



Development of the Portfolio Management Game 2.0

Master Project

UNIVERSITY OF ZURICH - DEPARTMENT OF BANKING AND FINANCE

Authors:

ROLAND SCHLAEFLI - ROLANDSCHLAEFLI@GMAIL.COM
PASCAL ZEHNDER - PASCAL_ZEHNDER@OUTLOOK.COM

Supervisor IFI:

PROF. DR. CHAT WACHARAMANOTHAM

Supervisors DBF:

PROF. DR. MARKUS LEIPPOLD, DR. BENJAMIN WILDING

Contents

1. Motivation	1
2. Project Description	2
2.1. Improvements intentions of the old simulation	2
2.2. Project Procedure	3
2.3. IT Target	3
3. Methodology	4
3.1. Requirements Engineering	4
3.2. User Interviews	4
3.3. Observation of Game Execution	4
3.4. Design and Iterative Prototyping	7
4. Architecture	8
4.1. Frontend	8
4.2. GraphQL	8
4.3. API / Prisma	8
4.4. Model	8
4.5. Simulation	9
4.6. Continious development	9
5. Market Model	9
5.1. Data and Data Ingestion	10
5.2. Performance Attribution	10
5.3. Market Model	10
5.4. Business Model	10
5.5. API Specification	10
6. Application Overview	10
6.1. Administration	11
6.1.1. Administrator login	11
6.1.2. Game management	11
6.1.3. Reports	14
6.1.4. Entities administration	14
6.2. Team View	15
6.2.1. Login	15
6.3. Period 0 decisions	15
6.4. Other periods decisions	16
6.4.1. TAA	16
6.4.2. Depot Realization	17
6.4.3. Business Administration	17

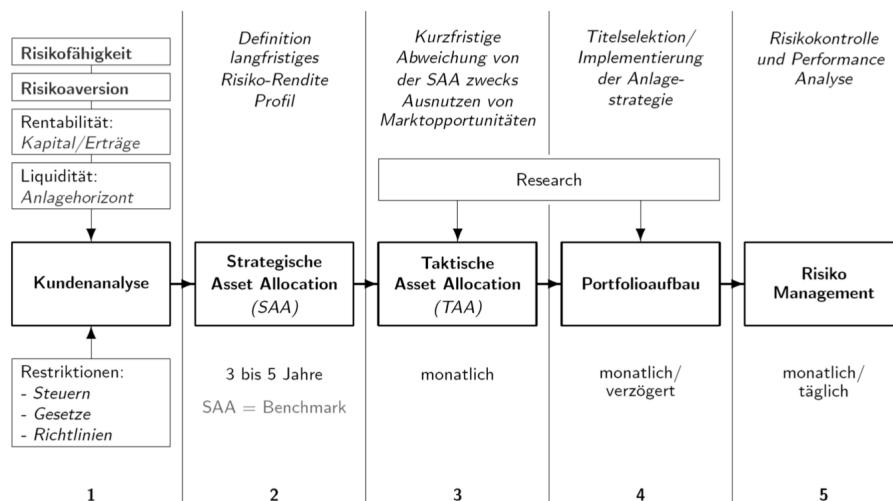
7. Future Development	18
A. Exemplary scenario	19
B. User Stories	19

1. Motivation

Students in the field of Banking and Finance at the University of Zurich learn a lot about asset management as well as business management aspects during various courses. In order to give students an opportunity to apply their knowledge and understanding of the portfolio management process, a Portfolio Management Game is used within a seminar for Master students. According to the Department of Banking and Finance, the main targets of this simulation are the following learning outcomes:

- Students learn how money can be systematically invested in financial markets.
- Students learn what factors make financial market forecasts possible and what limitations the models have for forecasting.
- Students learn which factors are relevant for the success (performance) of investments and can distinguish between factors that promise short-term success and aspects that are relevant in the long term.

In the simulation, the students act in groups as heads of a bank's portfolio management and are responsible for both the investment strategy and the business management of investment funds. The game's content focuses on a structured investment process, which covers the steps from getting to know different customer types of the bank, selecting a suitable long-term Strategic Asset Allocation, adjust it according to the status of the economy for the Tactical Asset Allocation and select appropriate titles for the depot realization. Competition for better performance for their clients among the different student teams makes the learning process entertaining.



However, the currently used version of the Portfolio Management Game is technically and didactically outdated. The currently used Portfolio Management Game (Portfolio Management SIM) was initially developed in 2005 by the Department of Banking and Finance at the University of Zurich in cooperation with the Swiss bank Julius Bär as well as game solution ag. A rapid technological development since that time allows new perspectives and possibilities in the field of game-based learning.

2. Project Description

This project aims to redesign and reprogram the existing Portfolio Management Game so that it is up to date both from a content, technical and didactic point of view. Therefore, a project team from the Department of Banking and Finance and Department of Informatics have decided to cooperate on a modern version of the Portfolio Management Game. From the content side, a project team around Prof. Dr. Markus Leippold and Dr. Benjamin Wilding have been assembled. From the IT side, Prof. Dr. Chat Wacharamanotham together with two students (also the authors of this work) are in the lead. Both student members of the project team work at the Department of Banking and Finance UZH as web developers parallel to their studies achieving their Master's degree in Informatics. Both interested in developing applications from scratch and analyzing the procedure of financial processes. By re-developing the application the Department of Banking and Finance wants to achieve a sustainable simulation of a typical portfolio management process. The simulation should help the students within their learning process by focussing on practical decision making, building up on their theoretical knowledge.

The present work focuses more on the IT side of the project. Subsequently, a more detailed description of the project scope is provided.

2. Project Description

2.1. Improvements intentions of the old simulation

As mentioned in the previous chapter, the current Portfolio Management needs to be revised. According to the involved members of the Department of Banking and Finance, the development of a new simulation intends to enhance different elements and also introduces new features:

- For the old solution, specially configured hardware is necessary to play the simulation. The game is based on outdated technologies and after each round, the supervisors had to collect a memory stick where all decisions of the students have been saved onto. The supervisors had to collect this data for each group on a central device with administrative access (on a windows native application) in order to calculate the result of the teams decisions. Especially due to this reason, only a limited amount of teams can play the game simultaneously. Through the transformation into a web-based environment, the simulation can be used independent of time and location, whereby the number of participants can be scaled. It is therefore also conceivable that the simulation can be offered not only to students at the Department of Business, Economics, and Informatics, but also to students of other faculties with appropriate support.
- Due to the use of historical, real financial market data in the previous simulation, students can improve their success in the simulation by researching past share prices. This means that currently, not those students who invest the money in a scientifically meaningful way who score best, but those who carry out the best research. A new simulation shall enable the use of data, which is simulated by mathematical processes before the execution. On the one hand, this improves fairness in the simulation and on the other hand, it also shows that it is not possible to forecast financial market data precisely. The simulation of the data lies within the task field of the Department of Banking and Finance Team.

- Students should be shown that the forecasting ability of financial markets is limited and that the investment of funds should, therefore, be based on fewer, theoretically sound principles. With the simulation the students that misconduct can lead to short-term profits, but that systematic behaviour is decisive for success in the long term.

The first point of the enumeration above is to be addressed from the IT project team (authors of this work) whereas the subsequent two items of the list are the task of the DBF project team.

2.2. Project Procedure

The project is first planned by the project management and the specifications for the implementation are defined in cooperation with the IT team. In a second step, a student from the DBF receives the task to prepare the economic model for the data simulation.

Thereafter, the IT framework is selected based on the specifications, expert as well as user surveys. In this important phase from an IT view, the simulation is being rebuilt and reprogrammed.

A testing and finalization phase follows after the end of this master project. Thereby, the game will be tested by the project team and additionally needed functionalities incorporated.

Finally, the finished product will be used for regular study purposes. This simulation of a portfolio manager was being used from the DBF in a course named "Advanced Portfolio Management Game". For the final seminar of the Finance Executive Education the game was being played for two days on Uetliberg. As soon as the new simulation is ready, it should be possible to play the portfolio game also within larger classes (e.g. assessment level students).

2.3. IT Target

The main targets for the IT-team are the following aspects:

- **Usability:** The different game sequences within the market model should be well-designed and comprehensible for the game master and the players.
- **Scalability:** Design a well functioning game that can be played with smaller and larger number of students (assessment: in about 700 students in the course Banking & Finance II).
- **Modularity:** Basic and advanced version(s) allows the game to be used on different levels of study.

Important characteristics and components of the game:

- The game should be self-explanatory and intuitive.
- A brief and concise game documentation is to be created (part of the project report).
- The game contains at least the useful components of the old game (except using industry-level instead of single firms).

3. Methodology

- Informative innovative graphical output (as self-explanatory as possible) for the instructor (based on the current Excel-evaluation and further ideas we provide in advance and students (see "Teilnehmerbericht" of the old game and further a depiction of performance-attribution).
- New market model created by the Department of Banking and Finance in an Excel spreadsheet which will be the base for the implementation of the authors.

3. Methodology

Different tools helped us to understand a typical investment process to model the game best for a proper learning of the students, as described in section 1. This part should give an insight into our procedure within the project.

3.1. Requirements Engineering

The typical requirements engineering builds the base of our engineering design process. By creating user stories we had a common basis to define the requirements together with our principals from the DBF. As usual when defining user stories we classified those stories into following three categories: Nice-to-have, Should-have, Must-have. Additionally they are structured into different functional or organizational parts. All the stories can be found in the appendix B. The state of the acceptance criteria is marked in the checkboxes of the corresponding story.

3.2. User Interviews

Interviews with professionals and other people with deep knowledge of the overall process have been held to get an insight into different practices during the investment process in different companies.

- Roger Burger, UBS
- Sandro Braun, Zürcher Kantonalbank

Both interviewers have described their job and their daily tasks, always referring to the game, as both interviewers already had played the old game. Additionally, they showed some screens of their internal applications which helped us to design the depot realization part of the students decisions.

3.3. Observation of Game Execution

Besides the interviews with experts, the project team had the opportunity during summer 2018 to collect feedback within three different game executions to deepen their knowledge for an investments process and to learn about crunchpoints of creating a new solution.

Firstly, at the beginning of July, the final seminar of the Finance Executive Education took place. At this point of their study, the participants have completed most of their courses and should know the portfolio management process at least theoretically. There are also practitioners who work in the field of asset management respectively private banking. The simulation itself was played during the three days. A group of in about 30 participants played in groups of three and four. The authors had

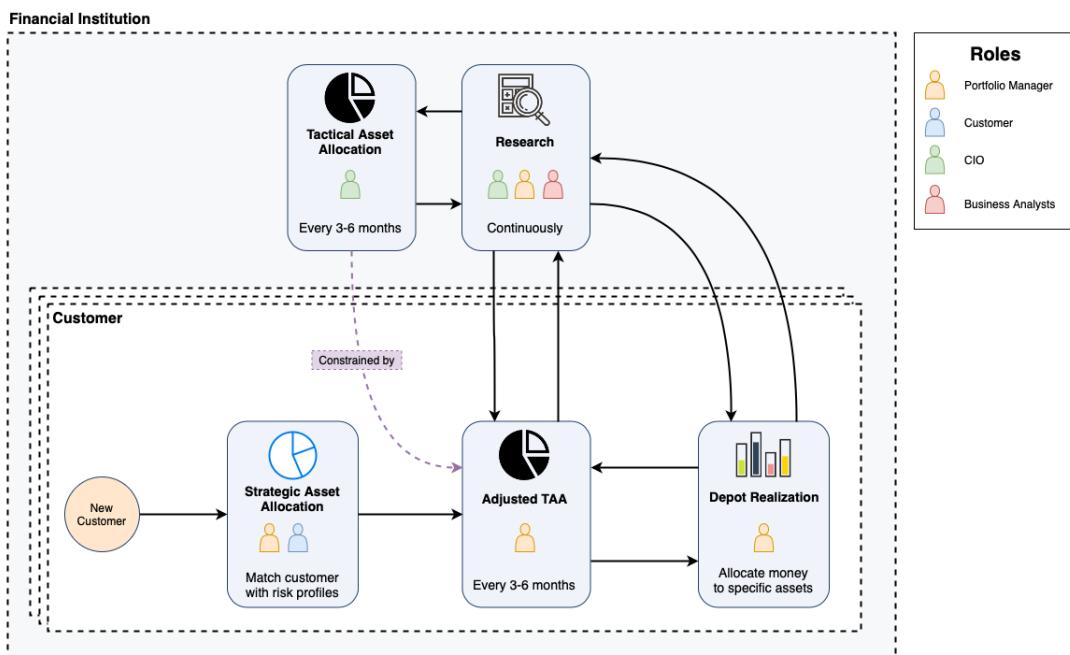
3.3. Observation of Game Execution

the chance to observe the groups at the beginning during their decision-making process and ask them directly for feedback. Additionally, the seminar management collected final feedbacks as well as ideas for further development at the end of the seminar, when they knew the game well, as multiple periods have been past.

The second setting was set up especially for observation purposes of this project. Two students on Bachelor's level with only basic knowledge in finance and two students on Master's level with advanced knowledge in finance played two periods of the game in a seminar room under the observation of the authors. The main intention of this run is also to gain understanding, how players with different understanding levels of the portfolio management process would approach a decision and how a new technically implemented game will improve their play procedure. In the end, they also provided detailed feedback.

A third observation chance was the Master seminar "Advanced Portfolio Management Game" of the DBF at the beginning of September. During two seminar days, the simulation was conducted at the Swiss Bank Julius Bär. In combination with practical lectures, the students can deepen their understanding of portfolio management and present their outcomes in front of a critical jury.

A large number of observed students and practitioners help to gain an overview of the game process and especially from the player's point of view obsolete or requested elements regarding the simulation. As result of thos observations and interview with students and professionals, following work model has been defined for a typical investment process:



Additionally, a number of relevant observations made by the authors as well as the seminar conductors and feedbacks from the participants during the three sessions is depicted – please note that in order

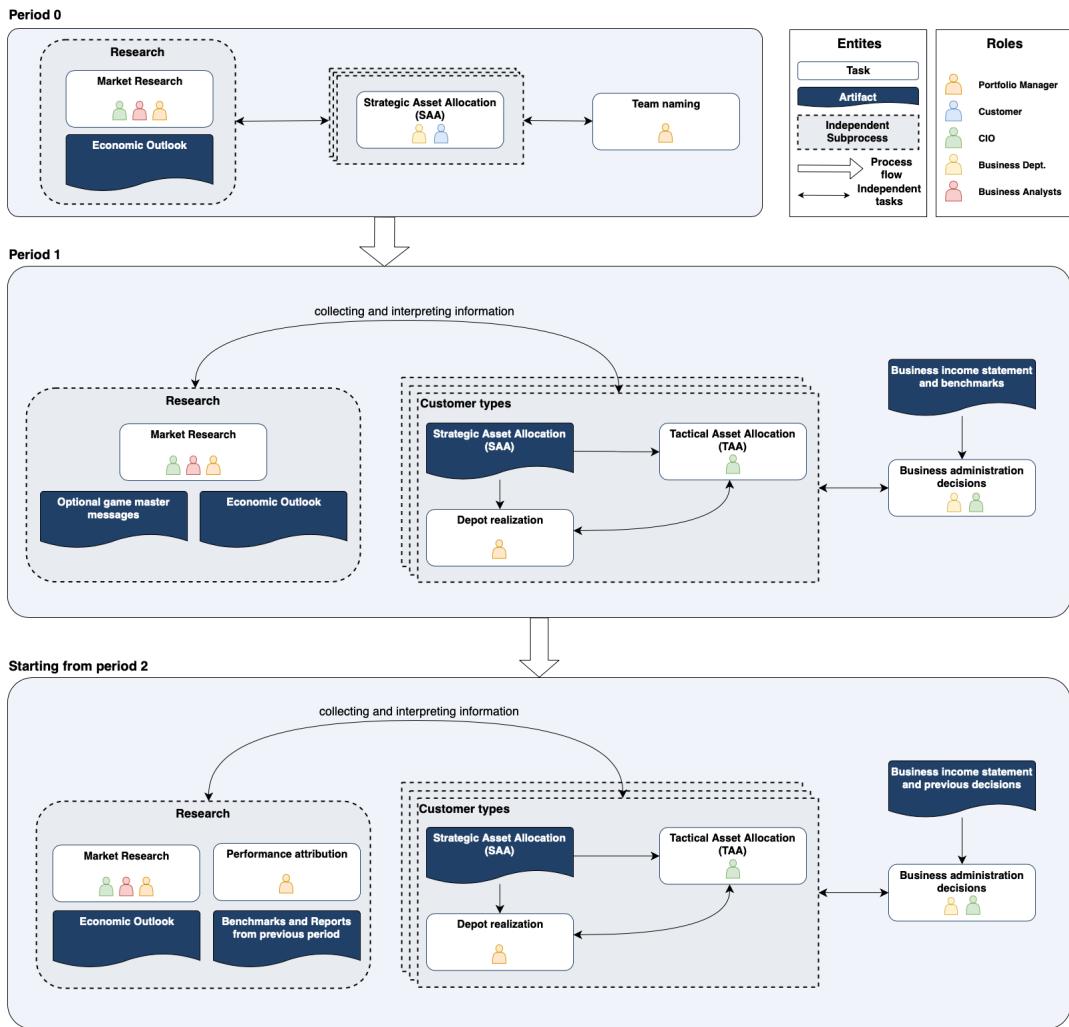
3. Methodology

to fully understand some of the following aspects, the reader should have seen the old version of the simulation:

- **General:** Generally, the participants enjoyed playing the game and regard it as helpful to deepen their theoretical knowledge for example from the lecture "Asset Management: Investments" for Bachelor students. However, they regard the system as outdated and provided the authors with various ideas and critics. Decision data for a starting period 0 will be filled out by participants in Excel for starting position before the seminar, afterward they will be saved onto the USB drives for all teams by the seminar conductors. The seminar conductors will let the market model run and save its outcome back on the USB drive. This process is time-consuming and error-prone. In general, the participants think that it is difficult to make a decision in the first round, as too few information is available. More easily accessible comparative figures for the previous year would be helpful. Additionally, the stock selection is based on insufficient knowledge about the different titles.
- **Investment Process:** The given and to be kept bandwidths for the different asset class positions are not optimally placed and have to be looked up frequently. An temporary over-investment during the decision process is not possible and is always disturbed by pop-up windows.
- **Business Administration:** Various decisions regarding marketing, human resources as well as logistics are not very clear as especially in the beginning, the background and previous period information are not completely clear for the participants. The point here is, that a suitable level of abstraction has to be chosen as on the one hand, not every decision that has to be made in reality can be implemented in such a simplified simulation. On the one hand, a suitable number of decisions have to be enabled in order to support an appropriate learning effect.
- **Report:** The reports provided after each round of the game load very slowly and the comparison to other teams is cumbersome. It would be helpful, if not only one group member can have the simulation and the reports on their screen. In general, more graphics are desired for a better visualization of key aspects.
- **Teamwork:** The enabling of a collaboration on several laptops within a team was mentioned many time. With the today's web-based technologies, much more implementation options are available.

The observation of the different players – students and practitioners, investment beginners and experts – allowed the project team to sense, what the strengths and weaknesses of the old game are. Further, it helped to define an impact direction for the new game being developed, which resulted in another work model describing the process of the game based on its different phases.

3.4. Design and Iterative Prototyping

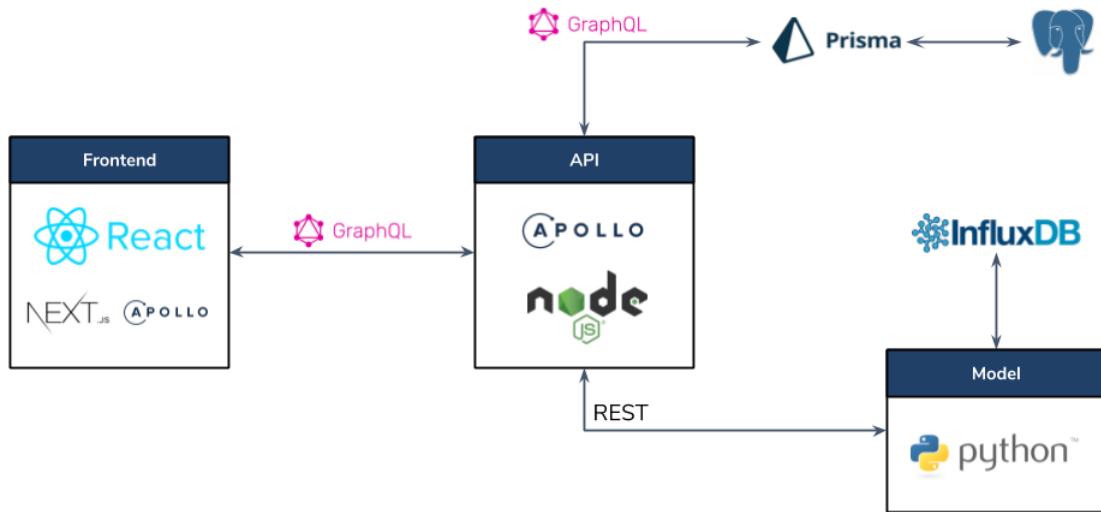


3.4. Design and Iterative Prototyping

Initially the authors designed multiple screens based on the predefined work model. Using a sketching software the basic screens for the students process which includes the SAA, TAA, depot realization and business administration were prototyped. As the team realized that the game does not only consist of screens from a student perspective they decided, due to time constraints, to start implementing screens by iterative prototyping.

Multiple concepts had to be defined, such as how to model the game session management.

4. Architecture



4.1. Frontend

- Frontend structured as a single-page web application
Contrary to native windows application of old game
- Allows for effortless setup and requires no manual data transfer
Based on the ReactJS and NextJS Javascript Frameworks

4.2. GraphQL

- Declarative data fetching
Code snippet (request and response)
Backbone for all networking between all application services (except model)

4.3. API / Prisma

- NodeJS backend that serves a single GraphQL API endpoint
- Handles authentication and authorization as well as all communications with the model endpoint
- Talks to the prisma database access layer for data persistence

4.4. Model

All calculations of the simulation are performed in a python-model which interacts with the time series data stored on an InfluxDB. A Restful service fetches the data from the model.

- Python market and business model (as described in chapter 5)
Raw logic and calculations as given by several excel files

- Publishes a REST API based on the Falcon framework that can be accessed for different use cases like:

Fetching a list of available assets for a certain time period

Computing the team scores and results given their decisions and a time period

4.5. Simulation

- Python service that handles time series hydration from the Datastream API as well as sector portfolio construction and new period simulations
- Main codebase was constructed by another student during his master thesis on time series simulation. We extended it with an API and additional functionality for the purposes of the game, as well as a more efficient replacement for the data hydration part. The simulation was specifically constructed for the purposes of this game and is planned to be integrated deeply into the portfolio game.
- We also handle the infrastructure setup and deployment procedures ("DevOps") as part of our collaboration.
- As this part is described in the thesis of the respective student, we do not go into any further detail regarding his part.

4.6. Continuous development

5. Market Model

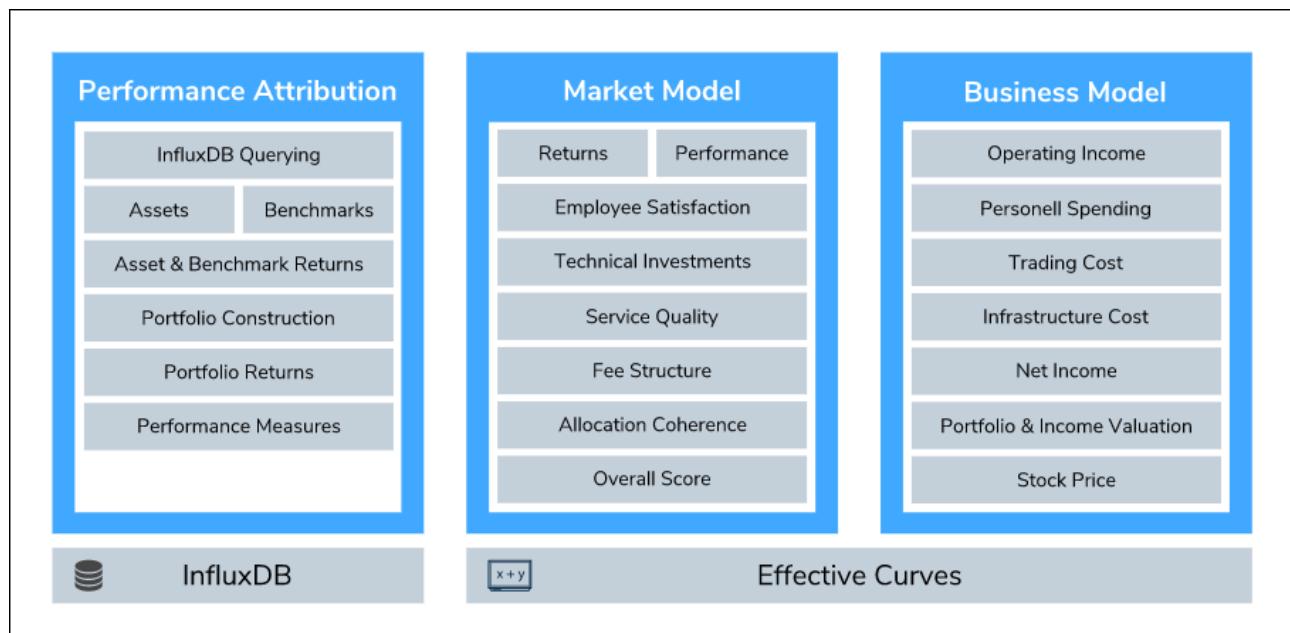


Figure 1: Market Model Overview

6. Application Overview

The PFM-Game market model is a module that produces period results based on the business decisions and portfolio allocations of teams participating in a given game. The market model is separated into several subcomponents that, when applied in sequence, produce results for a period of the game.

5.1. Data and Data Ingestion

The underlying data driving all portfolio-related calculations in the market model is comprised of several hundred time-series that are stored in InfluxDB. The majority of these time-series describe asset price or return indices (i.e., asset prices normalized by the payment of dividends and other interest) as extracted from the Thomson Reuters Datastream platform. Further relevant time-series are based on macroeconomic data extracted from the FRED (Federal Reserve Economic Data) database. These data are used to calculate portfolio and benchmark returns as well as parameters of an economic forecast.

The above described data can be extracted from Datastream and FRED and ingested into an instance of InfluxDB automatically by means of a Python module that was created as an extension to the PFM-Simulation project. Data to be ingested is defined inside an assets.csv file in the following CSV format:

Name	Symbol	Start Date	Market	Data Type	Asset Type	Currency
SWISS BOND AAA	SWBND3A	29.12.2006	Switzerland	RI	BONDS	CHF
NESTLE 'R'	S:NESN	01.01.1973	Switzerland	RI	EQUITY	CHF

Table 1: Exemplary assets in a valid assets.csv definition format (optional columns omitted)

During processing of the CSV definition of all assets, the module will incrementally extend existing time-series with new data up to the current day. Time-series that were not previously available will be stored as a new series in full-length.

5.2. Performance Attribution

The performance attribution module is the first module in the sequence of market model calculations that are applied to an incoming request.

5.3. Market Model

5.4. Business Model

5.5. API Specification

6. Application Overview

For playing a game an administrator of a specified game and an infinite number of teams have to interact together and compete against each other.

6.1. Administration

All administrative tasks will be described in this part. An administrator may administrate multiple games in one account and the games could be played simultaneously.

6.1.1. Administrator login

An administrator needs to have a login for having all administrative functionalities. Therefore he has to provide his credentials on the following screen which he reaches by following the instructions on the start page.

The screenshot shows a login interface for the 'Portfolio Management Game - Administrator'. The top bar is grey with the title 'Portfolio Management Game'. Below it is a white form with two input fields: 'Email' containing 'pascal.zehnder@bfuzh.ch' and 'Password' containing '****'. A blue 'Submit' button is at the bottom right. At the very bottom of the page is a dark blue footer bar with the text '© Department of Banking and Finance UZH'.

6.1.2. Game management

Game overview As landing page of the administrator the game overview exists. It serves as the control center of the game administration. Multiple games can be maintained simultaneously.

The screenshot shows the 'Game List' page of the administrator interface. On the left is a sidebar with tabs for 'Users', 'Games', and 'Entities'. The 'Games' tab is active. The main area shows a table with two rows. The first row is for 'Executive Finance Education 19', showing a status icon (green dot), 'of 19', a date '5.1.2019 14:07:45', and 'Completed (Period 4)'. The second row is for 'Team Game', showing a status icon (yellow star), 'team-game', a date '4.1.2019 10:08:44', and 'Running (Period 0)'. Both rows have a 'Details' button. At the top right of the main area is a blue '+' button. The top bar is dark blue with the title 'Portfolio Management Game - Administrator' and a user profile icon.

Game creation For creating a game the administrator needs to define some parameters which are structured into three tabs. By pressing on the "next"-button the administrator will be leaded through the form. Some tooltips help users to understand the purpose of the provided input. After submitting the creation of the game, the user will be redirected to the game detail of the selected game.

6. Application Overview

The screenshot shows the 'Game Creation' page of the Portfolio Management Game. On the left, a sidebar lists 'Users', 'Games', and 'Entities'. The main area has tabs for 'Game Details', 'Period Settings', and 'Customer Types'. Under 'Game Details', fields include 'Game Name' (Advanced Portfolio Management Seminar), 'Number of Participating Teams' (8), 'Game Identifier' (apm19), and 'Game Description' (HS19). Under 'Period Settings', there is a dropdown for 'Initial Customer Types' set to 'Balanced'. Under 'Customer Types', there is a dropdown for 'Initial Customer Count' set to 2500. A 'Next' button is at the bottom right.

Game detail The game detail for each game may be accessed over the game overview list. In this page a user can initialize period, start periods, having an overview about the teams submission and many other features, which will be described in this part:

Game initialization As the game creation may be done in advance we have splitted the game creation from the game initialization, such that last adjustments of the game may be done just before the start of the game.

The screenshot shows the 'Game: "Advanced Portfolio Management Seminar"' page. The sidebar is identical to the previous screenshot. The main area shows the initialized game details: Game Identifier (apm19), Initial Customers (2500), Simulation Type (Historical), Period Length (30 days), and Start Date of Period (2007-01-01). Below this, a timeline shows 'Period 0 (SAI)' from 2007-01-01 to 2007-01-31, followed by 'Period 1', 'Period 2', and 'Period 3'. A 'Team Overview' and 'Reports' tab are at the top right. A 'Initialize Game' button is at the bottom right.

Game start By starting the game the students or teams are finally able to start with their period 0 decisions. Administrators are able to give them some help over messages which will be visible for the teams in their report section.

The screenshot shows the 'Game: "Advanced Portfolio Management Seminar"' page after initialization. The sidebar and main area are similar to the previous screenshot. The main area now includes an 'Economic Outlook' section with a 'Report' link and a 'Messages' section with a 'Add new message' button. A 'Start Period' button is at the bottom right.

Team overview For providing access for all teams an administrator has an overview about the team logins, which are generated automatically when initializing the game.

6.1. Administration

Portfolio Management Game - Administrator		Team Overview - Advanced Portfolio Management Seminar		
Users	User Details			
	Users	team1	sso4624	
	Games	team2	JQY6ldDu	
	Games	team3	jUlnqGdI9	
	Entities	team4	jBZk6GVi	
	Assets	team5	bO33P1mI	
	Asset Types	team6	u6W1sfug	
	Currencies	team7	E1BaSkzN	
	Customer Types	team8	VybNIDsH	
Sectors				
 pascal.zehnder@bf.uzh.ch				

Running game Overview about the submission state of all teams. The administrator is able to get an insight about the decisions of all submitted teams. The period can only be finished if all teams submitted and therefore the state of the teams has been green.

Portfolio Management Game - Administrator

 pascal.zehnder@bfu.uzh.ch

Users

Users

Games

Games

Entities

Assets
Asset Types
Currencies
Customer Types
Sectors

Game: "Advanced Portfolio Management Seminar"

Game Identifier: apm19 Initial Customers: 2500 Simulation Type: Historical
Period Length: 30 days Start Date of Period 0: 2007-01-01

Team Overview Reports

Period 0 (SAA) 2007-01-01 2007-01-31

Period 1

Period 2

Period 3

Teams

✓ Team 1
✓ Julius Bull > Last submitted: 06.01.2019 13:23

✓ Team 3

✓ Team 4

✓ Team 5
✓ Students Kantonspark > Last submitted: 06.01.2019 13:25

Balanced (SAA)

Money Market (USD)	10%
Bonds (CHF)	20%
Bonds (USD)	10%
Equity (CHF)	50%
Equity (USD)	10%
Equity (JPY)	15%

✓ Team 7

✓ Team 8

Finish period

Initializing period After completion of period zero the administrator has to initialize a period in which the team decisions will be compared to the other teams decisions and evaluated. Additionally new customer types for the next period and other settings could be defined in this phase of the game.

Portfolio Management Game - Administrator

pascal.zehnder@bf.uzh.ch

Users

Games

Entities

Assets
Asset Types
Currencies
Customer Types
Sectors

Game: "Advanced Portfolio Management Seminar"

Team Overview Reports

Game Identifier: apm19 Initial Customers: 2500 Simulation Type: Historical
Period Length: 30 days Start Date of Period 0: 2007-01-01

Period 0 (SAA)
► 2007-01-01
► 2007-01-31

Period 1

Period 2

Period 3

Initialize period

Period start By completing the simulation, respectively evaluation of the previous period, a next period may be started. If the game is still paused the teams cannot access the decisions site. The administrator can define some optional messages which will be displayed in the teams report page. Some adjustments to the simulation results will be edited in this phase of the game.

6. Application Overview

The screenshot shows the 'Portfolio Management Game - Administrator' interface. On the left, a sidebar lists 'Users', 'Games', and 'Entities' sections. The main area displays game details for 'Game: "Advanced Portfolio Management Seminar"'. It includes a summary table with 'Game Identifier: apm19', 'Initial Customers: 2500', 'Simulation Type: Historical', and 'Period Length: 30 days'. Below this is a timeline showing 'Period 0 (SAA)' from 2007-01-09 to 2007-01-21, followed by 'Period 1' from 2007-01-31 to 2007-02-02, 'Period 2', and 'Period 3'. A 'Report' section allows viewing the economic outlook for the next period, and a 'Messages' section lets administrators add guiding or misleading messages to each team's economic outlook. A 'Start Period' button is at the bottom.

6.1.3. Reports

For presentation of the teams result in between two running periods being played, a report is accessible for the administrator. A more detailed description will be in section X, as the teams access the same reports as the administrator.

6.1.4. Entities administration

Assets

The screenshot shows the 'Assets' entity administration page. The sidebar lists 'Users', 'Games', and 'Entities' sections. The main area displays a table titled 'Synchronize Assets' with columns: Mnemonic, Name, Market, Sector, Asset Type, Available From, and Available Until. The table lists various bond assets from different global zones and years, such as SWBON3B (SWISS BOND BBB), RGAL1T3 (GLOBAL GOVERNMENT E-ZONE 1-3 YEARS), and RC1AALM (EURO CORPORATE (EXCLUDING BANKS) A RATED).

Mnemonic	Name	Market	Sector	Asset Type	Available From	Available Until
SWBON3B	SWISS BOND BBB	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL1T3	GLOBAL GOVERNMENT E-ZONE 1-3 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
SWBND3A	SWISS BOND AAA	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL10P	GLOBAL GOVERNMENT E-ZONE 10+YEAR	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
SWB2A1A	SWISS BOND AA-A	Switzerland	-	Bonds	2006-12-29T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL3T5	GLOBAL GOVERNMENT E-ZONE 3-5 YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL5T7	GLOBAL GOVERNMENT E-ZONE 5-7YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RGAL710	GLOBAL GOVERNMENT E-ZONE 7-10YEARS	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RC1AALM	EURO CORPORATE (EXCLUDING BANKS) A RATED	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z
RC38BLM	EURO CORPORATE (EXCLUDING BANKS) BBB RATED	Europe	-	Bonds	2003-01-01T00:00:00.000Z	2018-12-31T00:00:00.000Z

Asset Types A table showing all asset types which may be edited is the landing page of this entity. By editing a specified asset type the administrator can change some characteristics of its type, such as info text.

The screenshot shows the 'Asset Types' entity administration page. The sidebar lists 'Games', 'Entities' (Assets, Asset Types, Currencies, Customer Types, Sectors), and 'Assets'. The main area displays an 'Edit Entry' form for an asset type named 'EQUITY'. The form fields include 'Name' (EQUITY), 'Display name' (Equity), 'Info text' (Holding equity signifies ownership in a corporation and represents a claim on part of the corporation's assets and earnings.), and 'Order' (3). A 'Submit' button is at the bottom.

Currencies The currencies may be edited in a same manner as the asset types.

Customer Types An overview about all in the game available customer types is provided for the administrator. For each customer type the ideal strategic asset allocation and the ranges for currencies and asset types (both dimensions) can be modified. Additionally the info bullets and the displaying name may be modified too.

The screenshot shows the 'Customer Type - Growth' configuration page. On the left, there is a sidebar with navigation links: 'Users', 'Games', 'Entities', and 'Customer Types'. Under 'Customer Types', 'Sectors' is selected. The main area displays the 'Customer Type - Growth' settings. It includes a 'Display name' field set to 'Growth', an 'Info bullet' section with the text 'Suitable for investors focusing on the long-term growth potential of the equity market. The risk of fluctuation is limited by a broad diversification of investments. The return is heavier focused on capital and currency gains.', and a 'Strategic Asset Allocation' table. The table has columns for Money Market, Bonds, Equity, Alternative Investments, Total, Min., and Max. It lists five assets: CHF, USD, EUR, JPY, and EMD, with their respective percentages and min/max values. A summary row at the bottom shows the total allocation across all categories.

	Money Market	Bonds	Equity	Alternative Investments	Total	Min.	Max.
CHF	5	5	20	5	35%	30	80
USD		5	15	5	25%	5	35
EUR		5	15		20%	5	35
JPY			5		5%	0	20
EMD		5	10		15%	0	20
Total	5%	20%	65%	10%	100%		
Min.	0	10	40	0			
Max.	20	40	80	25			

Sectors Short overview about all sectors which are used in the asset overview.

6.2. Team View

6.2.1. Login

The screenshot shows the 'Team Login' page. It features input fields for 'Team Login' (containing 'team2') and 'Password' (containing '*****'). A 'Submit' button is located to the right of the password field. Below the form, a note states: 'There could be some inconsistencies if your team makes their decisions on multiple devices. Ensure that only one logged in user finally decides about the teams choices. Reports may be viewed on multiple devices without any problems.'

6.3. Period 0 decisions

In period 0 which represents phase 1 of the game, the teams define their SAA for all customer types which are enabled by the administrator of the specific game. The teams need to fulfill the ranges for all dimensions to submit their decisions. Supportive graphs in form of pie charts help the teams to decide about the share of the two dimensions. Additionally the players can name their team on the top left corner of the screen.

6. Application Overview

Screenshot of the Strategic Asset Allocation (SAA) screen:

Customer Types: Balanced

Information:

- This strategy is suitable for investors who wish to participate more strongly in the growth opportunities of the equity market and, at the same time, wish to profit from the stabilising effect of fixed interest rates.
- The returns are based on regular income as well as capital and currency gains.

Strategic Asset Allocation: The strategic asset allocation is a portfolio strategy that involves setting a long-term target allocation for various asset classes, whereby the risk/return profile of the customer is taken into account. If the portfolio deviates significantly from the initial setting due to differing asset returns, the portfolio is rebalanced to the original allocation.

	Money Market	Bonds	Equity	Alternative Investments	Total	Min.	Max.
CHF	10	30	5	5	45.0%	40%	80%
USD	20	10			30.0%	0%	30%
EUR	10		5		15.0%	0%	30%
JPY			5		5.0%	0%	15%
EMD			5		5.0%	0%	15%
Total	10.0%	30.0%	55.0%	5.0%	100.0%		
Min.	0%	30%	30%	0%			
Max.	20%	60%	60%	20%			

LAST SUBMISSION: No submission yet!

Asset Types (Pie Chart):

- Equity: 55% (Arrows point to CHF, USD, EUR, JPY)
- Bonds: 30% (Arrows point to EMD, CHF, USD, EUR)
- Money Market: 10% (Arrows point to CHF, USD, EUR, JPY)
- Alternative Investments: 0% (No arrows)

Currencies (Pie Chart):

- CHF: 45% (Arrows point to CHF, USD, EUR, JPY)
- USD: 30% (Arrows point to CHF, USD, EUR, JPY)
- EUR: 15% (Arrows point to CHF, USD, EUR, JPY)
- JPY: 10% (Arrows point to CHF, USD, EUR, JPY)
- EMD: 0% (No arrows)

6.4. Other periods decisions

Starting from period 1, a team has to complete multiple decisions separated into four pages. A strategic asset allocation is fixed and non editable for a customer type which was defined at the beginning of the game. When the administrator defines a new customer type for an upcoming period, the teams have to allocate an SAA for the new customer type.

For each step within this process, a progress state helps the teams to understand the state of each step. For saving their decisions, all four steps have to be completed. In the bottom left corner the submission state may be seen.

6.4.1. TAA

For the tactical asset allocation the teams can deviate from the SAA due to changes in the overall market. Equal to the strategic asset allocation screen the teams change the input within the table and get a illustrative support with two graphs, displaying the allocations for both dimensions of the table. Initially the inputs from the strategic asset allocation are loaded, whereas the students can adjust them to market changes. Arrows within the total summation of each asset type or currency show the status of being within the range.

Screenshot of the Tactical Asset Allocation (TAA) screen:

Customer Types: Balanced

Information:

- This strategy is suitable for investors who wish to participate more strongly in the growth opportunities of the equity market and, at the same time, wish to profit from the stabilising effect of fixed interest rates.
- The returns are based on regular income as well as capital and currency gains.

Tactical Asset Allocation: The tactical asset allocation is an active management portfolio strategy that allows short-term deviation from the strategic asset allocation in order to exploit market opportunities.

	Money Market	Bonds	Equity	Alternative Investments	Total	Min.	Max.
CHF	18	25	12	5	55.0%	40%	80%
USD	20	25	10				
EUR	5	18	20		23.0%	0%	30%
JPY	5	10	10		10.0%	0%	15%
EMD			10		0.0%	0%	15%
Total	18.0%	30.0%	52.0%	0.0%	100.0%		
Min.	0%	30%	30%	0%			
Max.	20%	60%	60%	20%			

LAST SUBMISSION: No submission yet!

Asset Types (Pie Chart):

- Bonds: 30% (Arrows point to CHF, USD, EUR, JPY)
- Money Market: 15% (Arrows point to CHF, USD, EUR, JPY)
- Equity: 52% (Arrows point to CHF, USD, EUR, JPY)
- Alternative Investments: 0% (No arrows)

Currencies (Pie Chart):

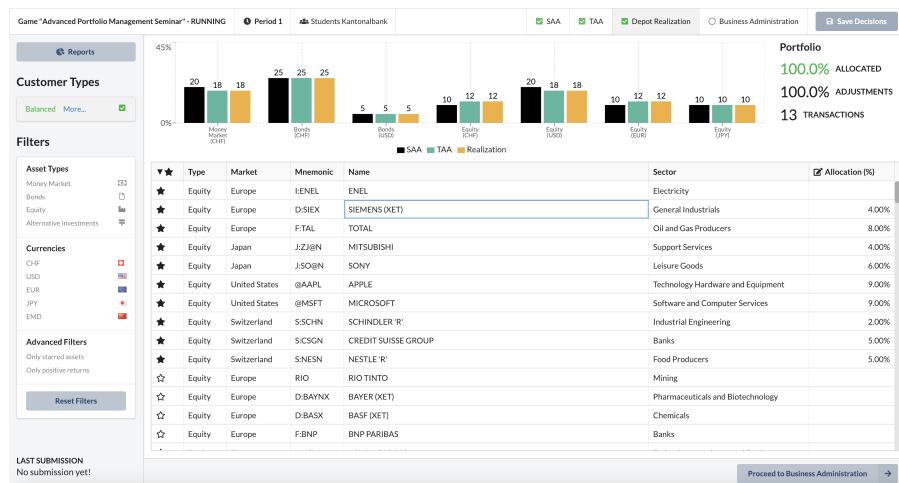
- CHF: 55% (Arrows point to CHF, USD, EUR, JPY)
- USD: 23% (Arrows point to CHF, USD, EUR, JPY)
- EUR: 12% (Arrows point to CHF, USD, EUR, JPY)
- JPY: 10% (Arrows point to CHF, USD, EUR, JPY)
- EMD: 0% (No arrows)

Proceed to Depot Realization

6.4. Other periods decisions

6.4.2. Depot Realization

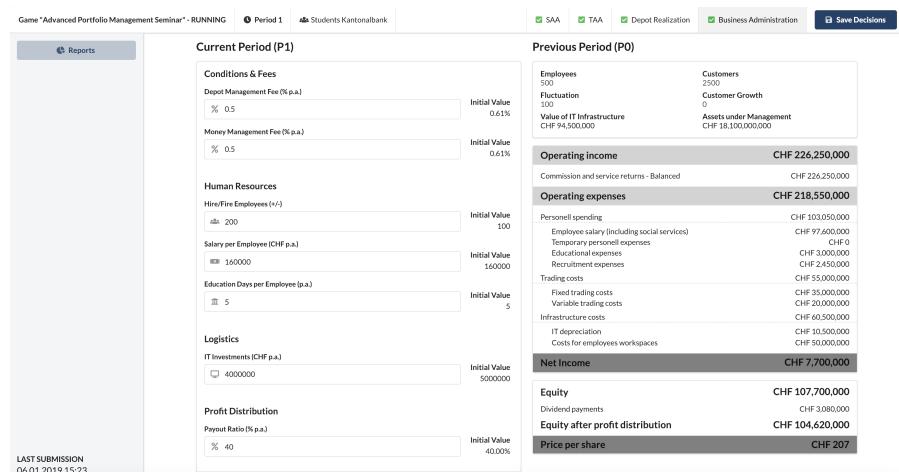
Based on SAA and TAA the teams finally have to allocate on specific assets. By having a bar chart on the top of the screen, students have an overview about their SAA and TAA decisions of the current active customer type. A target for the students is to allocate assets such that the yellow bar aligns with TAA for each asset type/currency combination. On the top right corner a short summary about the most important key numbers for the allocations is present. This process has to be repeated for each customer type defined by navigating on the left menu. Equal to the SAA and TAA screen, the progress of the customer types is highlighted with checkmarks and corresponding colors.



6.4.3. Business Administration

Business administration operates as the final decisions for a period. On the left side of the screen teams input numbers for four different categories: Conditions & Fees, Human resources, logistics and profit distribution. For each input field the initial value (in period 1) or the previous period value (for all other periods) is displayed next to the input field.

On the right side the balance sheet from the previous period is visualized to inform teams about their business results. Further key information is displayed on top of the balance sheet.



7. Future Development

7. Future Development

In the scope of the Master project the project team has set up an initial game which is executable and testable for various settings including multiple teams per game and the most important administrator features. As the project was accompanied by a project planning tool called "Trello", there have been a lot of future tasks which may be implemented in the future but weren't planned within the scope of this Master project. The most epic features will be described in the following paragraph.

As not enough data for a bootstrapped game was provided, the authors focused on developing a game which will be played with historical data. The game is easily extendable for this purpose, as the initial plan was to set up both modes. The authors had to revise this plan due to the lack of provided data. When creating a game the administrator can choose the game type which is either a bootstrapped or a historical game.

The projects plan is being ready for a first real game-execution by the Executive education's final seminar which will be held in July 2019. Additionally to the current courses where the application was used (as described in a latter chapter), the Department of Banking and Finance plans to set up another execution for the assessment course "Banking and Finance II", in which 700 students would participate in. The effort of setting this up for such a large number of students would need a lot of stress testing for the application.

A. Exemplary scenario

Follwoing scenario should generalize an exemplary playing of the portflio management game:

B. User Stories

General

ID: GE01	Date: 17.07.2018
Name: One login per team	
Story: As a game master, I want to be able to create one single login per participating team such that the participants are supported in their group work.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ Game masters can create team logins by creating a game ✓ Teams can login with the credentials they received from the game master 	
Priority: Must have	

ID: GE02	Date: 13.08.2018
Name: Maintaining multiple logins with a single account	
Story: As a team of students, we would like to be able to sign in on multiple devices such that we can perform research and preparations independently.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ Multiple login sessions can be maintained with a single team account ✓ Teams need to be appropriately informed about the possibility of inconsistencies due to multiple actions taken from different devices 	
Priority: Must have	

ID: GE03	Date: 13.08.2018
Name: Game master account creation	
Story: As the responsible person for the seminar I need to create different game master accounts such that multiple persons could overtake the lead of the game.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ A game master account can create new game master accounts ✓ Multiple game master accounts may be created 	
Priority: Must have	

ID: GE04	Date: 16.10.2018
Name: Provisional hand-in of allocations	
Story: As a team of students, we would like to be able to save our current state	

provisionally, such that other members of the team can also see the current state on their device.

Acceptance Criteria:

- SAA, TAA, and Allocations can be imperatively saved to the database without needing to end the period
- After saving the state, other members of the team with the same active login can reload their application and see the new state

Priority: Must have

Game Sessions

ID: SE01	Date: 13.08.2018
Name: Session creation	
Story: As a game master, I want to be able to create game sessions (multiple games) such that I can set up an execution of the game in advance.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ Game masters can initialize new game sessions ✓ Teams can be created based on number of teams and assigned to any initialized game session 	
Priority: Must have	

ID: SE02	Date: 13.08.2018
Name: Customer profiles	
Story: As a game master, I would like to define and parametrize different customer profiles that students have to work with.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ The game master can define any number of customer profiles that students will need to account for ✓ There are existing some predefined customer types ✓ Each customer profile can be parameterized with regards to their acceptance ranges (upper and lower limits per customer profile) ✓ Customer profiles can be enabled only after a certain number of rounds such that it is possible to start games with only one single type of customer (may be parametrized in advance) 	
Priority: Must have	

ID: SE03	Date: 13.08.2018
Name: Game execution	
Story: As a game master, I need to be able to explicitly start and continue sessions such that access is controlled and only available during the execution of the game.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ Initialized games can be started by the game master that created them (and only by them) 	
Priority: Must have	

ID: SE04	Date: 13.08.2018
Name: Session parametrization	
<p>Story: As a game master, I want to be able to parametrize games such that I can introduce reasonable variance between different games and showcase different economic environments.</p>	
<p>Acceptance Criteria:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Sessions can be parameterized with respect to the execution of the game <input type="checkbox"/> Sessions can be parameterized with respect to the simulation of stock market data (e.g., length and number of periods to simulate) <input type="checkbox"/> Sessions can be parameterized with respect to the internal market model (i.e., its effective curves and indices) <input type="checkbox"/> Sessions can be set to alternatively use periods of historical data instead of using the stock market simulation 	
<p>Priority: Must have</p>	

ID: SE05	Date: 13.08.2018
Name: Pausing and continuing sessions	
<p>Story: As a game master, I would like to be able to pause and continue sessions in-between rounds, such that I can account for any unexpected events in a fair manner.</p>	
<p>Acceptance Criteria:</p> <ul style="list-style-type: none"> ✓ Running sessions can be paused by the game master after a round is completed if all teams have submitted their decisions such that the students have some time pressure in the game ✓ Paused sessions can be continued by the game master ✓ After continuing a paused session, the next round can be started immediately 	
<p>Priority: Must have</p>	

ID: SE06	Date: 07.11.2018
Name: Parametrized Sessions - Scenarios	
<p>Story: As a game master, I would like to choose from different predefined templates that represent different critical points in financial history</p>	
<p>Acceptance Criteria:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Choose from multiple scenario templates within creation of the game 	
<p>Priority: Nice to have</p>	

ID: SE07	Date: 07.11.2018
Name: Add new customers	
Story: As a game master, I would like to have the possibility to add new customers for each Team after a period. This should be voluntary for each period.	
Acceptance Criteria: <ul style="list-style-type: none">✓ Game master can add a different number of new customers for each team❑ Game master can add a total summation of customers for every team	
Priority: Should have	

Asset Allocation

ID: AP01	Date: 13.08.2018
Name: Defining a Strategic Asset Allocation (SAA)	
Story: As a team of participants, we need to be able to define an initial strategic asset allocation for the game based on the different types of customers that are available to us.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> An SAA can be defined before any of the game rounds are played (period 0) <input type="checkbox"/> Once defined, the SAA provides a fixed point of reference for further rounds <input type="checkbox"/> The SAA can be extended to new customer profiles if any are added later on 	
Priority: Must have	

ID: AP02	Date: 13.08.2018
Name: Defining a Tactical Asset Allocation (TAA)	
Story: As a team of participants, we need to be able to define our tactical asset allocation at the beginning of each round, so that we can adjust our long-term strategic plans.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> A new TAA can be specified for each round of the game and if the SAA is defined within boundaries for all categories <input type="checkbox"/> While deciding on a TAA, the team is kept informed about their SAA and any ranges or game constraints they might not fulfill with their current allocation (e.g. max. 10% deviation from SAA) <input type="checkbox"/> Deviation for TAA from SAA may be defined for each game with default of 10% 	
Priority: Must have	

ID: AP03	Date: 13.08.2018
Name: Portfolio realization	
Story: As a team of participants, we need to be able to allocate our funds to specific assets and markets, as we want to achieve the portfolio state we defined in our SAA and TAA.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> Teams are able to distribute their funds on different asset categories based on their TAA decisions <input type="checkbox"/> Teams can choose from different markets and currencies <input type="checkbox"/> When investing in equity, teams can choose from different sectors of markets <input type="checkbox"/> Teams are being appropriately informed about any constraints and ranges that 	

<p>need to be followed, as well as their self-defined SAA and TAA constraints</p> <ul style="list-style-type: none"> <input type="checkbox"/> Maximum deviation of a share should be defined when creating the game by the game master (e.g. max. 10% deviation per share in next round)
<p>Priority: Must have</p>

ID: AP04	Date: 13.08.2018
Name: Hedging foreign currencies	
Story: As a team of participants, we would like to be able to hedge our investments into foreign currencies such that we are not exposed to currency risks.	
Acceptance Criteria:	
<ul style="list-style-type: none"> <input type="checkbox"/> Investments in other currencies can be optionally hedged when realizing a depot <input type="checkbox"/> Hedging incurs a reasonable cost 	
Priority: Should have	

ID: AP05	Date: 07.11.2018
Name: Define two phases for the game	
Story: As UI designer of the game we would like to define two phases of the game, whereas the first phase defines the initial SAA. In the second phase the teams can decide on their TAA, their depot realization and other business administration decisions.	
Acceptance Criteria:	
<ul style="list-style-type: none"> <input type="checkbox"/> Phase 1 enables the opportunity to define the initial SAA for each customer type <input type="checkbox"/> In phase 2 the teams can decide on TAA, depot realization or other business administrative decisions 	
Priority: Must have	

Business Administration

ID: BP01	Date: 13.08.2018
Name: Forecasting	
Story: As a team of participants, we would like to be able to generate forecasting reports based on our own estimates, such that we can evaluate our planned decisions without using additional tools (i.e., Excel).	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> Teams can provide estimates for future parameters (e.g., customer counts) <input type="checkbox"/> Based on their estimates and their input numbers, teams can generate a forecasting report that will show them some metrics about their decisions 	
Priority: Should have	

ID: BP02	Date: 13.08.2018
Name: Account balance	
Story: As a team of participants, we need to be able to see the balance of our accounts (i.e., assets under management), such that we can decide on how much money to spend in different expense categories.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> The necessary account balances are transparently visible to teams <input type="checkbox"/> Expected investments for the current period are simulated in the account balance 	
Priority: Must have	

ID: BP03	Date: 13.08.2018
Name: Defining fees and conditions	
Story: As a team of participants, we need to be able to define the fees and conditions we offer to our customers, such that we can optimize our profits.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> Fees and conditions can be defined for each customer type <input type="checkbox"/> All-in pricing model can be chosen with a provided percentage 	
Priority: Must have	

ID: BP04	Date: 13.08.2018
-----------------	-------------------------

Name: Marketing, HR, and Logistics

Story: As developers of the simulation, we need to ensure that teams can distribute their money to different expense categories, such that we can appropriately simulate business-related expenses (like marketing, HR, and logistic).

Acceptance Criteria:

- Teams can define their spend on marketing-related categories:
 - Marketing expenses for all different customer types
- Teams can define their spend on HR-related categories:
 - Employments and suspensions of personal
 - Salary of employees (for each employee)
 - Bonus
 - Education days for an employees per year
- Teams can define their spend on logistics-related categories:
 - Investments in IT

Priority: Must have

ID: BP05	Date: 13.08.2018
-----------------	-------------------------

Name: Fluctuation

Story: As a developer, we need to ensure that teams must account for fluctuation in their HR expenses, as we want to model a realistic business environment.

Acceptance Criteria:

- The market model includes fluctuation coefficients
- Fluctuation is based on several factors:
 - Satisfaction of the employees
 - Workload of the employees
 - Salary / Bonus

Priority: Must have

Evaluation / Simulation

ID: EV01	Date: 13.08.2018
Name: Team performance metrics	
Story: As a game master, I need to be able assess the performance of teams on several levels, including separate metrics and aggregate measures.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> After a completed round of play, different metrics are calculated for each team <input type="checkbox"/> Some metrics build on a predefined effective curve and result in an “index” <input type="checkbox"/> Other metrics assess the performance of teams with regards to their portfolios <input type="checkbox"/> An overall measure aggregates the different metrics and allows a ranking of teams 	
Priority: Must have	

ID: EV02	Date: 13.08.2018
Name: Customer satisfaction index	
Story: As developers of the game, we want to build a customer satisfaction index that, based on several key input numbers, calculates the satisfaction of all different customer types for each team.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> The customer satisfaction index is specific to each type of customer <input type="checkbox"/> The customer satisfaction index is calculated based on multiple factors: <ul style="list-style-type: none"> - Performance of the portfolios of the respective customer type - Track record - Risk-adjusted Performance (Sharpe-Ratio, Information-Ratio, ...) - Management fees - Availability of bank employees for consulting (HR) - Matching SAA to customer profile - Matching actual allocation to SAA 	
Priority: Must have	

Reporting

ID: RE01	Date: 13.08.2018
Name: Reports for presentation	
Story: As a game master, I want to be able to present an automatically generated comparison (graphs and reports) of individual team performances, such that I can explain some of the typical mistakes and decisions that could have been made throughout the seminar or the lecture.	
Acceptance Criteria: <ul style="list-style-type: none"> <input type="checkbox"/> After completion of any round, game masters can display a comparison report <input type="checkbox"/> The comparison report includes sensible means of visualization: <ul style="list-style-type: none"> - Graphs with ranking of all teams regarding different measures <ul style="list-style-type: none"> - Netto-performance per customer type - Netto-performance cumulative per customer type over all periods - Tracking error per customer type - Customer satisfaction index per customer type - Customer count per customer type - Assets under management - Net-new money - Total earnings - Total expenses - Gain / Loss - Cost / Income ratio - All in conditions - Depotgebührensatz - Marketing-expenses - Infrastructure (IT-index) - Education-index - Human Resources - current count of employees - Temporary employees - Customer advisory services - Employee Satisfaction - Service quality index - Total index - Total index cumulative - Benchmark using ideal SAA predefined by game master 	
Priority: Must have	

ID: RE02	Date: 13.08.2018
Name: After-period reports for individual teams	
Story: As a team of participants, we want to be able to access our past benchmarks and	

performance reports, such that we can decide about future actions in an informed way.

Acceptance Criteria:

- Teams can display their past reports at any time during the game
- No information is leaked about any of the other teams or the future of the game

Priority: Must have

ID: RE03

Date: 13.08.2018

Name: Economic outlook

Story: As a game master, I want to provide the participating teams with an automatically generated economic outlook (including forecasts) that I can customize with some sensible parameters, such that the students can take more informed decisions for the next period.

Acceptance Criteria:

- The system generates an economic outlook according to a predefined template
- Key numbers are taken from the parameters that have been defined for the simulation of the next period as well as from some randomization parameter
- The numbers in the economic outlook can be overridden manually before providing it to the participants

Priority: Must have

ID: RE04

Date: 13.08.2018

Name: View of the CIO

Story: As a game master, I would like to have the opportunity to provide a custom assessment and directions in my own wording that is provided to the students as the view of their bank's CIO (based on the economic outlook).

Acceptance Criteria:

- Game masters can provide custom plain text that is shown to the students under the premise of being from their own CIO
- The CIO assessment can include directions and guidelines as well as interpretations of the economic outlook

Priority: Should have

ID: RE05

Date: 13.08.2018

Name: Visualization of historical stock prices

Story: As a team of participants, we would like to get a historical overview of the stocks in our portfolio, such that we can make reasonable decisions about future investments.

Acceptance Criteria:

- Teams can access reports regarding the historical development of their stocks
- Teams can view all stocks, not just those they've chosen for their portfolio

Priority: Should have

ID: RE06

Date: 13.07.2018

Name: Performance attribution

Story: As a team of participants, we need to have a comprehensive report about the performance attribution of our assets, such that we can decide about further investments.

Acceptance Criteria:

- After each period, teams can access reports with their full performance attribution over past periods

Priority: Must have

Development

ID: DE01	Date: 12.07.2018
Name: Infrastructure	
Story: As a developer, I need to build my application on an extendable and scalable infrastructure, such that it will be easily maintainable in the future.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ The infrastructure is easily extendable by additional services (Docker) ✓ Multiple services can be included into the system 	
Priority: Must have	

ID: DE02	Date: 13.08.2018
Name: Continuous integration and deployment	
Story: As a developer, I want to have an environment that is continuously integrated and deployed, such that I can always rely on having current feedback and fast failures.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ On merges into the master branch, the application is continuously deployed to a staging environment, where it can be tested <input type="checkbox"/> On tagging of releases, the application is deployed to the production environment ✓ The CI pipeline includes a full test suite for the API of the application 	
Priority: Must have	

ID: DE03	Date: 13.08.2018
Name: Code versioning and maintenance	
Story: As a developer, I need to have access to reliable repositories for the application code, such that I can easily collaborate with others on the project and new developers could understand the code.	
Acceptance Criteria: <ul style="list-style-type: none"> ✓ The application services are stored in separate, modular repositories ✓ The repositories are managed by submitting merge requests that contain at least a short (but complete) description of the changes ✓ The application backend contains a full integration test suite as well as independent unit tests for each service <input type="checkbox"/> New developers understand the architecture of modular repositories by creating understandable readme files 	

Priority: Must have

ID: DE04

Date: 13.08.2018

Name: Local game execution

Story: As a game master, I need to be able to easily run the application on my local device, such that it can still be used even in case of network and/or other failures.

Acceptance Criteria:

- Application can be started on any local device with sufficient performance
- Backup datasets can be previously downloaded such that it is not necessary to load the entire stock market database onto the local device
- The application can be started by using simple scripts without extensive IT affinity

Priority: Should have