankLot
inventoryItem: string
buyingPrice: Order
getBuyingPrice(): double
Extends
Implements
Has
Uses
Creates
Manages
Inherits
Contains
Notifies
Verifies
Generates
Stores
Fetches
Places
Tracks
Initiates
Fulfills
Executes
Buys
Sells
Holds
Searches
Updates
Retrieves
Checks
Calculates
Displays



Place a sell order: Any system user can perform this activity. Here are the steps to place a buy order:



Code

Here is the code for the top use cases.

Enums and Constants: Here are the required enums and constants:

Java | Python

```java
public enum ReturnStatus {
  SUCCESS, FAIL, INSUFFICIENT_FUNDS, INSUFFICIENT_QUANTITY, NO_STOCK_POSITION
}

public enum OrderStatus {
  OPEN, FILLED, PARTIALLY_FILLED, CANCELLED
}

public enum TimeEnforcementType {
  GOOD_TILL_CANCELLED, FILL_OR_KILL, IMMEDIATE_OR_CANCEL, ON_THE_OPEN, ON_THE_CLOSE
}

public enum AccountStatus {
  ACTIVE, CLOSED, CANCELED, BLACKLISTED, None
}

public class Location {
  private String streetAddress;
  private String city;
  private String state;
  private String zipCode;
  private String country;
}

public static class Constants {
  public static final int MONEY_TRANSFER_LIMIT = 100_000;
}
```

StockExchange: To encapsulate all the interactions with the stock exchange:

Java | Python

```java
public class StockExchange {

  private static StockExchange stockExchangeInstance = null;

  // private constructor to restrict for singleton
  private StockExchange() { }

  // static method to get the singleton instance of StockExchange
  public static StockExchange getInstance()
  {
    if(stockExchangeInstance == null) {
      stockExchangeInstance = new StockExchange();
    }
    return stockExchangeInstance;
  }

  public static boolean placeOrder(Order order) {
    boolean returnStatus = getInstance().submitOrder(Order);
    return returnStatus;
  }
}

```

Order: To encapsulate all buy or sell orders:

Java | Python

```java
public abstract class Order {
  private String orderNumber;
  public boolean isBuyOrder;
  private OrderStatus status;
  private TimeEnforcementType timeEnforcement;
  private Date creationTime;

  private HashMap<Integer, OrderPart> parts;

  public void setStatus(OrderStatus status){
    this.status = status;
  }

  public bool saveInDB() {
    // save in the database
  }

  public void addOrderParts(OrderParts parts) {
    for (OrderPart part : parts) {
      this.parts.put(part.id, part);
    }
  }
}

public class LimitOrder extends Order {
  private double priceLimit;
}

```

Member: Members will be buying and selling stocks:

Java | Python

```java
// For simplicity, we are not defining getter and setter functions. The reader can
// assume that all class attributes are private and accessed through their respective
// public getter methods and modified only through their public methods function.

public abstract class Account {
  private String id;
  private String password;
  private String name;
  private AccountStatus status;
  private Location address;
  private String email;
  private String phone;

  public boolean resetPassword();
}

public class Member extends Account {
  private double availableFundsForTrading;
  private Date dateOfMembership;

  private HashMap<string, StockPosition> stockPositions;

  private HashMap<Integer, Order> activeOrders;

  public ErrorCode placeSellLimitOrder(
    string stockId,
    float quantity,
    int limitPrice,
```