Financial Use Case: Requirements, Scenario Definitions and Initial Evaluation Report Work Package 2 Task 2.1-2.3 Deliverable 2.2

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Table of contents:

1 Executive Summary 5

2 Introduction 6

2.1 Structure of the Deliverable 6

3 Requirements 7

3.1 Technical requirements 7
3.2 Requirements from the Experts 10
3.2.1 Further requirements by the Expert Users, ordered by use case 11
3.2.2 High level summary of Expert User Requirements 11
3.2.3 FPS Forecasting Price Swings 11
3.2.4 SRP Systemic Risk Prediction 12
3.2.5 DSI Decision Support for Investment Opportunities 12
3.2.6 Custom requirements 12
3.2.7 Process of implementing Expert User Requirements 12

4 Scenario Definitions and implemented Expert-user requirements 13

4.1 Summary of Financial Use Case Scenarios and Role Players 13
4.2 Translation of Expert Requirements to Pilot Features 14
4.2.1 Forecasting Price Swings 14
4.2.1.1 Requirements details – Forecasting Price Swings 17
4.2.2 Systemic Risk Prediction and early warning 18
4.2.2.1 Requirements details – Systemic Risk Prediction and early warning 20
4.2.3 Decision-Support for investment opportunities 21
4.2.3.1 Requirements details – Decision support for Investment Opportunities 23

5 Set-up of Tests and Evaluations of Pilot Applications 24

5.1 Technical Evaluation 24
5.1.1 Test plan 24
5.1.1.1 Test Objectives 24
5.1.1.2 Extent of Testing 24
5.1.2 Test Strategy 25
5.1.2.1 Test Assumptions 25
5.1.2.2 Test Principles 25
5.1.2.3 Scope and Levels of Testing 25
5.1.2.4 Test Acceptance Criteria 26
5.1.2.5 Test Deliverables 26
5.1.2.6 Test Execution Strategy 26
5.1.2.7 Test Cycles 27
5.1.2.8 Defects Management 27
5.2 Expert-user Evaluation 28
5.2.1 Background for Expert-user Pilot Evaluation Interviews and Questionnaires 31
5.2.2 Setup of Expert-user Pilot Evaluation Interviews and Questionnaires 31

6 Initial Evaluation Report 33

6.1 Report of technical Tests of pilot applications - in-house at SPRING 33
6.2 Analysis of the Expert User Interviews and Questionnaires 35
6.2.1 Needs and requirements of the experts 35
6.2.2 Approved and positively mentioned after review 35
6.2.3 What is still needed – or further requests 36

7 Conclusions and Outlook 38

Appendix: Expert User Questionnaires 39
Appendix A: Original questions from the questionnaire of Deliverable D2.1 39
Appendix B: Anonymised answers of the expert users on the questions from Appendix A 41
Appendix C: Original questions from the questionnaire of Deliverable D2.2 46
Appendix D: Anonymised answers of the expert users on the questions from Appendix C 50

1 Executive Summary

Deliverable D2.2 reports on the results of the requirements' collection for INFORE's Financial use case and INFORE's user scenarios for forecasting price swings, systemic risk prediction and decision support for investment opportunities. In particular, extracting actionable insights from the markets' behavior, spotting profitable investments based on trading instruments' volatility and seasonal price patterns, as well as the in-depth analysis of market risk are the use case scenarios from the INFORE Description of Work (DoW - see WP2), which are studied at a deeper level through the expert user interviews. Derived from the expert interviews, this deliverable details the role of players who interact with the financial applications. Furthermore, individual user scenarios, namely Forecasting price swings (FPS), Systemic risk prediction and early warning (SRP) and Decision support for investment opportunities (DSI) and their specific requirements and interactions with INFORE are summarized. On top of this, the deliverable provides preconditions for the data streams to be processed by INFORE and the algorithms to be applied to price swing prediction, risk calculation, and detection of investment opportunities.

Based on the findings described in D2.1 first prototypes were implemented. These implementations are the base of the evaluation in this deliverable. They have been provided to expert users to allow them to investigate on features and function based on the findings from D2.1. In addition, enhancements towards final prototypes have been identified through questionnaires and interviews.

This deliverable updates and refines the scenario definition and the use case requirements of Deliverable D2.1 and presents an initial evaluation of the INFORE prototype on this use case.

2 Introduction

In Deliverable D2.1, user-requirements for the INFORE financial use case scenario have been collected and summarized. They provided the basis for the initial practical development of the INFORE Financial use case tools and components, considering the interactions of this use case and of the financial data streams it produces with INFORE's algorithms and the overall architecture. An enhanced version of the requirements collected in the project are documented in this Deliverable D2.2.

For collecting the requirements, 3 expert users have been provided with installations of prototypes of financial software packages, along with a usage guide (workflow description). Afterwards, a questionnaire and corresponding expert user interviews have been processed and their contents are included in Appendix A, B and C, D, respectively. This course of action enables a practical, user-centered approach for further development and enhancement of INFORE's financial applications. Expert users were guided through predefined workflows to get an intuitive understanding on features and functions of the use case implementations.

2.1 Structure of the Deliverable

The rest of this deliverable is structured into five sections. Section 3 describes the requirements for the use case implementations – both technical aspects and expert user insights. Section 4 describes the financial user scenarios and how the requirements were implemented. Section 5 reports the approaches of evaluation – technical and human. Section 6 contains the evaluation reports and finally Section 7 makes a conclusion and gives an outlook on future work.

3 Requirements

The financial use case implementations are based on two types of requirements – technical requirements (for example algorithms, processing power and speed etc) and expert user expectations (provided functions, workflow, learning curve etc).

3.1 Technical requirements

The INFORE project will validate its results with respect to the financial domain in terms of three objectives: Forecasting price swings, Systemic risk prediction with early warning and Decision support for investment opportunities. The user scenarios for the financial domain will be discussed in more detail in Section 4.

Forecasting price swings is essential for almost all categories of trading. A swing forecasting the rising price of an asset would initiate a setup to buy it. A swing forecasting falling prices would lead to sell the asset, or to open a short position on it (a 'bet' on falling prices). In both cases, forecasting price changes may indicate an opportunity, and lets investors act accordingly. Forecasting in the financial markets is as old as the markets themselves and several forecasting approaches have been developed, mainly based on two different, concurrent analysis aspects:

The technical analysis follows the approach of building forecasts based on the past market data, assuming trends and patterns exist in the time series of asset prices. The fundamental analysis sets its focus on economic data, earnings, announcements and other market driving aspects.

The user scenario challenges revolve around the development of novel methods to extract market patterns. INFORE's distributed machine learning algorithms are to extract the market patterns, while INFORE's complex event forecasting component will then foresee their apparition. These components together with the processing power of a High Performance Computing (HPC) infrastructure and/or Big Data platforms would enable the analysis of wide sectors of assets in real time, thus expecting to achieve a competitive advantage compared to classical methods.

Systemic risk is identified as one of the major key factors for the stability of financial markets. It represents the situation where financial markets, and the exposure of financial institutions to those markets, become strongly dependent to each other, potentially leading to industry-wide market failure. The need to measure and identify systemic risk is one of the most challenging issues facing institutional users today. This is so because of the given velocity in financial markets and it has forced the need to rapidly identify and act on hotspots before contagion sets in. It is well known that nowadays financial markets are correlated to a degree significantly higher than in the past, and not simply within asset classes. Due to the risk-oriented nature of actual trading, wide ranges of asset classes have become strongly correlated, so that diversification of risk is more challenging.

The use case scenario targets institutional financial clients, such as Banks, Hedge Funds or Asset Managers. In this scenario, the challenge is to perform pre-trading risk analysis and real-time, real money trading risk analysis. The implemented algorithms will be integrated with the trading applications of SPRING and enhance them by a multivariate and multi-market risk analysis approach, which is expected to add important insights about systemic risks, and help avoiding fatal losses of the managed capital. To enable an early warning in case of rising systemic risk, INFORE needs to analyze systemic risk continuously and with small delay (near real time).

Finally, INFORE aims at providing investors with **support for their investment decisions**. This support is based on identifying new investment opportunities and analyzing risk on already existing investment ideas.

Table 1 summarizes the technical objectives of above use case related requirements, divided in generic objectives and financial use case related objectives.

Table 1: Measurable objectives for financial use case

Objective	Current Performance	Target Performance	Evaluation
Cross-sector Generic Measurable Objectives			
Time to set-up a new workflow for data processing, machine learning or data mining task (including exploratory model, parameter tuning).	~60 days	~ one order of magnitude reduction	Evaluation based on setting up new data processing tasks. Human Factors evaluation for visual workflow design and visual analytics.
On-line learning of complex (relational) event patterns	Processing <10K events/sec	Processing >100K events/sec	Comparison against manually constructed patterns in terms of predictive accuracy and theory size (ability to generalize).
Complex event forecasting	Limited expressivity; informal semantics	Full availability of regular expressions; formal (probabilistic) semantics	Comparison against ground truth in terms of forecast distance, spread and precision.
Exploratory Analytics	Minutes to Hours	Few seconds	Popular data exploratory solutions (such as Tableau, Microsoft BI and others) take from minutes to hours to query large datasets minimizing productivity. INFORE will achieve real time querying of Big Data.
Measurable Objectives of Financial Use Case			
Reaction time to issue an alarm upon the appearance of a medium-term elevated market risk	Next day	Split seconds	Comparison of the reaction time raised by INFORE against recent incidents.
Peak load that can be handled by the system (ratio peak/average load); approximation (portion of detected risk alarms/forecasts) due to unmanageable load	factor 20 (number of shed messages); ~55 %	factor 35 (number of shed messages); >>70%	Benchmarking based evaluation of the potential performance on the Big Data of the financial use case. Comparison against ground truth.
Total time for in depth risk	>5 days	<1 day	Comparison of the time

analysis over tens of thousands of streams			yielded by INFORE technology against current solutions. Human Factors evaluation.
Number of markets (each introducing thousands of streams) concurrently considered in risk analysis	5	>50	Benchmarking based evaluation of the potential performance on the Big Data of the financial use cases.
Warning time due to financial risk forecast (look-ahead time horizon)	1 day	> 3 days	Comparison against ground truth in real historical data. Comparison of the time at which INFORE forecasts a risk against the actual time.

However, due to the limited possibilities of accessing high performance computer clusters, the tests on prototypes were processed with a very small cluster with limited capacities of 10 processor cores on a spring in-house server, following the environment of Figure 1, which is not comparable with the expected final processing power of the INFORE infrastructure. Achievements on measurable objectives of Table 1 will be part of D2.3 Final evaluation report.

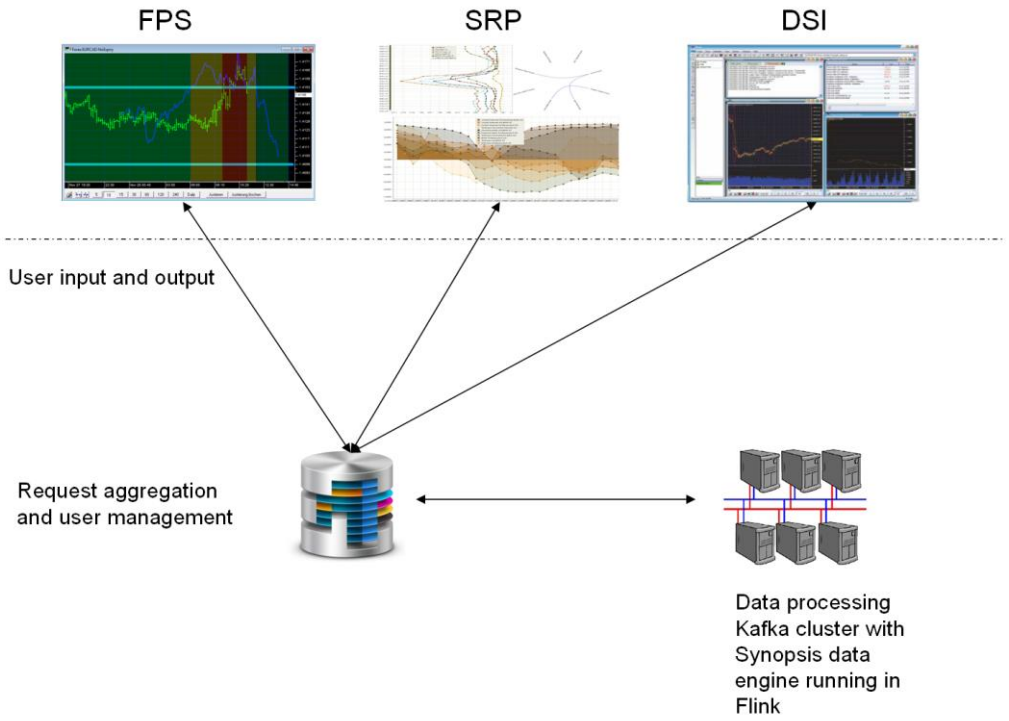

Figure 1: Technical environment for the financial use case

3.2 Requirements from the Experts

The requirements built from D2.1 result in 3 different use cases "Forecasting Price Swings" (FPS), "Systemic Risk Prediction and early warning" (SRP) and "Decision Support for Investment Opportunities" (DSI). For each use case, a desktop application was developed, based on already existing, but limited software tools from spring.

In Table 2 below, we show Expert users needs and requirements, ordered by relevance to use cases. These are derived from the Expert statements in Appendix B: Anonymised answers of the expert users on the questions from Appendix A, where we color coded according results for a better overview.

Table 2: Expert users needs and requirements, ordered by relevance to use cases – see color coded questionnaire results in Appendix B

FPS Forecasting Price Swings	
	Seasonal pattern trading opportunities
	A positive chance risk reward over 3:1
	Prognosis about the direction
	The right timing
	Finding volatile markets
	Different market cycles
	Seasonal patterns across different asset classes
	Detect and adjust changes in market cycles
	Higher performance when identifying seasonal and spread trading opportunities
	Ability to accurately forecast events of interest
	Better performance with seasonal and spread opportunities
SRP Systemic Risk Prediction	
	Prediction of rising Volatility for single market players
	Predict rising volatility
	Correct prediction of rising volatility
	Fundamental News ("unpredictable" events like 2015 „Swiss Volatility")
	Higher success rate in terms of better predicting volatility
	Learning algorithms that calculate risk
	Prediction of sudden risks of decline in value of the current portfolio
	More accurate and faster risk analysis of the existing portfolio and positions
	Managing risk, when a spread trade or seasonal pattern trade does not work out

DSI Decision Support for Investment opportunities	
	Trading opportunities with high reward/risk probability
	Manage trades
Custom requirements	
	Identifying futures spread trading opportunities
	Doing massive parallel analytics continuously
	High data load regarding computational power
	Check availability of fitting Call/ Put- options
	Identifying opportunities in Futures calendar spreads
	Identifying opportunities in Futures intermarket spreads
	Monitoring official trading publications like the “Commitment of Traders”
	Stabilized performance curve
	Better probability predictions

3.2.1 Further requirements by the Expert Users, ordered by use case

After the initial round of questionnaires and interviews, we made individual interviews with each expert, resulting in the following additional requirements:

Forecasting Price Swings
- Make different methods/algorithms for prediction selectable (e.g. ML-algorithms, statistical algorithms)
- Forecast also volatility

Systemic Risk Prediction
- Add fundamentals (profit, dividends, carrying amount, cash flow)
- Add Market and economic data (inflation, industrial production, COT1, …)
- Add dependencies against market and economic data

Decision Support
- Add filtering option to pre-select only high-return/low risk trading opportunities with custom user- defined metrics

3.2.2 High level summary of Expert User Requirements

While the Expert User Requirements provide a wealth of insight in each single remark and as a whole, for the process of implementing and assessing them, it is also important to perform a high-level summary. We will do so for each of the financial use cases and in addition for custom requirements of the experts (compare Table 2).

3.2.3 FPS Forecasting Price Swings

Forecasting price swings is all about taking the right position in the market at the right time to achieve positive performance goals.

1 Commitment of Traders; https://en.wikipedia.org/wiki/Commitments_of_Traders

Summarizing the experts´ requirements, there is a need for seasonal pattern forecasts across different asset classes. This goes hand in hand with the aim for higher performance when identifying seasonal and spread trading opportunities. One of the experts specifies a positive chance for capital appreciation with a reward to risk ratio of over 3:1. Forecasting price swings also touches the topic of market volatility. Other than in the concept of systemic risk, with forecasting price swings, volatility is perceived as good and desirable, as it provides opportunities for profitable directional trades.

3.2.4 SRP Systemic Risk Prediction

Volatility is also a top topic in terms of systemic risk prediction. Experts state, that prediction of rising volatility for single market players is a key factor of their analysis.
Further top requirements for this use case are learning algorithms that calculate risk. A great factor of calculating risk is the correlation between selected market players.

Furthermore, correct prediction of rising volatility is required, when fundamental news hit the market. An expert names “unpredictable“ events like 2015 “Swiss Volatility” as an example. The “Swiss Volatility” event refers to the decoupling from a government-backed minimum price level between Euro and Swiss Franc. This leads to sudden increases of volatility in the Forex market, which even caused brokers to go bankrupt.

3.2.5 DSI Decision Support for Investment Opportunities

In Decision Support for Investment Opportunities, trading opportunities with high reward/risk probability are a key priority.

In addition, the experts would like to be provided with filtering options to pre-select only high-return/low risk trading opportunities with custom user-defined metrics. This reflects the overall idea of financial decision support systems: Setting an investment goal and scanning the market in a big-data way to find the most fitting and promising investment opportunities to achieve this goal.

3.2.6 Custom requirements

Custom requirements include doing massive parallel analytics continuously, requiring high data load regarding computational power. In this sense, doing massive parallel analytics continuously is a similar requirement.

Finally, the requirement to stabilize the performance curve, is a general need of the expert users, which is valid for all use cases. It reflects the aim to generate constant capital appreciation with low account volatility on the way.

3.2.7 Process of implementing Expert User Requirements

The above described requirements, gained from the Expert questionnaires and interviews, are taken to enhance the features and functions of the Financial Use Case pilots.

The findings from Table 2 mainly define the roadmap for the further development of the use case application implementations. In general, the provided workflow of the applications was useful for all experts; their main focus is on implementing more functions and analysis algorithms.

For use case FPS, many requests can be solved by making different algorithms of ML- and time series prognosis available (e.g. cycle analysis for seasonal predictions). Due to the Synopsis Data Engine (SDE; see D6.1) of INFORE, this can be implemented fast and without huge effort, during and after the end of the project.

The requests for use case SRP mainly focus on analysis of market volatility ad this is also a matter of algorithms.

Use case DSI requests are more special like managing trades, beside that most of the requests of use cases FPS and SRP are also valid for this use case, as the decision support is mainly based on price forecasts and risk prediction.

4 Scenario Definitions and implemented Expert-user requirements

In this chapter, we describe the different scenarios of each use case and how the user requirements from chapter 3 of this deliverable were implemented. For each use case, a single desktop Windows application was provided, that allows the expert users to follow analysis workflows based on their needs.

4.1 Summary of Financial Use Case Scenarios and Role Players

In this section, we describe the 3 user scenarios for institutional financial clients. The application users are the role players that interact with the visual analytic tools to be built on top of INFORE's architecture. They access the system with a task at hand (e.g., risk analysis of a certain asset) and use the INFORE' tools to perform this task.

Users do not need to know how the underlying INFORE platform is configured or developed. The respective visualization tool should, however, support some flexibility regarding the data analysis, such as the selection of the market players to analyze, the time span to be considered in the analysis, etc. This functionality should also be supported through the graphical user interface of the application.

The most important role players for INFORE in the group of the financial users are:

Hedge Funds
Investment Companies
Investment Banks

We detail these role players in Table 3 below:

Table 3: Description of role players for the financial user scenarios

Financial user scenario role players	
Role player	**Hedge Funds**
Taking investment decisions over the hedge fund portfolio is a key task of a fund manager. For a successful hedge fund, it is required to achieve positive returns that are largely uncorrelated with the overall markets. This so called "alpha" is mostly generated by using niche strategies, which gain an edge in the markets. Furthermore, the strategy of risk management is of foremost importance. INFORE will be designed to provide the Hedge Funds with a complete set of tools to achieve these advantages by forecasting price swings, identifying investment opportunities and managing systemic and portfolio risk. Hedge funds can use it for portfolio optimization or risk management and hedging.	
Role player	**Investment Company**
An Investment Company usually sets up its own exchange traded investment vehicles like e.g. Exchange-traded funds ("ETFs") and invests the pooled capital of its investors there. From a trading related point of view, Investment Companies have similar requisites as Hedge Funds. However, they often have even stricter rules regarding trading style and risk management. With the trading vehicles of Investment Companies, there is a differentiation between closed-end mutual funds and open-end mutual funds. While open-end funds buy back shares from investors every business day, closed-end funds usually offer shares to the public only once, when created. Public trading is later possible on a stock exchange.	

Role player	Investment Bank
Investment Banks manage enterprise-wide risk across a wide range of asset types. This has become a major regulatory requisite in addition to being a prerequisite for effective capital allocation. The need to include a network of potential exposure outside of the investment bank has recently become recognized, in the sense that internal liquidity is no longer a sufficient indicator of financial stress. By providing an Investment Bank with a tool that identifies in real time the co-dependencies and avenues of contagion between major market participants, it will be better able to manage such exposures.	

4.2 Translation of Expert Requirements to Pilot Features

For each use case, the expert users were provided with a desktop application. Generally these applications allow the user to select markets and market segments, perform different analytics and visualise their results. Each user workflow can be saved for recurring use and ongoing modifications.

The user has a view on a visual interface, which hides the underlying infrastructure of INFORE. Therefore, the technical complexity is low and allows the users to focus on their analysis tasks with a short learning curve.

The functions of each use case application are based on the collected requirements of D2.1. For each use case, we added a table that describes how these requirements were implemented as well as how we plan to implement the requirements that are not yet implemented. For use case FPS, this is shown in Table 5, for use case SPR, this is shown in Table 7 and finally for use case DSI, Table 9 shows the requirements.

In the following, the three financial use cases are described. In a later part of each chapter, the single Expert User requirements are detailed in the form of tables and descriptions. Within this, tables are divided up in requirements from D2.1 and requirements from D2.2 (compare Section 3 and Appendix B).

4.2.1 Forecasting Price Swings

In this user scenario, role players (Hedge Funds, Investment Company) are looking for new investment opportunities. They use INFORE to identify upcoming price swings as shown in Figure 2, that either seem to have good trading opportunities (Buying assets) or that predict falling prices of assets, that are already in the investor's portfolio (Selling assets). So INFORE will provide decision support for new investments, as well as for already investments that have already been performed, as shown in Table 4.

Table 4: Description of user scenario FPS

User Scenario Description	
Identifier	FPS
Name	Forecasting Price Swings
Role player	Hedge Funds, Investment Company
Goal	Assist investment decision makers in forecasting and evaluating price swings of selected assets. Giving an "edge" in the markets, while taking into account user-specific risk/reward ratios.

Requisites	Forecasting price swings in several specified timeframes, e.g. 30 minute, 60 minute, daily, etc. Emphasis on forecasting and/or reacting on sudden, unexpected and large price swings. Price swings that are not commonly identified and, therefore, provide an "edge" in the market. Examples: Individual seasonal patterns, uncommon price swing patterns that are found by using Machine Learning and similar techniques. - Main markets: Liquid stocks, Main Forex pairs, Index Futures, Commodity Futures.
Data input streams	- Historical price data of the analyzed asset along with the same data for identified correlation assets - Real time streams of the analyzed asset along with the identified correlating assets (to update the analysis after each selected time frame
Data and Functions	a. User information, login and authentication functions b. User creates or opens a specific workspace with markets to be analyzed. c. User selects the markets to be analyzed and specific analysis factors like time frame and risk/reward measures. d. Output visualizations, e.g. selected opportunities as chart and numeric. Table visualization as overview of selected forecasts. Summaries of hypothetical historical results of selected forecasts. e. Optional adjustments and optimizations by the user (restart at point b.)

Figure 2: Continuous price swing forecast

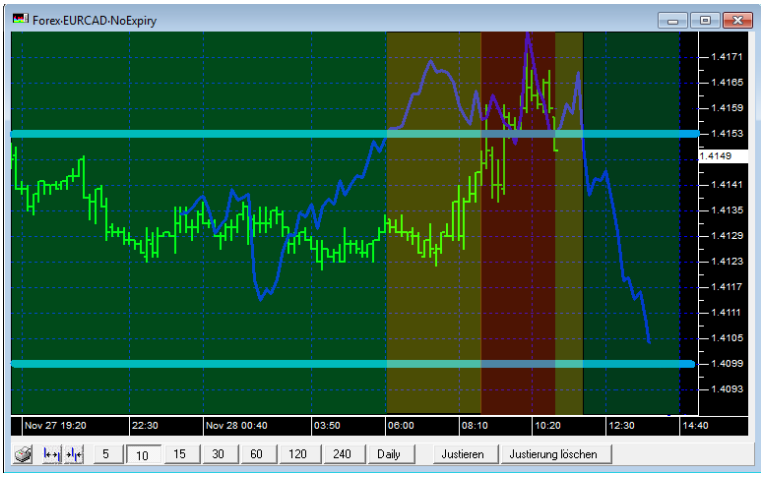

Figure 3: Price forecast and Volatility interpretation

The "Forecasting price swings" application assists investment decision makers in forecasting and evaluating price swings of selected assets in relation to different market conditions (like volatility as shown in Figure 3). This can be broken down to the following main features:

- Forecasting in Main markets: Liquid stocks, Main Forex pairs, Index Futures, Commodity Futures
- Forecasting price swings in several specified timeframes on specified horizons
- Ongoing forecasting based on historic market data (historical prices, real time updates)

As shown in Figure 4, "Forecasting price swings" mainly targets Hedge Funds and Investment Companies. The offering of the according INFORE Use Case provides forecasts of price swings in order to assess assets in an existing investment portfolio and for pointing out new investment opportunities as shown in Figure 5.

Figure 4: Value oriented workflow of "Forecasting price swings"

US- Sugar 11 Future	000657	2020-06-08	2020-06-29	15	↑	6 %	21	76.19 %	**5.15 %**	10.99 [2020-05-22]	2.03	2.75	2	000657
US- Natural Gas-Future	000517	2020-06-09	2020-06-15	4	↑	5 %	15	85.71 %	**4.72 %**	1.707 [2020-05-25]	4.25	5.66	1	000517
US- Sugar 11 Future	000657	2020-06-09	2020-06-26	13	↑	7 %	21	76.19 %	**4.43 %**	10.99 [2020-05-22]	2.11	2.03	2	000657
US- Natural Gas-Future	000517	2020-06-10	2020-06-16	4	↑	5 %	15	80.00 %	**4.02 %**	1.707 [2020-05-25]	2.19	3.22	1	000517
US- Sugar 11 Future	000657	2020-06-10	2020-06-29	13	↑	10 %	21	76.19 %	**4.48 %**	10.99 [2020-05-22]	2.51	1.43	2	000657
US- Natural Gas-Future	000517	2020-06-11	2020-06-17	4	↑	5 %	15	86.67 %	**4.39 %**	1.707 [2020-05-25]	2.16	5.71	1	000517 ⚠
US- Sugar 11 Future	000657	2020-06-11	2020-06-25	10	↑	6 %	21	76.19 %	**4.17 %**	10.99 [2020-05-22]	2.02	2.22	2	000657
US- Sugar 11 Future	000657	2020-06-12	2020-06-26	10	↑	6 %	21	80.95 %	**4.88 %**	10.99 [2020-05-22]	2.42	3.46	1	000657 ⚠
EU- STOXX 50-Future	965236	2020-06-15	2020-06-25	8	↓	8 %	21	76.19 %	**-1.39 %**	2878 [2020-05-25]	2.19	.56	1	965236 ⚠
US- Natural Gas-Future	000517	2020-06-15	2020-06-24	7	↓	5 %	15	86.67 %	**-4.15 %**	1.707 [2020-05-25]	2.46	5.4	1	000517
US- Sugar 11 Future	000657	2020-06-15	2020-06-29	10	↑	8 %	21	80.95 %	**4.54 %**	10.99 [2020-05-22]	2.01	2.41	1	000657 ⚠
US- Natural Gas-Future	000517	2020-06-16	2020-06-25	7	↓	6 %	15	80.00 %	**-2.56 %**	1.707 [2020-05-25]	2.18	1.71	1	000517
US- Sugar 11 Future	000657	2020-06-16	2020-06-29	9	↑	7 %	21	80.95 %	**4.69 %**	10.99 [2020-05-22]	2.15	2.85	2	000657 ⚠
US- Natural Gas-Future	000517	2020-06-17	2020-06-23	4	↓	3 %	15	80.00 %	**-3.31 %**	1.707 [2020-05-25]	2.05	4.41	2	000517
US- Sugar 11 Future	000657	2020-06-17	2020-06-29	8	↑	7 %	21	80.95 %	**3.20 %**	10.99 [2020-05-22]	2.01	1.94	1	000657

Figure 5: Price swings forecast table from the INFORE application with detailed position holding durations, price targets and success-probabilities

4.2.1.1 Requirements details – Forecasting Price Swings

Table 5: Requirements from D2.1 and according implementation in the INFORE infrastructure and financial use cases

Requirement from D2.1	Implementation/ ToDo
- Seasonal pattern trading opportunities - Forecasting price swings in several specified timeframes, e.g. 30 minute, 60 minute, daily, etc. - Prognosis about the direction	Algorithms pre-selected, but not yet implemented in Synopsis Data Engine
- The right timing - Ability to accurately forecast events of interest	Add ML algorithm in Synopsis Data engine: Pattern recognition
Finding volatile markets	Springs's real time data server connected to INFORE infrastructure
Different market cycles	INFORE infrastructure has access to historical data server
- Seasonal patterns across different asset classes - Detect and adjust changes in market cycles	Add Seasonality algorithm in Synopsis Data engine
- Higher performance when identifying seasonal and spread trading opportunities	Deployment of INFORE infrastructure on HPC cluster

- Doing massive parallel analytics continuously - High data load regarding computational power	
- Identifying opportunities in Futures calendar spreads - Identifying opportunities in Futures intermarket spreads	Springs's real time data server connected to INFORE infrastructure
Historical and streaming data processing	Supported through INFORE infrastructure

4.2.2 Systemic Risk Prediction and early warning

The role player (Hedge Funds, Investment Company, Investment Bank) wants to check if his already existing portfolio is diversified in terms of risk, or not, like shown in Table 6. The given user scenario workflow assumes that the role player wants his portfolio to be as diversified as possible. INFORE will identify dependencies within the portfolio, which allows the investor to sell/reduce position sizes of assets that have strong dependencies among each other.

Table 6: Description of user scenario SRP

User Scenario Description	
Identifier	SRP
Name	Systemic risk prediction and early warning
Role player	Hedge Funds, Investment Company, Investment Bank
Goal	Early warning of systemic risk factors in existing and planned portfolios. Suggestion of risk-reduced portfolios and portfolio members, taking into account the specific requisites of the user.
Requisites	Early detection of potentially risky constellations of portfolio members by evaluating the diversification.
Data input streams	- Real time streams of the analyzed portfolio assets to continuously analyze the portfolio internal dependencies
Data and Functions	a. User information, login and authentication functions. b. User creates or opens a specific workspace with portfolio to be analyzed. c. Output visualizations, in particular cluster and table visualizations. d. Optional adjustments and optimizations by the user (restart at point b).

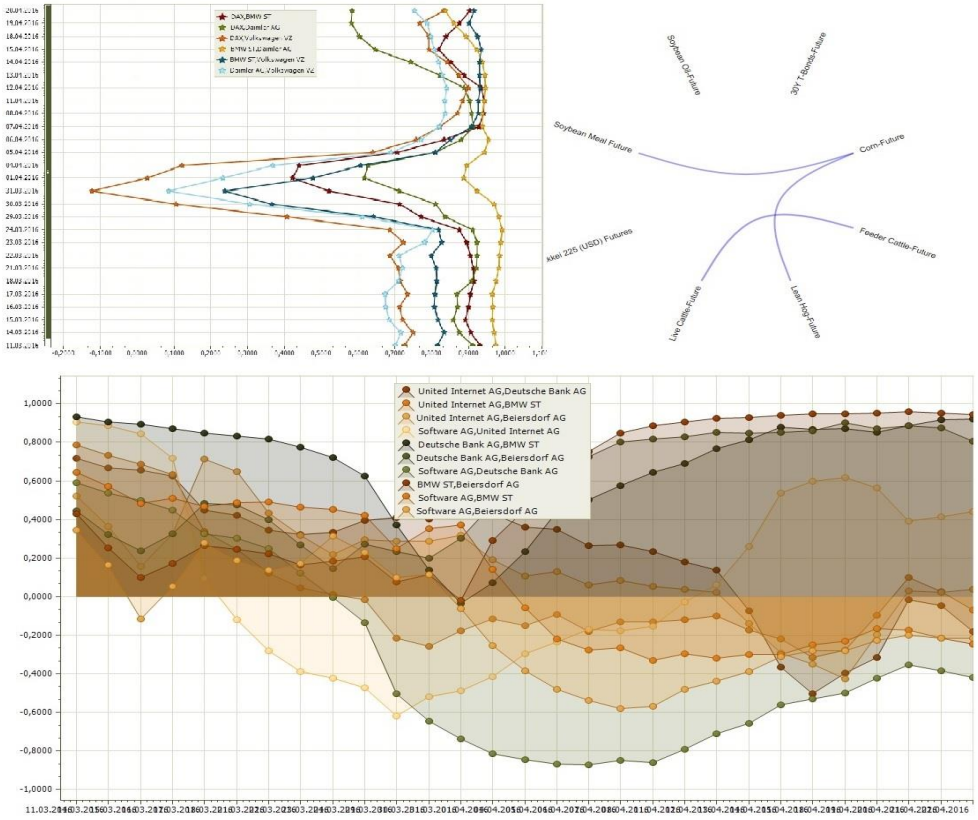

Figure 6: Visualizations of dependencies of market players

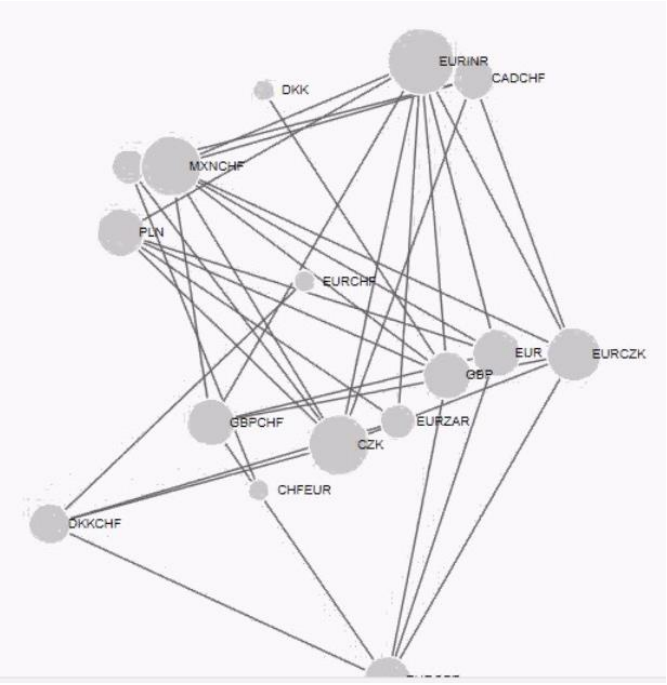

Figure 7: Graph visualization of currency correlations

Systemic Risk Analysis provides target clients like Investment Banks with early warning of systemic risk factors in existing and planned portfolios. In detail, this can be summarized as follows:

- Early detection of potentially risky constellations of portfolio members by evaluating the diversification
- Ongoing evaluation of dependencies of portfolio members (historical prices, real time updates), as shown in Figure 6 and Figure 7.
- Ongoing evaluation of dependencies of market segments/Indices against portfolio (historical prices, real time updates)

As schematically shown in Figure 8 below, the Investment Bank wants to assess the grade of diversification of their portfolio. The target client also wants to achieve a constant monitoring and early detection of systemic market risk with respect to their existing portfolio and potential new investments. This is achieved by continuously measuring and forecasting dependencies of relevant market players. In the end, the client is able to make informed decisions about asset allocations to calculate and reduce portfolio risk.

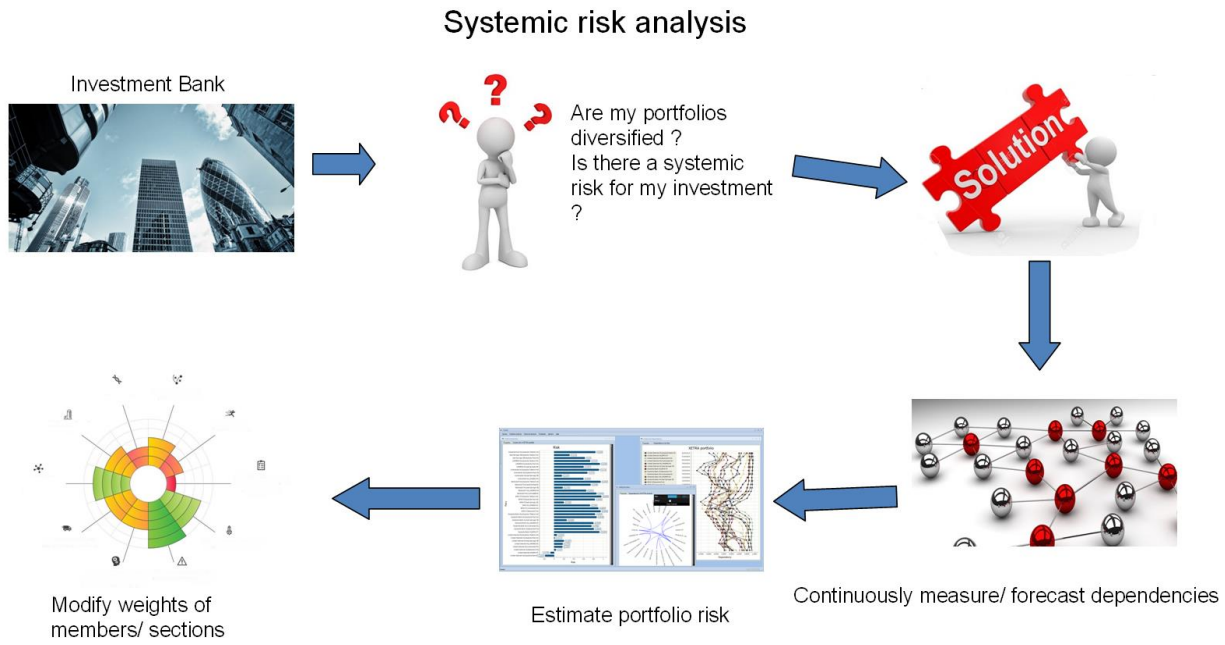

Figure 8: Value oriented workflow of "Systemic Risk Analysis"

4.2.2.1 Requirements details – Systemic Risk Prediction and early warning

Table 7: Requirements from D2.1 and according implementation in the INFORE infrastructure and financial use cases

Requirement from D2.1	Implementation/ ToDo
- Prediction of rising Volatility for single market players - Predict rising volatility - Correct prediction of rising volatility - Higher success rate in terms of better predicting volatility - Learning algorithms that calculate risk	Add ML pattern recognition algorithm in Synopsis Data engine
Fundamental News ("unpredictable" events like 2015 „Swiss Volatility")	Add additional news data feed

- More accurate and faster risk analysis of the existing portfolio and positions - Doing massive parallel analytics continuously - High data load regarding computational power	Deployment of INFORE infrastructure on HPC cluster
- Prediction of sudden risks of decline in value of the current portfolio - Correlation measurement - Early detection of potentially risky constellations of portfolio members by evaluating the diversification.	Supported through Correlation Coefficient in SDE

4.2.3 Decision-Support for investment opportunities

The investor (Investment Company or Investment Bank) checks the risk of market segments of interest or the overlying market to modify their management of liquidity, as shown in Table 8. Rising risk will lead the investor to reduce asset position sizes and hold more liquidity. The opposite scenario is that the investor may reduce liquidity and invest in more assets (based for example on Predictive Price Swings), when the risk in the market is relatively small.

Table 8: Description of user scenario DSI

User Scenario Description	
Identifier	DSI
Name	Decision support for investment opportunities
Role player	Investment Company, Investment Bank
Goal	Identification of selected investment opportunities over a broader range of markets. Automated “cherry picking” of best opportunities from a large basket of markets and market players.
Requisites	Measurement of under-valued or over-valued assets. Identification of opportunities, which provide an above average risk to reward factor and medium to long term (12 to 36 and more months) positive return. Opportunities that are or not strongly correlated with traditional benchmark markets (e.g., the S&P500 index) are preferred.
Data input streams	- Historical price data of the analyzed asset along with the same data for identified correlation assets - Real time streams of the analyzed asset along with the identified correlating assets to update the analysis after each selected time frame - Real time streams of the analyzed portfolio assets to continuously analyze the portfolio internal dependencies

Data and Functions	a. User information, login and authentication functions. b. Broader market segment information, preview of selected potential investment opportunities. c. User selects markets to be analyzed and specific analysis factors like timeframe and risk/reward measures. d. Output visualizations. e. Optional adjustments and optimizations by the user (restart at point c).

Figure 9: Decision support interface with customized charts, quotes and user menus

Figure 10: Several data and visualization screens for decision support

This use case facilitates the identification of selected investment opportunities over a broader range of markets as shown in Figure 9 and Figure 10 and can be broken down as follows:

- Measurement of under-valued or over-valued assets
- Identification of opportunities with above reward-to-risk factor
- Opportunities, uncorrelated to main benchmarks

This offering provides a solution to the need to identify investment opportunities and to pick the best assets for investment as shown in Figure 11.

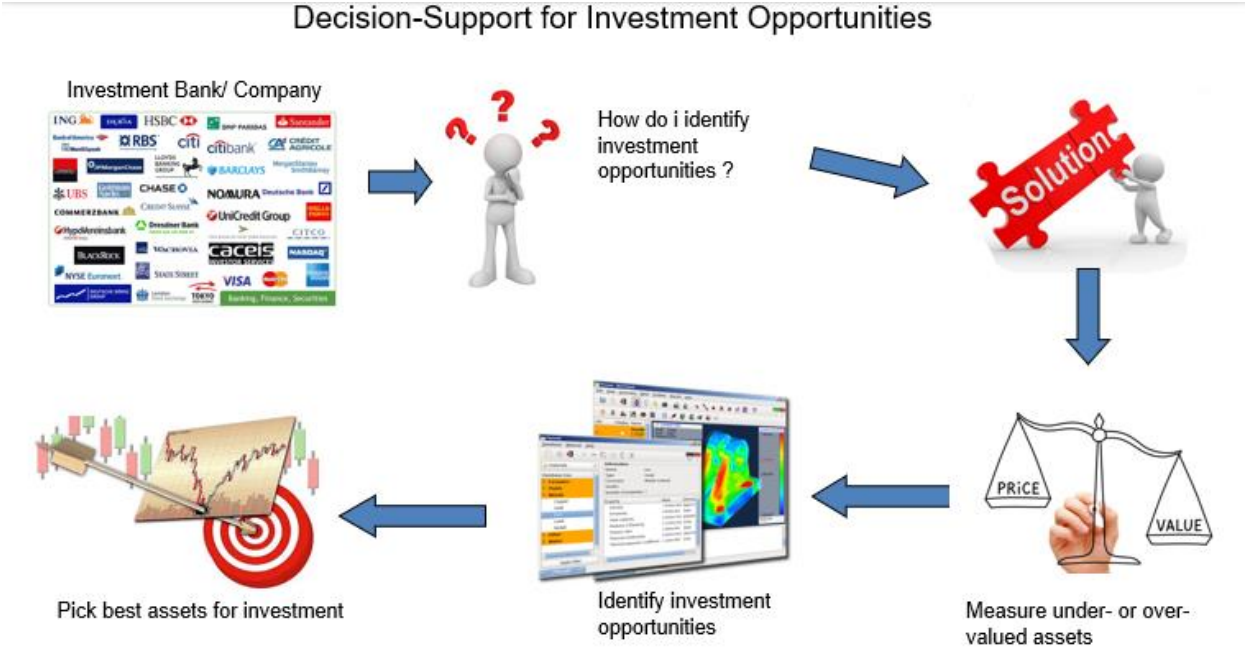

Figure 11:Value oriented workflow of "Decision-Support for Investment Opportunities"

4.2.3.1 Requirements details – Decision support for Investment Opportunities

Table 9: Requirements and Implementation for DSI

Requirement from D2.1	**Implementation/ ToDo**
- Trading opportunities with high reward/risk probability - Stabilized performance curve - Better probability predictions	Add ML pattern recognition algorithm in Synopsis Data engine
Manage trades	Planned beyond the scope of the project
Identifying futures spread trading opportunities	Add additional quote data feed
- Doing massive parallel analytics continuously - High data load regarding computational power	Deployment of INFORE infrastructure on HPC cluster
- Identifying opportunities in Futures calendar spreads - Identifying opportunities in Futures inter-market spreads - Monitoring official trading publications like the "Commitment of Traders"	Add additional news data feeds

5 Set-up of Tests and Evaluations of Pilot Applications

For each of the 3 financial user scenarios, an application was developed following the requirements of expert users documented in D2.1. The test and evaluation phase was divided into 2 parts: In the first part, we processed a technical in-house testing to ensure the applications to work properly as expected during the expert evaluations. After finishing the testing, the applications were provided to the expert users for an evaluation with domain specific expert knowledge.

5.1 Technical Evaluation

Following the plan to technically test the user scenario applications test strategy covering objectives from the requirements was developed. Based on defined test principles, each user scenario application was explored manual with functional tests by a software test team, comparing the results with functional specifications. Test results were reported to the developer (QA = quality assurance) team allowing to fix the bugs. Based on an exit strategy, tests were being repeated after reported as fixed from the QA team.

5.1.1 Test plan

5.1.1.1 Test Objectives

The objective of the testing is to provide adequate coverage metrics, requirements validation and system quality data such that sufficient data is provided for those making the decision to release.

5.1.1.2 Extent of Testing

The testing referenced herein is written to validate user scenarios and requirements (both functional and non-functional) using Manual Testing. Test cases will be developed based on the requirements mentioned, test cases will be executed across Windows Operating system, bugs will be captured in Spreadsheet and finally test report will be prepared to summarize the overall testing status. Figure 12 describes the relationships between test documentations.

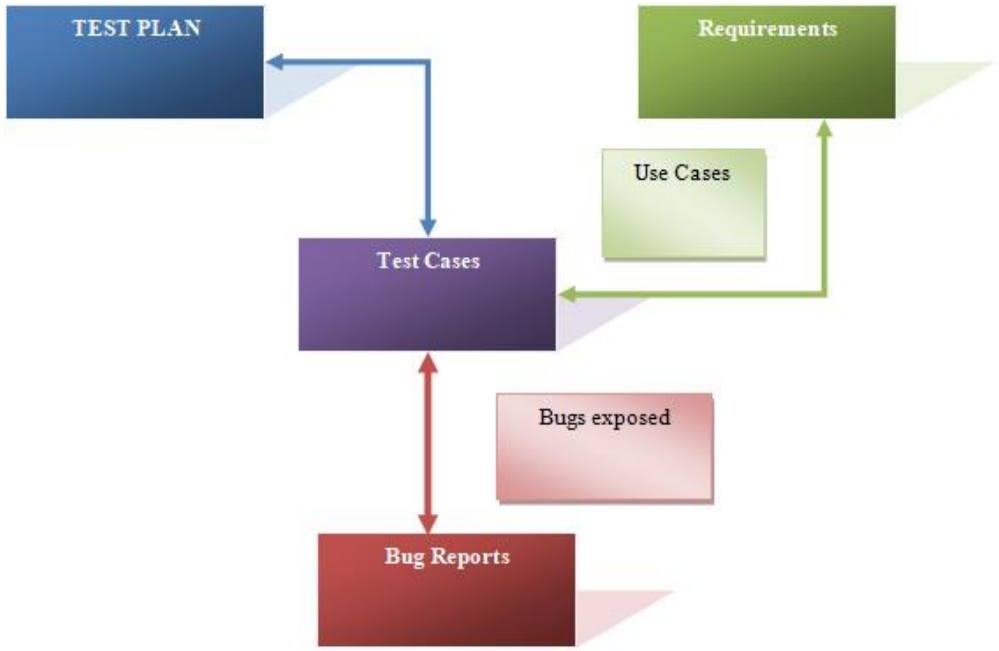

Figure 12: Relationship of documentations

5.1.2 Test Strategy

5.1.2.1 Test Assumptions

- Exploratory Testing would be carried out initially for 2-3 days after the software is installed in the System to gain knowledge on the application.
- All the defects would come along with proper screenshot/video required.
- The Test Team assumes all necessary inputs required during Test design and execution will be provided.
- Test case design activities will be performed by QA Team.
- Test environment and preparation activities will be owned by QA Team.
- The defects will be tracked through Excel/ Bugzilla only. After bug fixes, new build of the software will be provided to the QA Team.
- Project Manager will review and sign-off all test deliverables.
- The project will provide test planning, test design and test execution support.
- Test team will manage the testing effort with close coordination with Project Manager.
- Test team has the knowledge and experience necessary, or has received adequate training in the system, the project and the testing processes.

5.1.2.2 Test Principles

- Testing will be focused on meeting the business objectives, cost efficiency, and quality.
- Testing processes will be well defined, yet flexible, with the ability to change as needed.
- Testing activities will be built from scratch.
- Testing will be a repeatable, quantifiable, and measurable activity.
- Testing will be divided into distinct phases, each with clearly defined objectives and goals.

5.1.2.3 Scope and Levels of Testing

- **EXPLORATORY**
  - **PURPOSE:** The purpose of this test is to make sure critical defects are removed before the next levels of testing can start.
  - **METHOD:** This exploratory testing is carried out in the application without any test cases and documentation.
  - **TIMING:** At the beginning of each cycle.

- **FUNCTIONAL TEST**
  - **PURPOSE:** Functional testing will be performed to check the functions of application. The functional testing is carried out by feeding the input and validates the output from the application.
  - **METHOD:** The test will be performed according to functional test cases developed by the QA team.
  - **TIMING:** After exploratory test is completed.

5.1.2.4 Test Acceptance Criteria

- Approved functional specification document, user scenario documents must be available prior to start of test design phase.
- Test cases approved and signed-off prior to start of test execution.
- Test environment with application installed, configured and ready to use state.

5.1.2.5 Test Deliverables

- The following artifacts will be delivered by the QA team
- Test Plan
- Test Cases
- Bug Reports
- Test Summary Report

5.1.2.6 Test Execution Strategy

ENTRY AND EXIT CRITERIA

- The entry criteria refer to the desirable conditions in order to start test execution; only the migration of the code and fixes need to be assessed at the end of each cycle.

- The exit criteria are the desirable conditions that need to be met in order proceed with the implementation.

- Entry and exit criteria are flexible benchmarks. If they are not met, the test team will assess the risk, identify mitigation actions and provide a recommendation. All this is input to the project manager for a final "go-no go" decision.

- Entry criteria to start the execution phase of the test: the activities listed in the test planning section of the schedule are 100% completed.

- Entry criteria to start each cycle: the activities listed in the test execution section of the schedule are 100% completed at each cycle.

Table 10 summarizes the exit criteria for test execution.

Table 10: Test exit strategy

EXIT CRITERIA	TEST TEAM	QA TEAM	NOTES
100% Test cases executed	✓	✓	Completed
No open Critical and High severity defects	✓	✓	Completed

90% of Medium severity defects have been closed	✓	✓	Completed
All remaining defects are either cancelled or documented as Change Requests for a future release	✓	✓	Completed
All expected and actual results are captured and documented with the test cases	✓	✓	Completed
All defects logged	✓	✓	Completed
Test Closure Report completed and signed off	✓	✓	Completed

5.1.2.7 Test Cycles

- There will be two cycles for functional testing. First cycle will execute all the test cases. Second cycle will execute the failed test cases to ensure the bugs are corrected.
- The objective of the first cycle is to identify any blocking, critical defects, and most of the high defects.
- Test Automation scripts will be executed towards the last phase of the test

5.1.2.8 Defects Management

Figure 13 describes the life cycle of bugs

- QA Team will report bugs in the Excel/BTS and assign them to the respective people for resolution.
- Product Owner / Development Team Lead / Business Analyst will assess the bugs and decide which one to fix in what order.
- After the bugs are fixed, QA Team will again retest the bugs and mark them Resolved (If found fixed after the retest) / In Progress (If found not fixed after the retest). In Progress bugs will again go through the Development process and QA process until it is resolved.

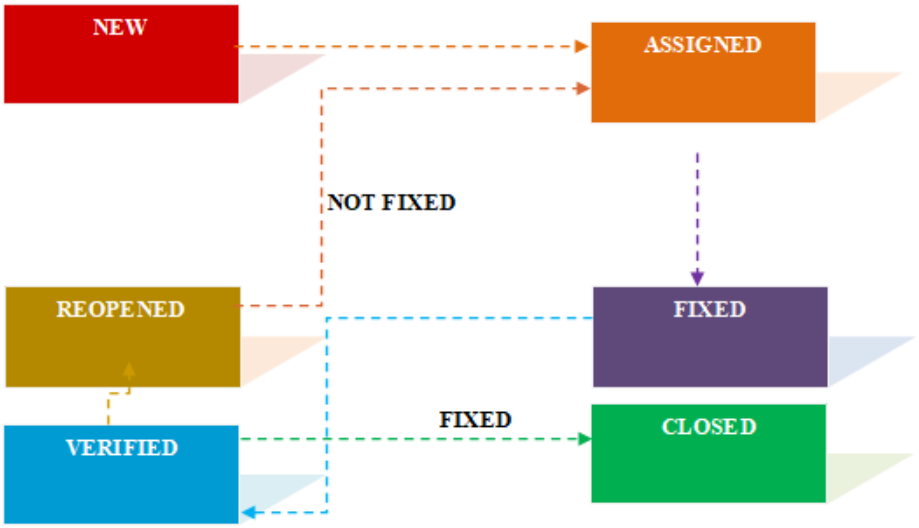

Figure 13: Bug Life Cycle

- **Critical** – Issue is a business blocker for one or more users and requires immediate attention (System down, user unable to proceed with the subsequent actions).
- **High** – Issue is significantly impacting one or more users' ability to work but does not prevent them from completing their job (Isolated I/O error, Incorrect data)
- **Medium** – Issue is impacting one or more users but does not prevent them from completing their job (Performance issues, Incorrect Validation, Incorrect Data Format)
- **Low** – Issue does not have significant impact on the user and does not prevent them from completing their job (Incorrect message)

All tests were processed on different OS versions of Windows 10. As tools for software tests, we used the open source bug tracking solution Bugzilla.

Currently, INFORE's financial applications are at a prototype state and not all parts of the needed infrastructure and functions are available yet.

Therefore, advanced tests with focus on the objectives described in Table 1 will be processed on the final prototypes of INFORE's financial applications and will be reported in D2.3 (Final Evaluation report) on month 36.

This includes quality dimensions such as timeliness, accuracy, efficiency (performance) and resource consumption in the context of the applications and the INFORE system.

5.2 Expert-user Evaluation

SPRING has identified three main finance industry user scenarios that will benefit from the advanced forecasting and risk analysis capabilities envisioned by INFORE. The workflows and requisite details are supported by the interviews based on questionnaires given out to 3 area experts and reported in D2.1, who gave insights of their work and needs that lead to concrete user scenario applications reflecting the user needs in conjunction with the project objectives. The utilized questionnaire and responses from expert users are included in Appendix A and Appendix B, respectively.

The user scenario applications are a useful method for collecting requisites in a user-centered way. Starting from a set of role players, i.e., a set of persons or other systems that interact with the system under consideration,

user scenario applications reflect the interaction of those role players with the system. The advantages of user scenarios are that they are intuitive and easy to handle due to their textual form. Besides that, they do not only support the description of the normal flow of interaction, which helps in the identification of required system functionalities, but in an advanced form they also support the description of exceptional cases, which provides a more in-depth view of the expected system specifications.

For the documentation of the user scenario workflows, tables have been used. Each table contains:

- The user scenario name
- The goal of the user scenario
- The scenario description (interaction steps) for successful execution of the user scenario (typically, the role player and the system alternate in their interaction).

A first expert evaluation was processed with 3 expert users from the financial domain. These are a CEO of a financial analysis company, a CEO of a hedge fund company and a financial analyst. The experts were asked to first follow predefined scenarios, which not only follow a typical workflow, but also allow the testers to learn the handling of the applications and then follow their own, intuitive storylines. Table 11, Table 12 and Table 13 show an example of a typical workflow within each of the 3 financial user scenarios.

Table 11: A workflow for the application Forecasting Price Swings

Forecasting price swings	
Scenario: Create a new workspace for market player price forecasting	
Step no	**Description**
1	Login to the Forecasting price swings application by selecting the respectively icon on the Desktop of your Windows computer
2	Select an asset from the left selection panel by selecting a category first, then choose the asset. Click on Open Chart.
3	A first prognosis with standard settings is processed and displayed.
4	Click on Prognosis Details to get insights on the displayed prognosis, probability, variability and other statistics.
5	Repeat from step 2 until step 3 with the same asset
6	Click on Algorithms and select a different prognosis ML algorithm.
7	Again, click on Prognosis Details to get insights on the displayed prognosis, probability, variability and other statistics.
8	Comparing the 2 prognosis detail data will allow you to estimate, which ML algorithm fits better to the current asset
9	Repeat steps 5 to 8 to evaluate as much algorithms as you like.
10	Save your workspace by selecting the menu File – Save Workspace. Your work is now saved.
11	Select a different time compression to change the prognosis length and depth by clicking on the Compression buttons at the bottom of the chart.
12	Based on the selected ML algorithm, you may access more prediction parameters from the Algorithms dialog

Table 12: A workflow for the application Systemic Risk Analysis

Systemic Risk Analysis	
Scenario: Modify an existing setup in the Systemic Risk Analysis application	
Step no	**Description**
1	Login to the Systemic risk analysis application by selecting the respectively icon on the Desktop of you Windows computer
2	Select the menu File, choose Open Setup.
3	Select the setup Default, click Open.

4	Right click on the window Basic chart, select Properties
5	Click on the tab Colors.
6	Click on Background, select white color, confirm with OK
7	Click on Foreground, select black color, confirm with OK
8	Click on Grid, select light gray, confirm with OK
9	Click on Series, select dark blue, confirm with OK
10	Right click on one of the Classic correlation table windows, select Properties
11	Click on the small button right from Back color, select light yellow color, confirm with OK
12	Change Header height from 20 to 40
13	Disable Dependency coloring
14	Confirm with OK
15	Right click on the window Parallel chart, select Properties
16	On the tab Symbol, navigate to the node Forex, open its list by clicking on +
17	Add one market player
18	Confirm with OK
19	Select menu File, choose Save Setup
20	Click Save and confirm replacing.

Table 13: A workflow for the application Decision Support for Investment Opportunities

Decision Support for Investment Opportunities	
Scenario: Inspect a previous saved setup for updates on monitored asset trading opportunities	
Step no	**Description**
1	Login to the Decision Support application by selecting the respectively icon on the Desktop of your Windows computer
2	Select the menu File, choose Open Setup.
3	Select the setup US Stocks, click Open.
4	Identify the Dashboard window, click on Order Desk
5	Compare the assets from the Open Positions tab with your current investments. These should be in line with your investments, if you updated/ entered your orders the previous cycle.
6	Compare your orders with the trading signals of the Order tab, and if needed, update, cancel or add changed orders.
7	Go to the Dependency window. Check, if dependencies of the monitored asset have significantly raised. If yes, take into account to lower positions in connected assets.
8	Check, if dependencies of the monitored asset have significantly fallen. If yes, take into account to enter or enhance positions in not-any-more-connected assets.
9	If from the actions of step 6 – 8 new assets have entered your focus, add a prognosis window for the specified asset to your workspace.
10	If from the actions of step 6 – 8 assets have left your portfolio and focus, remove the corresponding windows from your workspace.
11	Check the Market indicator window for significant changes. This may affect the over all risk of your portfolio and triggers the action of changing the overall amount of investment for parts of your portfolio or for the whole portfolio.
12	Check the News window. This lists times of upcoming news related to financial markets and investments. Look for critical events like federal bank announcements. You may take additional actions to prevent your portfolio from losses due to rising volatility.
13	The News window also may give you hints on new market opportunities based on new developments in world markets.
14	Finally, save your work by using the Save Workspace menu in the application

In order to refine the INFORE application features and handling, a questionnaire has been prepared (see section 6) in the scope of WP2. The aim of the questionnaire has been to collect inputs from the experts of financial markets and risk assessment. The experts can give their impressions and add comments and expert suggestions. In addition, one-to-one interviews with each expert have been done. From these interviews, more detailed and personalized feedback has been received and was summarized beyond the questionnaires in the field “Further remarks” (See Appendix D).

5.2.1 Background for Expert-user Pilot Evaluation Interviews and Questionnaires

This section covers the focus the questionnaires and interviews are designed for. The first part of the questionnaire comes with questions related to the usability for the different user scenario applications. The second part asks for the relevance of the implementations – does the software provide functions related to the specific user scenario? Finally, the questionnaire asks, how effective this is done and if the way, how it is implemented has an impact to the users work.

Table 14 shows the sections of the questionnaire.

Table 14: Sub sections of the questionnaire

Evaluation of Usability	
Understandability	Easily understood?
Documentation	Comprehensive, appropriate, well-structured user documentation?
Installability	Straightforward to install on a supported system?
Learnability	Easy to learn how to use its functions
Evaluation of fitting to requirements	
Relevance	Coverage of the needs for Forecasting Price Swings Pilot, Systemic Risk Pilot, Decision Support Pilot
Efficiency	program producing worthwhile results
Impacts	Did the program contribute to the intended outcomes

The coverage of feedback from the experts to be received in INFORE shall be maximized to provide a comprehensive market analysis. However, there is a trade-off between the amount of data being processed and the computational cost. Processing more information consumes more computing resources. On the other hand, there is a trade-off between the amount of the data to be processed and efficiency, with a given set of resources consumption constraints (more information takes longer to be processed). Here, user triggers from the applications might enable the user to influence the calculation and to express precise preferences in terms of coverage versus performance. In this initial evaluation, efficiency will not reflect the final performance at the end of the project.

5.2.2 Setup of Expert-user Pilot Evaluation Interviews and Questionnaires

We sent the questionnaires to 3 expert users, we identified upfront. These experts agreed on installing our software packages and testing them thoroughly. As the experts have different focuses due to their business, they tested the different applications with different intensity. But nevertheless, we got 3 appraisements for each application. We asked them to initially follow the predefined workflows described in 5.3 to get a feeling for the application's workflows and then follow their own intuitive work flows. Each expert used the applications for around one week and filled the questionnaire during this process. At the end of this test, we called each of them and asked them some

additional questions along with the possibility to tell us their impressions and thoughts – without any standard protocol.

All questions of the questionnaire can be found in Appendix C. We summarized the answers of the 3 expert users in Appendix D.

6 Initial Evaluation Report

6.1 Report of technical Tests of pilot applications - in-house at SPRING

The in-house testing for the three user scenarios pinpointed 21 issues, where 7 of them have been in a critical state with priority High. This means, those issues needed to be solved before deeper testing in that direction was possible. At the end of the test period, all highly prioritized issues have been solved and only 4 issues stay unsolved. 2 of them are performance related and will be solved in the final versions of the applications, when the complete INFORE infrastructure is involved. The remaining two issues have low priority and will be solved until the end of the project. Table 15 lists all issues.

Table 15: Summary of detected issues

Summary of tests

Total Incidents: 21
Major priority Issues: 7
Open or Unresolved incidents: 4
Resolved: 17

No	Application	Topic	Priority	Fix cycle	Comment
1	DSI	Login failed	High	1	Wrong user credentials sent
2	DSI	News window only updates on start, not continuously.	Medium	1	
3	DSI	Chart settings lost, when changing chart type.	High	1	
4	All	After resizing main window, scrollbars should be available in each segment, where necessary.	Low	1	
5	All	Color setting dialog only allows basic colors.	Low	1	
6	FPS, DSI	Not all ML algorithm settings saved.	High	1	
7	SRP	Dependency table gets unviewable, if too much assets are added.	Medium	1	
8	SRP	In some dependency windows, the length of dependency	Medium	1	

		measure cannot be changed.			
9	All	Not all menu functions are supported by Hotkeys.	Low	-	Will be fixed until the end of the project.
10	FPS, DSI	Slow prediction analysis.	Medium	-	This is a performance issue and will be solved, once the HPC INFORE infrastructure is connected.
11	SRP	Calculation of larger sets of dependencies needs long time.	Medium	-	This is a performance issue and will be solved, once the HPC INFORE infrastructure is connected
12	All	Customizable knob for threshold settings is too small.	Low	1	
13	All	Printing results has bad format sometimes.	Low	-	Needs further investigation
14	All	If connection to real time data feed is lost, no clearly notification appears.	High	1	
15	FPS	After changing ML method, application freezes sometimes.	High	2	
16	SRP	Dependency measure updates come without time stamp.	Medium	1	
17	DSI	In case, an asset is delisted at the exchange, no warning message appears in the application.	High	1	
18	DSI	In case of changes in the workspace, sometimes the user is not asked to save his work when closing the application.	Medium	2	
19	All	Saving workspace	High	1	Warning message with options is

		overwrites workspace with same name without warning.			now shown.
20	All	Saving workspace should also be possible at different places than the default folder.	Medium	1	
21	DSI	When saving a workspace under a different name, the caption in the main application isn't updated correspondent.	Medium	1	

6.2 Analysis of the Expert User Interviews and Questionnaires

As the applications are in a prototype state, many tasks in terms of documentation and feature access are not implemented or not finished yet. The final evaluation report on month 36 will report the progress also in these areas.

In order to get an overview, we break down the expert's pilot review answers in three categories:

- Needs and requirements of the experts
- Approved and positively mentioned after review
- What is still needed – or further requests

6.2.1 Needs and requirements of the experts

In this section, the experts reiterate some of their most important requests and needs from the first interview – in addition to new key requirements. Additionally, they reveal important elements of their trading style, they would like to have represented in the INFORE Financial Market software:

- Stable performance curves and annual gains with low risk
- Swing trading and spread trading
- The right timing for entry and exit is important for my trading
- Investment opportunities regarding timing are especially needed
- Finding opportunities with excellent risk/reward ratio
- Spread trading, especially Futures Calendar spreads.
- For "old school" analysts, textual results in form of tables and reports would be appreciated

6.2.2 Approved and positively mentioned after review

As the applications are in a prototype state and not all functions and documentations are finished, the approvals in this section are based on the already implemented features.

- The software provides sophisticated correlation metrics and visualizations

- The software as it is now, has all features I requested in the first questionnaire

- Provides an overview over correlating stocks, which could help me as an additional indicator when selecting and entering positions.

- The included example trading strategies already delivered results, one can build upon.

- The software gives decision support for investment opportunities

- Investment opportunities […] timing […] finding opportunities with excellent risk/reward ratio. The software provides both.

- Seasonal patterns are very well covered.

- All markets, I trade are implemented. I also see that the authors of the software offer more markets on request.

- Accurate and fast risk analysis of the existing portfolio and positions

- […] my requirements are met by the updated version

- Prognosis about direction - is implemented

- Reward more than 3 times higher than risk: My initial testing looks promising.

- Timing of entries/exists, detecting changing market cycles and finding volatile markets is achieved.

- My requirements “Changing correlation” and also “finding uncorrelated assets” are implemented.

6.2.3 What is still needed – or further requests

In this section, we collect the replies from the experts, in which they state, what still could be improved regarding the pilot applications. This also includes suggestions, which are not part of the INFORE Financial User Scenarios, but could be included in future versions of SPRINGs financial software.

- Would need more time to test

- Name [of the software] could […] be more specific, naming seasonal price swings and seasonal patterns

- More time for deeper tests needed. Especially, when it comes to evaluating the future trading performance

- Longer period of testing and observing trading recommendations

- There could be more functionality regarding spread trading, especially Futures Calendar spreads.

- Trading opportunities with high reward/risk probability could automatically be detected

- You might implement the opportunity to scan whole portfolios for certain rare but very profitable patterns

- Might cover Futures spread opportunities with good risk/reward ratio

- Real money trading performance is required
- Implementation of fundamental news
- Make an API to connect to our already in use infrastructure (e.g. Order automation)
- Decision support is a growing requirement and should be reflected through a rising number of tools inside this software
- [User interface design] allow all the sub windows of the application to be placed outside the main window

In summary, the requests point to assistance in decision support, in terms of forecasting price swings as well as analyzing market risk. So far, the experts were satisfied with the provided solutions in terms of algorithms and user workflow. Beyond that, they gave us several useful suggestions on how to improve and enhance each software tool.

Table 16: Major suggestions from Expert User Pilot Evaluation and according implementation in the INFORE infrastructure and financial use cases

Suggestions from Expert User Pilot Evaluation	**Implementation/ ToDo**
Longer period of testing and observing trading recommendations	Provide application again to expert users
Trading opportunities with high reward/risk probability could automatically be detected	Integration of a market scanner
Might implement the opportunity to scan whole portfolios	Integration of a market scanner
Might cover Futures spread opportunities with good risk/reward ratio	Add spread data feed
Make an API to connect to our already in use infrastructure (e.g. Order automation)	Investigate on major existing platforms and their APIs
[User interface design] allow all the sub windows of the application to be placed outside the main window	Change window behavior

7 Conclusions and Outlook

In this deliverable we described the results of the final requirements collection for the INFORE financial user scenarios. We detailed the user-centric view of INFORE for the financial domain in terms of user scenarios for institutional financial clients. We described the three user scenarios, namely, “Forecasting Price Swings” (FPS), “Systemic risk prediction and early warning” (SRP) and “Decision support for investment opportunities” (DSI).

After the expert user feedback has been implemented in the three user scenario applications, a new round of evaluation has been initiated. This new round includes technical and functional in-house testing as well as the Expert User Pilot Evaluation.

In summary, the major conclusions that can be drawn from the Expert User Pilot Evaluation and that have been considered as inputs for the improvement of the INFORE Financial user scenarios applications are the following:

- Follow the already taken path for further improvements
- Add sound practices for ML forecasting algorithms
- Make decision support tools interoperable with already used tools from the industry

From now on the three software tools will be improved based on the suggestions of the experts. We will execute a final evaluation with a broad user group to shift the applications forward to final prototypes that enter the state of commercial products. Table 16 describes the next development steps based on the suggestions

Appendix: Expert User Questionnaires

Appendix A and B deal with the initial questionnaire.
Appendix C and D deal with the second «Pilot Evaluation» questionnaire.

Appendix A: Original questions from the questionnaire of Deliverable D2.1

INFORE- User requirements questionnaire

1. User background information

- Company/organization
- Professional position [and years of experience]
- Domain of expertise
- Background studies (university degree major, etc.)
- What are your main job tasks?
- To whom are you responsible for performing these tasks?

2. Existing workflow

- Please describe the different kinds of data sources that you use in your day-to-day tasks and the tools that you use to process them

Kind of data sources	Format	Volume (approx.)	Purpose (task involved)	Tools used to process the data*	Automatic/Manual/Semi-automatic	Historical/ real-time	Update frequency

*If custom programs are used to process the data, please mention the programming language.

- Which is the aim of the analysis you perform (what kind of insights do you try to find)?
- What data processing challenges do you experience in your day-to-day tasks (e.g., fusion of heterogeneous sources, performance, analytics)?
- Provide examples of use case studies
- What problems do you run into in your day-to-day work when performing your data analysis? Is there a standard way of solving each of them, or do you have a workaround?
  - Why is this a problem?
  - How do you currently solve the problem?
  - How would you ideally like to solve the problem?
- Is any of the tools, mentioned in the table above, a must (one that no alternative execution on other tools/platforms would be allowed) for the case studies that you describe?
- Are you able to program/set up a new/custom data processing workflow?
- How long does it take to program/set up a new data processing workflow?
- Are you capable of optimizing your data analysis operations?
- On what kind of infrastructure do you usually run the analysis (e.g. personal laptop, high spec workstation, server, cluster, HPC etc)

3. Expected benefits from using INFORE
- A. Please mention more data sources that would you like to use and why.
- B. Which new information would you like to extract from these (old and new) data sources

● C. Are there specific events that you would like to forecast in real-time, which you currently cannot forecast?
● D. Would you find it an acceptable trade-off to significantly speed up your data analysis tasks, if the provided output was a fairly accurate approximation of the correct result?
● E1. Rate the following objectives of INFORE, based on how useful they may be at YOUR data analysis (1: Not useful, 2: Little Use, 3: Average Use, 4: Quite useful, 5: Very useful)
○ Ability to design data processing workflows with no code required
○ Ability to change algorithm parameters graphically
○ Ability to receive quick approximate answers instead of 100% accurate, but long running queries
○ Ability to interactively explore the data in order to detect patterns/features of interest
○ Ability to accurately forecast events of interest
○ Ability to automatically optimize your data analysis task over different data processing platforms (HPC, Big Data Platforms, etc).
● E2. Rate the following objectives of INFORE, based on how useful they may be at the data analysis of OTHER data analysts in your organization (1: Not useful, 2: Little Use, 3: Average Use, 4: Quite useful, 5: Very useful)
○ Ability to design data processing workflows with no code required
○ Ability to change algorithm parameters graphically
○ Ability to receive quick approximate answers instead of 100% accurate, but long running queries
○ Ability to interactively explore the data in order to detect patterns/features of interest
○ Ability to accurately forecast (defined or currently unknown) events of interest
○ Ability to automatically optimize your data analysis task over different data processing platforms (HPC, Big Data Platforms, etc).
● F. What are your expectations regarding the system usability?
● G. What is the expected added value from INFORE for you and your corporation?

Appendix B: Anonymised answers of the expert users on the questions from Appendix A

Color Code for integrating Expert Users answers to Questionnaire.
Colors and markups added by the authors of this deliverable.

FPS **Forecasting Price Swings**
SR **Systemic Risk**
DS **Decision Support**
Custom requirements

1. User background information

● **Company/organisation**
Expert User 1: Investment Company for private equity investment
Expert User 2: Professional trading consultant and advisor
Expert User 3: Trading coach and Hedge Fund Manager

● **Professional position [and years of experience]**
Expert User 1: +20 Years
Expert User 2: +20 Years
Expert User 3: CEO, Technical Analyst and Financial Consultant

● **Domain of expertise**
Expert User 1: Option strategies trading
Expert User 2: Futures spread trading, seasonality trading, stocks, Forex
Expert User 3: Technical Analysis, Prediction of stocks, currencies, Trading Psychology

● **Background studies (university degree major, etc.)**
Expert User 1: Professional Training and Trainee as banker
Expert User 2: No answer
Expert User 3: Business Engineering

● **What are your main job tasks?**
Expert User 1: Creating continuous performance with minimum drawdown
Expert User 1: Real-time Trading
Expert User 2: “Alpha” and constant 10%+ p.a. performance with minimum risk
Expert User 3: Analysis and Prediction of plausibility’s with historical data (based on quantitative finance)
Expert User 3: Support for trading systems
Expert User 3: Coaching Financial Behavior

● **To whom are you responsible for performing these tasks?**
Expert User 1: My company & our clients
Expert User 2: Private coach and advisor, responsible for educating and advising my clients and for delivering trading performance
Expert User 3: No answer

2. Existing workflow

- Please describe the different kinds of data sources that you use in your day-to-day tasks and the tools that you use to process them

Kind of data sources	Format	Volume (approx.)	Purpose (task involved)	Tools used to process the data*	Automatic/Man ual/Semi-automatic	Historical/ real-time	Update frequency
Real-time stock/ Options data	Tick data stream	+3000 streams	Positive performance with low drawdown	Excel (VBA), Tradestation (Easy Language)	Manual & Semi automatic	Both combined	1/s
Real-time Data Historical Data	Stream/ text files	80-100 Currencies, Commodities	Quantitative Analysis	Seasonal Advisor Trading view ATAS Volume	Automatic & Semi automatic	Historical & real-time	daily
Real-time Futures, stocks, Forex	Tick data stream	+2000 streams		Trade- station (Easy Language), Metatrader 4, proprietary analysis tools	Manual & Semi automatic	Both combined	1/s

Which is the aim of the analysis you perform (what kind of insights do you try to find)?
Expert User 1: Prediction of rising Volatility for single market players
Expert User 2: Identifying trading opportunities with high reward/risk probability; identifying futures spread trading and seasonal pattern trading opportunities
Expert User 3: Try to find profitable chances in the market
Expert User 3: A positive chance risk reward over 3:1
Expert User 3: Prognosis about the direction
Expert User 3: Suitable Time for entry and exit

- **What data processing challenges do you experience in your day-to-day tasks (e.g., fusion of heterogeneous sources, performance, analytics)?**

Expert User 1: Doing massive parallel analytics continuously (+K)
Expert User 2: High data load regarding computational power for analysis, when identifying spread and seasonal opportunities
Expert User 3: The right timing (Exit and Entry)
Expert User 3: Finding volatile markets
Expert User 3: Sensitive fundamental data and market influence
Expert User 3: Changing Correlations
Expert User 3: Different market cycles

● **Provide examples of use case studies**

Expert User 1: Monitor stocks
Expert User 1: Focus on low volatility
Expert User 1: Predict rising volatility
Expert User 1: Check availability of fitting Call/ Put- options
Expert User 1: Open positions
Expert User 1: Manage trades
Expert User 2: Identifying and monitoring seasonal patterns across different asset classes
Expert User 2: Identifying opportunities in Futures calendar spreads (same commodity and different Futures trading months)
Expert User 2: Identifying opportunities in Futures intermarket spreads (making use of winning opportunities, trading different commodities against each other)
Expert User 2: Monitoring official trading publications like the "Commitment of Traders" Report and drawing trading conclusions from it
Expert User 3: 20 Currencies which aren't correlating

● **What problems do you run into in your day-to-day work when performing your data analysis? Is there a standard way of solving each of them, or do you have a workaround?**

Expert User 1: Main problem is the correct prediction of rising volatility. The success rate needs to be higher. There is currently no workaround.
Expert User 2: Managing risk, when a spread trade or seasonal pattern trade does not work out as planned.
Expert User 2: High real time dataload, when calculating and simulating winning opportunities in this trading logic
Expert User 3: Quality of data
Expert User 3: Timing
Expert User 3: Fundamental News („unpredictable" Events like 2015 „Swiss Volatility") to process and interpret data correctly
Expert User 3: Detect and adjust changes in market cycles (Like Brexit Event or elections)

○ **Why is this a problem?**

Expert User 1: The failing quote can produce losses in investment
Expert User 2: Risk management is key to professional investment – for most investors even more important than high performance. Real time risk management, considering a varity of factors, can be improved
Expert User 3: It lowers the quality of the analysis

● **How do you currently solve the problem?**

Expert User 1: Filter for best predictions
Expert User 2: Work with available risk and computational performance facilities
Expert User 3: No current solution

● **How would you ideally like to solve the problem?**

Expert User 1: Having higher success rate in terms of better predict volatility
Expert User 2: Take into account more risk factors, learning algorithms that calculate risk; higher performance when identifying seasonal and spread trading opportunities
Expert User 3: Enhancing event prediction

- **Is any of the tools, mentioned in the table above, a must (one that no alternative execution on other tools/platforms would be allowed) for the case studies that you describe?**

Expert User 1: No. But an advanced export of results would be fine for internal automation.
Expert User 2: No
Expert User 3: Metatrader
Expert User 3: Real-time Data Feed
Expert User 3: Direct Market Access Broker

- **Are you able to program/set up a new/custom data processing workflow?**

Expert User 1: Yes, in a limited way by using Excel.
Expert User 2: No
Expert User 3: Yes, with parts of the tools mentioned above

- **How long does it take to program/set up a new data processing workflow?**

Expert User 1: Several days
Expert User 2: Days
Expert User 3: Few Month because of back testing

- **Are you capable of optimizing your data analysis operations?**

Expert User 1: No
Expert User 2: Partially, using Tradestation “Easy Language”
Expert User 3: Partially

- **On what kind of infrastructure do you usually run the analysis (e.g. personal laptop, high spec workstation, server, cluster, HPC etc)**

Expert User 1: Laptop, Server
Expert User 2: Trading Computer with several screens, Server
Expert User 3: VPS Server
Expert User 3: Personal Multiscreen workstation

3. Expected benefits from using INFORE

- **A. Please mention more data sources that would you like to use and why.**

Expert User 1: No new
Expert User 2: No answer
Expert User 3: Fundamental Data Real-time
Expert User 3: Correlation
Expert User 3: Divergence between different markets
Expert User 3: Diversification
Expert User 3: Pattern Plausibility

- **B. Which new information would you like to extract from these (old and new) data sources?**

Expert User 1: No new, but better information/ analysis
Expert User 2: No answer
Expert User 3: Connections of different patterns
Expert User 3: Fundamental aspects
Expert User 3: Market cycles

● **C. Are there specific events that you would like to forecast in real-time, which you currently cannot forecast?**

Expert User 1: Market drops
Expert User 2: Prediction of sudden risks of decline in value of the current portfolio
Expert User 3: Volatility
Expert User 3: Market direction

● **D. Would you find it an acceptable trade-off to significantly speed up your data analysis tasks, if the provided output was a fairly accurate approximation of the correct result?**

Expert User 1: Yes
Expert User 2: Yes
Expert User 3: A speed up of data analysis caused in inaccurate data and results

● **E1. Rate the following objectives of INFORE, based on how useful they may be at YOUR data analysis (1: Not useful, 2: Little Use, 3: Average Use, 4: Quite useful, 5: Very useful)**

- Ability to design data processing workflows with no code required [2] [3] [2]
- Ability to change algorithm parameters graphically [2] [4] [4]
- Ability to receive quick approximate answers instead of 100% accurate, but long running queries [4] [4] [3]
- Ability to interactively explore the data in order to detect patterns/features of interest [3] [5] [4]
- Ability to accurately forecast events of interest [5] [5] [5]
- Ability to automatically optimize your data analysis task over different data processing platforms (HPC, Big Data Platforms, etc). [3] [3] [3]

● **E2. Rate the following objectives of INFORE, based on how useful they may be at the data analysis of OTHER data analysts in your organization (1: Not useful, 2: Little Use, 3: Average Use, 4: Quite useful, 5: Very useful)**

- Ability to design data processing workflows with no code required [2] [3] [3]
- Ability to change algorithm parameters graphically [2] [4] [5]
- Ability to receive quick approximate answers instead of 100% accurate, but long running queries [4] [4] [3]
- Ability to interactively explore the data in order to detect patterns/features of interest [3] [5] [4]
- Ability to accurately forecast (defined or currently unknown) events of interest [5] [5] [4]
- Ability to automatically optimize your data analysis task over different data processing platforms (HPC, Big Data Platforms, etc). [3] [3] [3]

● **F. What are your expectations regarding the system usability?**

Expert User 1: Fast learning curve
Expert User 2: Easy to use and customized to my current trading style and focus
Expert User 3: Easy to understand
Expert User 3: Customizable
Expert User 3: Transmissible to multiple markets
Expert User 3: Quick results by using

● **G. What is the expected added value from INFORE for you and your corporation?**

Expert User 1: Stabilized performance curve
Expert User 2: Better performance with seasonal and spread opportunities
Expert User 2: More accurate and faster risk analysis of the existing portfolio and positions
Expert User 3: Improving our historical and real-time data
Expert User 3: Trading Strategy update
Expert User 3: Better probability predictions

Appendix C: Original questions from the questionnaire of Deliverable D2.2

Understandability how straightforward is it to understand: What the software does and its purpose? The intended market and users of the software? The software's basic functions? The software's advanced functions?	**Yes/ No, supporting comments if warranted**
High-Level description of what/who the software is for is available.	
High-Level description of what the software does is available.	
High-Level description of how the software works is available.	
Design rationale is available – why it does it the way it does.	
Architectural overview, with diagrams, is available.	
Descriptions of intended user scenarios are available.	
Case studies of use are available	

Documentation Looking on the user documentation, what is its Accuracy? Completeness? Clarity?	**Yes/ No, supporting comments if warranted**
High-level overview of the software is provided.	
Assumed background and expertise of the reader is stated.	
Resources for further information are listed.	
Is task-oriented.	
Consists of clear, step-by-step instructions	
Gives examples of what the user can see at each step e.g. screen shots.	
For problems and error messages, the symptoms and step-	

by-step solutions are provided.	
Is on the project web site.	
Documentation on the web site makes it clear what version of the software the documentation applies to.	

Installability How straightforward is it to: Meet the pre-requisites for the software on a target platform? Install the software onto the target platform? Configure the software following installation for use? Verify the installation for use?	**Yes/ No, supporting comments if warranted**
Web site has instructions for installing the software.	
All mandatory third-party tools are currently available.	
Tests are provided to verify the install has succeeded.	
When software is installed, its contents are organized into sub-directories (e.g. docs for documentation, libs for dependent libraries) as appropriate.	
All source and binary distributions contain a README.TXT with project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc.	
All GUI contains a Help menu with commands to see the project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc	
Installers allow user to select where to install software.	
Uninstallers uninstall every file or warns use of any files that were not removed and where these are.	

Learnability How straightforward is it to learn how to achieve: Basic functional tasks? Advanced functional tasks?	**Yes/ No, supporting comments if warranted**
A getting started guide is provided outlining a basic	

example of using the software.	
Instructions are provided for many basic use cases.	
Instructions are provided supporting all use cases.	
Reference guides are provided for all GUI options.	

Forecasting price swings	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	
The software provides the function promised in its name.	
The software functions cover the user-expected market segments.	

Systemic Risk Analysis	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	
The software provides the function promised in its name.	
The software functions cover the user-expected market segments.	

Decision Support for Investment Opportunities	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1	

requirement analysis.	
The software provides the function promised in its name.	
The software functions cover the user-expected market segments.	

Efficiency To what extent is the software achieving the intended outcomes, in the short, medium and long term? To what extent is the software producing worthwhile results (outputs, outcomes) and/or meeting each of its objectives? Do the outcomes of the software represent value for money? To what extent is the relationship between inputs and outputs timely, cost-effective and to expected standards?	**Yes/ No, supporting comments if warranted**
The software provided the promised analytics in long term (monthly).	
The software provided the promised analytics in mid term (daily).	
The software provided the promised analytics in short term (near real time).	
The analysis output has the expected quality.	
The results of the analysis are worth one's salt.	
The relation between speed and costs are sufficient.	
The relation between quality and costs are sufficient.	

Appendix D: Anonymised answers of the expert users on the questions from Appendix C

Expert 1

Understandability how straightforward is it to understand: What the software does and its purpose? The intended market and users of the software? The software's basic functions? The software's advanced functions?	**Yes/ No, supporting comments if warranted**
High-Level description of what/who the software is for is available.	Yes
High-Level description of what the software does is available.	Yes
High-Level description of how the software works is available.	Yes
Design rationale is available – why it does it the way it does.	Yes
Architectural overview, with diagrams, is available.	Yes
Descriptions of intended use cases are available.	Yes
Case studies of use are available	Yes

Documentation Looking on the user documentation, what is its Accuracy? Completeness? Clarity?	**Yes/ No, supporting comments if warranted**
High-level overview of the software is provided.	Yes
Assumed background and expertise of the reader is stated.	Yes
Resources for further information are listed.	Yes
Is task-oriented.	Yes
Consists of clear, step-by-step instructions	Yes

Gives examples of what the user can see at each step e.g. screen shots.	Yes
For problems and error messages, the symptoms and step-by-step solutions are provided.	For selected error messages
Is on the project web site.	Did not test this.
Documentation on the web site makes it clear what version of the software the documentation applies to.	

Installability How straightforward is it to: Meet the pre-requisites for the software on a target platform? Install the software onto the target platform? Configure the software following installation for use? Verify the installation for use?	**Yes/ No, supporting comments if warranted**
Web site has instructions for installing the software.	Yes
All mandatory third-party tools are currently available.	Access to INFORE core system available?
Tests are provided to verify the install has succeeded.	
When software is installed, its contents are organized into sub-directories (e.g. docs for documentation, libs for dependent libraries) as appropriate.	Yes
All source and binary distributions contain a README.TXT with project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc.	Yes
All GUI contains a Help menu with commands to see the project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc	Yes
Installers allow user to select where to install software.	Yes
Uninstallers uninstall every file or warns use of any files that were not removed and where these are.	Yes

Learnability How straightforward is it to learn how to achieve: Basic functional tasks? Advanced functional tasks?	**Yes/ No, supporting comments if warranted**
A getting started guide is provided outlining a basic example of using the software.	Yes
Instructions are provided for many basic use cases.	Yes
Instructions are provided supporting all use cases.	Yes
Reference guides are provided for all GUI options.	Yes

Forecasting price swings	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Stable performance curves and annual gains with low risk are key. I would need more time to test, if the software forecasts seasonal patterns in a way that I could achieve these goals. Overall, the software as it is now, has all features I requested in the first questionnaire.
The software provides the function promised in its name.	Yes. The name could however be more specific, naming seasonal price swings and seasonal patterns.
The software functions cover the user-expected market segments.	Yes. US-stocks, Futures and FOREX.

Systemic Risk Analysis	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Yes. The software provides sophisticated correlation metrics and visualizations. This is not quite my main area of operations, as I am more involved in swing trading and spread trading. The software however provides an overview over correlating stocks, which could help me as an additional indicator when selecting and entering positions.

The software provides the function promised in it's name.	Yes
The software functions cover the user-expected market segments.	Yes. US-stocks, Futures and FOREX.

Decision Support for Investment Opportunities	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Yes, but there might be more time for deeper tests needed. Especially, when it comes to evaluating the future trading performance, the software provides. The software requires the ability to code trading ideas. The included example trading strategies already delivered results, one can build upon. Finally, a longer period of testing and observing trading recommendations from the software will tell if it provides and edge.
The software provides the function promised in its name.	Yes, the software gives decision support for investment opportunities.
The software functions cover the user-expected market segments.	Yes. US-stocks, Futures and FOREX.

Efficiency To what extent is the software achieving the intended outcomes, in the short, medium and long term? To what extent is the software producing worthwhile results (outputs, outcomes) and/or meeting each of its objectives? Do the outcomes of the software represent value for money? To what extent is the relationship between inputs and outputs timely, cost-effective and to expected standards?	**Yes/ No, supporting comments if warranted**
The software provided the promised analytics in long term (monthly).	Yes
The software provided the promised analytics in mid term (daily).	Yes
The software provided the promised analytics in short term (near real time).	Yes

The analysis output has the expected quality.	Yes
The results of the analysis are worth one's salt.	Yes
The relation between speed and costs are sufficient.	Yes. Software costs estimated as provided from vendor.
The relation between quality and costs are sufficient.	Yes. Software costs estimated as provided from vendor.

Summary from the interview

Further remarks	**Whatever needs to be remarked and was not asked above**
	The right timing for entry and exit is important for my trading. Investment opportunities regarding timing are especially needed. On top of this, finding opportunities with excellent risk/reward ratio. The software provides both. More testing is needed to evaluate the result of the software in depth.

Expert 2

Understandability how straightforward is it to understand: What the software does and its purpose? The intended market and users of the software? The software's basic functions? The software's advanced functions?	**Yes/ No, supporting comments if warranted**
High-Level description of what/who the software is for is available.	Yes
High-Level description of what the software does is available.	Yes
High-Level description of how the software works is available.	Yes
Design rationale is available – why it does it the way it does.	Yes
Architectural overview, with diagrams, is available.	Yes
Descriptions of intended use cases are available.	Yes
Case studies of use are available	Yes

Documentation Looking on the user documentation, what is its Accuracy? Completeness? Clarity?	**Yes/ No, supporting comments if warranted**
High-level overview of the software is provided.	Yes
Assumed background and expertise of the reader is stated.	Yes
Resources for further information are listed.	Yes
Is task-oriented.	Yes
Consists of clear, step-by-step instructions	Yes
Gives examples of what the user can see at each step e.g. screen shots.	Yes
For problems and error messages, the symptoms and step-by-step solutions are provided.	Yes
Is on the project web site.	Yes
Documentation on the web site makes it clear what version of the software the documentation applies to.	Yes

Installability How straightforward is it to: Meet the pre-requisites for the software on a target platform? Install the software onto the target platform? Configure the software following installation for use? Verify the installation for use?	**Yes/ No, supporting comments if warranted**
Web site has instructions for installing the software.	Yes
All mandatory third-party tools are currently available.	Yes
Tests are provided to verify the install has succeeded.	
When software is installed, its contents are organized into sub-directories (e.g. docs for documentation, libs for dependent libraries) as appropriate.	Yes
All source and binary distributions contain a	Yes

README.TXT with project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc.	
All GUI contains a Help menu with commands to see the project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc	Yes
Installers allow user to select where to install software.	Yes
Uninstallers uninstall every file or warns use of any files that were not removed and where these are.	Yes

Learnability How straightforward is it to learn how to achieve: Basic functional tasks? Advanced functional tasks?	**Yes/ No, supporting comments if warranted**
A getting started guide is provided outlining a basic example of using the software.	Yes
Instructions are provided for many basic use cases.	Yes
Instructions are provided supporting all use cases.	Yes
Reference guides are provided for all GUI options.	Yes

Forecasting price swings	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Seasonal patterns are very well covered. There could be more functionality regarding spread trading, especially Futures Calendar spreads.
The software provides the function promised in its name.	Yes
The software functions cover the user-expected market segments.	Yes, all markets, I trade are implemented. I also see that the authors of the software offer more markets on request.

Systemic Risk Analysis	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Accurate and fast risk analysis of the existing portfolio and positions seem to have been achieved.
The software provides the function promised in its name.	Yes
The software functions cover the user-expected market segments.	Yes

Decision Support for Investment Opportunities	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	In general, my requirements are met by the updated version. Here is a suggestion: As a further feature, trading opportunities with high reward/risk probability could be automatically detected.
The software provides the function promised in its name.	Yes. In addition, you might implement the opportunity to scan whole portfolios for certain rare but very profitable patterns.
The software functions cover the user-expected market segments.	Yes

Efficiency To what extent is the software achieving the intended outcomes, in the short, medium and long term? To what extent is the software producing worthwhile results (outputs, outcomes) and/or meeting each of its objectives? Do the outcomes of the software represent value for money? To what extent is the relationship between inputs and outputs timely, cost-effective and to expected standards?	**Yes/ No, supporting comments if warranted**
The software provided the promised analytics in long term (monthly).	Yes

The software provided the promised analytics in mid term (daily).	Yes
The software provided the promised analytics in short term (near real time).	Yes
The analysis output has the expected quality.	Yes
The results of the analysis are worth one's salt.	Yes
The relation between speed and costs are sufficient.	Yes.
The relation between quality and costs are sufficient.	Yes.

Summary from the interview

Further remarks	**Whatever needs to be remarked and was not asked above**
	You might cover Futures spread opportunities with good risk/reward ratio in a later software version.

Expert 3

Understandability how straightforward is it to understand: What the software does and its purpose? The intended market and users of the software? The software's basic functions? The software's advanced functions?	**Yes/ No, supporting comments if warranted**
High-Level description of what/who the software is for is available.	Yes
High-Level description of what the software does is available.	Yes
High-Level description of how the software works is available.	Yes
Design rationale is available – why it does it the way it does.	Yes
Architectural overview, with diagrams, is available.	Yes
Descriptions of intended use cases are available.	Yes
Case studies of use are available	Yes

Documentation Looking on the user documentation, what is its Accuracy? Completeness? Clarity?	**Yes/ No, supporting comments if warranted**
High-level overview of the software is provided.	Yes
Assumed background and expertise of the reader is stated.	Yes
Resources for further information are listed.	Yes
Is task-oriented.	Yes
Consists of clear, step-by-step instructions	Yes
Gives examples of what the user can see at each step e.g. screen shots.	Mostly, yes
For problems and error messages, the symptoms and step-by-step solutions are provided.	Couldn't check that
Is on the project web site.	Yes
Documentation on the web site makes it clear what version of the software the documentation applies to.	Yes

Installability How straightforward is it to: Meet the pre-requisites for the software on a target platform? Install the software onto the target platform? Configure the software following installation for use? Verify the installation for use?	**Yes/ No, supporting comments if warranted**
Web site has instructions for installing the software.	Yes
All mandatory third-party tools are currently available.	No tools necessary
Tests are provided to verify the install has succeeded.	Yes
When software is installed, its contents are organized into sub-directories (e.g. docs for documentation, libs for dependent libraries) as appropriate.	Yes
All source and binary distributions contain a README.TXT with project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc.	Yes

All GUI contains a Help menu with commands to see the project name, web site, how/where to get help, version, date, license and copyright, location of entry point into user doc	Yes
Installers allow user to select where to install software.	Yes
Uninstallers uninstall every file or warns use of any files that were not removed and where these are.	Yes

Learnability How straightforward is it to learn how to achieve: Basic functional tasks? Advanced functional tasks?	**Yes/ No, supporting comments if warranted**
A getting started guide is provided outlining a basic example of using the software.	Yes
Instructions are provided for many basic use cases.	Yes
Instructions are provided supporting all use cases.	Not sure
Reference guides are provided for all GUI options.	Yes

Forecasting price swings	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Yes. My requirement - prognosis about direction - is implemented. Requirement -Reward more than 3 times higher than risk: My initial looks promising. More testing and real money trading performance is required to finally assess this. Timing of entries/exists, detecting changing market cycles and finding volatile markets is achieved.
The software provides the function promised in its name.	Yes
The software functions cover the user-expected market segments.	Yes, and even more market segments

Systemic Risk Analysis	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Yes. My requirements “Changing correlation” and also “finding uncorrelated assets” are implemented. I do not yet see the implementation of fundamental news.
The software provides the function promised in its name.	Yes
The software functions cover the user-expected market segments.	Yes

Decision Support for Investment Opportunities	
Fitting for requirements How relevant are the functions of the software? Does the software cover all requirements?	**Yes/ No, supporting comments if warranted**
The software provides the functions from the D2.1 requirement analysis.	Yes. Suggestion for further development: Make an API to connect to our already in use infrastructure (e.g. Order automation).
The software provides the function promised in its name.	Yes. Nevertheless, decision support is a growing requirement, which should be reflected by a rising number of tolls inside this software.
The software functions cover the user-expected market segments.	Yes

Efficiency	**Yes/ No, supporting comments if warranted**
To what extent is the software achieving the intended outcomes, in the short, medium and long term? To what extent is the software producing worthwhile results (outputs, outcomes) and/or meeting each of its objectives? Do the outcomes of the software represent value for money? To what extent is the relationship between inputs and outputs timely, cost-effective and to expected standards?	

The software provided the promised analytics in long term (monthly).	Yes
The software provided the promised analytics in mid term (daily).	Yes
The software provided the promised analytics in short term (near real time).	Yes
The analysis output has the expected quality.	Yes, as far, as I could check it.
The results of the analysis are worth one's salt.	This need more time to explore.
The relation between speed and costs are sufficient.	Depends on the final price
The relation between quality and costs are sufficient.	Depends on the final price

Summary from the interview

Further remarks	**Whatever needs to be remarked and was not asked above**
	Most of the tools and function of the software products produce results in form of visualizations. This is fine so far, but for "old school" analysts, textual results in form of tables and reports would be appreciated. From my personal experience, it would be better to allow all the sub windows of the application to be placed outside the main window. This allows spreading the windows over more than one screen and helps to get a better overview in a more complex workspace.