Deliverable information

WP NO.	WP7
DEL. REL.	D7.6
DEL. NO.	D24
TITLE	Intermediate Evaluation Report
NATURE	Report
EST. DEL. DATE	31.12.2019

Document information

DATE	25.09.2020
WRITTEN BY	FIRAMIS
APPROVED BY	Paolo Giudici

Intermediate Evaluation Report

By Dr. Jochen Papenbrock, FIRAMIS, FIN-TECH consortium partner and the other consortium partners

Frankfurt, 30.06.2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825215 (Topic: ICT-35-2018 Type of action: CSA)

1. Acknowledgement 3
2. Introduction 4
3. Structure and underlying methodology of this report 7
4. Main achievements 13
5. Feedback regarding the use cases 15
   Big Data Analytics Research 15
   Artificial Intelligence Research 17
6. General, direct feedback by supervisors 26
   Main topics: 26
   Topics covered and some results and statements 27
   New insights and main takeaways 28
   Positive feedback 29
   Aspects that should be corrected 31
7. Feedback by the industry 33
8. Feedback by the international advisors 39
9. Feedback by the fintechs 42
10. Ongoing involvement 44
11. Platform for code-based use cases 45
12. Forms engine 51
13. Feedback by banks, fintechs and international supervisors/regulators 57
   Collecting feedback from the financial industry 57
   Further dissemination activities 63
14. Background information on the paper 'Explainable AI in credit risk management' 67
15. Self-reporting statistics by partners - 70

16. SupTech Workshop Statistics 71
a. Big Data Analytics statistics 72
b. Artificial Intelligence statistics 88

1. Acknowledgement

We would like to thank all partners and coordinators who made this project and feedback evaluation report possible. You carried out almost 100 workshops in Europe, developed the contents, did the practical research and established the dialogue with the financial industry and especially their supervisors.

We would like to thank the supervisors for their engagement and involvement in this project. Your curiosity, expertise, knowledge and support turned this project to a success.

We would like to thank the participants from the financial service, technology and consulting industry who followed this project and who actually implement financial technology with a European approach.

Last but not least we would like to thank our international advisors who dedicated their energy to support us, attended many workshops and delivered their feedback.

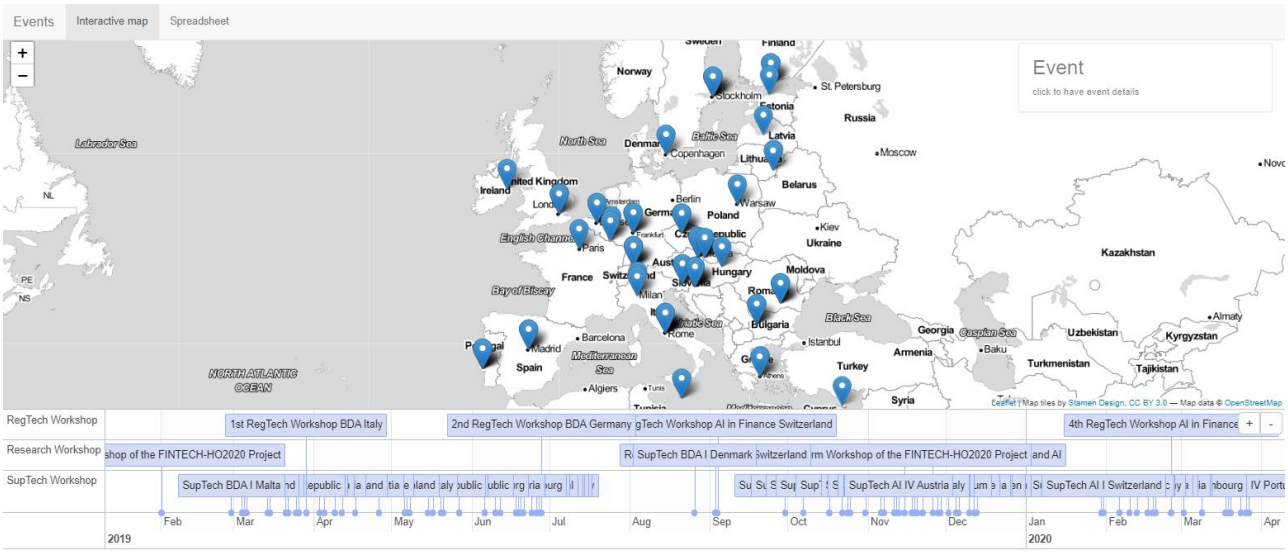
2. Introduction

This is the re-submission of the first Intermediate Evaluation Report. It is an extended version not only covering period M1-M12 but M1-M15. That means it covers not only the full BDA (Big Data Analytics) part but also a large fraction of the AI (Artificial Intelligence) part. It covers > 100 workshop and event results, received by supervisors, consortium partners and the financial industry. These workshops took place across Europe with many European and national/international supervisors participating. It also covers workshop results and feedbacks from the financial industry as well as from the projects' international advisors. The FIN-TECH project is truly inclusive and state-of-the-art, having mobilized the European financial service ecosystem, including their supervision and cutting edge fintech research. These are the consortium partners who made this happen:

Project partnerc	Lead	Country
University of Pavia	Paolo Giudici	Italy
Humboldt University Berlin	Wolfgang K. Härdle	Germany
ZHAW Applied Sciences	Jörg Osterrieder	Switzerland
University College London	Tomaso Aste	UK
Bucharest University	Vasile Strat	Romania
WU Vienna	Ronald Hochreiter	Austria
Panteion University	Veni Arakelian	Greece
INESC-TEC	Paula Brito	Portugal
University of Paris 1	Prof. Christophe Henot	France
Politecnico of Milan	Emilio Barucci	Italy
University College Dublin	Andreas Hoepner	Ireland
University of Luxembourg	Radu State	Luxembourg
Jozef Stefan Institute	Marko Grobelnik	Slovenia
University of Warsaw	Piotr Wojcik	Poland
University of Rjeka	Saša Živković	Croatia
Universidad Complutense de Madrid	Javier Arroyo	Spain
University of Economics in Bratislava	Jana Peliova	Slovakia
Kaunas University of Technology	Audrius Kabasinkas	Lithuania
Masaryk University Brno	Oleg Deev	Czech Republic
Varna University of Economics	Stefan Vachkov	Bulgaria
University of Tampere	Lasse Koskinen	Finland
Modefinance	Valentino Pediroda	Italy
Firamis	Jochen Papenbrock	Germany

2

The following map shows some of the events in the reporting time line:



Here are some project facts, numbers and highlights:

- > 80 SupTech events and almost 10 workshops for RegTech, Research and Validation
- > 20 industry events where FIN-TECH has been presented/introduced
- > 30 financial institutions and associations like involved, including some of the largest commercial banks, consultants and tech companies in Europe (like EBF, Unicredit, Intesa Sanpaolo, Deutsche Börse, Deutsche Bank, Commerzbank, Allianz, Sparkassenverband, BBVA, Ernst&Young, KPMG, Oliver Wyman, NVIDIA, Barclays, HSBC, Santander)
- > 25 national supervisors and European supervisors / central banks involved including ECB, EBA, ESMA, EIOPA
- Several fintech hubs from Europe's financial capitals involved
- > 1300 participants registered, > 550 feedbacks, average workshop rating is 4 out of 5
- > 160 forms prepared to collect workshop feedback from organisers and participants
- > 120 pages of detailed partner feedback about the workshops
- Many supervisory authorities and banks sent their top staff from management and technology
- Knowledge exchange ranging across the European financial landscape like managers, lawyers, economists, fintech experts, AI experts, (data and computer) scientists, researchers, consultants, auditors, chief inspectors, supervisors' association representatives, fintech hubs, local governments
- Some of the most trending technologies in BDA and AI covered (like eXplainable AI, network analysis and graph theory)
- Central project platform for project management, dissemination, evaluation, feedback generation and coding with > 300 users and almost no downtime since project inception in 2019
- Social media posts with high number of views

It can be stated that the knowledge transfer, the trainings, the discussions, the feedback, the research and the practical use cases of this project have been very useful and impacting, especially at this point in time where the financial, technological and regulatory landscape is changing to an almost disruptive extent and where the financial services industry undergoes a major transition towards a fully digital financial economy. Many obstacles to fintech scaling could be identified and the risks and opportunities of financial technologies are better understood now. Communication among all parties, disciplines and EU geographies involved is crucial and this is what this project has enabled.

The perfect storm for change has many amplifying forces: availability, generation and storage of enormous amounts of data, availability of advanced and intelligent analytics, cloud and super-computing capabilities, University teaching and research programs, large global communities of programmers and developers sharing their tools and open-source software, involvement of bigtech companies, innovation and incubation programs in the financial service industry, as well as new data and intelligence-driven business models, ecosystems, investor networks and many other factors. New financial technologies like Big Data

Analysis (BDA) and Artificial Intelligence (AI) are trending and emerging. They carry enormous potential for the European financial industry and their data-driven, analytical, intelligence-driven products and services. They truly disrupt the way banking has been done before, with more customized, inclusive, cheaper, transparent and safer financial services and products for EU citizens and at the same time a prospering and growing financial service ecosystem and industry across the EU.

However, these new financial technologies carry a large risk, they do have their limits and impose enormous challenges, both on the industry as well as for their supervisors and regulators. The EU is currently developing their own approach, governance and guidelines to trustworthy and ethical use of AI and data. Many different stakeholders with very different backgrounds and agendas are engaged. Data, technology, banking business models challenge, regulation, consumer protection and ethics are all involved in this process. The continuous flow of information, the dialogue, the knowledge transfer, the debate and discourse need to be established and cultivated at all times and levels. And this is happening in this project.

This report specifically addresses the following questions: extensive information on the outcome of the workshops/presentations: who are the parties participating, their roles and their responsibilities, how will they stay involved, what is their feedback on the use cases presented, are the selected use cases in the end the ones that meet the expectations and requirements at most?

3. Structure and underlying methodology of this report

The report rests on 5 columns of feedback:

1. Workshop participants' feedback: each workshop/event organized by the partners has participants who is given a form to deliver feedback. Use cases and entire workshops could be evaluated and feedback could be given. Participants of SupTech events are supervisors, participants of Regtech events are supervisors, banks, fintechs and other members of the financial services ecosystem.
2. National supervisor feedback: Each supervisor could deliver a feedback on entire blocks of workshops, categorized by BDA and AI
3. Partner feedback: the organisers and presenters of the workshops could evaluate their workshops, describe the feedback of the audience and report about the dynamic exchange and topics discussed among workshop participants.
4. Feedback has been collected from the financial service industry and the European-level supervisors/regulators
5. Feedback has been collected from the international advisors of the project

A central platform with unified content supports the workshop activity and the feedback culture. More details about this platform can be seen in chapter 'Platform for code-based use cases'.

This report is based on some repositories and background information. Here is a list of them:

Name	Contents	quantity
Event_participation_and_feedback	An automated summary for each event separately. The following information is given: the underlying forms, some summarizing statistics and the contents of the feedback forms.	> 1300 participants registered > 550 feedbacks
Partner_feedback	Partners sent a detailed manual report about the outcome of each events/presentation and addressing the following questions: who are the parties participating, their roles and their responsibilities, how will they stay involved, what is their feedback on the use cases presented, are the selected use cases in the end the ones that meet the expectations and requirements at most? Besides these manual reports there is the a 'forms-based reporting' which includes background information on each workshop collected by a standard form.	> 70 form-based feedbacks > 20 partners prepared manual reports each of which summarises all their event
Supervisor_feedback	This is a forms-based feedback that every partner sends to their supervisor to evaluate an entire block (BDA or AI). Special feedback including statistics has been delivered by Bundesbank/UBER.	> 30 reports by the supervisors on either BDA or AI blocks > extensive feedback reports

		by Bundesbank/UBER
Agendas	The respective agendas for all the events to receive more information about the speakers, the contents and the use cases presented.	> 100 agendas covering all events
Extra_feedback	Advisor Feedback: feedback by our international advisors EY: a presentation by Ernst&Young on XAI which explains the status-quo in the industry Financial Industry Feedback: the feedback acquired by Banks through UNIPV and FIRAMIS: A longer blog XAI including the recent supervisory activities, interview and background information on Brussels workshop International_supervisors: the agendas corresponding to the workshops where feedback was collected PARIS1: special report and feedback on BDA and AI, special involvement in XAI topic by supervisor Press release: one of the press releases of the project involving XAI	4 advisor feedbacks 5 industry feedbacks (more are in the pipeline)

Event reporting process

The event reporting and the evaluation structure of the fintech project was set up since the beginning, with different phases and timing of the put in action of the structure.

The workflow started right after the platform technicalities were ready to perform the tasks related to creating registration and evaluation links for each event of the project. (around M2-M4)

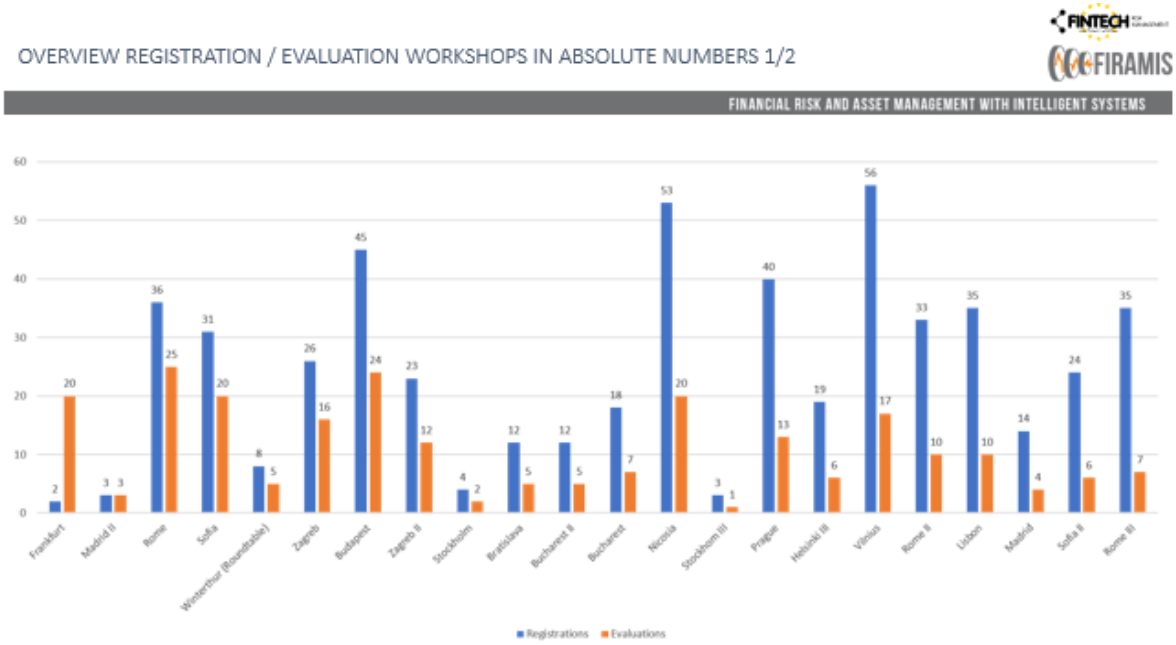
The partners have been instructed since the first Management Board (Kick off 1st of February) about the rules in place for approval of event's agendas and for the structure to be followed in order to collect evaluations from participants. The rationale behind this have been discussed and agreed in the first meeting with the Eu Commission where the key point of mapping the needs of the national regulators, the fintechs and the supervisors is of crucial importance for the sustainability and added value of the project.

In line with this we reformulated the evaluation structure according to main pillars:

- Event reporting
- Feedback reporting:
    - From participants to event,
    - From Partners
    - From National supervisors
    - From Industry (Banks, Fintechs)

The results regarding the event reporting system has been presented at every Management Board meeting and disseminated within the consortium.

The first event report, presented at the Management Board in Winterthur, 3dh of September covered the M1 – M6 period with summary statistics regarding the number fo participants, the number of evaluations from participants and the instructions for partner to accomplish with the event reporting process.



The second event report has been presented during the Management Board in Bucharest, 15 of November and covered the period M1- M11 where individual statics for each partners has been presented regarding: 1.the number of participants to BDA and AI events sessions 2. the number of evaluations 3. the number of partner's feedback report received and supervisors' feedback report.

Structure of this report

We first present the main achievements of the project and then report the feedback of the official use cases. Then follows a section dedicated to general supervisor feedback, then to the industry feedback and to the feedback by the international supervisors and fintechs.

Then follows a list of 'ongoing involvement' extracted from the partner feedbacks. After that we describe the 'platform for code-based use cases' which has been one of the tools used in the workshops. Then follows a chapter about the 'forms engine' to collect feedback. The chapter 'feedback by banks, fintechs and international supervisors/regulators' is based on the activity of UNIPV and FIRAMIS for the dissemination and evaluation work package, including their activity during the acquisition and feedback collection in the financial industry as well as their workshop activity with the international supervisors like ECB, EIOPA, ESMA and EBA.

The final chapter 16 contains in-depth quantitative analysis and reporting about the Suptech workshops.

In order to meet the overarching objective of the project and contribute to ensuring a common understanding of risk management tools and instruments associated with the new concepts of Big Data Analytics, Artificial Intelligence and Blockchain in Finance, the approach implemented during the project evolved including the experience and expertise developed over each step.

Big Data Analytics pillar:

In order to ensure a stable structure at the start of the project and to focus on consistency, the first pillar, Big Data Analytics, was structured around three central use cases which were selected, polished and presented during all Suptechs across Europe. Each event was accompanied by a final evaluation with the clear purpose of collecting structured data regarding the explainability, the predictive accuracy and the perceived utility of the presented use cases. In order to further stress on consistency and structure but to also support diversity the Suptechs were attended by representatives of Supervisors, by representatives of the Consortium partners and in some cases by representatives of International Regulators/ Advisers and representatives of Banks and Fintechs. The mix of participants was influenced heavily by the limitations expressed by the National Supervisor and also by the collaborative network existing at national level between the different stakeholders.

Based on the collected data the feedback was summarized and presented in a structured manner based on statistics, tables and charts. Also, relying on the consistency provided by the usage of only three main uses cases the structured feedback was aggregated and an overall panel of statistics and data was created. The charts produced in Chapter 16 present the following analysis for BDA:

- Number of participants per workshop;
- Number of participants per role;
- Number of feedbacks by role per workshop;
- Average overall rating of the workshop per workshop;
- Average overall rating of the workshop per role;
- Best use case (number of votes per use case);
- Best use case (number of votes per use case / per workshop);
- Best use case (number of votes per use case / per role);
- Average rating of uses cases' explainability per workshop;

- Average rating of uses cases' explainability per role;
- Average rating of uses cases' predictive accuracy per workshop;
- Average rating of uses cases' predictive accuracy per role;
- Average rating of uses cases' perceived utility per workshop;
- Average rating of uses cases' perceived utility per role;

Artificial Intellegence pillar

In order to further develop the methodology used in elaborating and selecting the uses cases and to factor in more the diversity (regarding needs and interests) identified across Europe (National Supervisors, the strength of the Fintech Network between different National level stakeholders), for the second pillar represented by Artificial Intelligence a more fluid approach was preferred. Also due to the fact that the project grew and reached a level of maturity the use case and papers were produced on a rolling basis and more were obtained. Since Suptech organisers based on their previous experience selected a different mix of use cases, the Suptechs were penalised in what consistency is regarded, but have gained in what the diversity identified across Supervisors is regarded. In order to maintain the process of obtaining feedback needed for updating the use cases and for improving future events, each event was accompanied by a final evaluation with the clear purpose of collecting structured data regarding the explainability, the predictive accuracy and the perceived utility of the presented use cases. Also for this second pillar in order to further stress on consistency and structure but to also support diversity the Suptechs were attended by representatives of Supervisors, by representatives of the Consortium partners and in some cases by representatives of International Regulators/ Advisers and representatives of Banks and Fintechs. The mix of participants was influenced heavily by the limitations expressed by the National Supervisor and also by the collaborative network existing at national level between the different stakeholders. One of the main limitations brought by the rich diversity and fluidity to the feedback collection process is represented by the conflict between standardization needs and complexity (a very complex feedback form that could capture feedback on a granular level would have been diminished dramatically the chance of obtaining feedback).

Based on the collected data the feedback was anyhow summarised and presented in a structured manner based on statistics, tables and charts. This approach was used for each workshop but since the use cases presented across Suptechs vary producing the overall comparison based on charts and statistics for all AI Suptechs is no longer a feasible option. Therefore, for this second pillar, more was produced in terms of use cases, diversity was encouraged but structure and consistency across Europe were sacrificed.

The charts produced in Chapter 16 present the following analysis for AI:

- Number of registrations by workshop.
- Number of registrations by role.
- Total workshop rating by workshop

- Total workshop rating by role
- Best use case by selecting the workshops where a top use case had been presented and counting the numbers of best use case selection.
- Average use cases' explainability by workshop.
- Average use cases' explainability by role.
- Average use cases' predictive accuracy by workshop.
- Average use cases' predictive accuracy by role.
- Average use cases' perceived utility by workshop.
- Average use cases' perceived utility by role.

Factoring in all experience gathered during the first two pillars the approach for Blockchain will be updated. The main coordinates that will evolve are:

- more uses cases will be available (plus from AI);
- the uses cases will not be developed in a rolling manner (plus from BDA);
- the feedback mechanism for Suptechs will be updated (a mix between AI and BDA, structured and extensive)

4. Main achievements

Reviewing the large amount of collected feedback and evaluation data it can be stated the project activity is in line with the project objectives. The workshops/presentations are very useful and the use cases meet the expectations and requirements. The amount and quality of the feedback and evaluation data could be further increased in the last weeks and months.

We have made the following main observations:

the workshops were very much appreciated by the supervisors and the wider public. It is assumed that the industry is currently experiencing major changes and upheavals driven by technology. There are enormous challenges for both those working in the financial industry and for supervisory activities. Knowledge, training and experience in the new financial technologies are of crucial importance. Supervisors are generally very grateful for the introductory knowledge sessions on Big Data Analytics (BDA) and Artificial Intelligence (AI). There is a lot of high-level semi-scientific literature, so it was very welcome that the consortium partners explained in a structured and scientific way how they work, approaches, models and techniques, how they really work and what can be expected from them in terms of outcomes and risks. Technical and especially non-technical supervisors were introduced to the algorithms and approaches for the first time, which was very helpful. They now have a better chance of keeping up with the rapid developments in their financial industry and financial technology.

This transfer of education and knowledge has not always been easy. While the larger part of the workshop participants welcomed the project, there was also a smaller part that had difficulties accepting the knowledge presented. This is completely understandable, as the material presented can be really complicated, as so many different disciplines are involved: Data Science, Computer Science, Fintech Business, Law&Law, etc. The partners of the consortium tried to involve everyone.

Another challenge was that the activities of the supervisors are very diverse and heterogeneous. They range from banking supervision to financial markets. The size and approaches of the supervisory authorities in Europe are also as different as the countries involved. The consortium partners also had to familiarize themselves with the supervisory landscape and their day-to-day business in order to be able to hold more individual workshops, which was sometimes quite a challenge.

Similar to the first observation was the perception about the practical coding. The majority of the workshop participants had their first contact with real computer code and the question how to use it for BDA and AI. The experience was very welcome as they now have a better idea of what drives the new Fintech business models. They now have a better understanding of the rapid changes brought about by software development and AI services in the cloud and the open source and open data revolution. The flipside of this coin was that a minority of the workshop participants rejected these presentations because of their irrelevance to their day-to-day business.

The experiences of 1 and 2 were reflected very well by the partners, and the data show that they have started to change the structure of their workshops and their workshop contents. It has been made more suitable for the addressees, e.g. by dividing the audience into technical and non-technical personnel, by changing the workshop material and by improving the online and offline participation described in some of the next paragraphs.

Workshop participants had many opportunities to get involved and stay involved in the project activity. First of all, there are not only the standard presentations, but also many customer-specific enhancements by the partners. This material is shared on the central platform and made available to the users. The research repositories contain not only the publication activities of the partners, but also many relevant and recommended publications to immerse into the material. The code for some of the use cases is provided together with the presentations and papers, so that participants are able to follow the course material and the extended material 'offline' after the workshops. Many partners established links with the contact persons and the audience of the workshops to maintain dialogue and answer questions. Each workshop day was also introduced by an overview of project activities throughout Europe, so that workshop participants also had the opportunity to travel to other workshop locations and build a network. They were also able to follow the project on the social media channels set up by the project.

The use cases developed by the consortium partners received good feedback and fulfilled the expectations and requirements. It was well understood that BDA is also very complex and dynamic, so it is very important to apply information processing that correctly extracts the essential information in an easily digestible and understandable way. The decision making, predictions and conclusions made by the models must also be transparent. One way to explain a model is to visualize complex data. Some of the focus areas of the use cases of the project were network analysis, graph theory and explainable AI (XAI). It was well understood that such approaches are the key to a trustworthy, responsible and human-centered use of financial technology. This is independently underscored by Gartner's conclusion that graph analysis and XAI will be among the technologies with the greatest trend in the coming years (https://www.gartner.com/smarterwithgartner/gartner-top-10-data-analytics-trends). Many workshop participants also understood that not only banks and fintechs should be guided by these principles when using technology. Supervisors themselves have large amounts of structured and unstructured data that should be used for data-driven, digital supervision. Network theory and XAI could also be used by them to take a more trusted, human-in-the-loop approach to the use of these new technologies. It appears that regulators from Germany, France, Spain and the UK, as well as many other EU countries, are very interested in these issues. These include the European Commission (e.g. AI HLEG and Fintech Lab) as well as international regulators and central banks in Europe. We have had personal contact with most of these institutions and received confirmation that our project supports these highly important developments.

Obtaining feedback from supervisors/regulators can be extremely difficult and challenging. The reason for this is that financial regulators need to be extremely careful with their communications, as it is one of their most powerful tools. Discretion and reputation are critical aspects of supervisory activity. Furthermore, supervisors must be neutral in many dimensions, such as technology, market participants and business models. The consortium took a careful approach to build trust and receive feedback in a way that satisfied both regulators and partners.

It can be seen that many regulators are currently launching new initiatives on digitalisation and financial technology. Regulatory teams are very open to input on new technologies such as BDA and AI. They value the freedom, perspective and knowledge of the academic community and like to interact and share with academics. In this respect the project has good timing. However, it must also be noted that some supervisory teams are not yet ready for the AI/BDA age due to a lack of tools, infrastructure and knowledge. However, these teams are now in the process of launching some initiatives, which of course takes time.

5. Feedback regarding the use cases

We first report on a general feedback on the use cases currently available in the platform (BDA 3 use cases, AI 3 use cases). There are very strict rules according to which a use case can be considered as such like an open access peer reviewed paper. There were many more use cases prepared in the platform that were also taught in the workshops but only a few could become official use cases and these are the ones that we discuss here. The underlying feedback is gathered from the workshop participants as well as from the supervisors, partners and industry.

Big Data Analytics Research

The use cases are:

1. Network based scoring models to improve credit risk management in peer to peer lending platforms

2. Factorial Network Models to Improve P2P Credit Risk Management

3. Spatial regression models to improve P2P credit risk management

Use case 1 was most often presented and best rated, followed by use case 2 and 3. The perceived utility, predictive accuracy and explainability were above average. The general feedback was good and met the expectations and requirements.

The use cases have been presented to wide range of functionaries:

Financial Technology and Innovations Department, Supervisory Inspector, Securities Market, Insurance and Pension Savings, Banking and Payment Services Supervision Department, Macroprudential Supervision Department, Consumer protection, Governance, Market and Banking supervision, Transparency regulations, New Products and Services Unit, Legal, IT Risk Supervision, IT auditor, Data Analyst and Analysts in general, Actuaries, Financial Analysts, Researchers, IT & Security, Analysts, Risk Analysis Data Analytics and Reporting, Systemic Risk Department, Funds and Investment Firms Supervision Division, Insurance, Leasing and Factoring Supervision Division, International Regulations and Cooperation Department, Funds and Investment Firms Supervision Division, Pension Funds Supervision Department, Insurance Supervision Department, Investment Funds and Investment Firms Supervision.

On the industry side the following parties were addresses by the use cases: banks, insurance companies, p2p lending, crowdfunding platforms and other actors. The background ranged from risk management (credit risk, market risk, operational risk) to product management, general management, legal&regulation, data science and IT.

It was well understood that the uses cases addressed principles like adding network features, split the dataset into cluster in order to build several better suited models, to combining several complex data sets. The utilization of network analysis, graph theory and clustering can be applied very well in p2p lending use

cases but is can be easily extended to scoring and credit assessment and risk management, e.g. in larger banks.

It was stated that current risk and scoring models lack the notion of contagion which can be addressed with network models, thus improving fintech risk management.

The use cases can also be extended to other fintech business models and use cases, e.g. in robot advisory. It was also understood that there is a fruitful combination of network analysis and clustering with (supervised) machine learning.

The uses cases proved to be very useful for the participants as tools for making them understand some of the research directions and they were excellent starts for brainstorming regarding their impact in practice and the impact they would have on the activity of the supervisor.

The network analysis approach raised much interest as it is a general 'AI tool' to better understand complex and linked financial data sets which can even be temporal and dynamically changing. Supervisors identified the method a very useful also for their own applications in better understanding contagion and spreading of (systemic) risk. Specifically, several participants indicated the possibility of using the presented methodology for tracking central nodes within payment systems and interbank systems.

The network centrality measures guide the user to most relevant points in a huge and complex data set. The transparency and interpretability properties of graph theory / network analysis is very suitable for visualization the complex data sets.

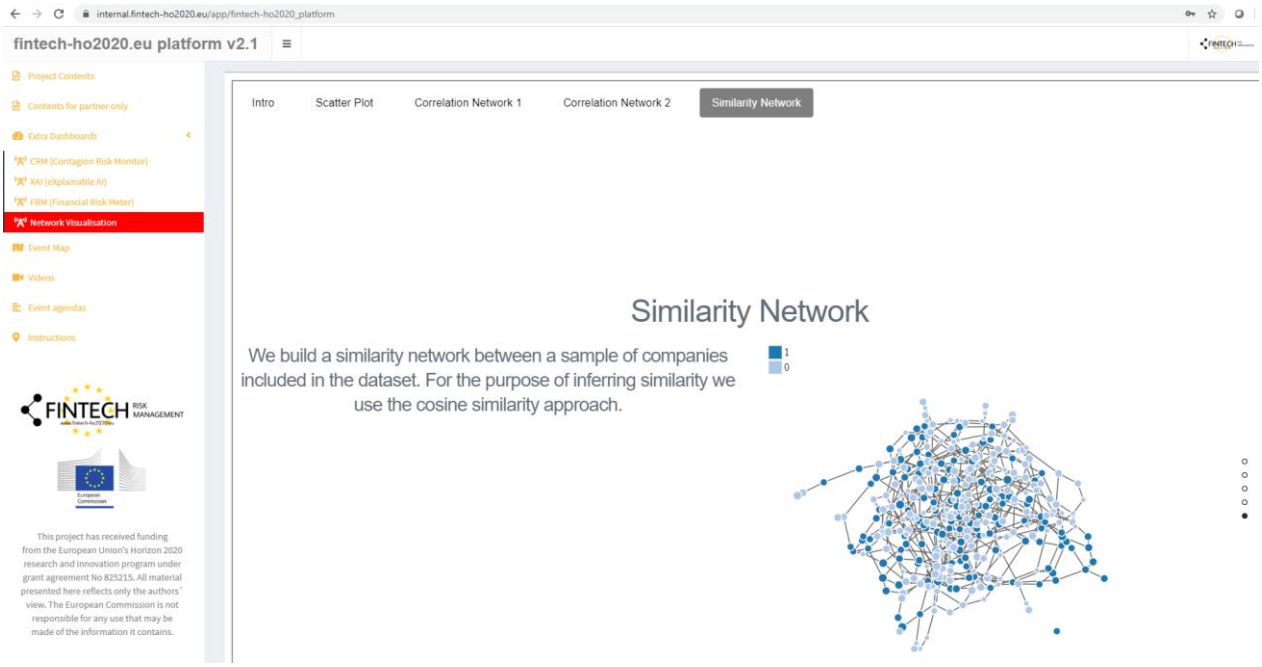
Network analysis and clustering are well-suited to process complex data for the following reasons:

- Advanced Analytics (paths, connectivity / neighborhood, communities / clusters, centrality
- Visualisation
- Framework for machine intelligence
- Natural fit for financial date like transactions network
- Scientific: analyse complex systems

The use cases plus codes plus visualization enabled very lively and two-sided discussions and involvement with the audience, leading to valuable communication between supervisors and researchers. It was often the basis to also discuss the p2p business models and industry perspectives.

A broader debate was held over the data. Besides the privacy, bias, ownership and ethical discussion it was pointed out that the interpretability and predictive accuracy of the use cases can be improved by adding more features and covering a longer period of data for testing and for identifying changes across the business cycle. It was discussed that it is very hard for academics to get access to data. Several initiatives like 'Kaggles for Europe' or Financial Big Data Clusters and cloud infrastructures supported by EU governments are on their way. Artificial or synthetic data sets could also be a contribution to the solution of the problem.

For most of the supervisory audience the practical link to their day-to-day work was given by the use cases. However, for some of them there was not enough relation to their daily monitoring or implementation in supervisory activities. For a few it was hard to follow and they would have preferred to longer discuss the statistical and econometric basics before proceeding to ML and AI. Partners tried to keep it as simple as possible but needed to move on to the new financial technologies at some point.



This examples shows some network filterings and visualizations produced Branka Hadji Misheva, one of the consortium partners. It can be seen that network models in general are very helpful and interpretable due to their visualization properties and their roots in graph theory.

Artificial Intelligence Research

The use cases are:

1. Network models to enhance automated cryptocurrency portfolio management
2. Convergence and Divergence in European Bond Correlations
3. eXplainable AI (XAI) in Credit Risk Management

Use cases 2 and 3 were almost equally picked and rated similarly well. Use case 1 slightly less prominent. Also here, the perceived utility, predictive accuracy and explainability were above average. The general feedback was good and met the expectations and requirements.

The use cases were able to address a very diverse audience of supervisors and financial industry participants (similar to BDA).

Network models to enhance automated cryptocurrency portfolio management

Use case 1 has been widely discussed in the context of portfolio management, robot advisory and automated finance. Indeed the use of cryptocurrencies and automated consultancy, is widely spreading in the last few years. However, automated consultancy services are not exploiting the potentiality of this nascent market, a class of innovative financial products that could be proposed by financial actors and robot advisors. To this end we propose an extension of the Markowitz model by combining Random Matrix

Theory and network measures, in order to enhance portfolios' risk-return profiles. Overall, the methodology proposed in the use case overperforms several competing alternatives, maintaining a relatively low level of risk. The use case could be applied also to a variety of alternative data sources. For instance, one may consider using other cryptocurrencies for his/her analysis, or he/she might want to consider other types of securities, such as traditional stock markets, bond market, exchange traded funds, and so on.

Use case 1 has been discussed, has been given feedbacks and has improved in various occasions.

First of all, the use case has been developed mostly in the University of Pavia environment. Here, the authors of the use case have received various suggestions from the people from the University of Pavia. Some members of the group of statistics of the department of economics and management have suggested which centrality measure should have been included in the portfolio allocation problem from his expertise on network metrics and centrality measures specifically. Furthermore, another member of the lab suggested to include the so-called residuality coefficient to compares the relative strength of the connections in cryptocurrency returns above and below a threshold distance value, to gain insights on the network structure of cryptocurrencies and to use it to foster portfolio management activities.

Secondly, the use case has been discussed internally with all project partners. The main feedbacks gathered here are to compare the model proposed with more alternative specifications. In other words, the model produces outcomes customized by the choice of the risk-aversion parameter, which is investor specific. Partners have suggested to take into account different figures of the risk-aversion parameter, and try some sensitivity analysis on this specific parameter. The authors have implemented this suggestion and have determined which kind of risk-aversion parameter worked at best with historical data of cryptocurrency prices. Then, partners also gave minor comments to improve the quality and readability of the work.

Thirdly, as one of the co-authors (Gloria Polinesi) of the use case is from “Università Politecnica delle Marche”, the use case has been internally presented in the “Università Politecnica delle Marche”, both informally and in the occasion of the department of economics and social sciences seminars. Here, an audience of econometricians and academic experts in the field suggested to improve the algorithm by including some filter to the modified correlation matrix of cryptocurrency returns given as an output from the random matrix theory. After some discussion, they referred to many seminal papers in the field of econophysics and suggested the use of techniques such as the minimal spanning tree in order to reduce the link dimensionality in the cryptocurrency network structure and achieve potentially better performance than those obtained by just employing the random matrix theory.

Fourthly, the paper has been presented in the Winterthur regtech, which took place in September 2019, by Paolo Pagnottoni. In this occasion, partners, people from the academia and people from the industry had the occasion to see the use case explanation and code running. The feedbacks were very good and there was much interest from both the academic and industry people. The main comment raised regards the efficient computation of eigenvalues of the correlation matrices in the random matrix approach and the academic person in question from UCL suggested a way to improve this. A second main comment was on the use of the use case with regards to alternative financial instruments, a need which can be easily and satisfactorily addressed.

Fifthly, the use has been presented in the Suptech AI in Malta in November 2019, held by Paolo Giudici and Paolo Pagnottoni, at the Malta Financial Services Authority MFSA. Here the use case was very much

appreciated by the audience, who was mixed in backgrounds, meaning there were both people from the law/regulatory side and people having quantitative background and tasks. The use case was mostly appreciated by the audience with necessary quantitative skills to understand the overall algorithm, however also the other people found it interesting. The main feedback we gathered here is on the alternative model specifications to be used to compare our results with. In other words, the authors have been suggested to use a more powerful and network-related model specification for the portfolio allocation strategy to test whether the portfolio strategy proposed would have still held the primacy in total returns and risk profiles. The authors have consequently employed the Glasso Markowitz portfolio, which combines the Glasso framework with the Markowitz portfolio construction, and they have demonstrated that their proposed asset allocation method still achieves better results in terms of risk-return profiles-

Sixthly and lastly, the authors have submitted the use case to an open access journal and subsequently published on it: "Frontiers in Artificial Intelligence", with special issue "Artificial Intelligence in Finance". Reviewers have made many comments and provided many feedbacks which notably improved the quality of the use case. One main comment was on the benchmark used to evaluate portfolio performances. The authors have been suggested to use the cryptocurrency index CRIX, a market index for cryptocurrencies which follows the Laspeyres construction, to evaluate the portfolio performances against it. This has been useful as the CRIX is a synthetic measure of the dynamics of the cryptocurrency market prices, and it is therefore a sound choice to use as a benchmark. Another main comment was on the evaluation of the risk-return profile of the portfolio. One of the reviewers argued that the sharpe ratio is sometimes not enough accurate to provide a measurement of a portfolio's risk-return profile. Therefore, the reviewer suggested to employ the Rachev ratio. Unlike the sharpe ratio, which is a reward-to-variability metric, the Rachev ratio is a reward-to-risk ratio, as it measures the right tail reward potential relative to the left tail risk instead, in a non-Gaussian framework. The authors have implemented the Rachev ratio and demonstrated that results are qualitatively unchanged: the proposed methodology still outperforms the others maintaining a relatively low level of risk. A last feedback that made the use case notably improve was that of conducting a sensitivity analysis on the starting point of the analysis and on the size of the rolling window used to estimate the model and then produce results. The authors have implemented the sensitivity analysis as suggested by the reviewer and have proved that the proposed asset allocation methodology still overperforms the others in terms of risk-returns profile.

Convergence and Divergence in European Bond Correlations

This use case is addressing contagion in financial markets - an important phenomenon during the European sovereign debt crisis of 2010-2012 that had substantial impact on the Euro area and led to massive central bank interventions and even the setup of new institutions, especially the European Stability Mechanism (ESM). The use case reveals the convergence and divergence of European bond correlations over time in some sort of nearcasting, as market makers parametrize their quote machines for the secondary market with correlations that reflect their risk assessment. Negative correlation parameters between two markets imply a diverging reaction of market prices to future news and therefore already anticipate increasing risk sentiment. The use case could be applied to different markets, asset classes and geographies if data availability and coverage is sufficient.

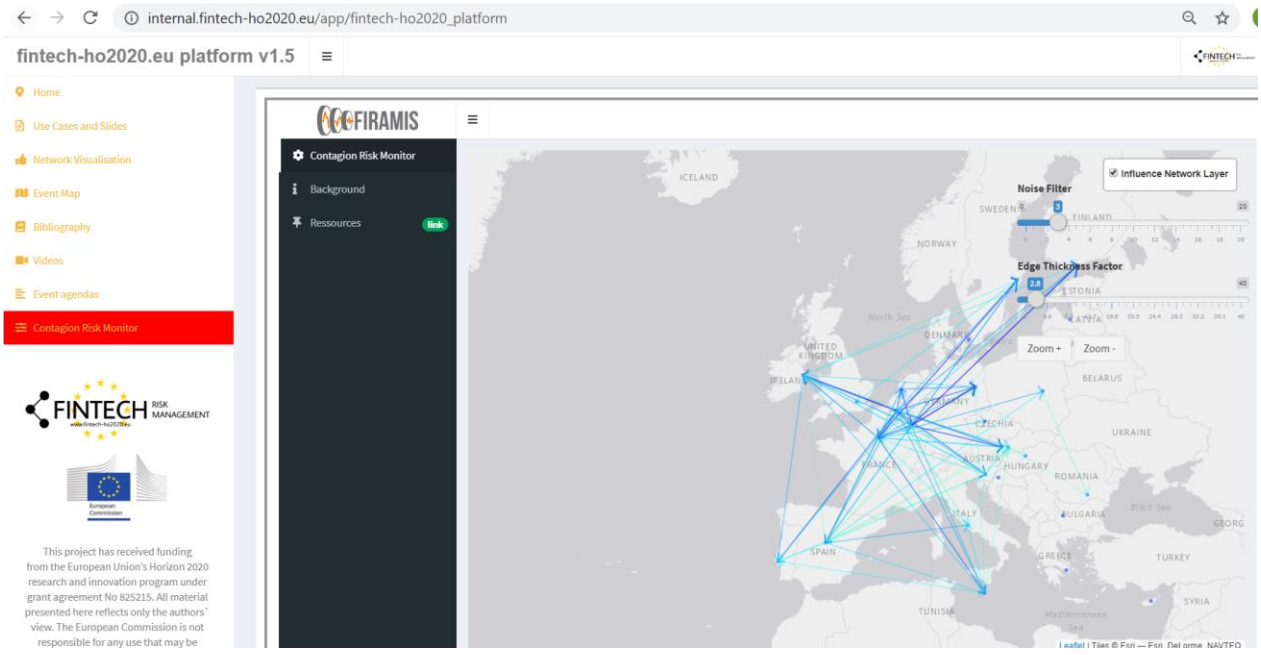
Here is one of the feedbacks:

'Convergence and Divergence in European Bond Correlations and the presentation of this model was clear with the right balance of technical depth being value adding and at the same time provoking the engagement from the audience.'

The feedback of the audience from workshops and conferences was consistent to their background: financial market practitioners and also the regulators during the Copenhagen workshop (August 2019) pointed out the usefulness for the practical assessment of short-term market sentiment. Academic economists were usually hesitant to consider a model without a lag structure. They prefer the standard Diebold-Yilmaz framework or similar approaches. The reviewers from the project questioned if the method qualifies as "AI", as it does not implement a self-learning system. Our working definition of AI includes supervised and unsupervised learning. The suggested use case approach belongs into the group of unsupervised learning methods. Tomaso Aste (UCL) suggested to complement the correlation influence method with transfer entropy (Keskin and Aste 2019). We will follow up on this idea.

Some participants with an economist background gave the feedback that the data could be more granular, focused on the reaction to specific isolated news and the analysis could be mixed with other data like country macro data. Financial market practitioners, on the other hand side, welcomed the absence of macroeconomic data in the approach, as financial markets price assumptions for future economic developments and often preempt macroeconomic changes.

Workshop participants could follow the presentation very well because the use case is structured in an easy ways and can be explained step by step, including the data. The 'clever graphical presentations help in understanding dynamic dependencies':



This use cases is supported by interactive visualizations and dashboards produced by Rshiny on the project platform. This helps to explain the use cases and get intuitive access to the methodology.

The methodology implemented in the use case was developed by ZHAW together with the European Stability Mechanism (ESM). Apart from the academic publication

Schwendner, Peter; Schüle, Martin; Ott, Thomas; Hillebrand, Martin, (2015). European government bond dynamics and stability policies : taming contagion risks. Journal of Network Theory in Finance. 1(4), S. 1-25

it was featured on the ESM website:

https://www.esm.europa.eu/publications/european-government-bond-dynamics-and-stability-policies-taming-contagion-risks

and in the ESM annual reports 2015 and 2016

ESM Annual Report 2015, p. 59/60, 16.6.2016, www.esm.europa.eu/publications/esm-annual-report-2015

ESM Annual Report 2016, p. 53-55, 15.6.2017, www.esm.europa.eu/sites/default/files/emergingfinancialtechnologybringsesmchallengesandopportunities.pdf

The FIN-TECH project and the related refined publication with additional applications

Schwendner, Peter; Schüle, Martin; Hillebrand, Martin, (2019). Sentiment analysis of European bonds 2016 - 2018. Frontiers in Artificial Intelligence. 2(20)

helped to further disseminate the use case. The authors were invited from ESM to contribute to the technical appendix to the Evaluation Report "Lessons from the Financial Assistance to Greece" that was published on June 11, 2020. The Independent Evaluator, Joaquín Almunia, presented his report to the Board of Governors of the ESM, after more than a year of work and consultation. His evaluation assesses the financial assistance to Greece in terms of relevance, effectiveness, sustainability, efficiency and cooperation. It strongly focuses on the European Stability Mechanism (ESM) supported programme from 2015 to 2018, while taking into account the preceding Greek financial assistance by the European Financial Stability Facility (EFSF). It also assesses the post-programme developments up to end-September 2019.

Reference:

Hillebrand, Martin and Schwendner, Peter: Contribution of Greek financial assistance programmes to reduce spillover risks. Technical Appendix (p.39-43) of: Lessons from Financial Assistance to Greece. Report from the Independent Evaluator Joaquín Almunia (11.6.2020).

Press release: https://www.esm.europa.eu/press-releases/programme-evaluation-greece-published-today-0

Evaluation Report: https://www.esm.europa.eu/financial-assistance/evaluation-efsfesm-programmes

Technical Appendix: https://www.esm.europa.eu/sites/default/files/greece_evaluation_technical_appendix.pdf

eXplainable AI (XAI) in Credit Risk Management

Use case 3 'eXplainable AI (XAI) in Credit Risk Management' is based on similar data sets as the BDA use cases and combines the network approach with explanation technologies rooted in cooperative game

theory (SHAP values) for local and global variable importance. It is basically an unsupervised representation learning on top of the results of a potentially black box supervised learning. It has applications in a wide area just like the BDA use cases (it actually bridges the two packages BDA and AI), namely in p2p lending and credit scoring/assessment/risk management as well as in other financial domains like robot advisory and market risk management (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3528616). It can also be applied in the context of supervisory machine learning. It is an approach to get access to and visualise the 'brain of an AI model'.

A related paper has been produced in this project on a different but comparable data set: 'Explainability of a Machine Learning Granting Scoring Model in Peer-to-Peer Lending' (https://ieeexplore.ieee.org/document/9050779).

This use case is just one example of explaining a black box machine learning model. The use case is a smaller building block of a larger debate around transparency, interpretability and explainability of machine learning models which is currently being discussed among supervisors, regulators and the financial industry worldwide and also in this project, of course. We will report about this debate here because it seems to be very important and was mentioned in a larger number of feedbacks. The projects' feedback material documents activity and discussion at national supervisors from countries like France, Germany, Spain, Denmark, the UK, and Romania during the workshops. Some supervisors stated that explainability/interpretability of models is a first priority for financial institutions and is very high on the agenda. Therefore, supervisors, show a special interest in the ML and AI interpretability topic. They consider extremely important for the models to be explainable from theoretical point and with parameter values reasonable.

In many decision-making applications, regulatory and transparency concerns slowed down the industry from embracing these new technologies due to the nature of black box of AI models. To overcome this problem, explainable AI models provide details or reasons to make the functioning of AI clear or easy to understand, thus they are potentially suitable in regulated financial services. If XAI is able to report the reasoning to make its functioning clearer to understand by humans, it would be potential to improve regulated financial services. This could be an important contribution to fintech scaling across Europe.

Biases, explainability/interpretability, data privacy and the transition from a development to a deployment stage are issues of the utmost importance and some solutions already exist. Supervisor have contributions to be make in this area and could aim at implementing sound concepts and practices, by getting inspiration from academic work and working closely with those in charge, in the financial sector, of developing operational AI solutions.

The German Bafin states that 'It is the responsibility of supervised institutions to ensure the explainability and traceability of BDAI-based decisions. At least some insight can be gained into how models work and the reasons behind decisions, even in the case of highly complex models, and there is no need to categorise models as black boxes. For this reason, supervisory authorities will not accept any models presented as an unexplainable black box. Due to the complexity of the applications, it should be considered whether process results, in addition to documentation requirements, should also be examined in the future.' (https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/BaFinPerspektiven/2019_01/bp_19-1_Beitrag_SR3_en.html;jsessionid=DDFA1EBC7153FD5A23B710F25C5DAFA0.1_cid393)

Another regulator calls it the 'explanatory gap of AI':

‘It is often difficult to know

(i) how reliable the inferred relationship between input and output is and

(ii) which causality exists between them. This is called the explanatory gap of AI. […]

Supervisors have to adjust their approaches and skills to escort the introduction of AI/ML in banking. Banks have to give supervisors sound explanations of what their AI/ML systems actually do, as well as to what end. ‘ (Joachim Wuermeling, Member of the Executive Board, Deutsche Bundesbank, page 158 ff.: https://www.eurofi.net/wp-content/uploads/2020/04/views-the-eurofi-magazine_zagreb_april-2020.pdf)

One can find similar public statements on the black box problem by many other national and international supervisors/banks, for example by Financial Stability Board, Bank of England, and FCA.

One of the most recent publications on ‘Governance of Artificial Intelligence in Finance’ and XAI has been submitted by Banque de France where our consortium partner established a dialogue on XAI and related topics. (https://acpr.banque-france.fr/en/governance-artificial-intelligence-finance). The partner from France has also created an extra feedback/white paper about BDA & AI.

Another report by BoE and FCA deals with ‘Machine learning in UK financial services’ (https://www.bankofengland.co.uk/-/media/boe/files/report/2019/machine-learning-in-uk-financial-services.pdf) and many practical issues arise, also related to XAI. For some of the workshops we relied on this paper to establish some check lists that could be used in supervisory practice.

The XAI use is also closely connected by two model publications by:

Bank of England: ‘Shapley regressions: a framework for statistical inference on machine learning models’: https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2019/shapley-regressions-a-framework-for-statistical-inference-on-machine-learning-models.pdf

Bank of England: ‘Shapley regressions: a framework for statistical inference on machine learning models’: https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2019/shapley-regressions-a-framework-for-statistical-inference-on-machine-learning-models.pdf

We also had the chance to present the XAI use case and discuss the topic in smaller on-premise workshops at ECB, EBA, and ESMA. ECB, EBA and EBF also attended our special workshop in Brussels where the XAI use case has been presented. All institutions pointed out that XAI is an important tool to overcome some obstacles of black box machine learning. Due to one of our use case presentations on XAI we were also invited to present at the EIOPA InsureTech task force.

‘Ethics Guidelines for Trustworthy AI’ developed by the High-Level Expert Group on Artificial Intelligence (AI HLEG; https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines) and the White paper on Artificial Intelligence by the EC (https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf) also address XAI. XAI is a building block for trustworthiness, transparency, interpretability, fairness, model de-biasing and model debugging.

‘Europe is well-positioned to tap into the potential of AI by capitalising on Europe’s competitive industrial and professional markets, including financial services, and its digital innovation and research capacities. At the same time, building an ecosystem of trust is essential. A European approach to AI should ensure that machine-based learning technologies are human-centric, ethical, sustainable and respect fundamental

rights and values.' ('The European approach to Artificial Intelligence in Fintech: current efforts and ambitions' ,Pēteris Zilgalvis J.D., Head of Unit, Digital Innovation and Blockchain , DG Communications Networks, Content and Technology & Co Chair, FinTech Task Force, European Commission, page 158 ff.: https://www.eurofi.net/wp-content/uploads/2020/04/views-the-eurofi-magazine_zagreb_april-2020.pdf)

More on this is written in the blog of one consortium partner: https://firamis.de/ai-fintech-riskmanagement-regulation/. The underlying presentations are part of the material used to communicate the XAI use case and can be found here: 06-Extra_feedback\Firamis\Blog

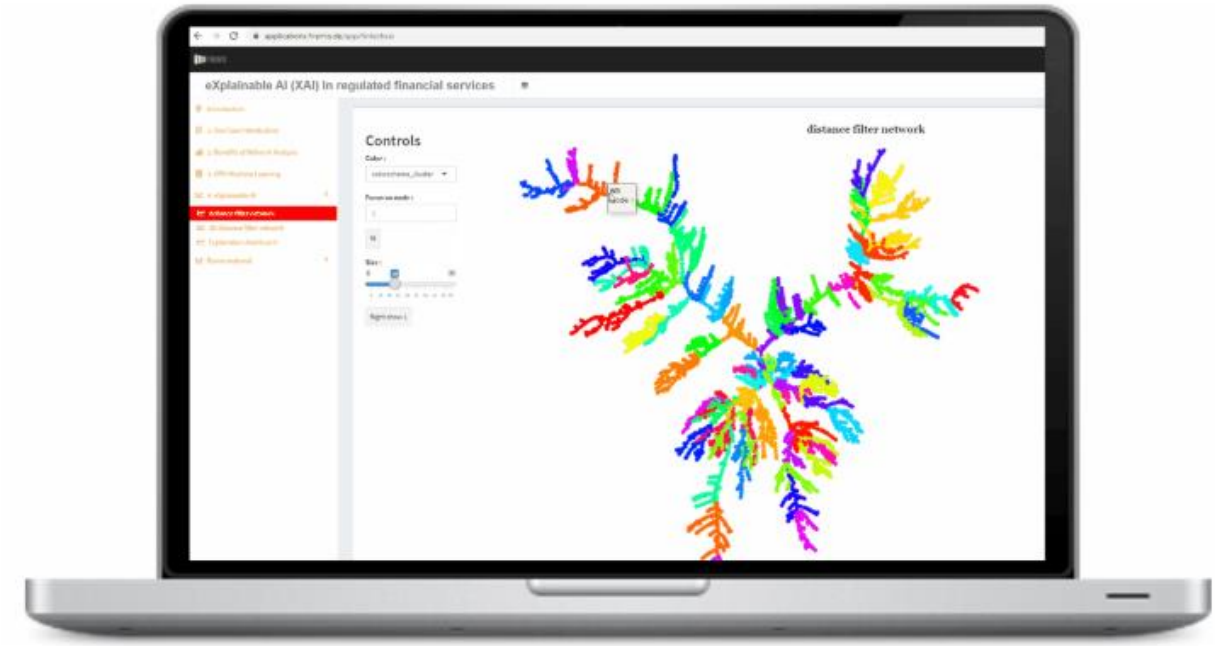
V29 Legal's Evaluation of the use case can be found in 06-Extra_feedback\V29_Legal. A connection is established to the 'Ethics Guidelines for Trustworthy AI' by the AI HLEG. The company has recently also made a 'contribution to the European Commission's Public Consultation on the White Paper on Artificial Intelligence' where the XAI use case and the FIN-TECH project are mentioned (https://aace002b-1655-41a1-b32a-9ae30cfe1c36.filesusr.com/ugd/c2b398_2b5df13ef91f4f30901e153170bf5248.pdf)

Some of the workshops of XAI have been enriched by the presentation 'Machine Learning in the banking landscape: Market experience, a view on specific risks, controls and audit considerations' by Ernst&Young.

The perceived 'black box' nature of the neural networks methodology also decreases its perceived utility specially when improvements in accuracy are not significant vs more traditional 'white boxes' methodologies. The explainable AI might solve the 'black box' constrain but only if it can be translated into layperson language to explain to front-office, borrowers and non-experts why a certain borrower is considered more or less risky.

Also, the different understandings of the XAI notion should be clarified if the supervisor is to express its expectations in this area.

There are also mentioned causal (cause-effect) or rules-extraction approaches to explain machine learning which can be an extension of the XAI use case presented.

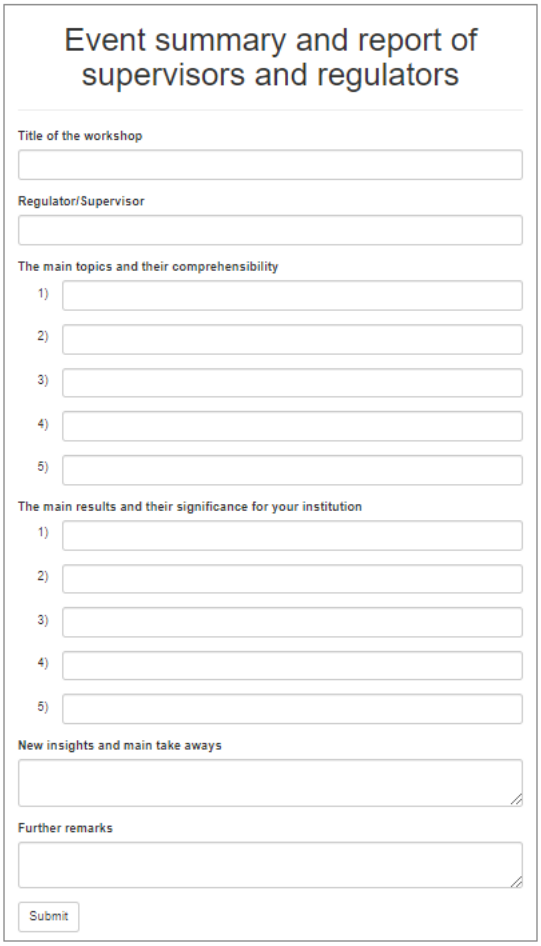


This interactive dashboard and visualization helps to teach the XAI use case in the workshops.

6. General, direct feedback by supervisors

We report the forms-based feedback and extract the most supportive, remarkable as well as controversial feedback.

The feedback by supervisors are summaries for each block BDA and AI. In the form we asked for the topics covered and how comprehensible they were. Then we asked for the main results and how significant they were for the supervisor. The following form was used:



Event summary and report of supervisors and regulators

Title of the workshop

Regulator/Supervisor

The main topics and their comprehensibility

1)
2)
3)
4)
5)

The main results and their significance for your institution

1)
2)
3)
4)
5)

New insights and main take aways

Further remarks

Submit

Main topics:

Consortium partners gave overview sessions and general introductions to BDA and AI, as well as to Market Risk and Robot Advisory, Fintech and big tech credit risk analytics, P2P lending market and business, data management, machine learning, explanation of statistical tools applications but also in programming and using open source-based programming tools and Machine Learning for Time Series Forecasting.

Some partners presented a large number of use cases whereas others more concentrated on a few use cases, especially those applied to supervisory issues.

Use cases and topics mentioned often und marked as relevant were those on Interpretability and Explainability, especially as a key concern from the model validation perspective. As outline in the the sections before it is a subject with high priority for supervisors. It is also recognized as feature engineering tool.

There were also other use cases mentioned that are based on network models, namely to improve robot advisory portfolio management, to enhance automated cryptocurrency portfolio management and for sovereign risk analysis. The latter was mentioned several times when it comes to analyzing the Convergence and Divergence in European Bond Correlations.

Topics covered and some results and statements

'How to use data to construct a network, network representation and graph analytics'

'The audience understood how it works P2P lending and how'

'That XAI is also on other people's minds'

'growth of knowledge about artificial intelligence and machine learning'

'Insight into new trend in financial products and financial management'

'Training has increased knowledge of new technologies'

'Detailed information on how statistical learning from big data is applied'

'Good review of the state of the arts this new statistical techniques'

'Better knowledge and understanding of statistical, ML and AI methods used by FinTech companies'

'Understanding how Machine Learning works'

'The Explainable AI concepts are interesting since this technology will definitely start to be used more and more in the future. '

'Understanding of interrelations of different methods available for financial market supervision'

'Understand how and when Machine Learning techniques can be used'

'Network models using centrality measures and contagion patterns are another interesting topic. '

'Deeper understanding of artificial intelligence and robotic advisory'

'Given the gaining popularity of AI solutions in financial decision making, the understanding of such methods and their potential risks are vital for the central bank. '

‘The use of big data is an area of active interest in our institution. It is good to hear what others are doing in this area. ‘

‘More understanding among supervisors of new technologies and their effects on banking and insurance activities‘

‘growth of knowledge about deep learning and P2P lending and crowdfunding platforms‘

‘Introduction to fast evolving area of FinTech‘

‘Predictive capacity of future bank failures and crisis‘

‘Brainstorming of new red flags to be raised in the validation these models‘

Good intro to most important aspects

‘Detailed explanation, on real life examples, of models underlying the current risk management standard‘

‘Food for thought on the potential behind these models, and their risks embedded‘

‘We consider workshops a good basis for improving supervision and risk management frameworks of supervised entities‘

‘The audience understood the main risks in P2P lending‘

‘Good focus on main supervisory aspects and challenges‘

‘The conference was an opportunity to provide a very comprehensive and up-to-date analysis of the subject from different perspectives : technical, operational, statistical and legal. ‘

‘Information on the workshop program, agenda and speakers were disseminated very well in advance. The information on the content of the workshop was fully consistent with the effective presentations and the final take away of participants. ‘

New insights and main takeaways

‘The main insight will be the legal part and how the future P2P companies will start working in the local market. ‘

‘awareness of relevant impact of new technologies in development of fintech sector‘

‘We [...] had a very positive experience and reactions from our staff being able to immediately implement the theoretical notions explained in the lectures on real life examples. ‘

‘New models and how they are build, where to look for more information on possible risks stemming from the model‘

‘People from risk Units, market conduct, financial innovation, and research attended the workshop. It is a new field of interest specially for micro.prudential regulation. ‘

‘Change of financial market Dynamics. Driving forces. Necessary changes needed in the supervisory competence pool. ‘

‘Better understanding of interlinkages of different topics (ML, AI, Big Data, FinTech, P2P) and methods (supervised, unsupervised learning, network analysis for financial risk management) ‘

‘New technology can be useful for our mission. Great problem: explainability‘

‘Developing of technical skills for Supervisors is of future interest. More collaboration between Supervisors, academia and the business environment would be useful. More international collaboration.‘

‘The possibilities of artificial intelligence are currently incomprehensible, and at the same time it is a big leap into the unknown field. ‘

‘The abovementioned topics and the following discussion was significant for us in terms of building further understanding and expertise, and would eventually help us to initiate the implementation of internal innovative projects. ‘

‘The conference was an opportunity to provide a very comprehensive and up-to-date analysis of the subject from different perspectives: technical, operational, statistical and legal. ‘

‘All new research in interpretable ML applied to financial services would be welcome. ‘

‘Explainable AI. The subject is a priority for us, and the presentation was well suited for the general audience. ‘

Positive feedback

‘In terms of whole organization, the FINTECH HO 2020 program can undoubtedly be defined as effective and efficient. ‘

‘Network models to improve robot advisory portfolio management – Good’

‘Big Data Analytics: the topic was introduced with a direct focus on the risks and each speaker shared its analysis from its domain of expertise (lawyer, statistician, etc.) while presenting concrete applications from which the risks might arise.’

‘It was a good introduction to the foundations for big data analytics.’

‘Opening and introduction to Artificial Intelligence - Very good’

‘Financial Actors and Fintechs: very interesting insights form the banks and startups that participate in the development of big data and artificial intelligence technologies for financial applications.’

‘Visualization of complex relationships. This was new to many people, and it was nice to have it presented visually instead of in coding.’

‘Network models to enhance automated cryptocurrency portfolio management - the presentation of this model was clear with the right balance of technical depth being value adding and at the same time provoking the engagement from the audience.’

‘The concepts related to Artificial Intelligence are very interesting and useful. ‘

‘Introduction to Market Risk assessment – Good’

‘Network analysis and clustering models. A good introduction. The more general aspects were well received.’

’Paper on Stablecoins (still in research) - the presentation of this model was clear with the right balance of technical depth being value adding and at the same time provoking the engagement from the audience. ’

’AI/ML across banks: This presentation from EY was spot on what we, as more or less lay people, can comprehend. They focused in on the big topics and gave a few examples. Just enough detail to let us learn but not so much that we were left behind.’

’The uses cases are interesting and help get a better understanding of the opportunities and challenges brought by AI. Sometimes the presentation was too technical.’

’Network models to improve robot advisory portfolio management – Good’

’Research topics around AI: an understandable presentation by researchers on the most discussed risks and on controversial definitions of the literature.’

’xAI: This part is perhaps one of the more \down to earth\ parts, and was quite instructive. A further focus on \what should a regulator look for\ would have been appreciated, but all in all this part was really good’

’Machine Learning for Time Series Forecasting - Very good’

’I have heard from the few participants, that it was helpful in their further work.’

’Are cryptocurrencies connected to forex? - Very good’

‘Outstanding, we received a very good overview about the fields of this technology’

‘Our main goal was to make people interested in the subject, and all in all, I believe we succeeded. [...] the overall focus was fine to this effect.’

‘Significant’ (several times)

‘Outstanding, we were informed about the working mechanism of this lending platform, and we could deep dive into the relevant risks, and opportunities.’

‘The mix of public and private sector perspectives on regulation was valuable. ‘

‘Significant ‘

‘Network models: outstanding, good. ‘

‘Per our request, the last part of the workshop was devoted to the implementation of machine learning techniques in text mining. It was a great overview of potential techniques for the analysis of text documents available at the central bank. ‘

‘Training program has potential to increase the efficiency of supervisory activities and update knowledge of the newest financial technologies. ‘

‘The presented use cases were very useful from a supervisor's point of view. ‘

‘Great lectures that allowed to expand your sight. ‘

‘Highly experienced teachers’

‘In general, both topics allow our institution to improve our analysis and understanding the dynamic of financial markets, with a special focus on financial stability issues.’

‘I would like to thank the presenters for additional comprehensive discussion on the EU AI strategy’

It was great to hear more about available data sources on fintech and big tech credit.

Aspects that should be corrected

’Data science […]: I believe that this part of the day was much to detailed. ’

’We, as lay people, are not in a position to cope with such detail. It would have been better, if the focus had been much more high level/broad picture. ’

’Sometimes the presentation was too technical. ’ (several times)

’Perhaps too much foucs on actual coding and too little on interpretation’

’Presentation on Tree Models - should be improved’

’Presentation on Random Forest - should be improved’

’More focus on Suptech concepts would be useful.’

’Various coding sessions - these parts of the agenda was too focus on coding, and as only a small handful in the audience knows coding, the information content was sadly lost on almost everone. ’

‘Topic (data on consumer credit) not relevant for Belgium, because not in the remit of the regulator ‘

‘A few presentations were much to detailed [...]’

‘Unfortunately, a couple of existing [...] platforms do not implement any advanced statistical methods for portfolio optimization, but such workshop is nevertheless beneficial for us as a preparation for future development in industry solutions.’

’Mismatch between targeted audience and people present at this workshop. Unfortunately due to the abovementioned reasons no new insights and thus no added value. ’

’A result is to make a split for the next session, to have actual coding separate from the high level session’

‘Standard content delivered by the project was not relevant for […] , if stick to the imposed program, […] regulators might drop out of such workshops. Also, the envisaged length of the workshop (16h) is not feasible nor desirable. Should be organized in a more efficient way and much more hands on and related to the mission of the regulators. For the upcoming AI SupTech, we demand another much more tailored approach and are trying to work together with […] to achieve this.’

‘We were generally satisfied but had some complaints regarding the very steep learning curve that is expected from our staff in order to be able to follow and implement the presented cases.’

‘Keep it simple - at least when trying to reach a broad audience that is not working with the subject matter on a day to day basis.’

‘More interaction with colleagues from the network would be useful. More interaction with the business environment would be useful.’

7. Feedback by the industry

Feedback by V29 Legal

V29 Legal is a boutique law firm specializing in international dispute resolution as well as legal matters related to modern technologies.1 With regards to artificial intelligence (AI), V29 Legal works with innovators to drive change and shape the development and deployment of technology which is and will continue changing our life tremendously.

The company made a contribution to the European Commission's Public Consultation on the White Paper on Artificial Intelligence, also referring to the XAI use case (https://aace002b-1655-41a1-b32a-9ae30cfe1c36.filesusr.com/ugd/c2b398_2b5df13ef91f4f30901e153170bf5248.pdf):

In their Evaluation of the paper "Explainable AI in credit risk management" for this project they have similar findings. Also, they analyse if the XAI approach helps to implement or comply with existing or upcoming regulations. These questions are answered (mostly positive) along the Ethics Guidelines for Trustworthy AI.

Feedback by Bain&Company and DZ Bank

Bain & Company is an American management consultancy headquartered in Boston, Massachusetts. It is one of the "Big Three" elite management consultancies (besides McKinsey and BCG).

DZ Bank AG is the second largest bank in Germany by asset size and the central institution for more than 900 co-operative banks and their 12,000 branch offices.

The feedback is based a public LinkedIn Pulse article that summarises the Special Brussels Workshop organized by FIRAMIS which had been attended by c-level representatives of those two companies. Here is the LinkedIn article: https://www.linkedin.com/pulse/big-data-analytics-artificial-intelligence-sebastian-fritz-morgenthal/?trk=related_artice_Big%20Data%20Analytics%20and%20Artificial%20Intelligence_article-card_title

It can be observed that XAI has been a topic in most presentations (ECB, EBA, FIRAMIS). The day was rounded up by a panel discussion with Gilles Bouvier (ECB), Andreas Papaetis (EBA), Barak Chizi (KBC Bank), Davide Corda (Intesa Sanpaolo), Peter Neu (DZ Bank) and Sebastian Fritz-Morgenthal (Bain & Company)—the moderator: 'The discussion then moved on to the question of explainability of AI-based models. Explainability is key for banks as customers and regulators will expect their decisions to be transparent and well documented.'

The article ends with questions asking for engagement: 'Should algorithms be fair? Can they be trusted if they are not fair? Are fairness and discriminatory power not contradictory? We are interested in your opinions.'

These questions were further discussed in the AI roundtable of FIRM (Frankfurt Institute for Risk Management and Regulation) which Sebastian Fritz-Morgenthal and FIRAMIS head. FIRM is a high level group of risk experts in the financial industry: https://www.firm.fm/en/firm/members.html

Many banks including Commerzbank engaged in this discussion. In one of the next session we have German Bafin invited and also the French supervisor, discussing also the risk of AI in Fintech.

Feedback by NordLB

NordLB had been acquired as industry evaluator during the Special Brussels Workshop by FIRAMIS. They delivered an informal feedback presentation on the 3 BDA use cases that does not represent their official opinion.

Use case 1: 'The minimal spanning tree seems to be a good visualization for concentration risk. Maybe it would be possible to derive a simple algorithmic network area with high risk in order to obtain an easy indicator for risky loans.'

Use case 2: Sample size seems to be significant. 'Could the results from the factor segmentation be helpful for the explanation of the result?'

Use case 3: 'It's not completely clear, what is new according to the work of Calabrese et al. (2017).'

Feedback by Creval

Creval is part of our research evaluators group and Fabio Salis itself, the author of the feedback, has been engaged with our project since the Kick- off in Pavia the 1st of February 2019

Creval is a Parent Company of Credito Valtellinese Banking Group - Register of Banking Groups No. 5216.7 and member of the National Interbank Deposit Guarantee Fund and of the National Compensation Fund.

The Chief Risk officer of the group organized the feedback according to a process in which after participating to our kick - off and to events in which the BDA UseCase were disseminated he made some general comments relatively to possible improvements of the model design of the p2p lending use case:

- Small access to borrower's data: the model development is based only on the behavioral information of the counterparty. A possible solution to improve the credit assessment methodology is to evaluate the counterparty not in terms of rating classes, but in accordance with the "good or bad approach", by defining a cut-off under which the the credit is not granted.
- Rating review: since the predictive accuracy of the model is particularly sensitive to the borrower's behavior, the rating should be reviewed frequently, at least on a quarterly basis.
- Adoption of a definition of default based on a "delinquency approach", taking into consideration the cases in which the borrower is late or overdue on a payment.
- Application of multi-year time series: in order to improve the predictive capacity, the model should be based on historical time series of balance sheet and income statement data which include at least 5-10 years of observations.
- The model should take into account also behavioral information. A possible way of improvement can be represented by the inclusion of historical trends of the ratio used in the regression as additional inputs (for example QoQ or YoY variation).
- The model should take into account also behavioral information. A possible way of improvement can be represented by the inclusion of historical trends of the ratio used in the regression as additional inputs (for example QoQ or YoY variation).
- in order to better align the P2P credit scoring model to the banks models, it could be useful to integrate the original dataset based only on financial information with a qualitative set of information that takes into account, for example, the valuation of the management of the companies, long-term strategies and market size.
- Another way of improvement could be the develop of a cut-off of the scoring in rating classes, in order to better express the different risk underneath the single counterparty. It could be also added a traffic-light approach to measure the quality of the cut-off.
- It would be useful to clearly explain the definition of default adopted, in accordance with the regulatory framework.
- A possible additional area of improvement is connected to the valuation of the sensitivity of the model to the change of default definition (see EBA/GL/2016/07 - "EBA Guidelines on the application of the definition of default")

Feedback by Intesa San Paolo

USE CASE: Explainable AI in credit risk management

- Interesting approach to enrich the well-known Shapley values method for a supervised learning model leveraging an unsupervised method
- Comment more on the choice on the number of clusters from the hierarchical clustering. Do so many clusters correspond to different configurations of the Shapley values?
- Show the MST colouring it with a scale of the predicted probabilities rather than the actual default values. This could further show how the unsupervised method explains the supervised one rather than showing whether the clustering corresponds to the binary response or not
- Clarify in what ways the proposed method based on MST network clustering is useful for the explainability the scoring model
- Clarify in what ways the proposed method enhances or at least differs from other clustering methods in the Shapley valuespace
- Compare with this clustering approach "Hierarchical clustering in minimum spanning trees - Meichen Yu, Arjan Hillebrand, Prejaas Tewarie, Jil Meier, Bob van Dijk,Piet Van Mieghem, and Cornelis Jan Stam"
- Compare to a clustering (e.g. SOM 2D) on the original data observation
- Show computational cost in run and retraining phase

Use case: Network based scoring models to improve credit risk management in peer to peer lending platforms

- Similarity networks may be computed according to many different metrics or edge definition. Using the MST derived from the standardized Euclidean distance between the features' vectors is an interesting one
- Network measures are probably brand new information with respect to the standard balance-sheet ratios. Could this be supported by some statistical evidence? What about the coefficient and p-value in the logistic regression?
- Poor evidence that the proposed methodology actually reaches an improvement over the non-network scoring model: what about some statistical comparison?
- In some contexts, it may be important to analyze the results with a specific threshold/number of predicted positives or setting a maximum on the false positive rate. In future applications, this could be considered in the performance evaluation
- Specify the advance of the balance-sheet ratios with respect to the observation date(in particular for borrowers that defaulted in a specific date e.g. 1 year before, 2 years before ..)

Feedback by Illimity

Illimity team Claudio Nordio – Chief Risk Officer and Giacomo Le Pera – Head of Risk Analytics examined the paper https://doi.org/10.3389/frai.2019.00003 and submitted some preliminary remarks.

The proposed models apply to ECAI peer-to-peer lending data some machine learning techniques aimed at predicting the default of the borrowers. Indeed, it is well known that the application of machine learning leads to particularly favorable results in terms of accuracy and discriminating capacity. Furthermore, the paper defines a topology in the space of the features of the borrowers, that visually appears effective in grouping the defaulted borrowers locally in space, and therefore it is suggested that the “proximity” could itself constitute a feature.

However, the models show a substantial invariance in terms of final metrics after introducing those "proximity features", but in our view, this could be linked to the choice of the performance metrics, which may be affected by the unbalance of the sample (note that all Accuracies result around 1- default rate). In this sense it would be interesting to examine the results in terms of precision, recall, F1, etc. and moreover, the outcome of random forest or neural network models with and without the introduction of that features, in order to test if the ability of such models to capture nonlinear relationships would experience a substantial improvement.

Anyway, although the inclusion of the "proximity features" does not improve materially the performance metrics, they could still be used in the practical assessments of the creditworthiness of companies, especially in the presence of simplified (linear) default probability models vs more complex topologies (for instance, those underlying the supply chain of a firm or group of firms).

As an aside remark, it is not clear from the paper if the topology is estimated once and for all throughout the validation folds: this case would result in leakage that we would suggest to remove.

Feedback from Fintech companies collected by Modefinance

Fintech partners’ and participants’ feedbacks,
RegTech Workshop I, Milan 29th March 2019

By a former General Manager @ ItaliaFintech:

RegTech and Fintech are strictly interconnected: one of the biggest challenges in making finance smarter and more accessible is to preserve the accuracy and reliability of systems and solutions to the current regulation. The project, by opening a constructive and cross-country dialogue, allowed for a practical and theoretical conversation on how not only to preserve but improve the risk management in innovative credit scoring models.

Credit scoring models are a very crucial use case for the entire sector, allowing for faster and better access to finance for individuals and SMEs.

By a Business Development Director @ Fintech District:

Fintech has evolved fast and quite chaotically in the past years, and while most of the news about the sector have been dedicated to neo-banks side, technologies such as AI has allowed the discovery of new technological regimes such as Insurtech and Regtech. These are new subjects that require deep study and observation, and that is why we have decided to host the RegTech Workshop I session in Milan. The session held in Milan has been one-of-a-kind representation for our community, involving all the actors of the ecosystem: FinTech companies, institutions, banks and universities. One of the biggest challenges outlined has been to become more and more accurate and transparent, evolving in reliability of digital solutions, and helping regulators to learn and apply this to a renewed and effective law. The project persuaded more than 60 participants to take part to a practical and theoretical conversation on how to improve the risk management thanks to innovative credit scoring models. Credit scores represent just one of the many models, governed by AI and data science, crucial for the entire finance and economics world -no more seen as a competitor but a partner from the traditional finance and banks- allowing a rapid and more democratic access to advanced tech solutions, to SMEs and professionals worldwide.

By a former Head of Data @ Moneymour -acquired by Klarna- (participant)

The event has provided a full overview of the fintech needs, presenting interesting topics mixing the research and real business cases.

It has been interesting see how networks models fits well real case scenarios as credit scoring, observing not just direct connection but looking also for hidden patterns.

The application of AI and advance analytics techniques makes steps forward with event like this, where interesting use cases are presented and well explained. With these opportunities it is possible to understand how to create real value starting from data.

8. Feedback by the international advisors

Summary of report of advisor 1

'The concept of FinTech-ho2020 Project is very innovative. I am very pleased to see that under this project, people from different field and background could meet together to exchange the knowledge, discuss the new ideas, and train the young researchers for the future prosperity of fintech.'

'The conference was very well organized by bringing the participants from different backgrounds together to share their views on all these very critical issues from different perspectives.'

'The participation by people from different background dramatically increases the visibility and influence of the project. Moreover, the papers presented at academic session have very good potentials by using advanced methodologies like social network analysis, AI, machine learnings, etc.'

Suggestions:

Inviting Bigtech (cloud) companies in the future, given that financial industry might be dominated them.

➔ FIRAMIS established contact to Deutsche Telekom and other cloud providers. Deutsche Telekom did present their AI and BDA approach at the London virtual meeting.

Application of blockchain technology and issuance of digital currencies by central banks are gaining increasingly attentions. FinTech-ho2020 may include such topics in the future workshops.

➔ That is the blockchain part to come.

Summary of report of advisor 2

'The FinTech-HO2020 project is on a good pathway. The expertise of the project partners is diverse and interdisciplinary.'

'[..] the project has built up an international and interdisciplinary platform to develop and deep understanding and exchange on the research and implementation in FinTech and RegTech.'

'There are a number of achievements including past and future events on the highly relevant topics that boost the influence of the team. Some innovative thinking especially the idea of having an online teaching platform in addition to the lectures given at the industry partners has potential to provide long term contribution from the project, lasting even after the completion of the project itself.'

➔ FIRAMIS has initiated an intense exploitation phase outlined in this document. The platform created by FIRAMIS is constructed in a way that it is harmonized with modern open-source (cloud) infrastructures, using docker for example. It is compatible with most cloud systems so it can have a long-term, lasting contribution even after the project, being used as teaching and use case development platform.

'The talks were interesting and suited for both academia and industry, stimulating prospective academic-industrial collaborations.'

‘In summary, the project is running very well and has the potential to become an excellent example of cooperation within Europe. I would like to congratulate the team to their success and look forward to the further steps.’

Summary of report of advisor 3

First, the advisors summarized the project:

‘The FIN-TECH Horizon2020 project aims at the development of a European fintech risk management framework that can encourage innovations while protecting consumers and investors. A framework that can close the gap between technical and regulatory expertise, providing risk management procedures common to Regtech and Suptech, and uniform across countries. The FIN-TECH Horizon2020 project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 825215.

In the context of the project, use cases are produced and disseminated through a web-based platform, that describe new fintech risk management methods. These use cases are presented and discussed in workshops that are held across different European countries during the 2-year project period.’

Then comments on the research worshop attended: ‘The workshop took place at the ZHAW, and included speakers from industry, academia and regulators, as well as presentation of some of the use cases. I found the variety of speakers to be very complementary and one that provided a good balance across the different dimensions of the issues discussed. Three use cases developed in the context of the project were presented and discussed. I find these to be a great start and in the right direction to achieve the ultimate goals of the project. I find that tackling the important issues targeted by the project can only be achieved by the right collaboration across industry, regulators, and academics. Regarding the platform developed for the project, I think it is a very important tool to disseminate the products and deliverables of the project. I would encourage the project team to further develop it and its content to enhance its value and usefulness. I am looking forward to observing future activities of the project.’

Summary of report of advisor 4

‘The project is obviously valuable, as currently, the identification and assessment of the risk profile of FinTech solutions is a necessity, knowing that the financial industry is increasing its investments in technological solutions and increasingly depending on them.’

‘The collaboration fostered by this project between researchers, regulators and industry specialists is vital for such desired outcome.’

Now discussing project participants specialisties:

‘The workshop at Bucharest included a diverse and interdisciplinary audience […]’

‘Conclusion:

1. The workshop delivered the promised expertise diversity provided by its participants.

2. The expertise of the project partners is diverse and interdisciplinary.

3. Orientation, knowledge and experience are opened to young students and researches in terms of the importance of opportunities that FinTech provides.'

Now discussing the workshop attended:

'Conclusion:

The workshop provided research papers that work within the project three main technologies that drive the FinTech innovations. The speakers were provided a good knowledge base across the different dimensions of the issues discussed.'

Now discussing the project network:

'Conclusion:

It was noticeable the amount of effort that is dedicated by the local project team to organize and establish friendly network relations between participants. In addition, several participants embraced the collaboration opportunities opened for them through the project network.'

Now discussing the project platform:

'The project portal design is friendly; it allows for the navigation in an easy manner through the different links and folders.

'Portal needs to be improved in Bibliography section. '

'The Network Visualization Section seems to still be under construction' -> FIRAMIS: that is right. Visualisations now work properly and more dashboards and visualisations have been added in the meantime.

Now a final comment on the 'Outcome Sustainability Prospects':

'The project continued its successful progress through the workshop attended in Bucharest, and is expected to continue doing so in the future. The project has great potential to further host innovative work and research ideas, such as providing an open eLearning platform delivered by academics and FinTech industry representatives. The project can also continue as a main European FinTech hub that fosters collaborations between academics, industries and regulators.

In general, the project is running in a very good manner despite the withdrawal of France and the very few underperforming partners. If the project continues with its successful progress, it is expected to become essential in supporting the European cooperation and integration process.'

9. Feedback by the fintechs

Two longer questionnaires had been developed (recent one is this one: https://www.fintech-ho2020.eu/free/app/fintech_questionnaire) and may fintechs in the partner network and fintech hubs were addressed. More than 20 had the time to fill in the forms. Here are some summarizing results:

Are of activity of the Fintechs: Lending, AI, Open Banking, Payments

Most of the fintechs have revenues < 2 Million

Country_headquarters: Italy, Belgium, Germany, Spain, etc.

Supervisors are mostly characterised as collaborative

In how many countries are the fintechs active on average: 6.1

Importance BDA: 3.125/4

Importance AI: 3.5

Importance Blockchain: 2.25/4

Awareness of regulators of these topics: 2/4

Percentage of revenue spent on regulation: 5-10% sometimes up to 20%

Do you experience consistency across countries in the approach of the regulator towards fintech innovation? Answers range from 'no' to 'most of the time'

Has your business model suffered as a result of regulatory issues? If yes, how? What would you list as the main regulatory challenges that your company currently faces (or might face in the future)? Answers:

- 'We decided to adopt a model that outsources regulated activities.
- Increasing complexity and costs and time spent
- regulations are sometimes contradictory from one country to another
- Regulators should be more aware of new tech possibilities and react faster.
- Some restrictions the regulator imposes actually go further than the law states.

Also considering your answers to previous questions, do you have any suggestions to improve the relations between regulators and FinTechs in the EU? 'Armonisation of rules. For example: non regulated asset-based lending and restricting "ban on assignment" on receivables.'

Some answers on sandboxes:

- 'Only a few working groups that are actually on the market have almost no actual Fintechs working in them.'
- 'They only have associations and there have truly been no important movements in the EU to help Fintechs.'
- 'No regulatory sandbox in the home country'

Major benefits from sandbox

- Better knowledge of regulatory and supervisory mechanisms
- Economic advantages
- Better product outcomes
- Contacts with regulators
- Better reputation towards consumers/end-users
- Reduction of planning uncertainty

Here some feedback to the former PO on feedback suggestions from the sup tech sessions regarding fintech regulatory obstacles to scaling:[1]

1. NEED TO UNDERSTAND FINTECH RISKS AND THEIR MEASUREMENT: National supervisors need to understand what BDA, AI and Blockchain mean in terms of risks and related risk management procedures. While the effect of technologies on business models is clearer, the associated risks are not so clear, especially with regards to blockchain.

2. NEED TO CLOSE THE DISTANCE BETWEEN FINTECHS AND REGULATORS: It is perceived that the variety of business fintech models, and their globalisation, does simply the need to understand how they work in an operational way, and this can be achieved through a dialogue with finches. The perception is that, at the moment, fintechs may be afraid of regulations and of regulators and so the dialogue may be "difficult"

3. NEED OF A EUROPEAN PERSPECTIVE: A common perceived weak point is the lack of general, European indications. While national initiatives are welcome there is fear that this may create unfair competitive advantages. Common principles would be welcome especially considered that, likely, no country has enough scale for a specific fintech sector to be sustainable.

4. VALIDATION: They ask whether and how the use cases will be validated. We said though the banking system and this seems to be welcome as there is familiarity with bank risk management models.

5. INTERNATIONAL BENCHMARKS: A number of participants liked our classification of fintechs and of fintech risks. They find it helpful. They would like to know how our proposed fintech risk management procedures compare with those developed in America and Asia, and if there are similar experiences there. And, finally, if there are international benchmarks, on the regulator side.

[1] **From:** Paolo Giudici [mailto:paolo.giudici@unipv.it]
Sent: Tuesday, March 19, 2019 6:39 PM
To: MAZZONE Chiara (CNECT)
Cc: Dominique GUEGAN; ANCA MIRELA TOMA; Arianna Agosto; Dave Remue; Dr. Jochen Papenbrock; Antti Talonen; Audrius Kabasinskas; Oleg Deev
Subject: Re: Submission of FinTech project amendments

10. Ongoing involvement

Engagement level for workshop participants are manifold, ranging from online to offline, from personal to digital.

Each workshop is accompanied by a set of presentation slides with both standardised and customized decks. Some workshop participants received the material even beforehand for preparation. The material is shared during and after the workshops. Workshop participants have access to the platform where they can not only access their workshop material but also material from other and past workshops.

The platform also has further background material and repositories of own and other research papers. The platform also has code-based use cases which can be studied online or downloaded for offline use and extension.

Some of the workshop participants stay in contact with the partners to exchange ideas or even work on joint projects and publications. Sometimes material is shared and disseminated inside the supervisory organization. Some supervisors also prepare data and use cases to discuss them in the next workshops.

The website and platform have information about future events there has been a lot of regional exchange where supervisors attend other supervisor's workshops to broaden the network and exchange ideas. Partners also regularly inform about the past and futures activities and ambitions of the FIN-TECH projects in the workshops.

Some partners are committed to providing participants with a report that collects comments and feedback from the same seminars in other EU countries.

There are also special workshops like the one in Brussels (see chapters below), the one in Romania and the final workshop in Berlin. Besides the program there are many opportunities to network and exchange. There will not only be the national and international supervisors, but also many partners, academics, researchers, financial industry experts and our international advisors.

Some supervisors also embedded some FIN-TECH workshops into their broader research and education programs. In some cases, the audience became very large.

There are also many bilateral connections that were established during the project. Supervisors profit from the intellectual freedom, open communication and independence of the researchers and researchers in turn learn about supervisory practice and latest developments in the industry.

11. Platform for code-based use cases

The code-based use cases are prepared and maintained in a login-protected platform which has been created in line with the so-called Regtech framework.

The RegTech framework aims to create an operational fintech risk management expertise through knowledge exchange workshops dedicated to fintechs. Each workshop will allow participants to test possible solutions for automatized compliance. The RegTech material is based on the same material shared in WP5 and will add practical aspects through the development of coding examples on the project use cases. During the regtech sessions, open source language software will be used, thus ensuring the project's overall neutral and non-commercial nature. While the SupTech workshops are decentralised in each of the considered European countries, RegTech workshops will be organised at the European level, at the premises of fintech hubs, to encourage uniform fintech risk management practices across Europe.

The objectives of this work package are: To develop technical solutions to automate compliance of fintech companies (RegTech); To test different technical solutions for automated compliance using open source papers, software and real data.

The work is divided into the following tasks: Creation of a unified content. For the purpose of developing common understanding concerning the technical aspects of fintech risk management models, the content of the RegTech workshops will be material relative to the use cases (as in WP5), divided into three topics: big data analytics, artificial intelligence and blockchain application.

Creation of a research and development environment, creating a coding technical infrastructure that is scalable and extendable in a modular approach. The basis for the infrastructure will be open-source projects like R which gives access to developed machine learning projects. These research and development environments will be made available in a dedicated cloud server environment to manage the code, scripts, GUIs, models, users' access rights, software interaction and workflows.

The following languages and (open-source) tools are combined:

- Ubuntu
- Nginx
- Docker
- Shinyproxy
- R
- Rstudio
- Rshiny
- Hugo/R-blogdown
- LDAP server

The platform uses Ubtunu as OS and Docker for containerization of the applications. We use modular docker containers that contain R code, files, input data and all environment packages and variables needed. Each use case exists in such a container and also has an Integrated Development Environment (IDE) like Rstudio.

Each use case is prepared in a way that all libraries and packages required for its execution are already provided in the same container. This provides an infrastructure with least possible entry barriers to run the use cases. This is important as can be seen from the feedback as many users see the code and a modern coding infrastructure for the first time. Users only need a modern Web browser and platform access to instantly run the code.

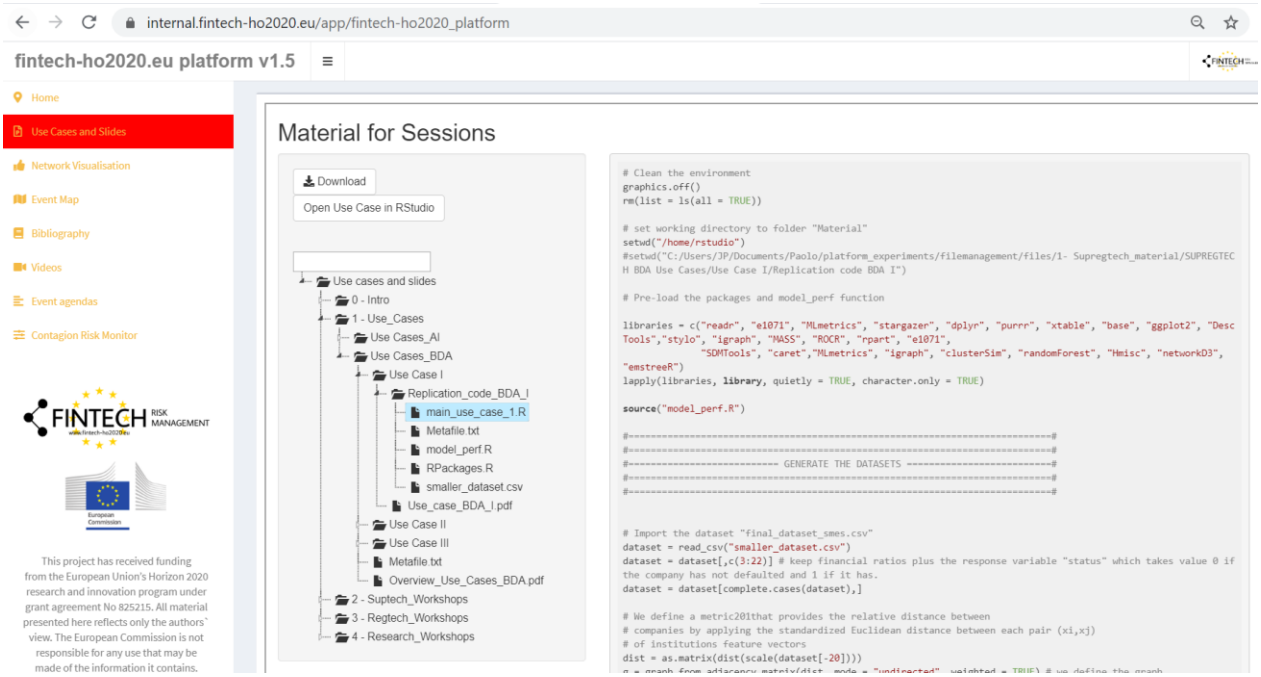
Besides the code there are other containers whose purpose is to run R-Shiny applications. This is used for flexible dash-boarding, interactive visualization, file browsing, file previews and file downloading.

The modular platform can scale by using Docker Swarm technology. For example, there can be several hundred nodes each of which is reserved for one or more users. In this way, there can be live and online trainings for several hundred people at the same time. The amount of nodes has to be reserved and managed during the event.

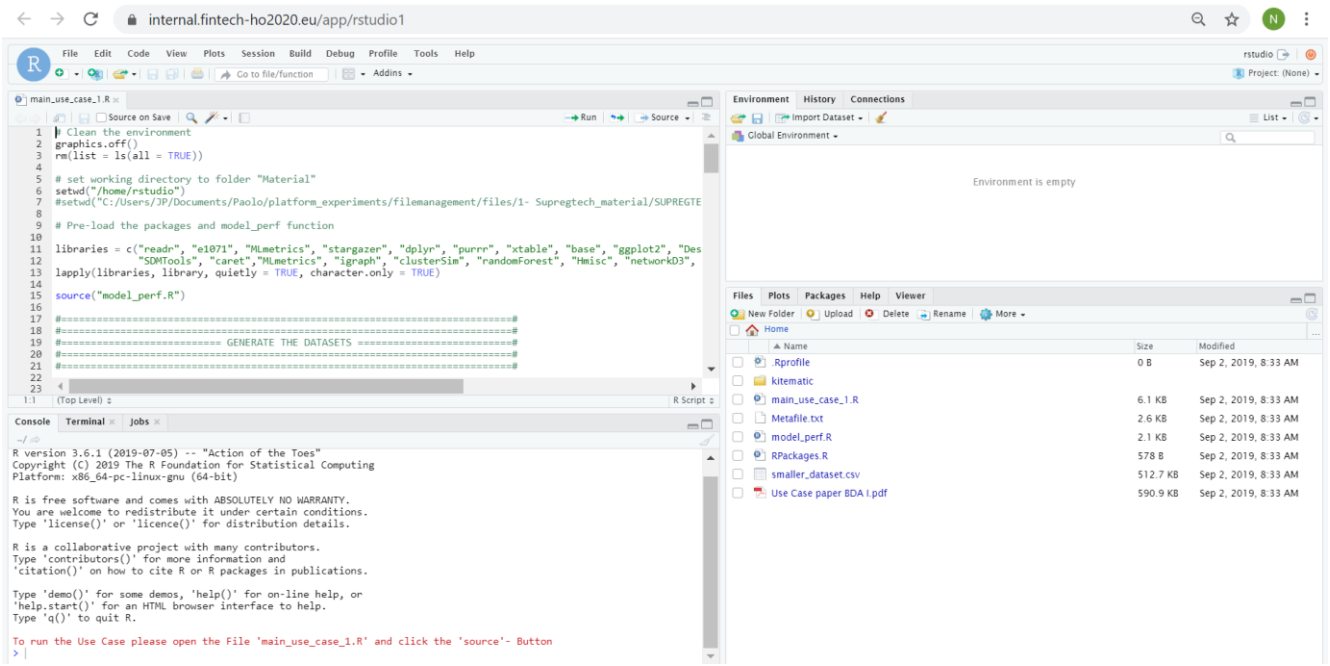
The platform has served hundreds of users since beginning of 2019, supporting Regtech and SupTech workshops as well as the evaluation and dissemination process. It had almost zero downtime since beginning of 2019. For information about the platform architecture can be found here: https://firamis.de/data_science_platform/

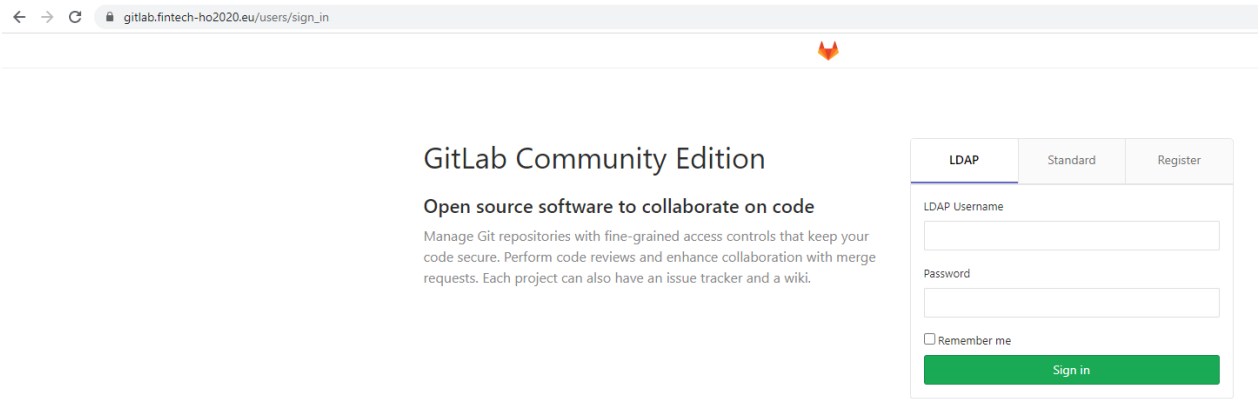
The workflow for new code-based use cases is the following:

Firamis receives the new code from the partners and checks which open-source software packages and libraries are involved in total. A docker container is then created that contains the downloaded libraries. Additionally, some extra packages for Ubuntu have to be installed to be able to run those libraries. In a first test it is checked if all libraries load properly. Then the partners' code is is added in a second docker container that includes the first one. The code is checked line by line and analysed in two directions: 1) to see if it executed properly or if there are conflicts with package versions, or errors or warnings. 2) the code results are compared to the underlying paper results. At this point the paper also has to be understood regarding the AI, BDA or blockchain use case. Graphics and figures have to be checked and a welcome text has to be created that points to the right file to start and execute the use case. After the use case is checked and finished we upload the docker container to the platform, and link it to the general file structure. We then ask the responsible partners to check their use case on the platform. If positive the new use case can be officially added to the use case portfolio and it can be picked by the workshop organisers. In some cases, we enrich the use case by an interactive dashboard and visualisation as in the case of Financial Risk Meter and Contagion Risk Monitor.

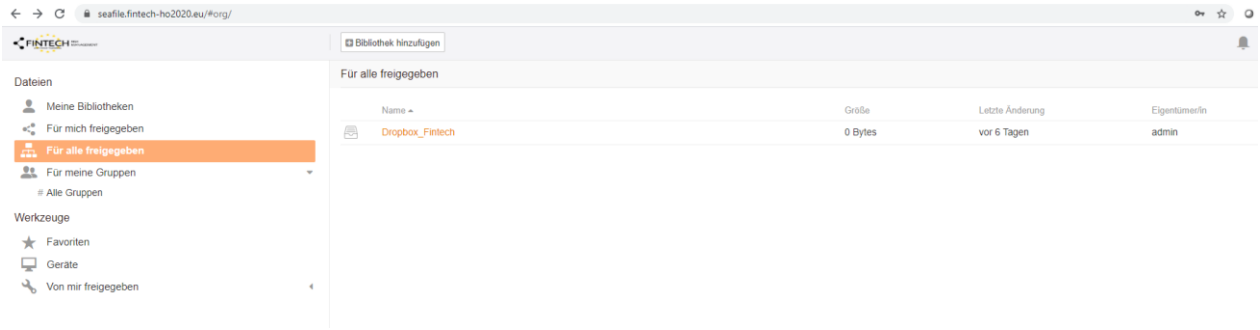


Platform landing page with side menu and file browsing functionality. Most file types can be previewed and all files can be downloaded. Whenever there is a prepared R use case, another button appears that opens a new tab with IDE and the preloaded use case as in the screenshot below.

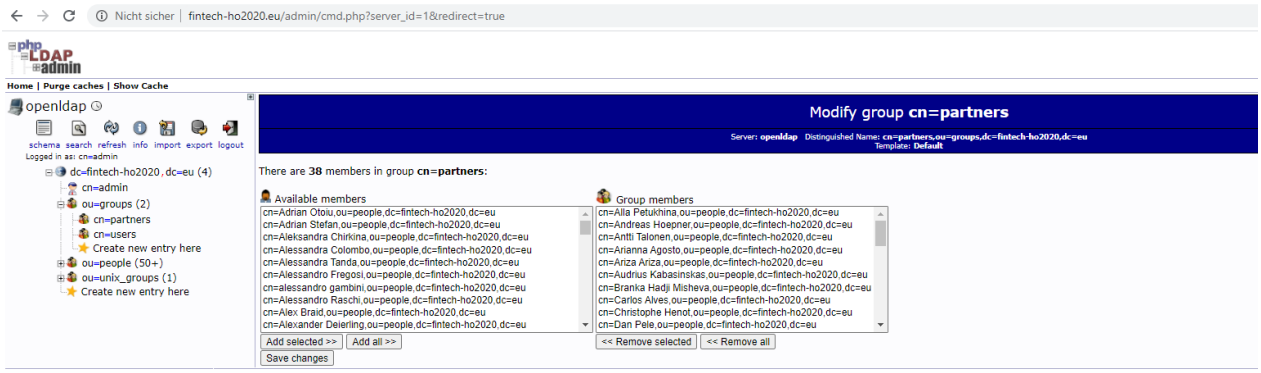




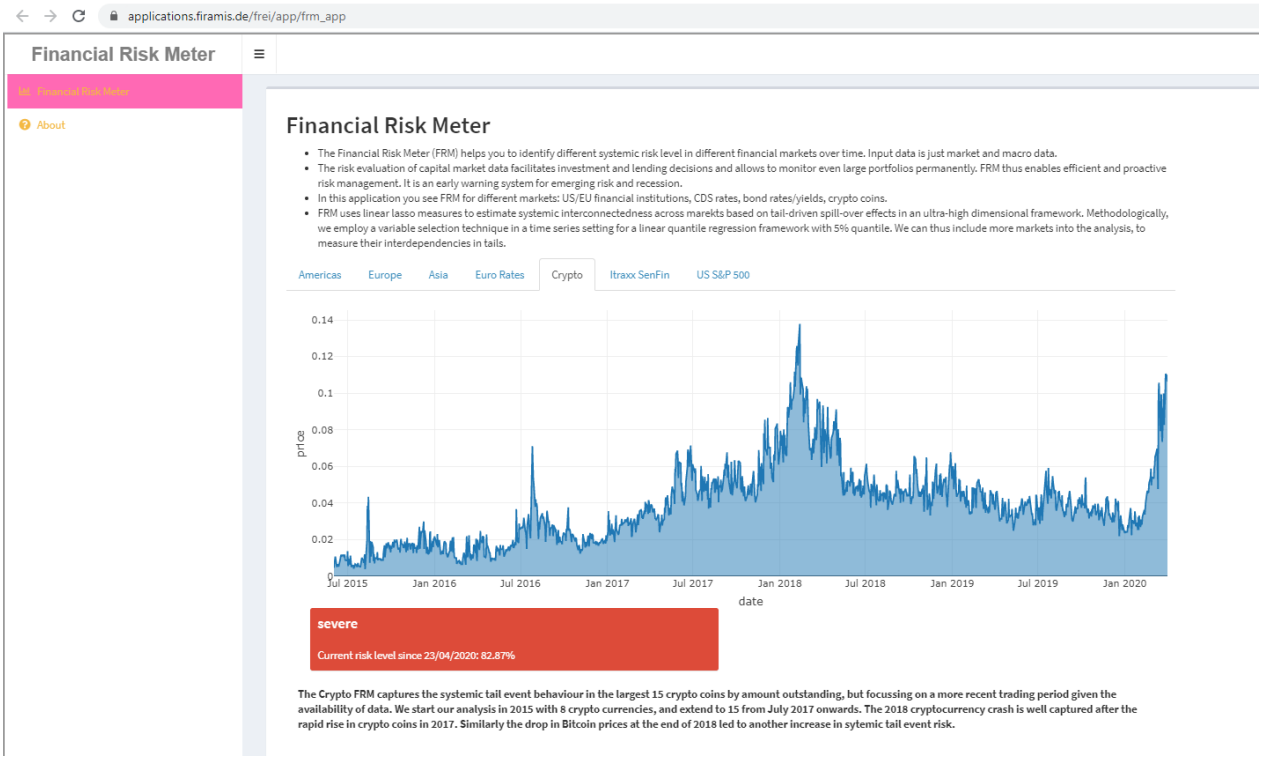
This is the git-based coding infrastructure where several developers can collaborate. A code versioning system supports the joint development work. It is hosted on the FIN-TECH server.



The seafile file exchange system is similar to Dropbox but is hosted on the FIN-TECH servers. For Each user it can be defined which files can be seen, changed and shared. It also includes a versioning system.



This LDAP dashboard supports the login management of the platform, the git-structure and the file exchange system. Inside each tool there can be different groups with different access rights to data, files and applications. External evaluators receive access to the use cases and material of the platform and in return they deliver the use case evaluations and feedback.



This examples shows the use case related to the Financial Risk Meter by UBER.

The automatic emailing has the following text:

Dear {{Name}} {{Surname}},

Welcome to the EU Horizon 2020 FIN-TECH project.

We are happy to have you as a member of our community.

The European FIN-TECH project coordination team hereby confirms your successful registration to use our online platform.

You can now login to the PLATFORM at https://www.fintech-ho2020.eu/links/ using the following email-address and static password:

- *email-adress: {{email}}*
- *password: {{Password}}*

Please contact us at info@fintech-ho2020.eu if you have any questions. During the registration process we have registered the following Information about you:

your name, email, password, affiliation, department, position, and role.

We need this data so you can use our online platform without any problems and without delay. The reason for this is that we will use this online platform to carry out the FIN-TECH project training courses.

In order to guarantee the security of our online platform, a login is mandatory, for which we need the above data.

The processing of your personal data is based on Art. 6 para. 1 f) GDPR (General Data Protection Regulation). Our legitimate interest, in particular with regard to the storage of your data, lies in the secure maintenance of our online platform. This requires a login and prior registration.

Please note that your data will be stored on the server of our carefully selected IT company Baden-IT, located in Freiburg (Germany), i.e. in the EU. We will not pass on your personal data to so-called third-party providers.

We store your data as long as your user profile is stored in our online platform. This means that if your user profile is deleted, we will also delete your personal data immediately.

Alternatively, you can contact us at any time to delete your personal data without stating any reasons. The contact details of our responsible person within the meaning of the GDPR are as follows:

Prof. Paolo Guidici
University of Pavia
Strada Nuova 65
27100 Pavia
Italy
Phone: 0039-382 98 4351
Email: paolo.giudici@unipv.it
If you should wish this, our responsible person in the sense of the GDPR will also inform you at any time about your relevant rights of information, correction, deletion and objection according to the GDPR. In addition, Prof. Paolo Guidici will inform you, in case of your corresponding request, about a possible restriction of the described data processing of our project as well as about your right to data transfer.

For the sake of completeness, we would like to point out that we do not engage in profiling within the meaning of Art. 22 GDPR.

Yours sincerely

European FIN-TECH project coordination team

The platform has the following welcome text:

Disclaimer: The material contained here is the result of research and development of the partners of the fintech project. The material could be used only for the same purposes, acknowledging the source papers. Each user that is not a partner of the project, or a supervisor, is expected to write an intermediate and a final feedback report.

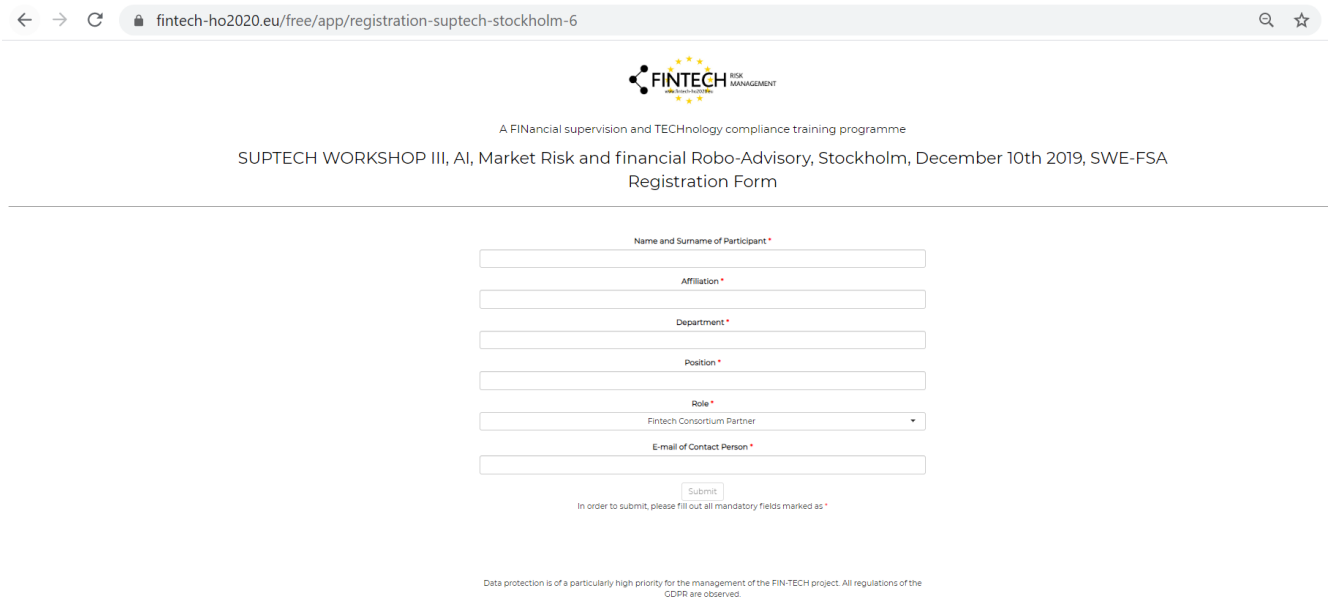
12. Forms engine

The forms engine enables a digital process for building repositories (workshop participants and participant feedback), collecting feedback and generating flexible reports for feedbacks and summary statistics.

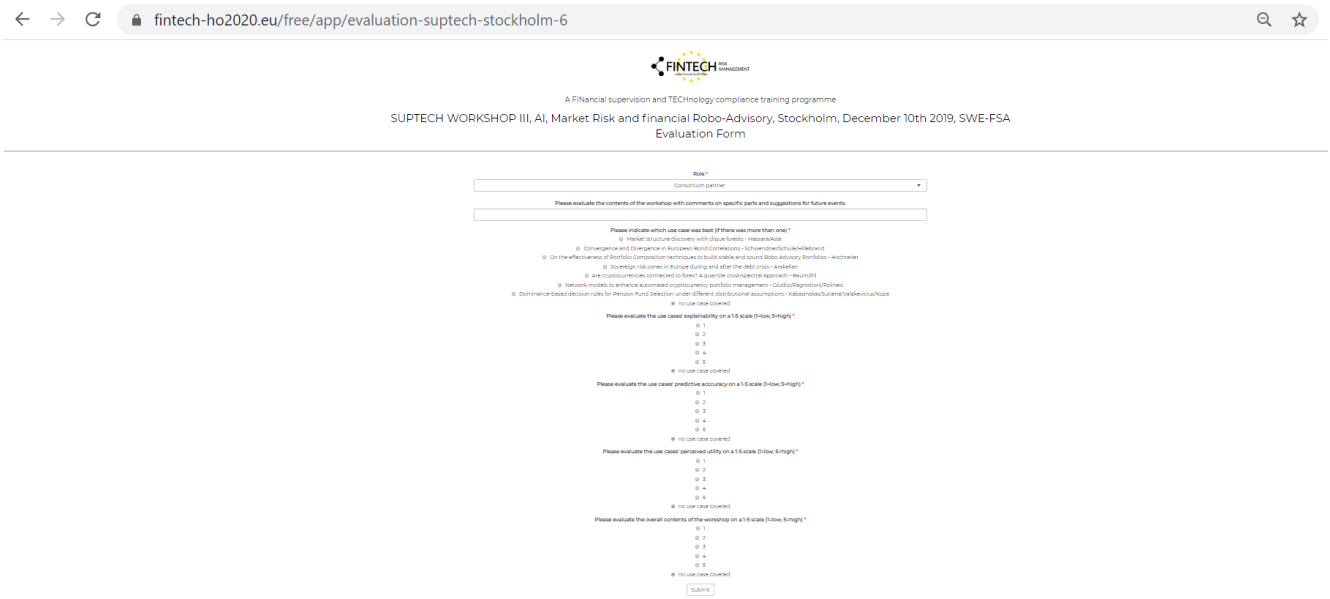
Based on Rshiny, we can set up new forms in minutes and add them to the automatic reporting. The engines collect feedback from supervisors, banks, fintechs, and other participant.

The forms engine has supported more than 200 forms in dozens of events/workshops (repositories, reports, statistics, documentation) since beginning of 2019. Here is an overview of the forms generated:

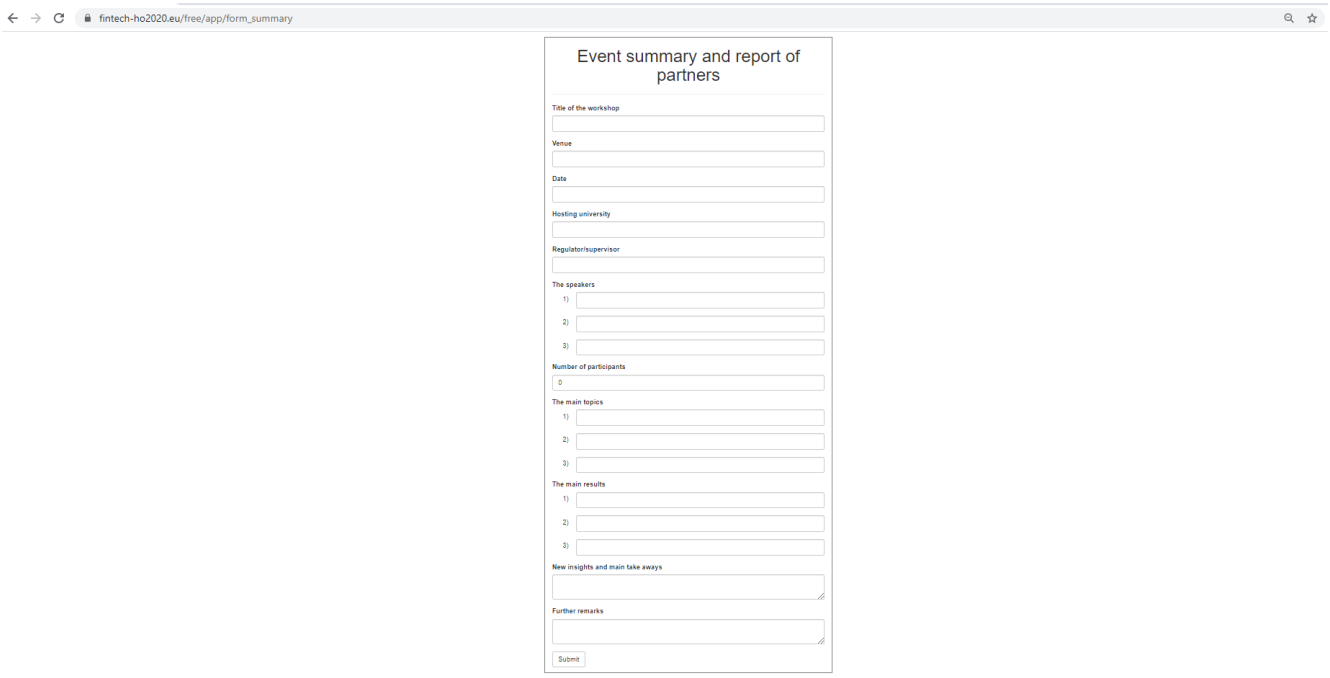
A typical registration form can be seen here: (https://www.fintech-ho2020.eu/free/app/registration-suptech-stockholm-6)



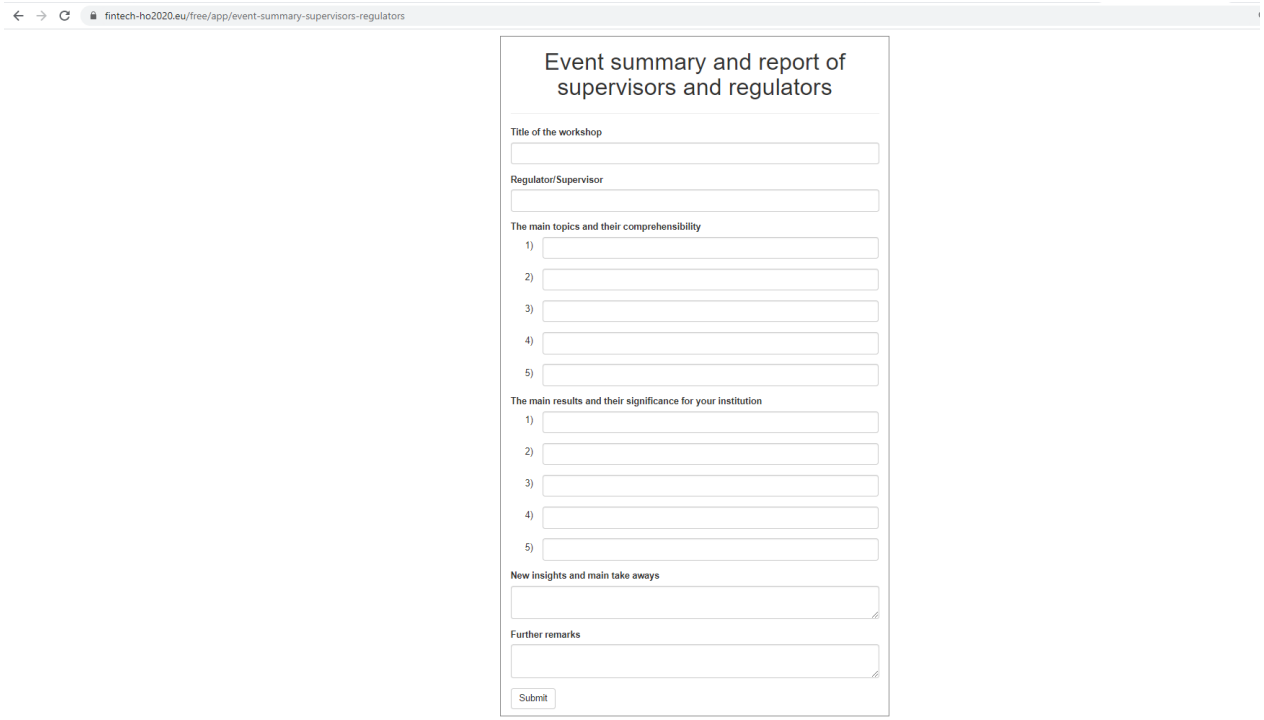
A typical suptech evaluation form can be seen here: (https://www.fintech-ho2020.eu/free/app/evaluation-suptech-stockholm-6)



Besides the usual Suptech and Regtech evaluation and registration forms there are special forms for collecting partner feedback for each event/workshop (more than 80 workshops supported so far): (https://www.fintech-ho2020.eu/free/app/form_summary)



And for collecting feedback from supervisors (the workshop coordinators) (https://www.fintech-ho2020.eu/free/app/event-summary-supervisors-regulators):

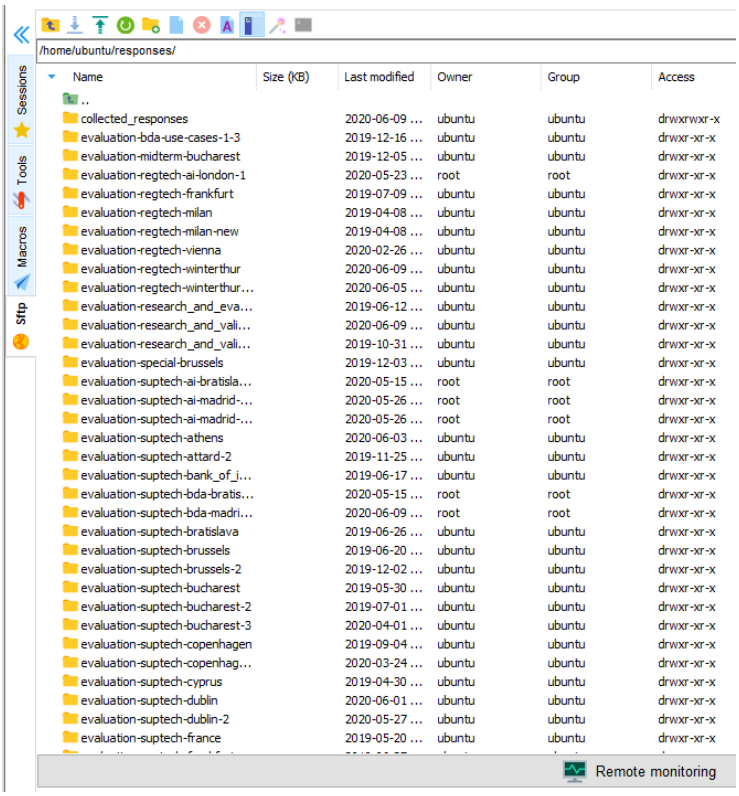


For the fintechs there is an older and newer version of forms (see below). It is directed towards understanding the obstacles to fintech scaling in Europe.

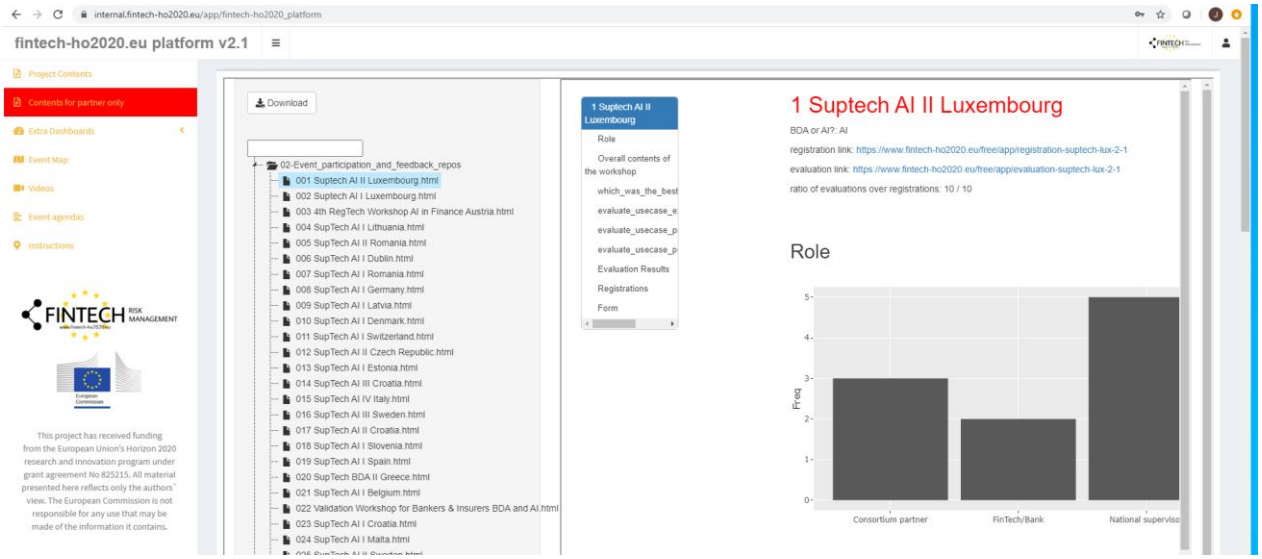
https://www.fintech-ho2020.eu/free/app/survey_impact_regulation

https://www.fintech-ho2020.eu/free/app/fintech_questionnaire

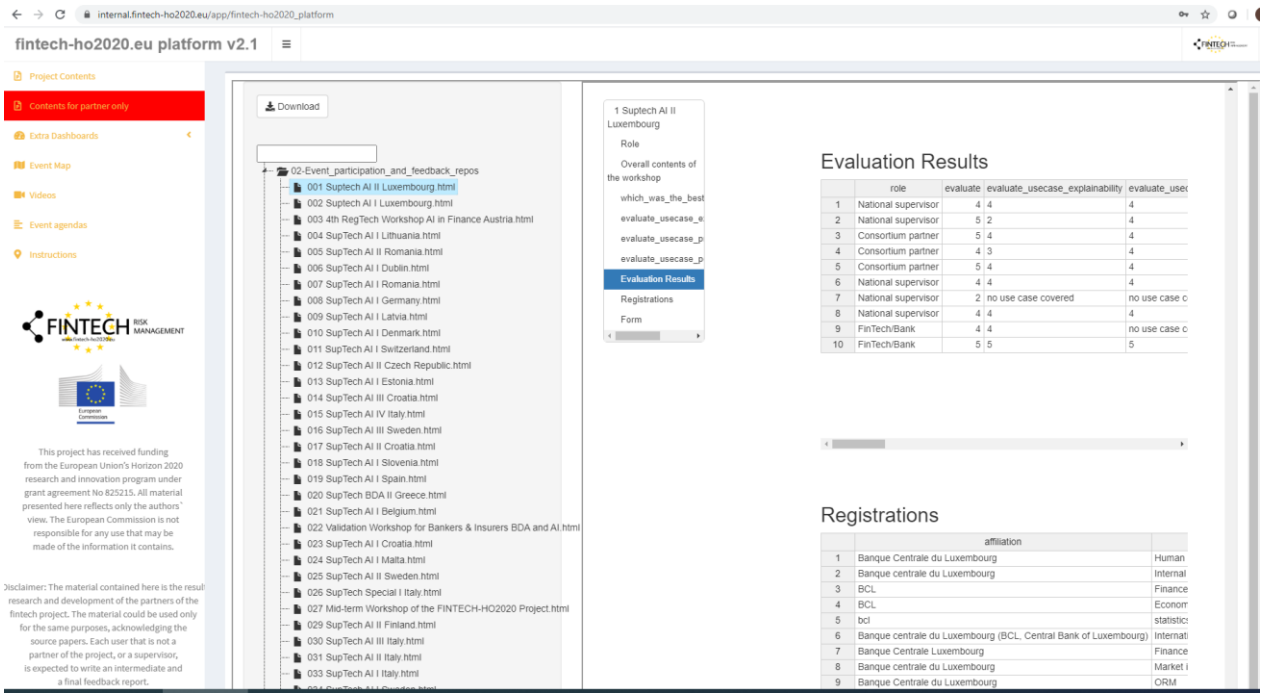
The forms are aggregated automatically on the server every minute by a script based to create a folder structure of csv files:



These raw files are then processed by tools for statistical analysis and interactive HTML reports of arbitrary granularity. The following screenshot shows a number of reports uploaded to the dissemination platform where they can be viewed and downloaded by specific users. The report shows some basic statistics:



The same report is displayed here in the platform's preview window and in this example the list of specific feedback entries can be visualized. The partners can view and extract the feedback which was given in their workshops by each workshop participant:


internal.fintech-ho2020.eu/app/fintech-ho2020_platform
fintech-ho2020.eu platform v2.1
Project Contents
Contents for partner only
Extra Dashboards
Event Map
Videos
Event agendas
Instructions
FINTECH RISK MANAGEMENT
This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 825215. All material presented here reflects only the authors` view. The European Commission is not responsible for any use that may be made of the information it contains.
Disclaimer: The material contained here is the result research and development of the partners of the fintech project. The material could be used only for the same purposes, acknowledging the source papers. Each user that is not a partner of the project, or a supervisor, is expected to write an intermediate and a final feedback report.
Download
02-Event_participation_and_feedback_repos
001 Suptech AI II Luxembourg.html
002 Suptech AI I Luxembourg.html
003 4th RegTech Workshop AI in Finance Austria.html
004 SupTech AI I Lithuania.html
005 SupTech AI II Romania.html
006 SupTech AI I Dublin.html
007 SupTech AI I Romania.html
008 SupTech AI I Germany.html
009 SupTech AI I Latvia.html
010 SupTech AI I Denmark.html
011 SupTech AI I Switzerland.html
012 SupTech AI II Czech Republic.html
013 SupTech AI I Estonia.html
014 SupTech AI III Croatia.html
015 SupTech AI IV Italy.html
016 SupTech AI III Sweden.html
017 SupTech AI II Croatia.html
018 SupTech AI I Slovenia.html
019 SupTech AI I Spain.html
020 SupTech BDA II Greece.html
021 SupTech AI I Belgium.html
022 Validation Workshop for Bankers & Insurers BDA and AI.html
023 SupTech AI I Croatia.html
024 SupTech AI I Malta.html
025 SupTech AI II Sweden.html
026 SupTech Special I Italy.html
027 Mid-term Workshop of the FINTECH-HO2020 Project.html
029 SupTech AI II Finland.html
030 SupTech AI III Italy.html
031 SupTech AI II Italy.html
033 SupTech AI I Italy.html
1 Suptech AI II Luxembourg
Role
Overall contents of the workshop
which_was_the_best
evaluate_usecase_e
evaluate_usecase_p
evaluate_usecase_p
Evaluation Results
Registrations
Form
Evaluation Results
role evaluate evaluate_usecase_explainability evaluate_usec
1 National supervisor 4 4 4
2 National supervisor 5 2 4
3 Consortium partner 5 4 4
4 Consortium partner 4 3 4
5 Consortium partner 5 4 4
6 National supervisor 4 4 4
7 National supervisor 2 no use case covered no use case c
8 National supervisor 4 4 4
9 FinTech/Bank 4 4 no use case c
10 FinTech/Bank 5 5 5
Registrations
affiliation
1 Banque Centrale du Luxembourg Human
2 Banque centrale du Luxembourg Internal
3 BCL Finance
4 BCL Econom
5 bcl statistic
6 Banque centrale du Luxembourg (BCL, Central Bank of Luxembourg) Internati
7 Banque Centrale Luxembourg Finance
8 Banque centrale du Luxembourg Market
9 Banque Centrale du Luxembourg ORM

13. Feedback by banks, fintechs and international supervisors/regulators

This chapter is more written from the perspective of the WP7 leader FIRAMIS. We worked closely with partners like UNIPV and many others to get feedback from by banks, fintechs and international supervisors/regulators.

Before approaching them we executed research on industry relevance of the project papers and use cases. We wanted to find out how relevant network models, graph theory and eXplainable AI is in the industry, how it is used, what are the risks and what publications exist by financial industry representatives, as well as by national and European supervisors. We also screened more than 400 articles, papers and websites related to these topics and use cases.

Also it was important to study the industry view on these topics, to set them into business context and develop a narrative to approach them and get feedback.

Nevertheless, it was not easy to recruit banks and fintechs as obviously they are extremely busy during their day-to-day business. We had access to a broad network and a connection to European fintech ecosystems based on our activity in this industry for more than 15 years.

One of the preparations was to establish contact the ECB and to the 3 European supervisory authorities (ESAs), namely:

- the European Banking Authority (EBA)
- the European Securities and Markets Authority (ESMA)
- the European Insurance and Occupational Pensions Authority (EIOPA)

The ECB offered a two-day 'Fintech dialogue' that we participated in and where we established contact to supervisors, banks and fintechs. We recognized that the intention of the ECB program was similar to ours so there very several internal meetings and workshops.

Collecting feedback from the financial industry

FIRAMIS organized a special workshop in Brussels for the following reasons:

- find banks and fintechs willing to evaluate the use cases
- connect to European supervisors, financial industry, EBF, local Hessian government
- Learn latest insights by European supervisors on BDA and AI
- Test the importance of XAI

Special Workshop Brussels organised by FIRAMIS
SPECIAL WORKSHOP FOR BANKERS & INSURERS on BDA AND AI
November 26th, 2019
With the friendly support of the Representation of the State of Hessen to the EU
In collaboration with EBF

Agenda:

Opening
Jochen Papenbrock & Prof. Paolo Giudici – The FINTECH project
Felix Holefleisch, Head of Unit- Hessian Ministry of Economics, Energy, Transport and Housing, Representation of the State of Hessen to the EU

Perspective of a European regulator / supervisor on modern Big Data and AI approaches
Gilles Bouvier, ECB

EBA's report on Big Data and Advanced Analytics
Andreas Papaetis, EBA

Big Data Analytics and Artificial Intelligence – risks and opportunities
Sébastien de Brouwer, EBF

The concept of Explainable AI
Jochen Papenbrock, FIRAMIS
Dimitri Marinelli, FIRAMIS

Panel
Moderator: Sebastian Fritz-Morgenthal, Bain & Company
Gilles Bouvier, ECB
Andreas Papaetis, EBA
Barak Chizi, KBC
Davide Corda, Intesa Sanpaolo
Peter Neu, DZ Bank

More information and feedback on this workshop can be found in this LinkedIn article created by workshop participants from DZ Bank and Bain&Company in the attachment 'DZ Bank_12.12.19.pdf' to the intermediate evaluation report as well as in the press release 'Brussels_special.pdf' also part of the intermediate evaluation report.

Parties participating, their roles and their responsibilities:

- European Central Bank
- AREA42 - Credendo
- CredaRate Solutions GmbH
- ESBG
- Professional Risk Managers International Association / FIS GLOBAL
- European Central Bank
- Austrian Savings Banks Association
- European Banking Federation
- National Bank of Belgium
- NVIDIA GmbH Germany
- European Commission
- European Banking Federation
- Deutsche Börse AG
- Deutsche Bank AG
- Landesbank Hessen-Thüringen
- DZ BANK
- Allianz SE
- ESBG
- NORD/LB
- Oliver Wyman GmbH
- Austrian Savings Banks Association
- Cicero Group
- European Association of Co-operative Banks

- ICLA In-house Competition Lawyers' Association
- AML
- BBVA
- European Banking Authority
- Intesa Sanpaolo
- Tetralog systems AG
- Banca MPS
- Bain & Company
- Ernst & Young GmbH
- ESBG-WSBI
- Intesa Sanpaolo
- KBC

Departments:

- Banking Supervision
- Innovation
- Internal Rating Models
- Digital, Retail and Markets Regulation
- Risk Management
- DG-MSIII
- European Affairs
- Policy
- Banking supervision
- Sales
- WWFO
- DG Connect
- Policy
- Department of Economics and Management
- Capital Markets Academy
- Regulatory Affairs
- Risk controlling
- Strategy & Corporate Development
- Group Regulatory and Public Affairs
- Regulatory Affairs
- Department
- Risk Control
- Commission
- Financial Services
- Brussels Office
- EU Public Affairs
- Retail Banking, Payments and Financial Markets
- Competition
- Risk and compliance

- European Public Affairs
- CEO Office
- Banking Markets, Innovation and Products Unit
- Group Data Office
- Partner
- Organizzation Area
- Economics
- Global Risk
- Machine Learning
- Management
- Intys FSA
- FSO Advisory - Quantitative and Analytics Services
- Regulatory Affairs
- European Regulatory and Public Affairs
- BDA and AI
- fintech partnerships
- KBC
- Bacon
- Algo Trading

Positions:

- Analyst
- Manager
- CEO
- Digital & Retail policy adviser
- Managing Director
- Supervisor
- Head
- Chief Policy Officer
- Financial & Risk Analyst
- Account Manager
- Sr. Solution Architect FSI-EMEA
- Policy Officer
- Policy Adviser
- Assistant Professor
- Team Head
- Regulatory Policy & Advocacy - Digital
- Head of portfolio methods
- Division Head, Managing Director
- Head of European Affairs Office
- Legal Advisor
- Senior Financial Services Correspondent
- Head of RiskLab

- Policy officer
- Partner
- EU Adviser
- Associate (focused on Fintech)
- Senior Adviser, Retail Banking and Consumer Policy
- ICLA Italia Chairman
- Software architect
- Head of EU Digital Public Affairs
- CEO
- Policy expert
- Head of Data Transformation
- Research Consultant
- Head of Process Innovation
- Professor
- Head of Global Risk
- Data scientist and quantitative analyst
- CLO
- Manager
- Partner
- Adviser
- Policy Adviser
- General manger big data, data analytics and AI
- partner
- GM AI and Big Data
- Producer
- Asst Vice President

How will they stay involved?
The event was intended, among other reasons, to connect each other and to strengthen the project network and ecosystem Workshop participants had the opportunity to connect to each other in interactive sessions like the panel discussion.
Also, we invited people to follow the project in the future and to acquire them as evaluators of the project use cases, granting access to the platform.

Back in Frankfurt we connected several of the participants by local physical meetings on by email/phone. They receive updates regarding the future activities of the project and how to engage.

What is their feedback on the use cases presented? Are the selected use cases in the end the ones that meet the expectations and requirements at most?

The event was a success. Many participants from a very heterogeneous background were involved. Several banks could be acquired to deliver a feedback on the XAI use case and the

network analysis use cases. Some banks invited us to deliver follow-up presentations on these topics. To some of them it was to learn about the potential to open black box models and to explain them.

The event preparation had begun several months before the event and was directed to activate a large group of relevant people to follow the activity. We could not only reach banks and fintech but also groups representing the financial service industry on European level. We use the FIRAMIS and UNIPV network for as well as social media like LinkedIn as well as our meetings with ECB, EBA, EIOPA and other authorities

Here some direct feedback by the participants:

'great event'

'Excellent workshop - very instightful even for a non-technical person. Found extremely intersting the part presented by FIRAMIS on how to overocme trade off between accuracy and description in models.'

'Discussions were very good, mix between Roles was good.'

'Good overview of current project status and activities for new (fintech)participants'

Further dissemination activities

A large number of channels, multiplicators and events was used to inform the public and the consortium partners about the project activities and related developments. It was used to spread the objective of the project, to create a network and ecosystem around it, to acquire new supporters and experts giving feedback, and find further partners e.g. for the exploitation phase. The following shows a list of activities (excerpt):

Section Frontiers Journal on AI in Financial Services: It is an open-access journal where Professor Giudici and Dr. Jochen Papenbrock are co-editors. A larger number of papers from this project have been published there:

https://www.frontiersin.org/journals/artificial-intelligence/sections/artificial-intelligence-in-finance

The BDA network-based use cases re in this journal as well as the XAI use case and this editorial:
R. Hochreiter, P. Giudici, J. Osterrieder, J. Papenbrock, P Schwendner. Editorial: AI and Financial Technology. Frontiers in Artificial Intelligence 2, 25. 2019.
(https://www.frontiersin.org/articles/10.3389/frai.2019.00025/full)

Events, external workshops, conferences, seminars etc.:

6th of december 2019, xai-presentation at EIOPA insurtech task force in Frankfurt (XAI and FIN-TECH presentation)
11th of december 2019, representing fin-tech and XAI project at eu fintech lab in brussels (most other fintech startups had XAI on the agenda as well)
ESMA morning 3rd Feb (presentation of use cases)
EBA afternoon 3rd Feb (presentation of use cases)
Banque de France (Autorité de contrôle prudentiel et de resolution) discussion on XAI
ECB January 30th (presentation of use cases)
EBC Fintech Dialogue (2 days)
Two trips to Brussels meeting the EC

Acquisition of Evaluators (Banks, Fintechs, Associations, Fintech Hubs, etc.): by email, phone, by personal visit and by extra events like the one in Brussels

Dashboard visualisations for the Financial Risk Meter (prof. Härdle from UBER) and Contagion Risk Monitor (Prof. Schwendner from ZHAW)

Press release: https://www.openaccessgovernment.org/artificial-intelligence-apps/72323/

Blog: https://firamis.de/ai-fintech-riskmanagement-regulation/

Partnering/Exploitation discussion by FIRAMIS:

Deutsche Telekom (Cloud): https://open-telekom-cloud.com/de)
Microsoft (Cloud/ML,XAI)
EBF
https://www.infinitech-h2020.eu/
https://bigdatastack.eu/
https://www.big-data-value.eu/
Dell
Fujitsu
Tagetik
FIRM: https://www.firm.fm/en.html (presenting the project at 2 AI Roundtables in front of risk management executives in the financial services industry)
AIinFS (https://www.aiinfs.com/) Meetup activity also presenting the project
BDC and State of Hessen Ministry of Economics
Blockhain Sandner and EU Observatory
AI4EU
www.v29.tech
https://frankfurt-digital-finance.de/
https://techquartier.com/
https://www.frankfurt-school.de/home/research/centres/blockchain
https://appliedai.de/
Several Associations of German/European Banks
Deloitte
Ernst&Young

Unicredit (XAI and network analysis with interest, recently with network on high prio to analyse the COVID shifts in clients begaviour)
Intesa (XAI and network analysis with high interest)
Oliver Wyman
DZ Bank
Allianz Investment Managers
Deutsche Bank
Quoniam
Commerzbank
PWC AI Meetup
Frankfurt Data Science Meetup

Social media activity:

Promoting the project through FIRAMIS social media channels (some of them > 10.000 views):

https://www.linkedin.com/posts/jochenpapenbrock_horizon2020-p2plending-crowdfunding-activity-6663010417968717824-tkck

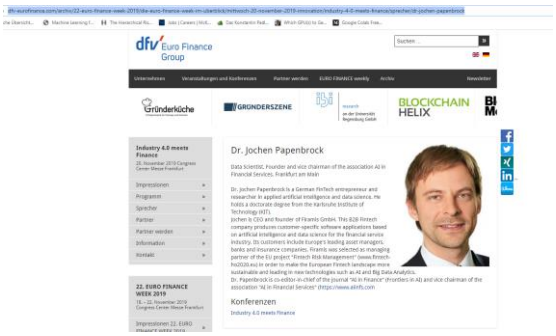
https://www.linkedin.com/posts/jochenpapenbrock_three-quant-lessons-from-covid-19-activity-6649223042629152768-ivNu/

Further event activity:

https://frankfurt-digital-finance.de/speakers/jochen-papenbrock/

Frankfurt digital finance -> we approached by Mr Wuermeling frm Bundesbank who confirmed the 'explainability gap of AI'

Euro Finance Week: https://www.dfv-eurofinance.com/archiv/22-euro-finance-week-2019/die-euro-finance-week-im-uberblick/mittwoch-20-november-2019-innovation/industry-4-0-meets-finance/sprecher/dr-jochen-papenbrock



14. Background information on the paper 'Explainable AI in credit risk management'

Paper download: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3506274

This research has received funding from the European Union's Horizon 2020 research and innovation program "FIN-TECH: A Financial supervision and Technology compliance training programme" under the grant agreement No 825215. Firamis acknowledges the NVIDIA Inception DACH program for the computational GPU resources.

The machine-learning-based and visual procedure proposed in the paper processes the outcomes of another arbitrary machine learning model. It provides more insight, control and transparency to a trained, potentially black box machine learning model.

It utilises a model-agnostic method aiming at identifying the decision-making criteria of an AI system in the form of variable importance (individual input variable contributions) with applications in credit risk assessment and management as well as in other (financial) areas.

A key concept is the Shapley value decomposition of a model, a pay-off concept from cooperative game theory. To the best of our knowledge it is so far the only XAI (explainable AI) approach rooted in an economic foundation.

The approach offers a breakdown of variable contributions to the forecast probability. That means that every data point (e.g. a credit or loan customer in a portfolio) is not only represented by input features (the input of the machine learning model) but also by variable contributions to the prediction of the trained machine learning model.

The new contribution of the paper

Similar combinations of variable contributions are mapped into spatial neighborhoods on a map. This means that the data points are arranged on a map such that neighboring data points exhibit similar decision making mechanisms of the trained machine learning model.

The similarity/proximity of variable contributions (the paper uses an Euclidean Distance matrix) is expressed as a symmetric matrix of dimension nxn where n Is the number of data points in the (train) data set. Each entry of the matrix measures how similar or distant a pair of data points is in terms of their profile or combination of variable contributions.

This matrix can be used for visual mapping based on dimensionality reduction techniques (like PCA, MDS, t-SNE), or for representation learning like clustering and graph-analytics (like community detection).

Those data-driven, learned representations reveal segmentations of data points (customers) where each of those clusters contains very similar decision making whereas data points in other clusters exhibit very different decision making

(Hierarchical) Clustering and especially graph theory and network analytics are very well suited to study complex systems. Those systems are characterized by emergent, self-organizing properties. Our approach treats the variable contribution outcome of a (black box) machine learning model as a complex system and further analyses its properties by graph theory and cluster analysis. In this way the user gets a better and deeper understanding of what exactly a black box machine learning has learned. The following phenomena inside the black box model can be analysed and understood: trends, anomalies, hot spots, emergent effects and tipping points. Since our methodology is model agnostic it can be applied to any machine learning model. This also enables a comparison of several machine learning models trained on the same data. The complex system of decision-making mechanisms that belong to a set of machine learning models can be compared to each other.

XAI and Graph Analytics are some of the most trending approaches, currently becoming very relevant in the financial service industry, both for regulatory and economic reasons. This is underlined by the conclusion of Gartner that graph analytics and XAI will be some of the most trending technologies in the next years (https://www.gartner.com/smarterwithgartner/gartner-top-10-data-analytics-trends/).

Paper uses TreeSHAP, a consistent and accurate method, available in open-source packages. Tree SHAP is a fast algorithm that can exactly compute SHAP values for trees in polynomial time instead of the classical exponential runtime (https://arxiv.org/abs/1802.03888)

Our Paper does not follow a causal approach. However, it brings transparency to the statistical inference of a potential black box machine learning in mapping and learning representations of the model's decision making mechanisms which in turn are based on the variable contributions produced by the black box model.

For the xgboost part of our model we use NVIDIA GPUs to considerably speed up the computations. The TeeSHAP method can quickly extract the information from the xgboost model.

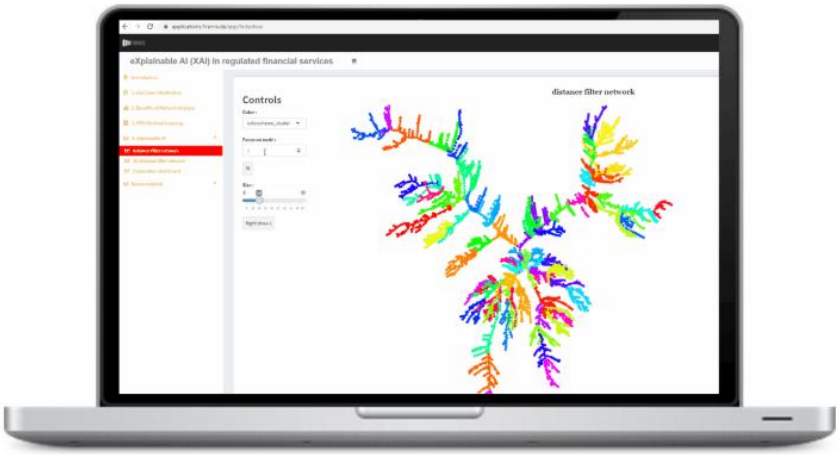
The paper is based on the SHAP concept:

S Lundberg, S.-I Lee. 'A unified approach to interpreting model predictions', Advances in Neural Information Processing Systems, volume 30, p. 4765 – 4774, https://arxiv.org/abs/1705.07874

The paper is related to:

- Bank of England: 'Machine learning explainability in finance: an application to default risk analysis' https://www.bankofengland.co.uk/working-paper/2019/machine-learning-explainability-in-finance-an-application-to-default-risk-analysis
- Bank of England: 'Shapley regressions: a framework for statistical inference on machine learning models': https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2019/shapley-regressions-a-framework-for-statistical-inference-on-machine-learning-models.pdf

Further information and the following visualisations of the XAI web-application can be found here: https://firamis.de/ai-fintech-riskmanagement-regulation/



Visualising the 'brain' of an arbitrary (black-box) AI model. Explainable AI is one of the key technologies for human-centric, trustworthy and responsible AI made in Europe. Among others there are two focus areas in this EU Horizon2020 project and also in the fintech company Firamis GmbH: Graph analytics and eXplainable AI (XAI). Nodes are customers of a credit portfolio. The links connect similar AI-decision-making for groups of customers. Similar decision making is color coded in the nodes.

Demonstrations of the XAI application to find and potentially explain buggy ‘areas’ of the machine learning model.

15. Self-reporting statistics by partners -

This is a feedback by the partners about their deliverables. It is mainly to check if all material the partners sent has been handed in and recognised.

0) Partner name:	POLIMI	Tampere University	ASE	KTU	UCM (Madrid)	ZHAW	Panteion	WU Vienna	FIRAMIS	Masaryk University	UNIPV	UBER	Rijeka, Croatia	INESC TEC	WARSAW	Modefinance	UCD	UCL	VARNA
1) # of Suptech workshops organized (break down by BDA and AI):																			
BDA	4	6	2	1	3	5	3	extra rep	1	2	2	1	4	1	1	1	1	3	2
AI	4	6	1	3	2	1	0	extra rep	1	2	2	1	3				1	1	
2) Total # of participants and # of feedbacks in all your workshops organised:																			
participants	168	174	34	162	29	136	100		159	92	160	38	135	36	17	61	15	22	59
feedbacks	69	43	13	48	21	72	38		73	39	35	32	115	10	5	14	15	24	30
3) Partner feedback (based on form AND as text file) for all your Suptech workshops organised delivered (yes or no):	YES	YES	YES	YES	YES	YES	YES	extra rep	YES	YES	YES	YES	YES	YES		NO	YES	YES	YES
4) Supervisors' feedbacks delivered? (answer separately for BDA and AI):																			
BDA	YES	YES	YES	YES	YES	YES	YES	extra rep	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	YES
AI	YES	YES	YES	YES	YES	NO	NO	extra rep	YES	YES	YES	YES	YES				YES	NO	
5) # of industry feedback reports collected:	NONE	NONE	NONE	NONE	NONE	pending	NONE	extra rep	3	NONE	NONE	NONE	NONE	NONE	NONE	3	NONE	NONE	NONE
6) Extra feedback provided? (yes or no):	NONE	NONE	NONE	NONE	NONE	NONE	NONE	extra rep	YES	NONE	YES	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

16. SupTech Workshop Statistics

As described in the content of the report it was created a forms-generating-engine at the beginning of the project and it was used to the majority of events. It collects, analyses and aggregates structured feedback from the workshops and in this annex we report about the feedback of the Suptech events with different pivot tables, slicing the data in different views and aggregations. We remove the influence of consortium partners from all analysis presented, so we catch only external evaluations.

The data collection process is applied to the large part of Suptech workshops, attempting to create a data base that is as structured, standardised and unified as possible. It was succeeded to create this data although applied to a large number of events, across several months since project inception, and across different countries and infrastructures. Noteworthy is the fact that there exist a few exceptions acting as outliers from the standardized approach. However, the main results of the structured data are representative for the entire range of events (Suptechs). The list of limitations aggregated based on the existing exceptions including the reasons is as follows:

The BDA data is more structured than AI as there was an almost constant number of use cases selected near project inception in order to start the structured workshops including feedback collection. The AI part is more open and there was a large variety of use cases presented in the workshops. Some of these use cases were later removed. Due to the larger amount of use cases not all of them were presented in each and every suptech. For this reason, there is a semi-automatic approach applied to identify the most prominent use cases.

1. The BDA data is more structured than AI as there was an almost constant number of use cases selected near project inception in order to start the structured workshops including feedback collection. The AI part is more open and there was a large variety of use cases presented in the workshops. Some of these use cases were later removed. Due to the larger amount of use cases not all of them were presented in each and every Suptech. For this reason, there is a semi-automatic approach applied to identify the most prominent use cases.
2. The forms emerged over time due to project feedback so there were slight breaks in structure.
3. Few workshops feedbacks were handed in as text feedback or in proprietary format, generated by the supervisors, relying on their own evaluation systems. Some of these were manually transformed into the data structure of the project, when possible.
4. Some workshops were organized as a mix of BDA and AI for organizational reasons, often related to constraints given by the supervisory authorities. Some workshops were also split in several sessions, some of them with less use case discussion, others entirely dedicated to use cases. Some workshop covered several days and a smaller or different audience was invited to the more technical use cases. This was necessary to keep up the relevance of the contents to the correct audience. There are smaller deviations from the standard in order to meet the local, temporal and specific requirements of the supervisors and presenters.

a. Big Data Analytics statistics

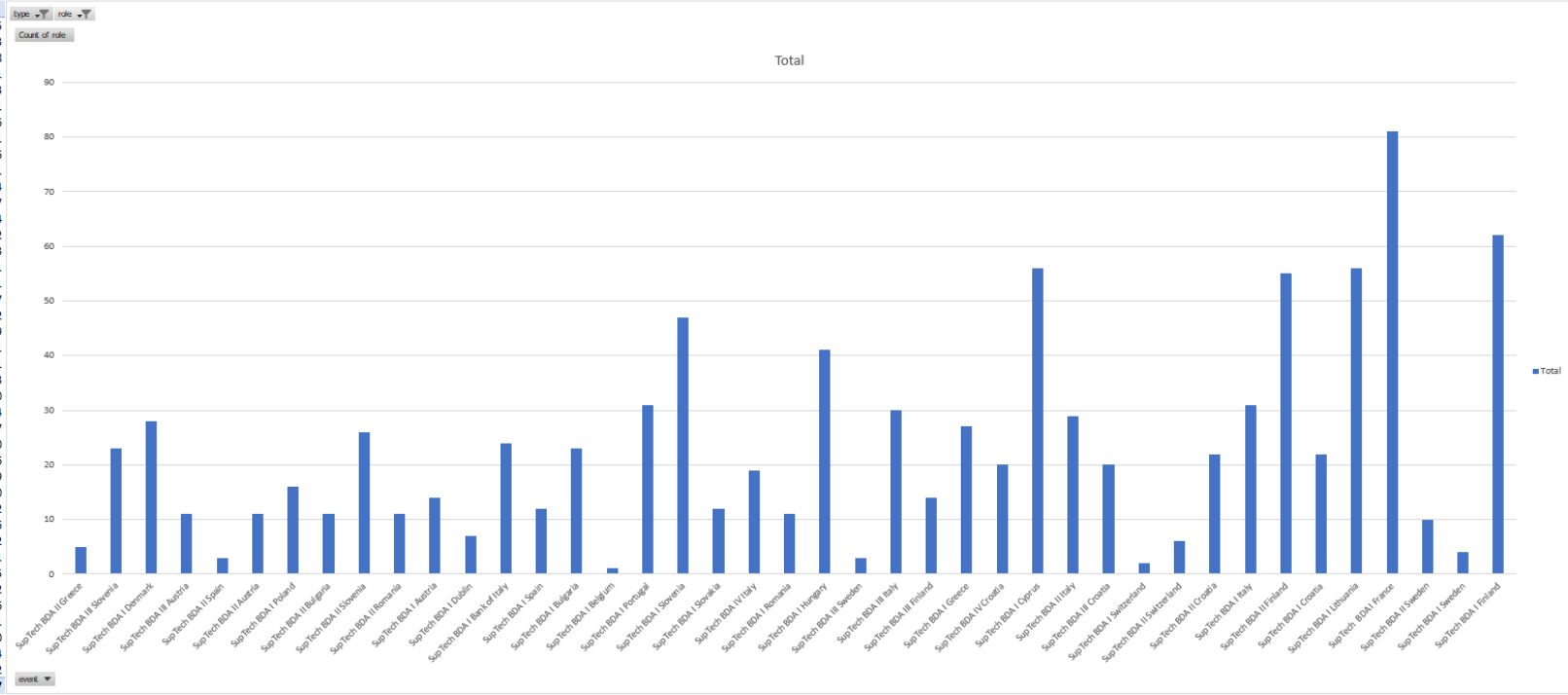
As introduced into the paragraph “Structured analysis” we report here the following statistics:

- Number of participants[2] per workshop;
- Number of participants per role;
- Number of feedbacks by role per workshop;
- Average overall rating of the workshop per workshop;
- Average overall rating of the workshop per role;
- Best use case (number of votes per use case);
- Best use case (number of votes per use case / per workshop);
- Best use case (number of votes per use case / per role);
- Average rating of uses cases’ explainability per workshop;
- Average rating of uses cases’ explainability per role;
- Average rating of uses cases’ predictive accuracy per workshop;
- Average rating of uses cases’ predictive accuracy per role;
- Average rating of uses cases’ perceived utility per workshop;
- Average rating of uses cases’ perceived utility per role;

[2] Registrants and participants are synonymous: although during events not all participants physically present met the requirement to register through the link provided with agendas and through dissemination channels.

type	BDA
role	(Multiple Items)

Row Labels	Count of role
SupTech BDA II Greece	5
SupTech BDA III Slovenia	23
SupTech BDA I Denmark	28
SupTech BDA III Austria	11
SupTech BDA II Spain	3
SupTech BDA II Austria	11
SupTech BDA I Poland	16
SupTech BDA II Bulgaria	11
SupTech BDA II Slovenia	26
SupTech BDA II Romania	11
SupTech BDA I Austria	14
SupTech BDA I Dublin	7
SupTech BDA I Bank of Italy	24
SupTech BDA I Spain	12
SupTech BDA I Bulgaria	23
SupTech BDA I Belgium	1
SupTech BDA I Portugal	31
SupTech BDA I Slovenia	47
SupTech BDA I Slovakia	12
SupTech BDA IV Italy	19
SupTech BDA I Romania	11
SupTech BDA I Hungary	41
SupTech BDA III Sweden	3
SupTech BDA III Italy	30
SupTech BDA III Finland	14
SupTech BDA I Greece	27
SupTech BDA IV Croatia	20
SupTech BDA I Cyprus	56
SupTech BDA II Italy	29
SupTech BDA III Croatia	20
SupTech BDA I Switzerland	2
SupTech BDA II Switzerland	6
SupTech BDA II Croatia	22
SupTech BDA I Italy	31
SupTech BDA II Finland	55
SupTech BDA I Croatia	22
SupTech BDA I Lithuania	56
SupTech BDA I France	81
SupTech BDA II Sweden	10
SupTech BDA I Sweden	4
SupTech BDA I Finland	62
Grand Total	**937**



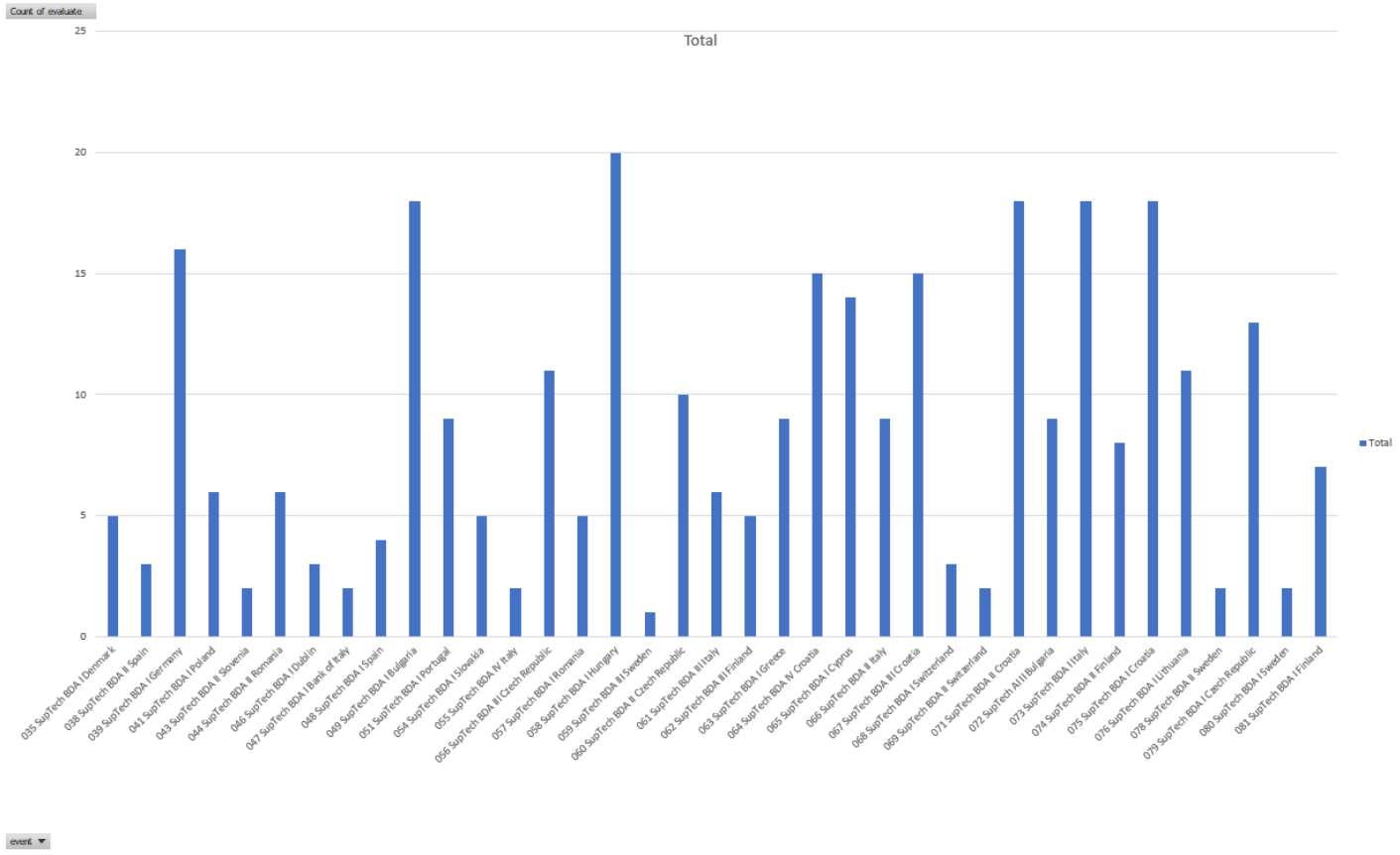
Number of registrations by workshop.

type	BDA

Row Labels	Count of role
FinTech/Bank	67
International regulator/adviser	40
National supervisor	830
Grand Total	**937**

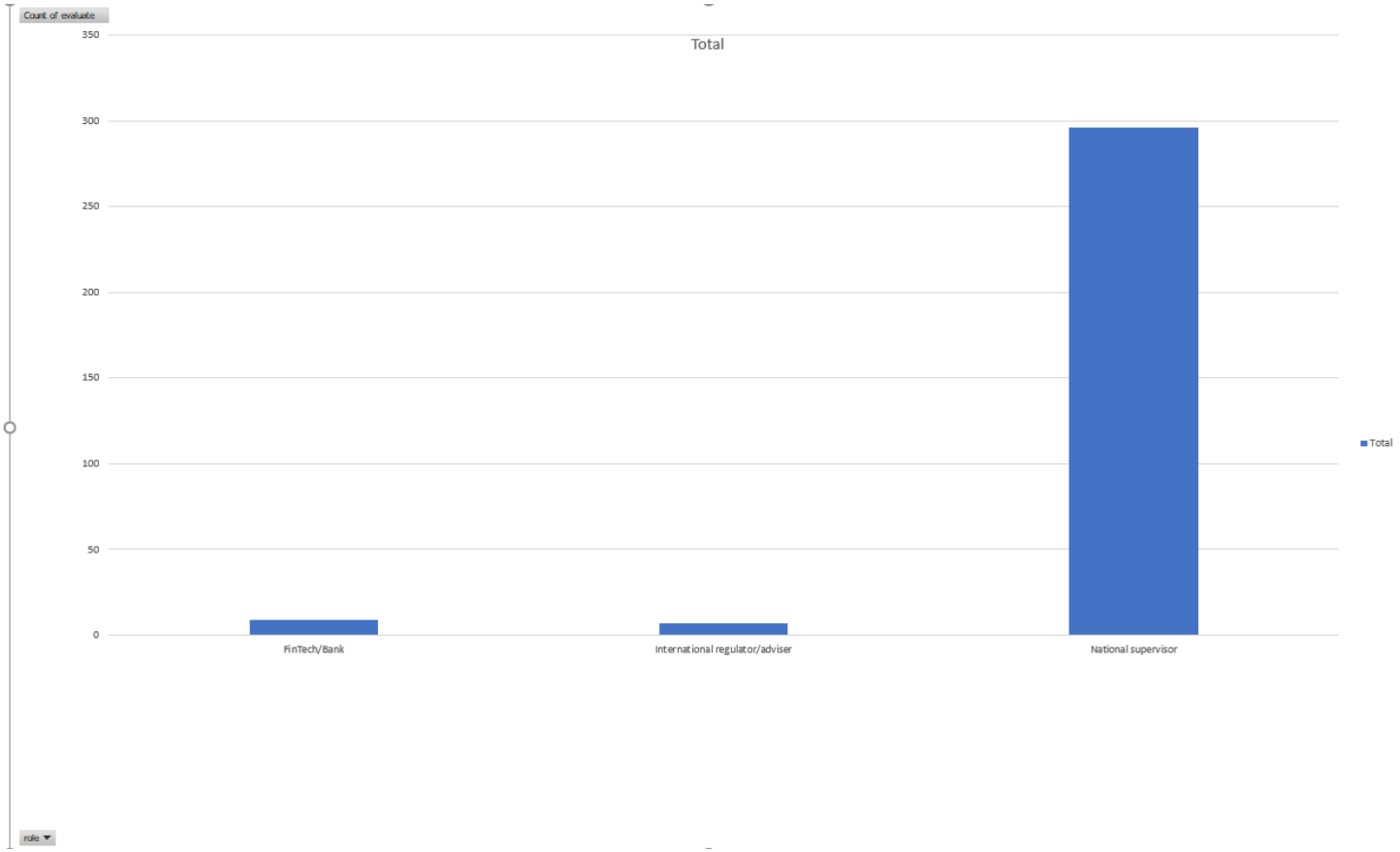
Number of registrations by role.

Row Labels	Count of evaluate
035 SupTech BDA I Denmark	5
038 SupTech BDA II Spain	3
039 SupTech BDA I Germany	16
041 SupTech BDA I Poland	6
043 SupTech BDA II Slovenia	2
044 SupTech BDA II Romania	6
046 SupTech BDA I Dublin	3
047 SupTech BDA I Bank of Italy	2
048 SupTech BDA I Spain	4
049 SupTech BDA I Bulgaria	18
051 SupTech BDA I Portugal	9
054 SupTech BDA I Slovakia	5
055 SupTech BDA IV Italy	2
056 SupTech BDA III Czech Republic	11
057 SupTech BDA I Romania	5
058 SupTech BDA I Hungary	20
059 SupTech BDA III Sweden	1
060 SupTech BDA II Czech Republic	10
061 SupTech BDA III Italy	6
062 SupTech BDA III Finland	5
063 SupTech BDA I Greece	9
064 SupTech BDA IV Croatia	15
065 SupTech BDA I Cyprus	14
066 SupTech BDA II Italy	9
067 SupTech BDA III Croatia	15
068 SupTech BDA I Switzerland	3
069 SupTech BDA II Switzerland	2
071 SupTech BDA II Croatia	18
072 SupTech AI II Bulgaria	9
073 SupTech BDA I Italy	18
074 SupTech BDA II Finland	8
075 SupTech BDA I Croatia	18
076 SupTech BDA I Lithuania	11
078 SupTech BDA II Sweden	2
079 SupTech BDA I Czech Republic	13
080 SupTech BDA I Sweden	2
081 SupTech BDA I Finland	7
Grand Total	**312**



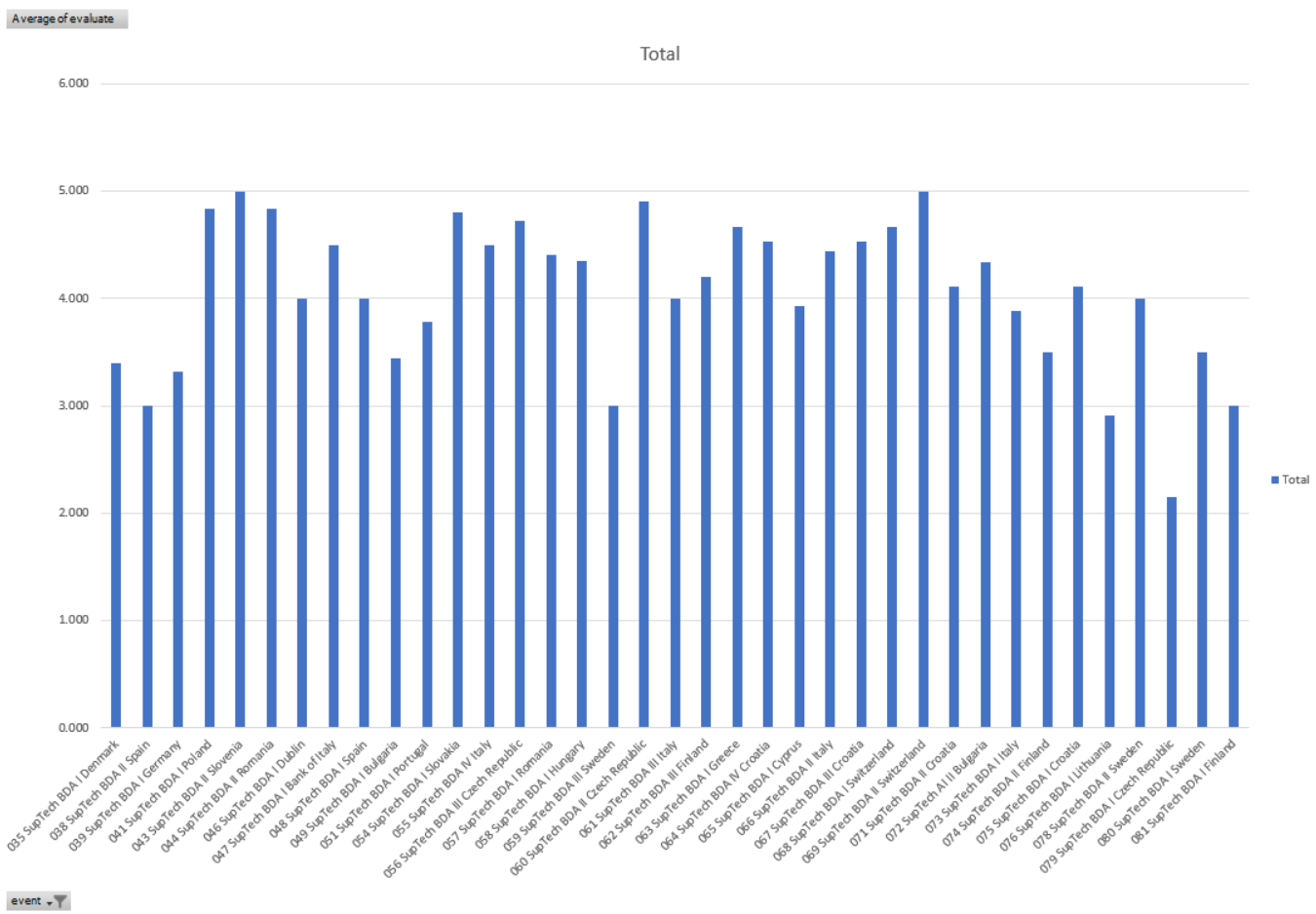
Amount of feedbacks generated per workshop.

Row Labels	Count of evaluate
FinTech/Bank	9
International regulator/adviser	7
National supervisor	296
Grand Total	**312**



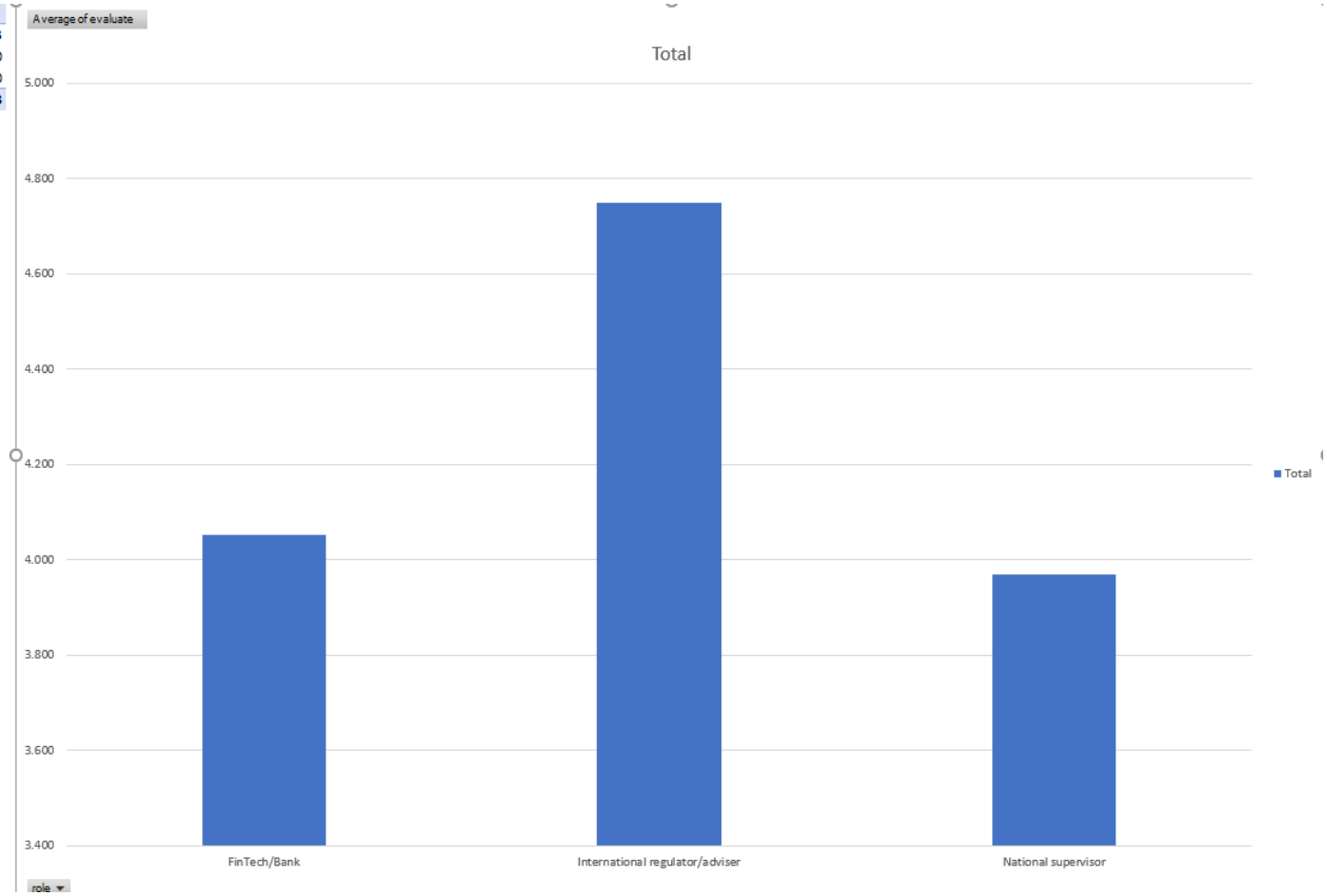
Amount of feedbacks generated per role.

Row Labels	Average of evaluate
035 SupTech BDA I Denmark	3.400
038 SupTech BDA II Spain	3.000
039 SupTech BDA I Germany	3.313
041 SupTech BDA I Poland	4.833
043 SupTech BDA II Slovenia	5.000
044 SupTech BDA II Romania	4.833
046 SupTech BDA I Dublin	4.000
047 SupTech BDA I Bank of Italy	4.500
048 SupTech BDA I Spain	4.000
049 SupTech BDA I Bulgaria	3.444
051 SupTech BDA I Portugal	3.778
054 SupTech BDA I Slovakia	4.800
055 SupTech BDA IV Italy	4.500
056 SupTech BDA III Czech Republic	4.727
057 SupTech BDA I Romania	4.400
058 SupTech BDA I Hungary	4.350
059 SupTech BDA III Sweden	3.000
060 SupTech BDA II Czech Republic	4.900
061 SupTech BDA III Italy	4.000
062 SupTech BDA III Finland	4.200
063 SupTech BDA I Greece	4.667
064 SupTech BDA IV Croatia	4.533
065 SupTech BDA I Cyprus	3.929
066 SupTech BDA II Italy	4.444
067 SupTech BDA III Croatia	4.533
068 SupTech BDA I Switzerland	4.667
069 SupTech BDA II Switzerland	5.000
071 SupTech BDA II Croatia	4.111
072 SupTech AI II Bulgaria	4.333
073 SupTech BDA I Italy	3.889
074 SupTech BDA II Finland	3.500
075 SupTech BDA I Croatia	4.111
076 SupTech BDA I Lithuania	2.909
078 SupTech BDA II Sweden	4.000
079 SupTech BDA I Czech Republic	2.154
080 SupTech BDA I Sweden	3.500
081 SupTech BDA I Finland	3.000
Grand Total	**4.003**



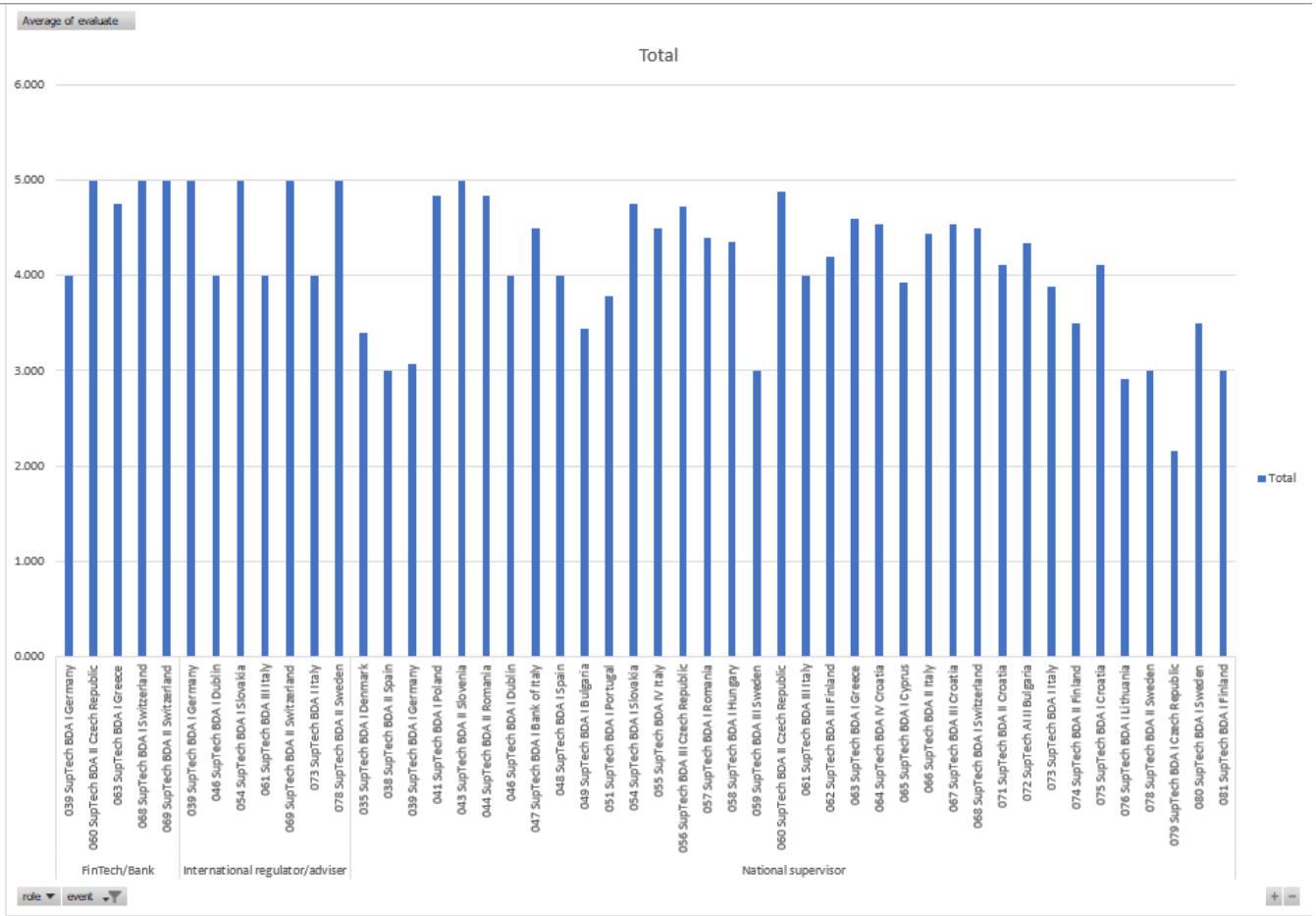
Average overall evaluation of workshops by workshop.

Row Labels	Average of evaluate
FinTech/Bank	4.053
International regulator/adviser	4.750
National supervisor	3.970
Grand Total	**4.003**



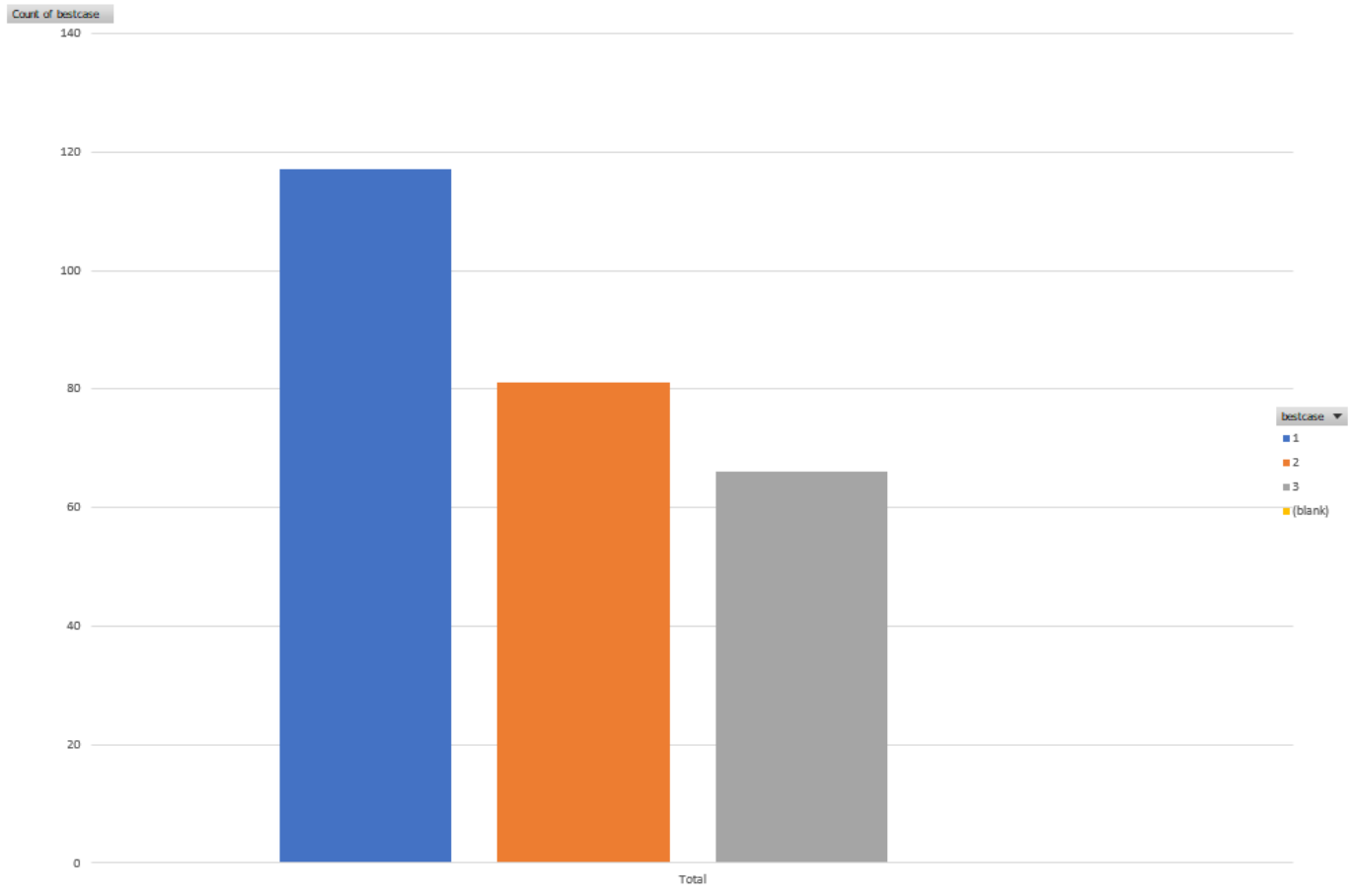
Average overall evaluation of workshops by role.

Row Labels	Average of evaluate
FinTech/Bank	**4.667**
039 SupTech BDA I Germany	4.000
060 SupTech BDA II Czech Republi	5.000
063 SupTech BDA I Greece	4.750
068 SupTech BDA I Switzerland	5.000
069 SupTech BDA II Switzerland	5.000
International regulator/adviser	**4.571**
039 SupTech BDA I Germany	5.000
046 SupTech BDA I Dublin	4.000
054 SupTech BDA I Slovakia	5.000
061 SupTech BDA III Italy	4.000
069 SupTech BDA II Switzerland	5.000
073 SupTech BDA I Italy	4.000
078 SupTech BDA II Sweden	5.000
National supervisor	**3.970**
035 SupTech BDA I Denmark	3.400
038 SupTech BDA II Spain	3.000
039 SupTech BDA I Germany	3.077
041 SupTech BDA I Poland	4.833
043 SupTech BDA II Slovenia	5.000
044 SupTech BDA II Romania	4.833
046 SupTech BDA I Dublin	4.000
047 SupTech BDA I Bank of Italy	4.500
048 SupTech BDA I Spain	4.000
049 SupTech BDA I Bulgaria	3.444
051 SupTech BDA I Portugal	3.778
054 SupTech BDA I Slovakia	4.750
055 SupTech BDA IV Italy	4.500
056 SupTech BDA III Czech Republ	4.727
057 SupTech BDA I Romania	4.400
058 SupTech BDA I Hungary	4.350
059 SupTech BDA III Sweden	3.000
060 SupTech BDA II Czech Republi	4.889
061 SupTech BDA III Italy	4.000
062 SupTech BDA III Finland	4.200
063 SupTech BDA I Greece	4.600
064 SupTech BDA IV Croatia	4.533
065 SupTech BDA I Cyprus	3.929
066 SupTech BDA II Italy	4.444
067 SupTech BDA III Croatia	4.533
068 SupTech BDA I Switzerland	4.500
071 SupTech BDA II Croatia	4.111
072 SupTech AI II Bulgaria	4.333
073 SupTech BDA I Italy	3.882
074 SupTech BDA II Finland	3.500
075 SupTech BDA I Croatia	4.111
076 SupTech BDA I Lithuania	2.909
078 SupTech BDA II Sweden	3.000
079 SupTech BDA I Czech Republic	2.154
080 SupTech BDA I Sweden	3.500
081 SupTech BDA I Finland	3.000
Grand Total	**4.003**



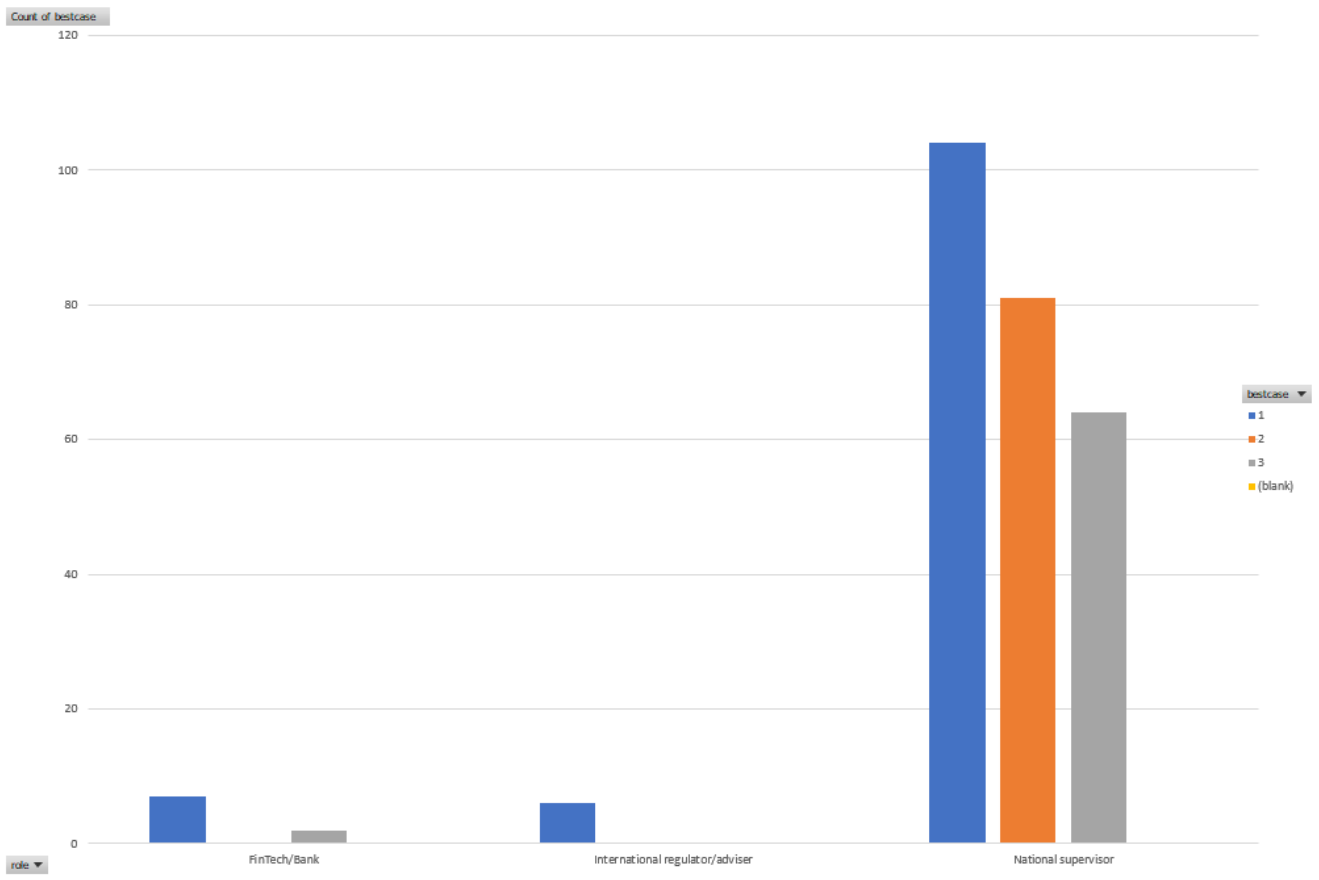
Average overall evaluation of workshops by role and workshop.

Column Labels	1	2	3	(blank)	Grand Total
Count of bestcase	117	81	66		264



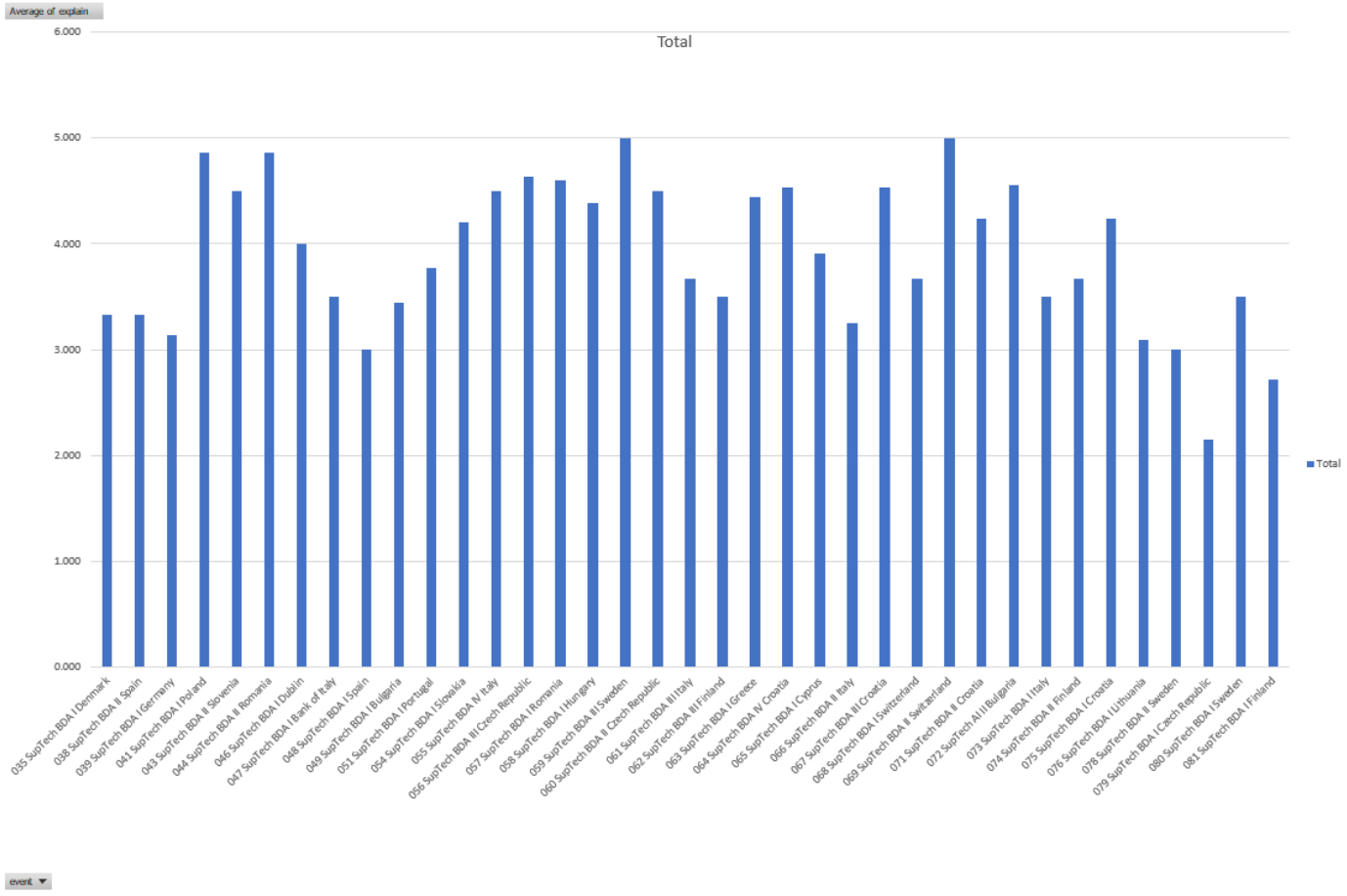
Best use case total (by counts).

Count of bestcase	Column Labels			
Row Labels	1	2	3 (blank)	Grand Total
FinTech/Bank	7		2	9
International regulator/adviser	6			6
National supervisor	104	81	64	249
Grand Total	**117**	**81**	**66**	**264**



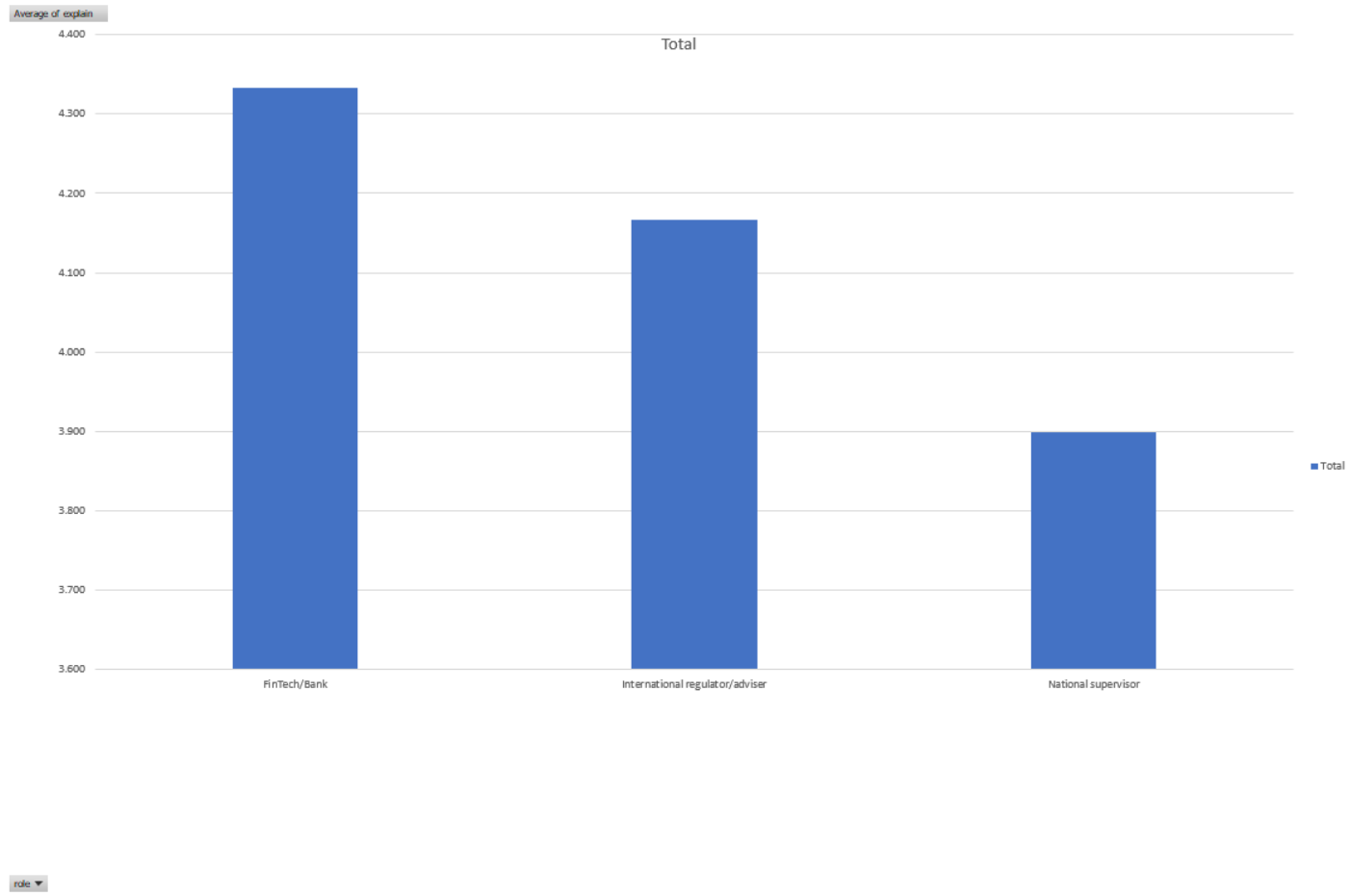
Best use case across roles (by counts).

Row Labels	Average of explain
035 SupTech BDA I Denmark	3.333
038 SupTech BDA II Spain	3.333
039 SupTech BDA I Germany	3.133
041 SupTech BDA I Poland	4.857
043 SupTech BDA II Slovenia	4.500
044 SupTech BDA II Romania	4.857
046 SupTech BDA I Dublin	4.000
047 SupTech BDA I Bank of Italy	3.500
048 SupTech BDA I Spain	3.000
049 SupTech BDA I Bulgaria	3.444
051 SupTech BDA I Portugal	3.778
054 SupTech BDA I Slovakia	4.200
055 SupTech BDA IV Italy	4.500
056 SupTech BDA III Czech Republic	4.636
057 SupTech BDA I Romania	4.600
058 SupTech BDA I Hungary	4.389
059 SupTech BDA III Sweden	5.000
060 SupTech BDA II Czech Republic	4.500
061 SupTech BDA III Italy	3.667
062 SupTech BDA III Finland	3.500
063 SupTech BDA I Greece	4.444
064 SupTech BDA IV Croatia	4.538
065 SupTech BDA I Cyprus	3.909
066 SupTech BDA II Italy	3.250
067 SupTech BDA III Croatia	4.538
068 SupTech BDA I Switzerland	3.667
069 SupTech BDA II Switzerland	5.000
071 SupTech BDA II Croatia	4.235
072 SupTech AI II Bulgaria	4.556
073 SupTech BDA I Italy	3.500
074 SupTech BDA II Finland	3.667
075 SupTech BDA I Croatia	4.235
076 SupTech BDA I Lithuania	3.091
078 SupTech BDA II Sweden	3.000
079 SupTech BDA I Czech Republic	2.154
080 SupTech BDA I Sweden	3.500
081 SupTech BDA I Finland	2.714
Grand Total	**3.918**



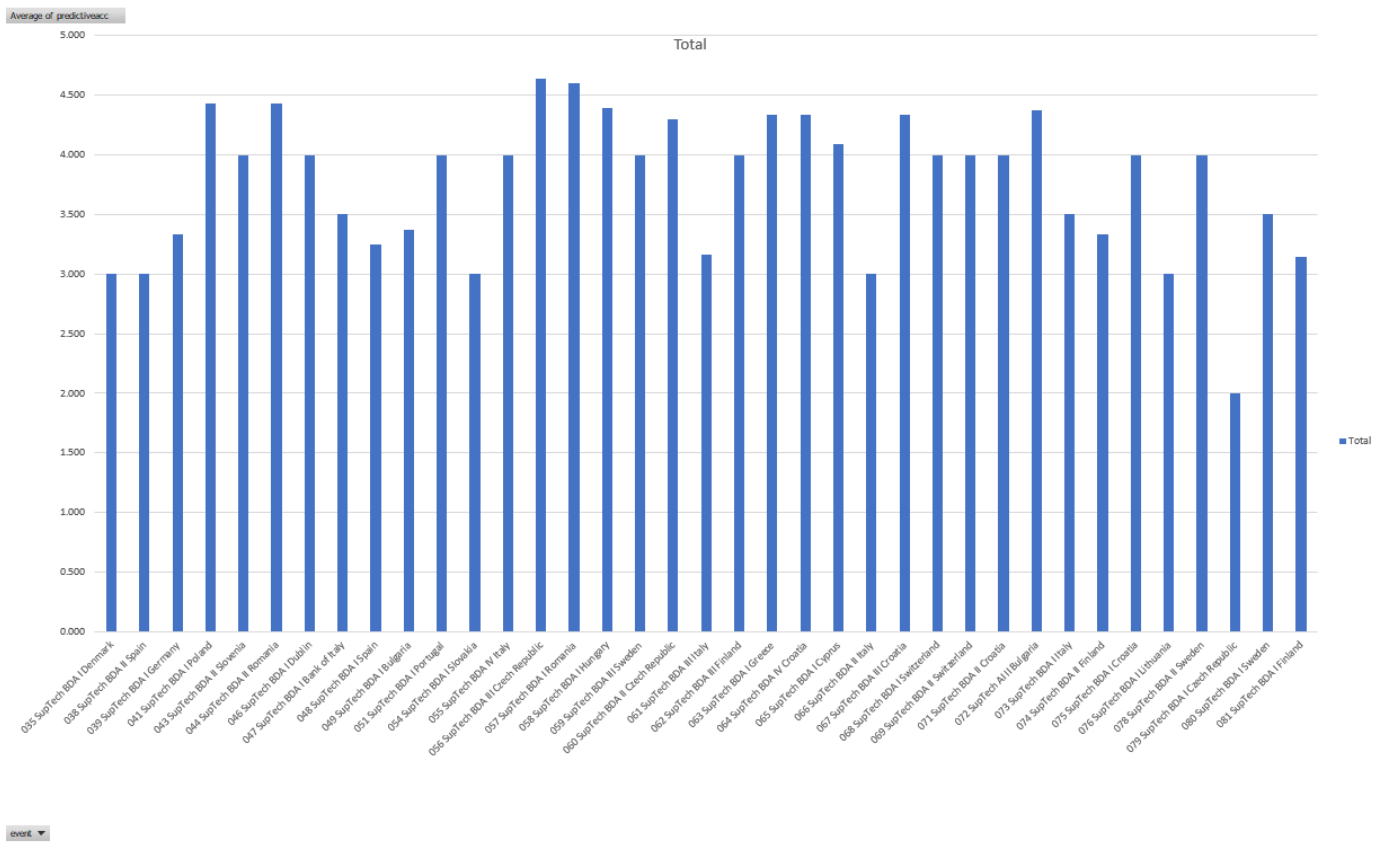
Use cases' explainability per workshop

Row Labels	Average of explain
FinTech/Bank	4.333
International regulator/adviser	4.167
National supervisor	3.898
Grand Total	**3.918**



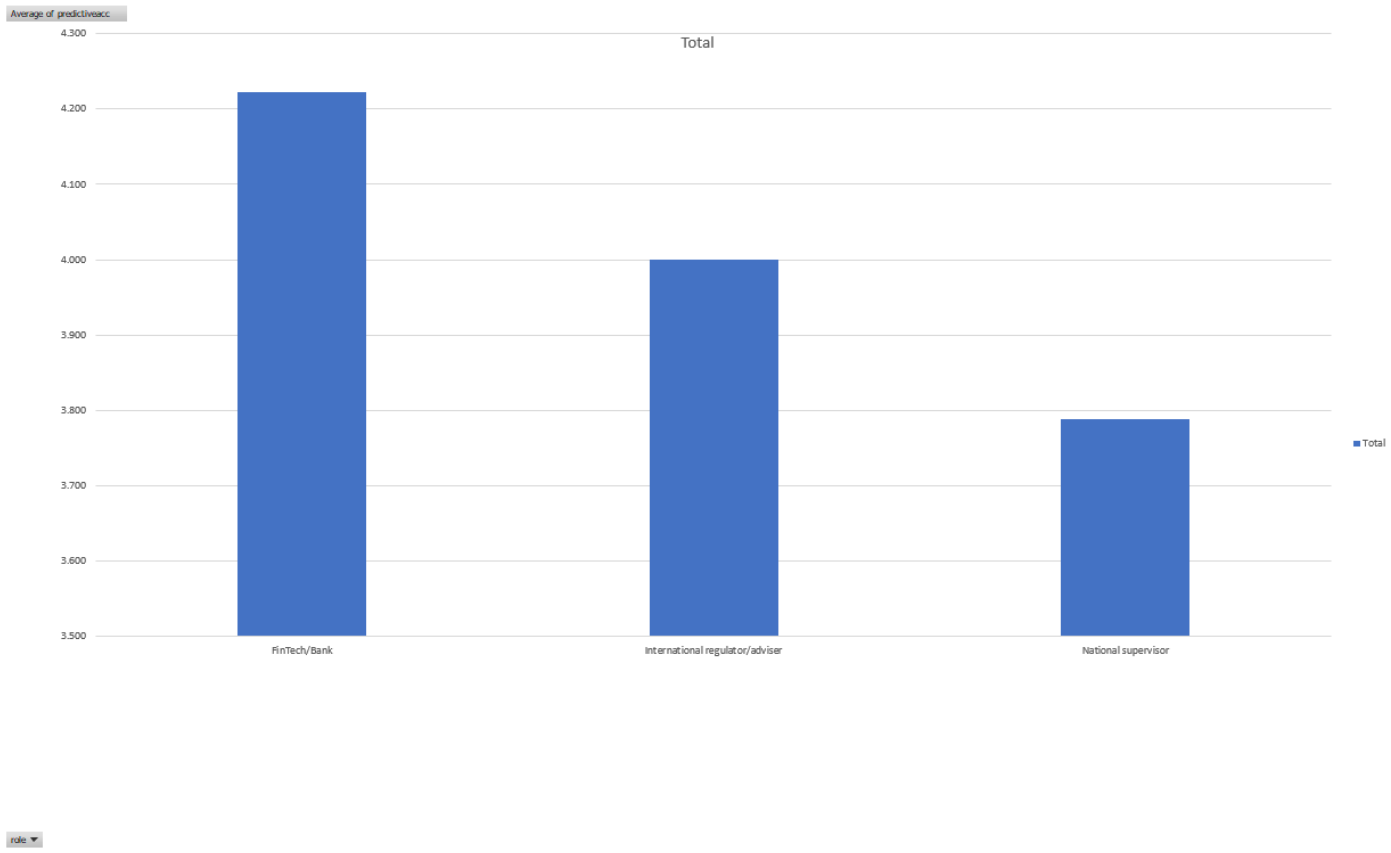
Use cases' explainability per role

Row Labels	Average of predictiveacc
035 SupTech BDA I Denmark	3.000
038 SupTech BDA II Spain	3.000
039 SupTech BDA I Germany	3.333
041 SupTech BDA I Poland	4.429
043 SupTech BDA II Slovenia	4.000
044 SupTech BDA II Romania	4.429
046 SupTech BDA I Dublin	4.000
047 SupTech BDA I Bank of Italy	3.500
048 SupTech BDA I Spain	3.250
049 SupTech BDA I Bulgaria	3.375
051 SupTech BDA I Portugal	4.000
054 SupTech BDA I Slovakia	3.000
055 SupTech BDA IV Italy	4.000
056 SupTech BDA III Czech Republic	4.636
057 SupTech BDA I Romania	4.600
058 SupTech BDA I Hungary	4.389
059 SupTech BDA III Sweden	4.000
060 SupTech BDA II Czech Republic	4.300
061 SupTech BDA III Italy	3.167
062 SupTech BDA III Finland	4.000
063 SupTech BDA I Greece	4.333
064 SupTech BDA IV Croatia	4.333
065 SupTech BDA I Cyprus	4.091
066 SupTech BDA II Italy	3.000
067 SupTech BDA III Croatia	4.333
068 SupTech BDA I Switzerland	4.000
069 SupTech BDA II Switzerland	4.000
071 SupTech BDA II Croatia	4.000
072 SupTech AI II Bulgaria	4.375
073 SupTech BDA I Italy	3.500
074 SupTech BDA II Finland	3.333
075 SupTech BDA I Croatia	4.000
076 SupTech BDA I Lithuania	3.000
078 SupTech BDA II Sweden	4.000
079 SupTech BDA I Czech Republic	2.000
080 SupTech BDA I Sweden	3.500
081 SupTech BDA I Finland	3.143
Grand Total	**3.807**



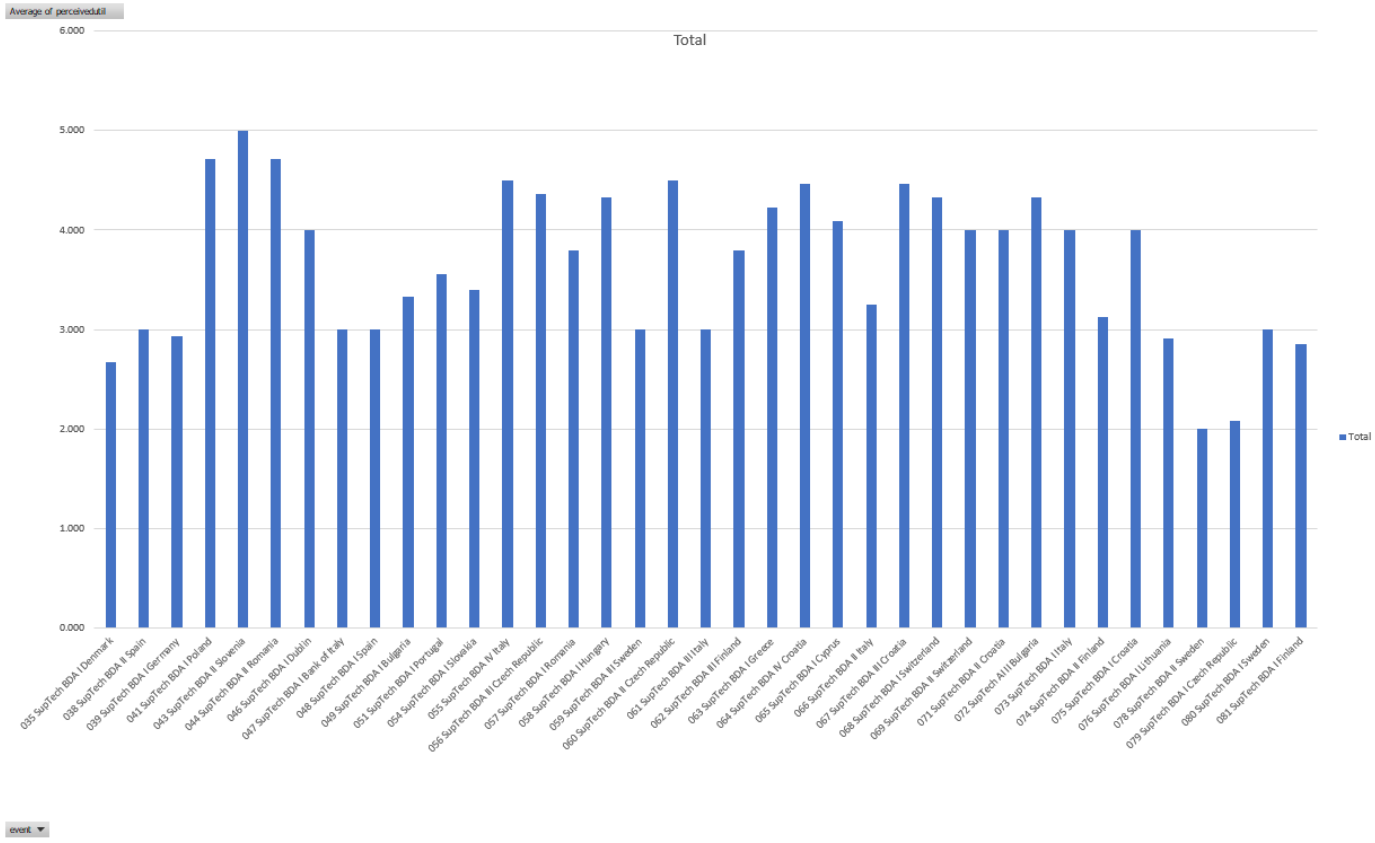
Use cases' predictive accuracy per workshop

Row Labels	Average of predictiveacc
FinTech/Bank	4.222
International regulator/adviser	4.000
National supervisor	3.788
Grand Total	**3.807**



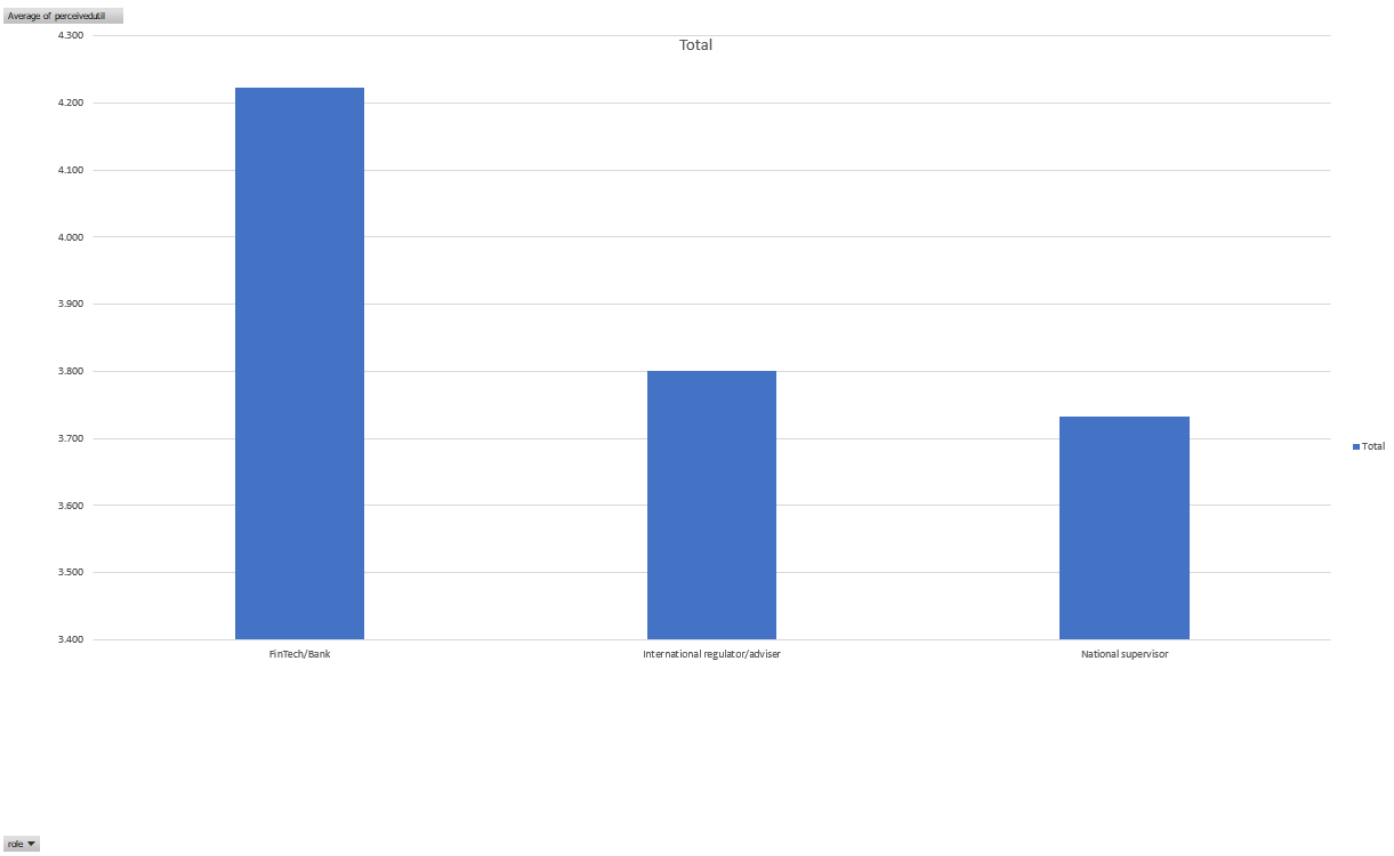
Use cases' predictive accuracy per role

Row Labels	Average of perceivedutil
035 SupTech BDA I Denmark	2.667
038 SupTech BDA II Spain	3.000
039 SupTech BDA I Germany	2.938
041 SupTech BDA I Poland	4.714
043 SupTech BDA II Slovenia	5.000
044 SupTech BDA II Romania	4.714
046 SupTech BDA I Dublin	4.000
047 SupTech BDA I Bank of Italy	3.000
048 SupTech BDA I Spain	3.000
049 SupTech BDA I Bulgaria	3.333
051 SupTech BDA I Portugal	3.556
054 SupTech BDA I Slovakia	3.400
055 SupTech BDA IV Italy	4.500
056 SupTech BDA III Czech Republic	4.364
057 SupTech BDA I Romania	3.800
058 SupTech BDA I Hungary	4.333
059 SupTech BDA III Sweden	3.000
060 SupTech BDA II Czech Republic	4.500
061 SupTech BDA III Italy	3.000
062 SupTech BDA III Finland	3.800
063 SupTech BDA I Greece	4.222
064 SupTech BDA IV Croatia	4.462
065 SupTech BDA I Cyprus	4.091
066 SupTech BDA II Italy	3.250
067 SupTech BDA III Croatia	4.462
068 SupTech BDA I Switzerland	4.333
069 SupTech BDA II Switzerland	4.000
071 SupTech BDA II Croatia	4.000
072 SupTech AI II Bulgaria	4.333
073 SupTech BDA I Italy	4.000
074 SupTech BDA II Finland	3.125
075 SupTech BDA I Croatia	4.000
076 SupTech BDA I Lithuania	2.909
078 SupTech BDA II Sweden	2.000
079 SupTech BDA I Czech Republic	2.077
080 SupTech BDA I Sweden	3.000
081 SupTech BDA I Finland	2.857
Grand Total	**3.749**



Use cases' perceived utility per workshop

Row Labels	Average of perceivedutil
FinTech/Bank	4.222
International regulator/adviser	3.800
National supervisor	3.732
Grand Total	**3.749**

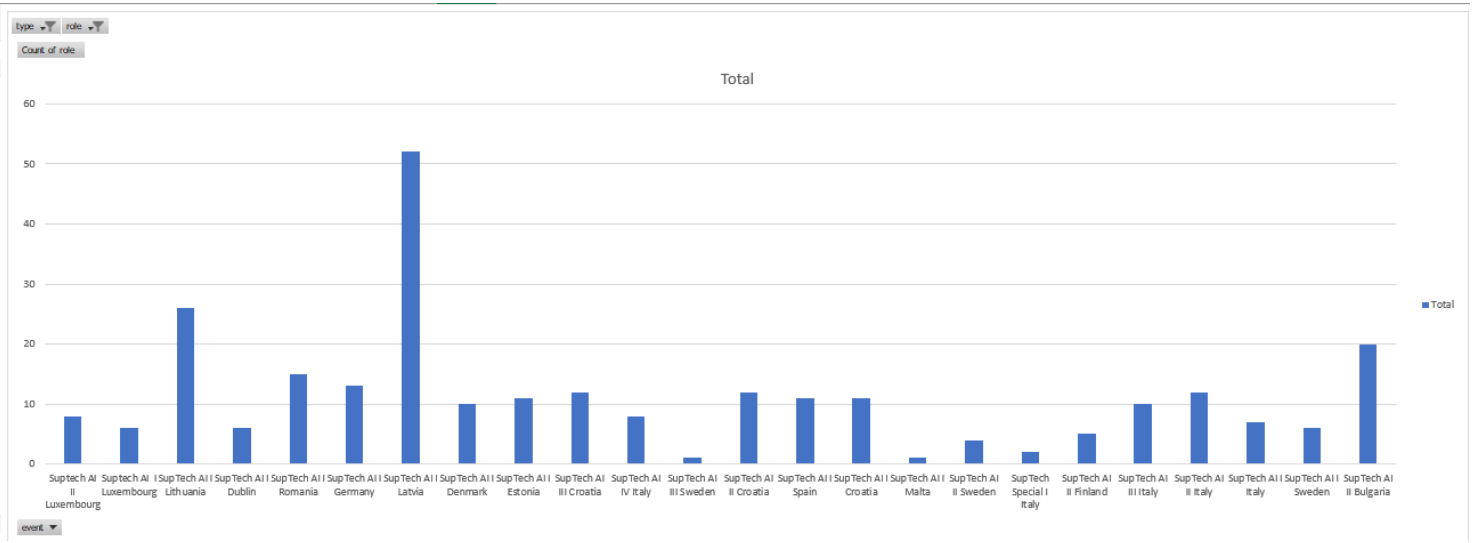


Use cases' perceived utility per role

b. Artificial Intelligence statistics

type	AI
role	(Multiple Items)

Row Labels	Count of role
Suptech AI II Luxembourg	8
Suptech AI I Luxembourg	6
SupTech AI I Lithuania	26
SupTech AI I Dublin	6
SupTech AI I Romania	15
SupTech AI I Germany	13
SupTech AI I Latvia	52
SupTech AI I Denmark	10
SupTech AI I Estonia	11
SupTech AI III Croatia	12
SupTech AI IV Italy	8
SupTech AI III Sweden	1
SupTech AI II Croatia	12
SupTech AI I Spain	11
SupTech AI I Croatia	11
SupTech AI I Malta	1
SupTech AI II Sweden	4
SupTech Special I Italy	2
SupTech AI II Finland	5
SupTech AI III Italy	10
SupTech AI II Italy	12
SupTech AI I Italy	7
SupTech AI I Sweden	6
SupTech AI II Bulgaria	20
Grand Total	**269**



Number of registrations by workshop.

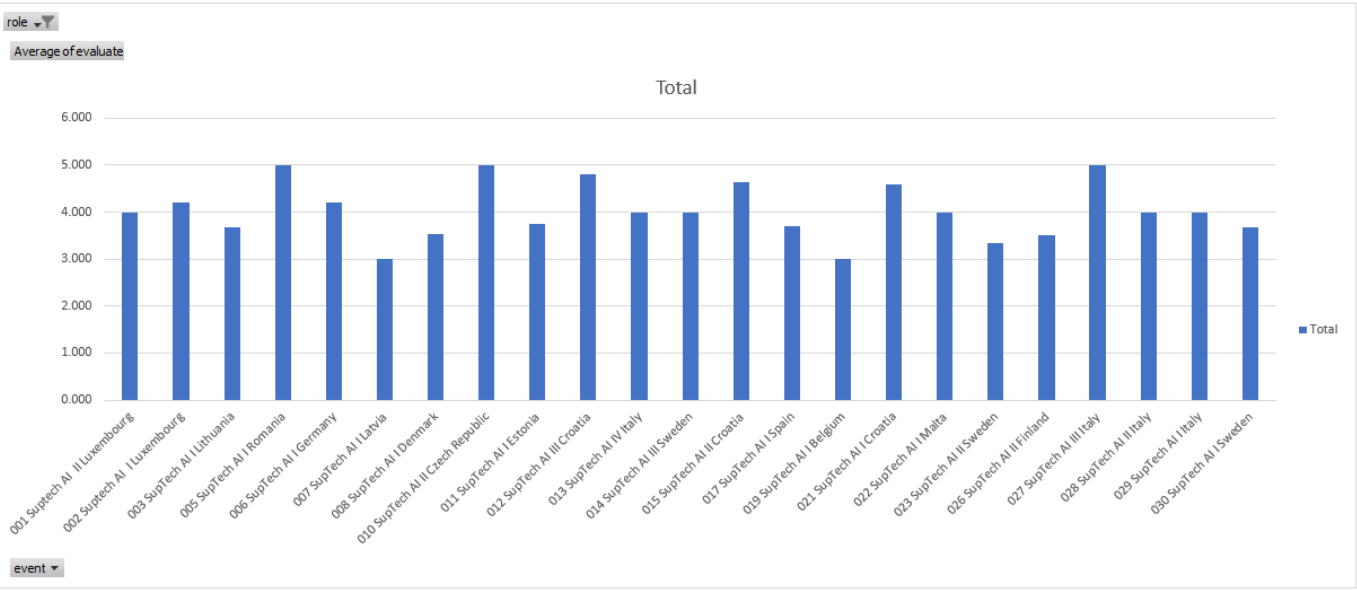
type	AI

Row Labels	Count of role
FinTech/Bank	52
International regulator/adviser	14
National supervisor	203
Grand Total	**269**

Number of registrations by role.

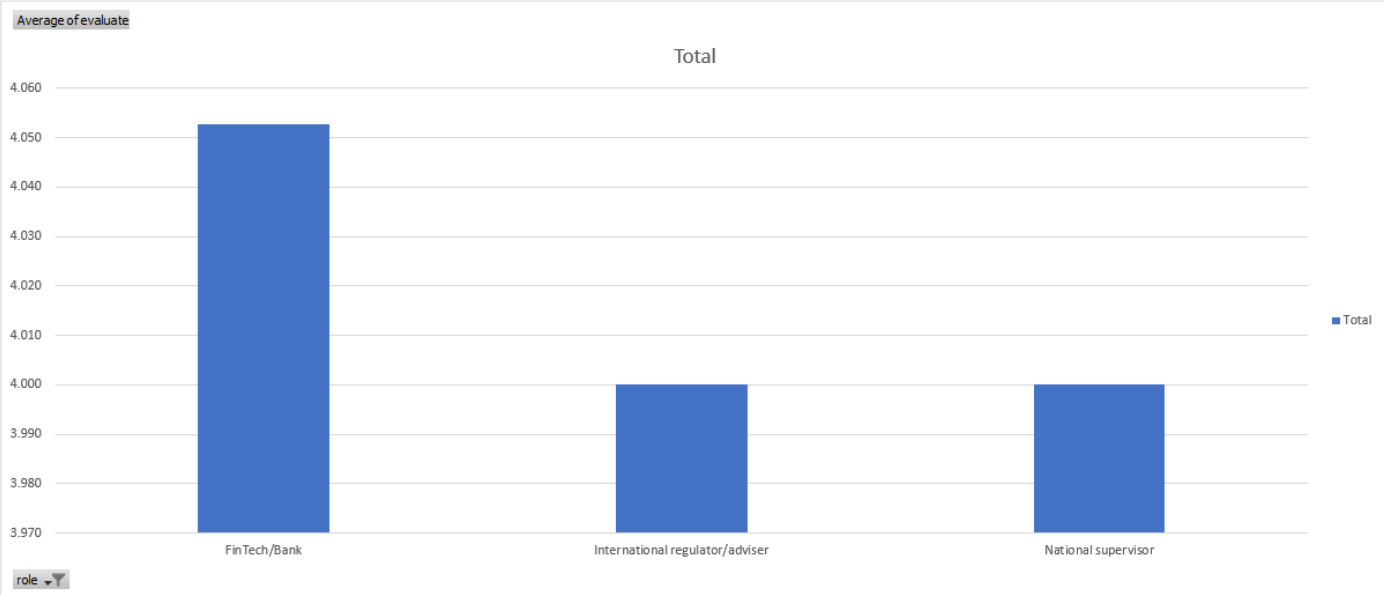
role	(Mehrere Elemente)

Zeilenbeschriftungen	Average of evaluate
001 Suptech AI II Luxembourg	4.000
002 Suptech AI I Luxembourg	4.200
003 SupTech AI I Lithuania	3.667
005 SupTech AI I Romania	5.000
006 SupTech AI I Germany	4.200
007 SupTech AI I Latvia	3.000
008 SupTech AI I Denmark	3.526
010 SupTech AI II Czech Republic	5.000
011 SupTech AI I Estonia	3.750
012 SupTech AI III Croatia	4.800
013 SupTech AI IV Italy	4.000
014 SupTech AI III Sweden	4.000
015 SupTech AI II Croatia	4.643
017 SupTech AI I Spain	3.692
019 SupTech AI I Belgium	3.000
021 SupTech AI I Croatia	4.583
022 SupTech AI I Malta	4.000
023 SupTech AI II Sweden	3.333
026 SupTech AI II Finland	3.500
027 SupTech AI III Italy	5.000
028 SupTech AI II Italy	4.000
029 SupTech AI I Italy	4.000
030 SupTech AI I Sweden	3.667
Gesamtergebnis	**4.007**



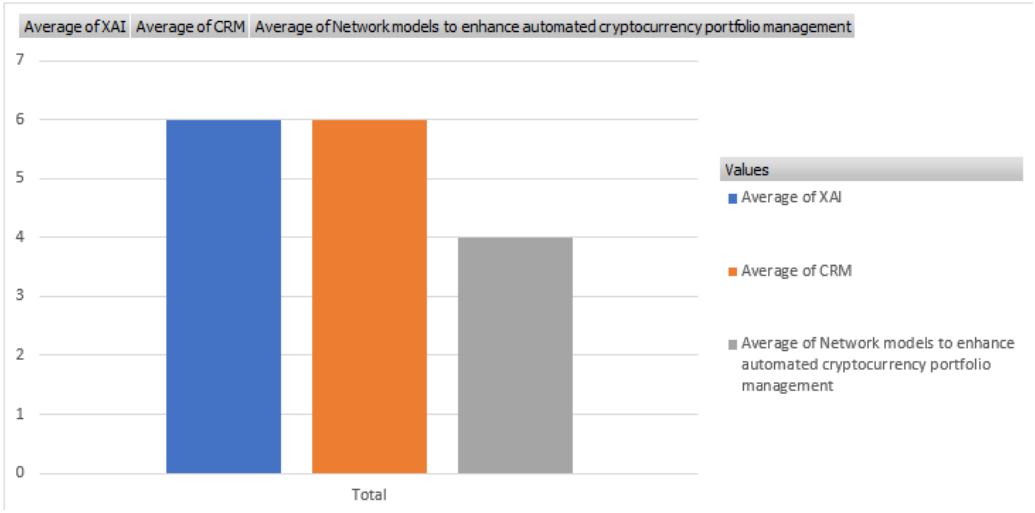
Total workshop rating by workshop

Row Labels	Average of evaluate
FinTech/Bank	4.053
International regulator/adviser	4.000
National supervisor	4.000
Grand Total	**4.007**



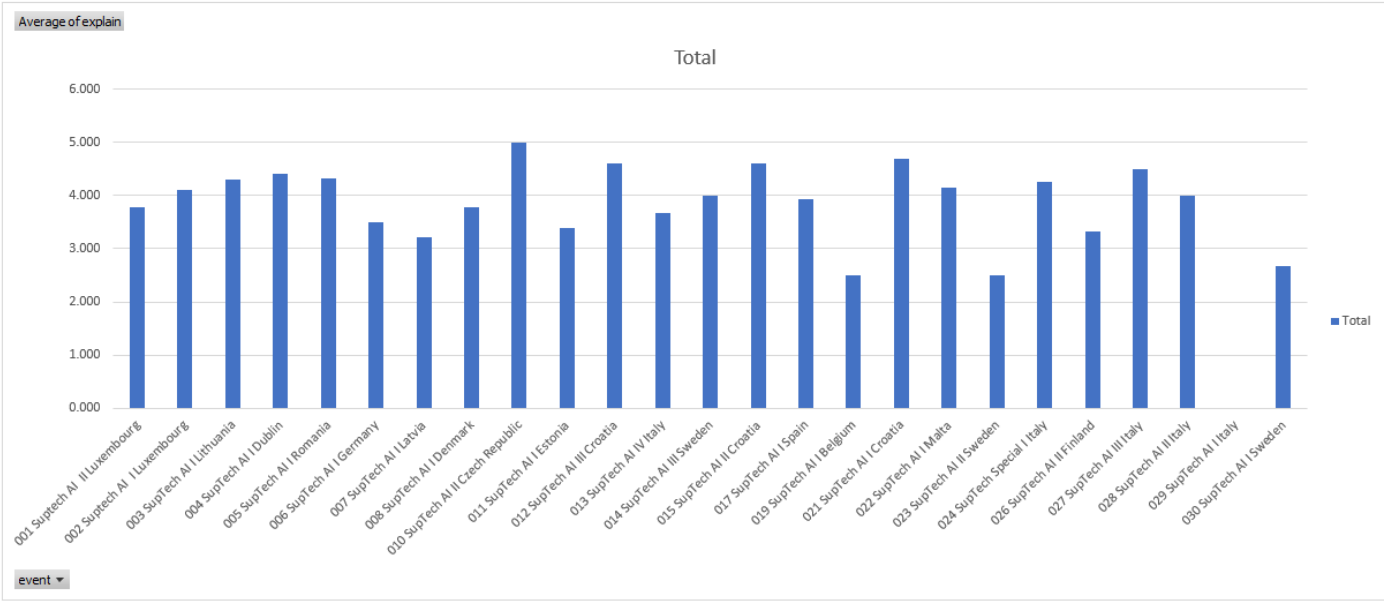
Total workshop rating by role

Average of XAI	Average of CRM	Average of Network models to enhance automated cryptocurrency portfolio management
6	6	4



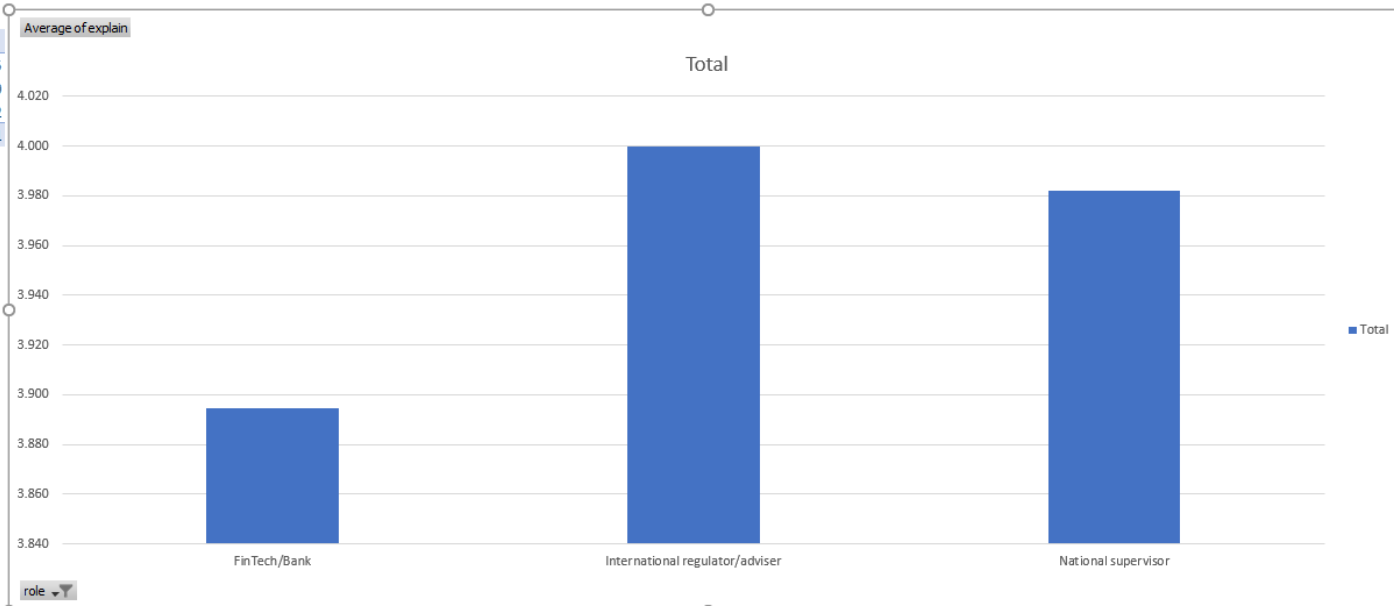
Best use case by selecting the workshops where a top use case had been presented and counting the numbers of best use case selection.

Row Labels	Average of explain
001 Suptech AI II Luxembourg	3.778
002 Suptech AI I Luxembourg	4.111
003 SupTech AI I Lithuania	4.300
004 SupTech AI I Dublin	4.400
005 SupTech AI I Romania	4.333
006 SupTech AI I Germany	3.500
007 SupTech AI I Latvia	3.222
008 SupTech AI I Denmark	3.778
010 SupTech AI II Czech Republic	5.000
011 SupTech AI I Estonia	3.400
012 SupTech AI III Croatia	4.600
013 SupTech AI IV Italy	3.667
014 SupTech AI III Sweden	4.000
015 SupTech AI II Croatia	4.615
017 SupTech AI I Spain	3.929
019 SupTech AI I Belgium	2.500
021 SupTech AI I Croatia	4.700
022 SupTech AI I Malta	4.143
023 SupTech AI II Sweden	2.500
024 SupTech Special I Italy	4.250
026 SupTech AI II Finland	3.333
027 SupTech AI III Italy	4.500
028 SupTech AI II Italy	4.000
029 SupTech AI I Italy	
030 SupTech AI I Sweden	2.667
Grand Total	**3.969**



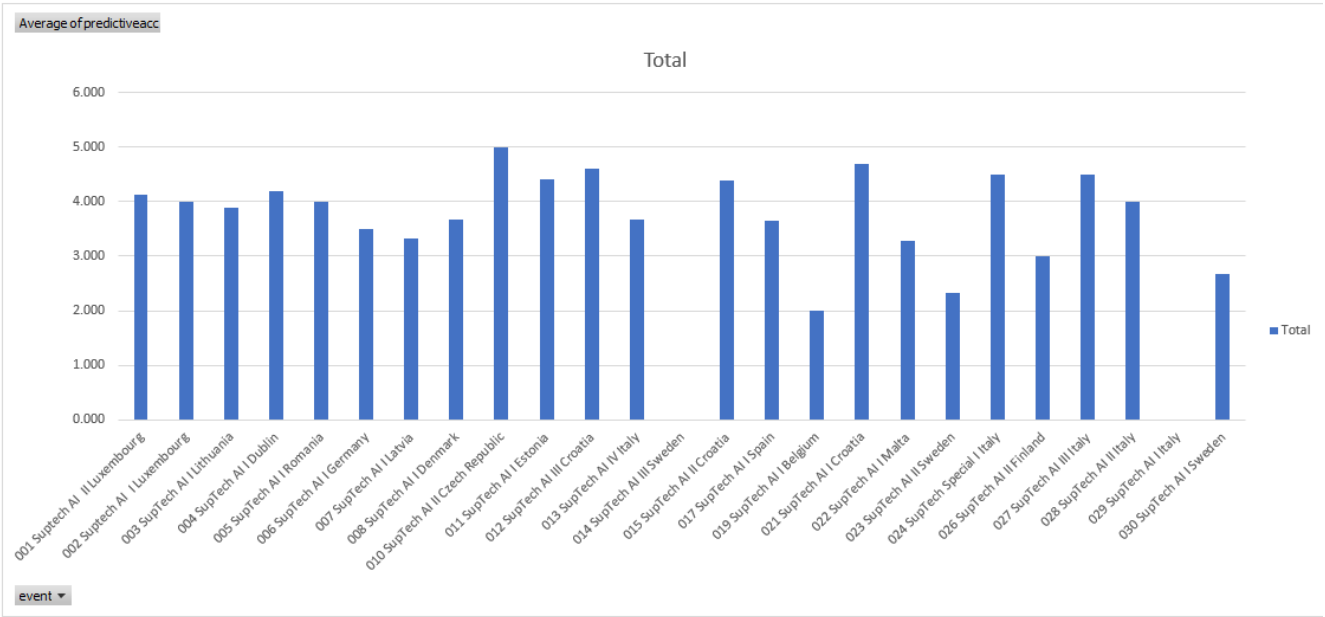
Average use cases' explainability by workshop.

Row Labels	Average of explain
FinTech/Bank	3.895
International regulator/adviser	4.000
National supervisor	3.982
Grand Total	**3.971**



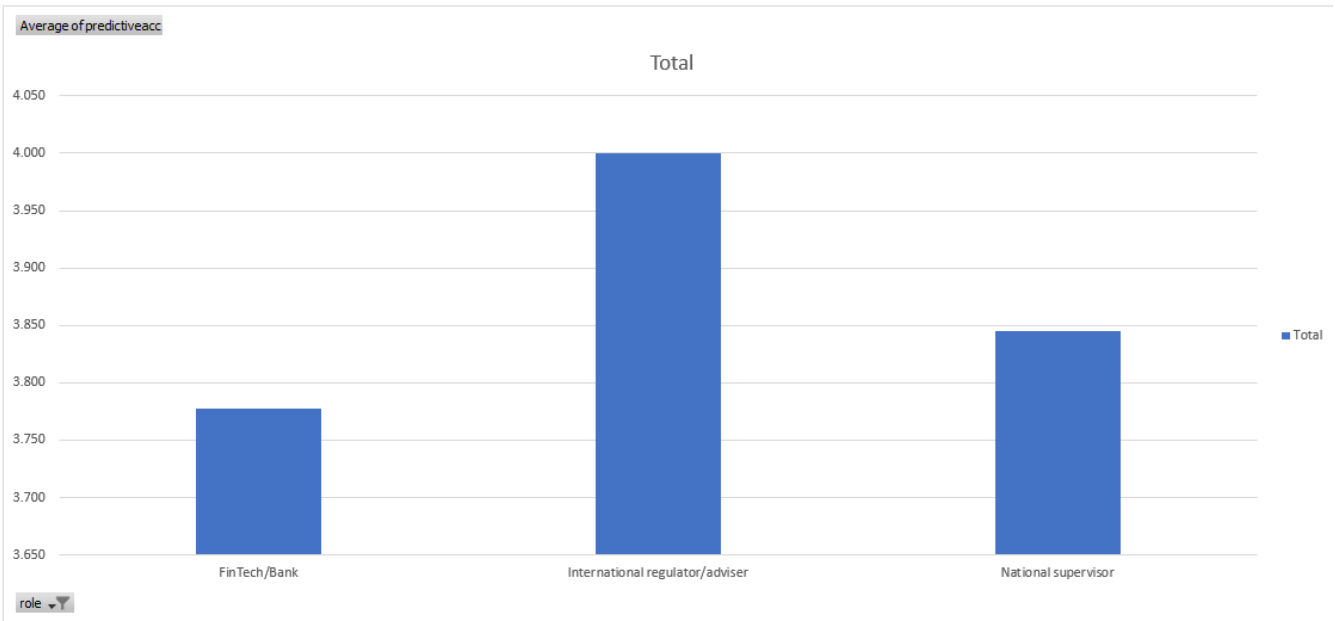
Average use cases' explainability by role.

Row Labels	Average of predictiveacc
001 Suptech AI II Luxembourg	4.125
002 Suptech AI I Luxembourg	4.000
003 SupTech AI I Lithuania	3.900
004 SupTech AI I Dublin	4.200
005 SupTech AI I Romania	4.000
006 SupTech AI I Germany	3.500
007 SupTech AI I Latvia	3.333
008 SupTech AI I Denmark	3.667
010 SupTech AI II Czech Republic	5.000
011 SupTech AI I Estonia	4.400
012 SupTech AI III Croatia	4.600
013 SupTech AI IV Italy	3.667
014 SupTech AI III Sweden	
015 SupTech AI II Croatia	4.385
017 SupTech AI I Spain	3.643
019 SupTech AI I Belgium	2.000
021 SupTech AI I Croatia	4.700
022 SupTech AI I Malta	3.286
023 SupTech AI II Sweden	2.333
024 SupTech Special I Italy	4.500
026 SupTech AI II Finland	3.000
027 SupTech AI III Italy	4.500
028 SupTech AI II Italy	4.000
029 SupTech AI I Italy	
030 SupTech AI I Sweden	2.667
Grand Total	**3.884**



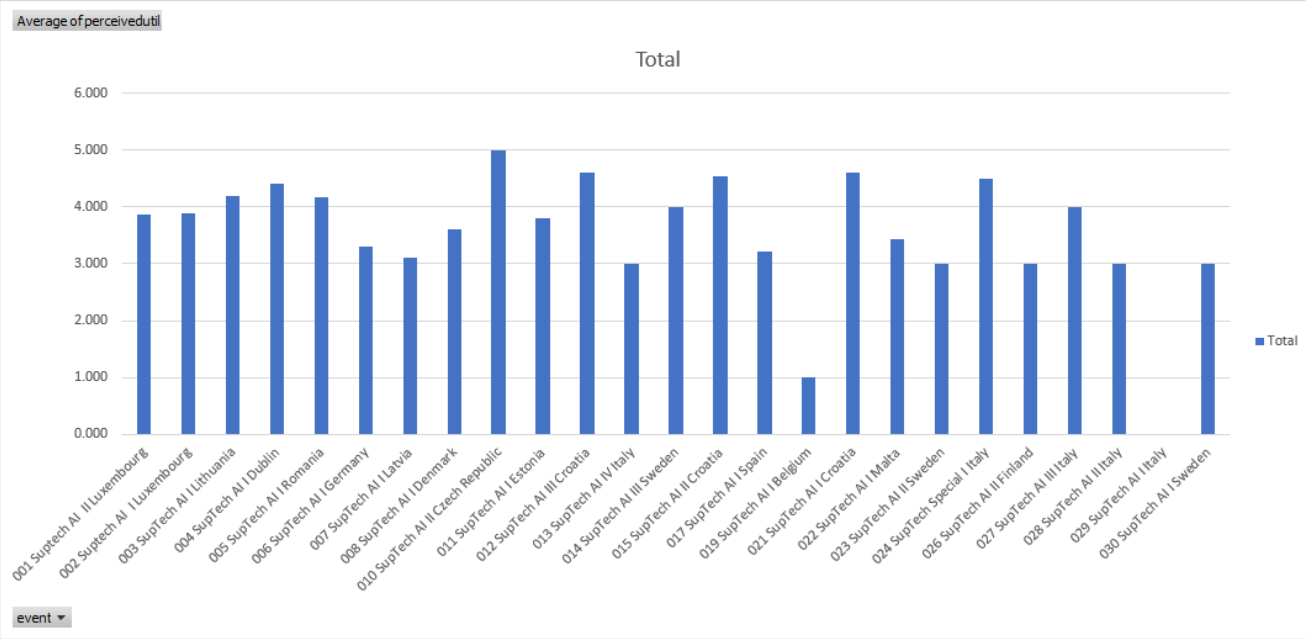
Average use cases' predictive accuracy by workshop.

Row Labels	Average of predictiveacc
FinTech/Bank	3.778
International regulator/adviser	4.000
National supervisor	3.845
Grand Total	**3.841**



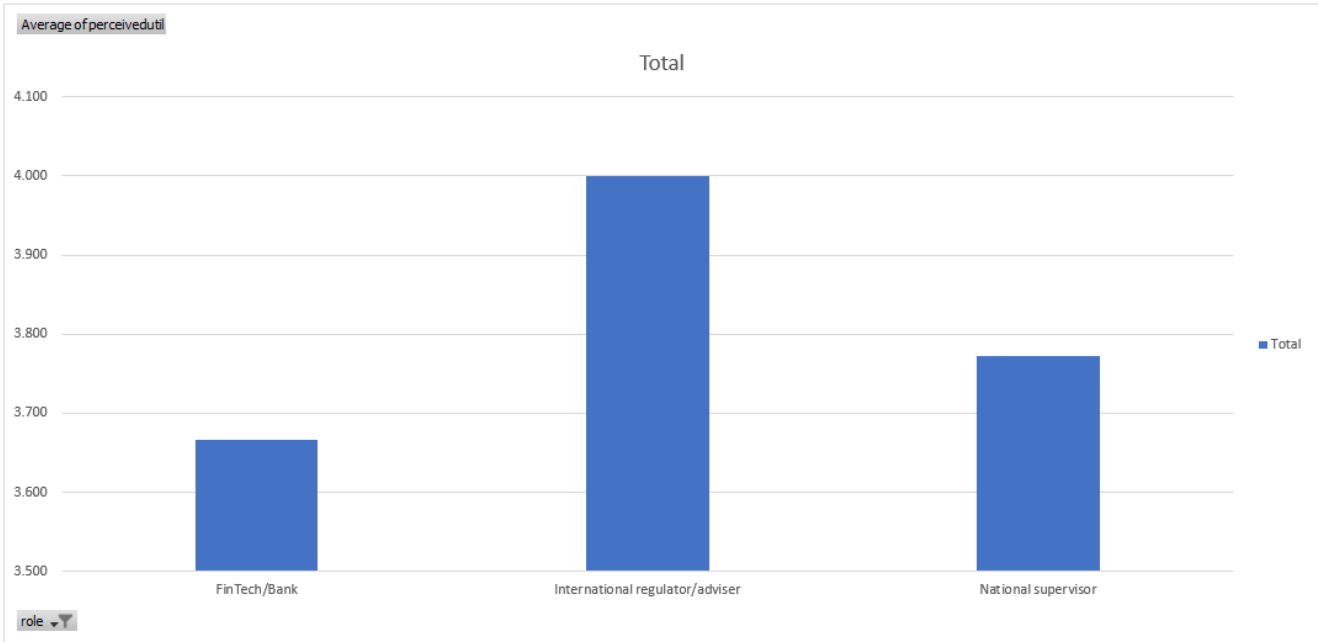
Average use cases' predictive accuracy by role.

Row Labels	Average of perceivedutil
001 Suptech AI II Luxembourg	3.875
002 Suptech AI I Luxembourg	3.889
003 SupTech AI I Lithuania	4.200
004 SupTech AI I Dublin	4.400
005 SupTech AI I Romania	4.167
006 SupTech AI I Germany	3.300
007 SupTech AI I Latvia	3.111
008 SupTech AI I Denmark	3.611
010 SupTech AI II Czech Republic	5.000
011 SupTech AI I Estonia	3.800
012 SupTech AI III Croatia	4.600
013 SupTech AI IV Italy	3.000
014 SupTech AI III Sweden	4.000
015 SupTech AI II Croatia	4.538
017 SupTech AI I Spain	3.214
019 SupTech AI I Belgium	1.000
021 SupTech AI I Croatia	4.600
022 SupTech AI I Malta	3.429
023 SupTech AI II Sweden	3.000
024 SupTech Special I Italy	4.500
026 SupTech AI II Finland	3.000
027 SupTech AI III Italy	4.000
028 SupTech AI II Italy	3.000
029 SupTech AI I Italy	
030 SupTech AI I Sweden	3.000
Grand Total	**3.801**



Average use cases' perceived utility by workshop.

Row Labels	Average of perceivedutil
FinTech/Bank	3.667
International regulator/adviser	4.000
National supervisor	3.773
Grand Total	**3.767**



Average use cases' perceived utility by role.