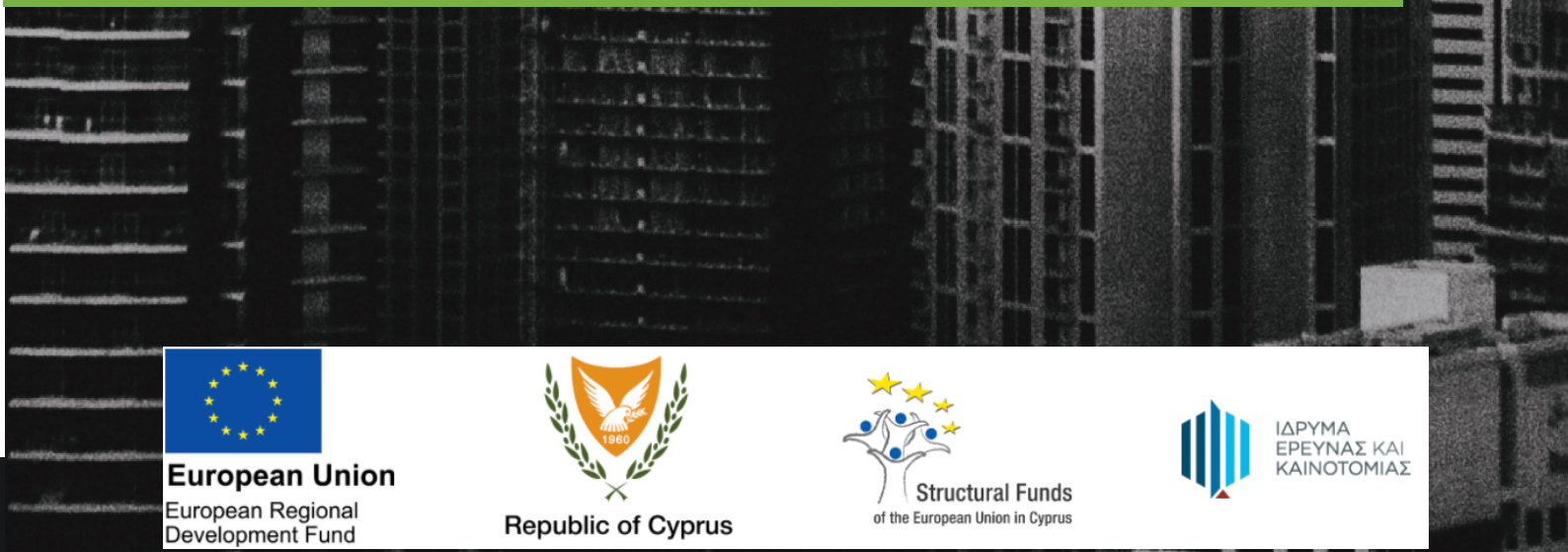
WORKSHOP ORGANIZATION

D07

IDEALVis Consortium

http://idealvis.inspirecenter.org/



European Union
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ΙΔΡΥΜΑ ΕΡΕΥΝΑΣ ΚΑΙ ΚΑΙΝΟΤΟΜΙΑΣ

Executive Summary

The main goal of the workshop of the project was to disseminate the scientific and technological results of the project to a wide audience and facilitate future collaborations. To this end, the consortium invited representatives of research and industry organizations and provided a summary of the project's results, highlighting the distinct research outcomes and technological components. The workshop of the project was organized on the 08 April 2022 in an open (i.e., accessible to anyone) and online format due to the restrictions imposed by the COVID-19 pandemic. Organizations from the industry and academia joined the meeting to learn about the project, its results, and discuss possible collaborations.

The workshop started with a presentation of the areas of data visualization, visual exploration and analysis, which has gained great attention recently. It then presented the important problems arising from not considering the human characteristics in the exploration process, leaving users, with different backgrounds, expertise and experience, being overloaded from the vast amount of high-quality visual information, which in turn, severely hinders their ability to efficiently assess situations, plan accordingly and swiftly take action. Next, it highlighted that most platforms still adopt a one-size-fits-all approach, providing only rudimentary support for customizing visualizations, based on predetermined alternatives and limited options that are available from the providers based on their understanding on what the end-users might want and need. The projects goal was then presented, highlighting how it aims to incorporate the users' individual differences in information processing, cognitive abilities, perceptual preferences, domain expertise and experience, to allow them to better understand the visual information and quickly act upon it.

Next, the scientific outcomes and publications and technological outcomes of the project were presented. The presentation demonstrated the key outcomes for both dimensions, aiming to allow the audience, regardless of expertise (i.e., academic or professional) and organizational culture to understand the key contributions. The presentation then proceeded with a Q&A session and concluded with the next steps.

At the end of the presentation, the workshop organizers received feedback that it efficiently and effectively presented the project outcomes. Noteworthy, was the fact that potential research and innovation collaborations were identified immediately after, including: (i) the design and development of persona-based user interfaces for existing software operated by industry partners; (ii) the joint participation in research and innovation projects related to incorporating adaptive visualizations to support efficient and effective data explorations but also improve trustworthiness; (iii) to evaluate the time spent on data exploration tasks to reveal bottlenecks.

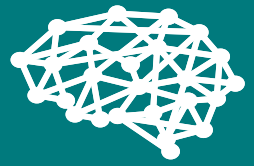
IDEALVis

Intelligent Data Exploration and Adaptive MeaningfuL Visualizations

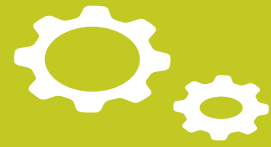
Workshop, 08/04/2022 @11:00-12:30

Business Users

Data Exploration



Machine Learning



User Modeling and Adaptation

inspire
INterdisciplinary Science Promotion & Innovative Research Exploration

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Workshop Agenda

11:00-11:05	Welcome
11:05-11:15	Introduction
11:15-12:00	Results and Outcomes
12:00-12:20	Q & A
12:20-12:30	Next Steps

Consortium

InSPIRE

Research and Innovation

KPMG

Data Analytics

RAI

Data Analytics and Market Research

IDEALVis Concept

Business users are different

They vary in terms of expertise, experience, preferences and cognitive characteristics

However, ….

Perform similar functions

They operate in the same environment

Use similar tools

Yet…

1. platforms still adopt a **one-size-fits-all** approach
2. Tools do not provide support for personalization
3. There is no ability to learn and adapt

Business Intelligence Visualizations

- Multiple Visualization Types for Structured / Unstructured Data
- Automated Visualization Recommendations
- Visualization Customization Features

- Not Personalised
- Follow the One-Size-Fits-All Approach
- Are built with Data/Task driven Models
- Do not Account for the UNIQUE user's Characteristics

To better illustrate the problem…

Meet Jane

Senior Analyst, Awesome Inc.
Expert
Field Independent
Analyst
High Working Memory
High Cognitive Speed Efficiency

Meet John

Junior Brand Manager, Awesome Inc.
Intermediate
Field Dependent
Wholist
Medium Working Memory
Low Cognitive Speed Efficiency

Critical Data Exploration Task

“For Brand Awesome,
Why have the sales increased
while the shares have dropped”

Need fast answers
to adapt marketing strategy

Jane's Process

Question: **For brand Awesome, why have the sales increased, while the shares have dropped?**

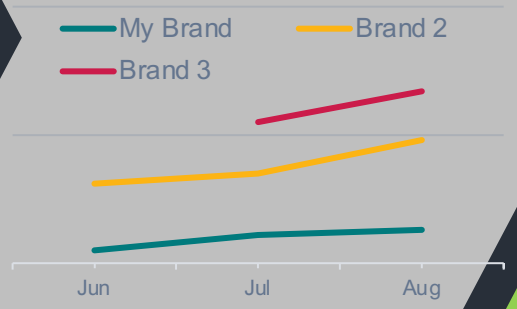
STEP 01

STEP 02

Query + Options

STEP 03

Result



STEP 04

Answer

Query: **Show me the sales of my Brand during the last 3 months and compare it with other Brands**

John's Process

Question: For brand Awesome, why have the sales increased, while the shares have dropped?

STEP 01

STEP 02

Query + Options

STEPS 03...

Exploration

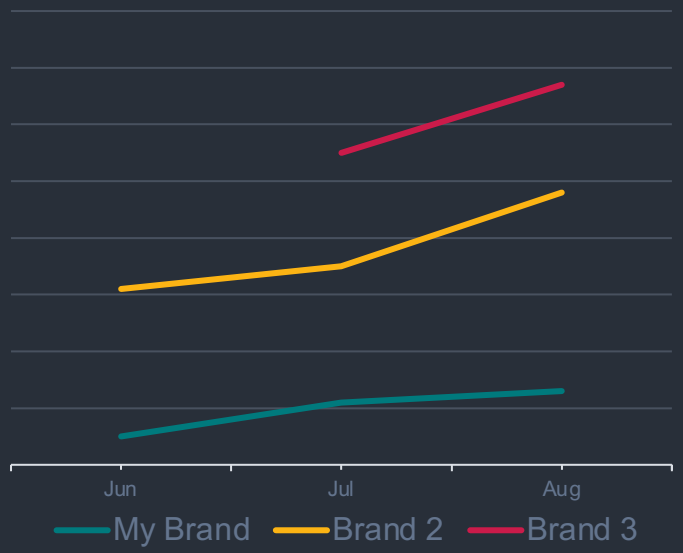
	My Brand
Jun	0.5
Jul	1.1
Aug	1.3

STEP X

Answer

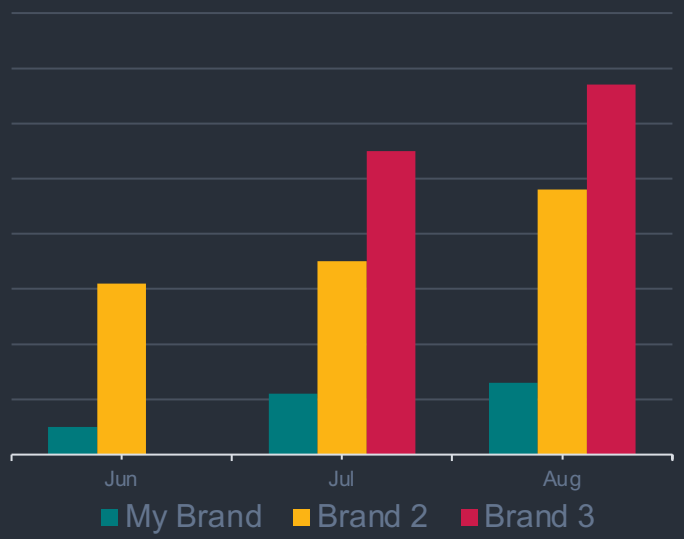
Query: Show me the sales of my Brand during the last 3 months

What are we trying to do?



OR

	My Brand	Brand 2	Brand 3
Jun	0.5	3.1	
Jul	1.1	3.5	5.5
Aug	1.3	4.8	6.7



Which are the most efficient?
Which are the most effective?

What are we trying to do?

Find the number of 7s

5	2	8	3	6	1	9	3	6	2	5	3	7	4	3	8	3
8	5	8	9	6	2	1	4	4	3	9	3	6	5	2	4	9
1	0	2	7	5	2	8	3	6	1	6	2	9	3	8	3	8
5	8	4	7	2	0	3	7	3	5	4	7	1	8	2	0	1
2	5	3	6	4	3	9	1	0	8	9	5	7	3	4	5	3
2	7	5	2	8	3	6	1	6	2	9	3	8	3	8	5	8
4	7	2	0	3	7	3	5	4	7	1	8	2	0	1	9	6
2	1	4	4	3	9	3	6	5	2	4	9	1	0	2	7	5
2	8	3	6	1	6	2	9	3	8	3	8	5	8	4	7	2
0	3	7	3	5	4	7	1	8	2	0	1	2	5	3	6	4
3	9	1	0	8	9	5	7	3	4	5	3	2	7	5	2	8
3	6	1	6	2	4	6	2	7	5	9	1	5	2	6	3	6

Change Visual Elements

56789

56789 color

56789 size

56789 orientation

56789 texture

5	2	8	3	6	1	9	3	6	2	5	3	7	4	3	8	3
8	5	8	9	6	2	1	4	4	3	9	3	6	5	2	4	9
1	0	2	7	5	2	8	3	6	1	6	2	9	3	8	3	8
5	8	4	7	2	0	3	7	3	5	4	7	1	8	2	0	1
2	5	3	6	4	3	9	1	0	8	9	5	7	3	4	5	3
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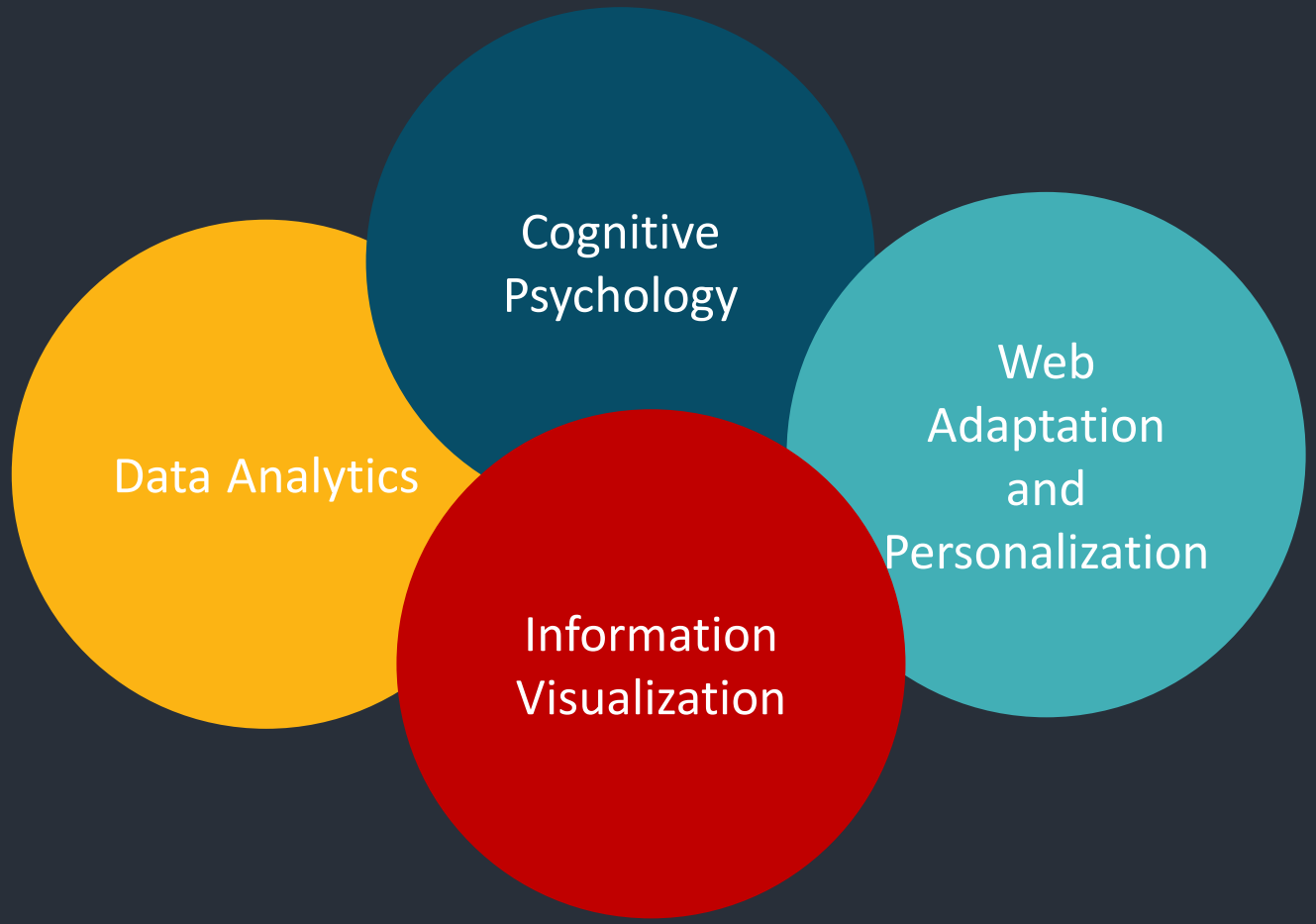
4	7	2	0	3	7	3	5	4	7	1	8	2	0	1	9	6
2	1	4	4	3	9	3	6	5	2	4	9	1	0	2	7	5
2	8	3	6	1	6	2	9	3	8	3	8	5	8	4	7	2
0	3	7	3	5	4	7	1	8	2	0	1	2	5	3	6	4
3	9	1	0	8	9	5	7	3	4	5	3	2	7	5	2	8
3	6	1	6	2	4	6	2	7	5	9	1	5	2	6	3	6

Which are the most efficient?

Which are the most effective?

Research Goals



- **Enable human-centred adaptive data visualizations**
- **Facilitate more efficient and powerful data exploration and analysis of complex and multivariate business datasets**
- **Enable more effective decision making on critical business tasks**

The Road So Far

User Study 1

What are the **characteristics of the users**?

Meet Jane

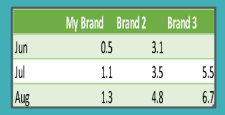
Senior Analyst, Awesome Inc.
Expert
Field Independent
Analyst
High Working Memory
High Cognitive Speed Efficiency

Meet John

Junior Brand Manager, Awesome Inc.
Intermediate
Field Dependent
Wholist
Medium Working Memory
Low Cognitive Speed Efficiency

User Study 2

What is the **impact of human factors on the type and elements of data visualizations**?



	My Brand	Brand 2	Brand 3
Jun	0.5	3.1	
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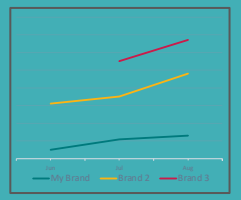

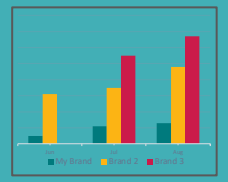

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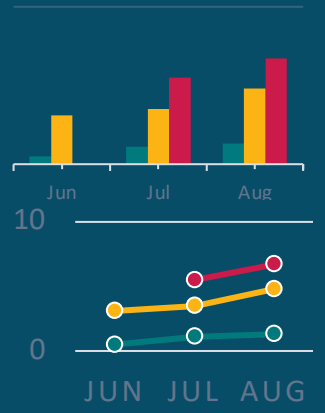
56789 size
56789 orientation
56789 texture

User Study 3

What is the impact of personalized visualizations?

Before



After

Scientific Results

User Study 1 – Understanding the Business Context

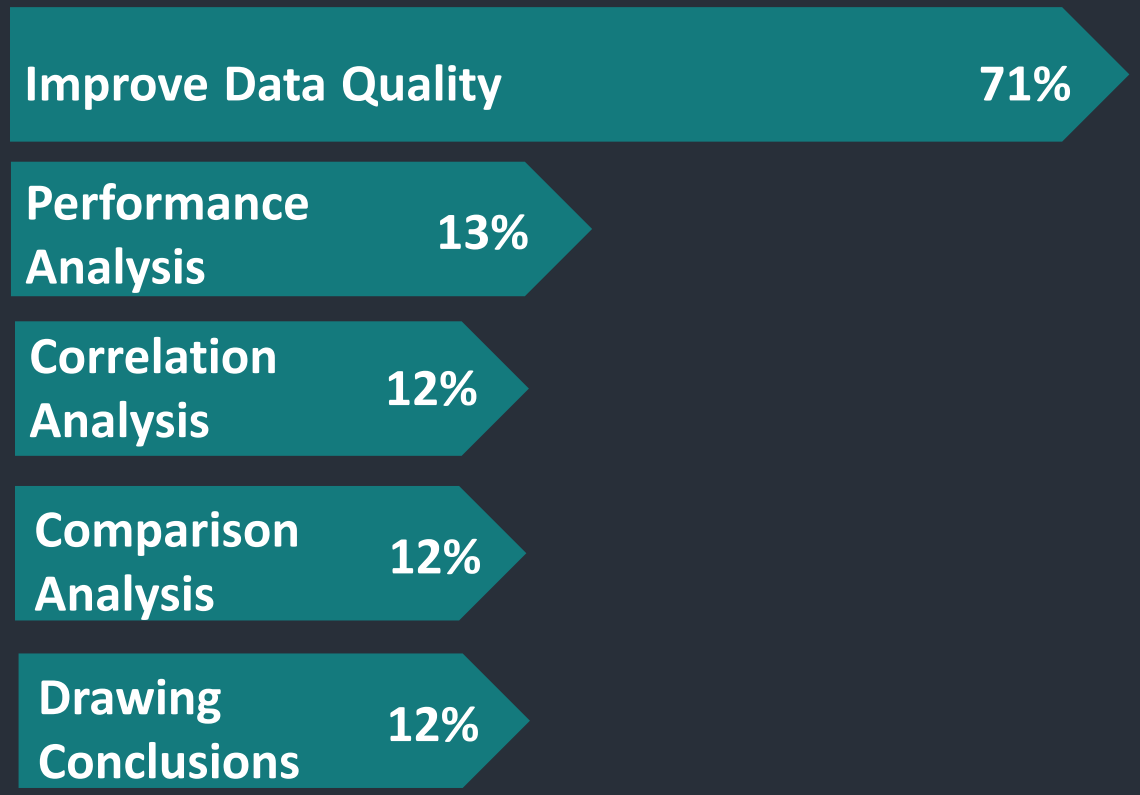
RQ1 Which are the most common tasks of the data analyst in the business domain regarding data visualization and exploration?

RQ2 What kind of data, visualizations and methods are used for the defined tasks?

RQ3 Which are the main challenges and needs of data analysts in the business domain?

Amyrotos, C., Andreou, P., Germanakos, P.: **Human-Centred Persona Driven Personalization in Business Data Analytics**. In: Adjunct Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization. pp. 175–180. Association for Computing Machinery, New York, NY, USA (2021).

Common Data Analysis Tasks in the Business Domain



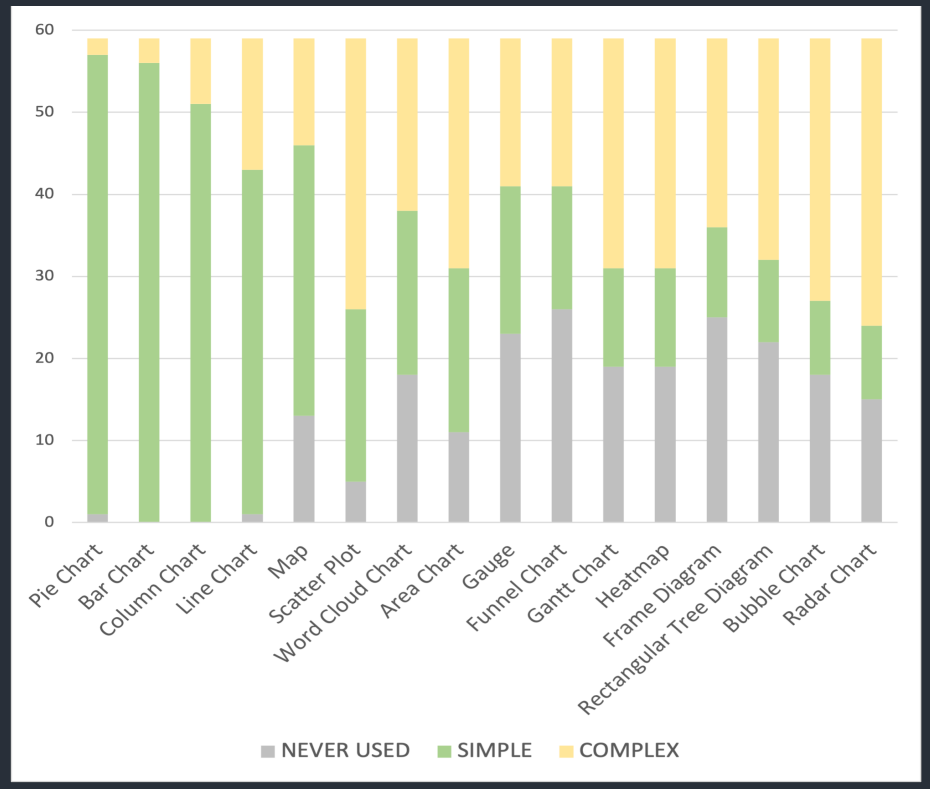
- **Visualization Usage**
  - Average of 2.5 days per week
  - Average of 2.5 hours per day
- **Data Analysis Tasks Performed**
  - Average of 3.5 tasks per week

- **Most Frequent Actions Reported**
  - Data Preparation
  - Exploration
  - Data Communication
- **Least Frequent Actions Reported**
  - Correlation
  - Prediction
  - Classification

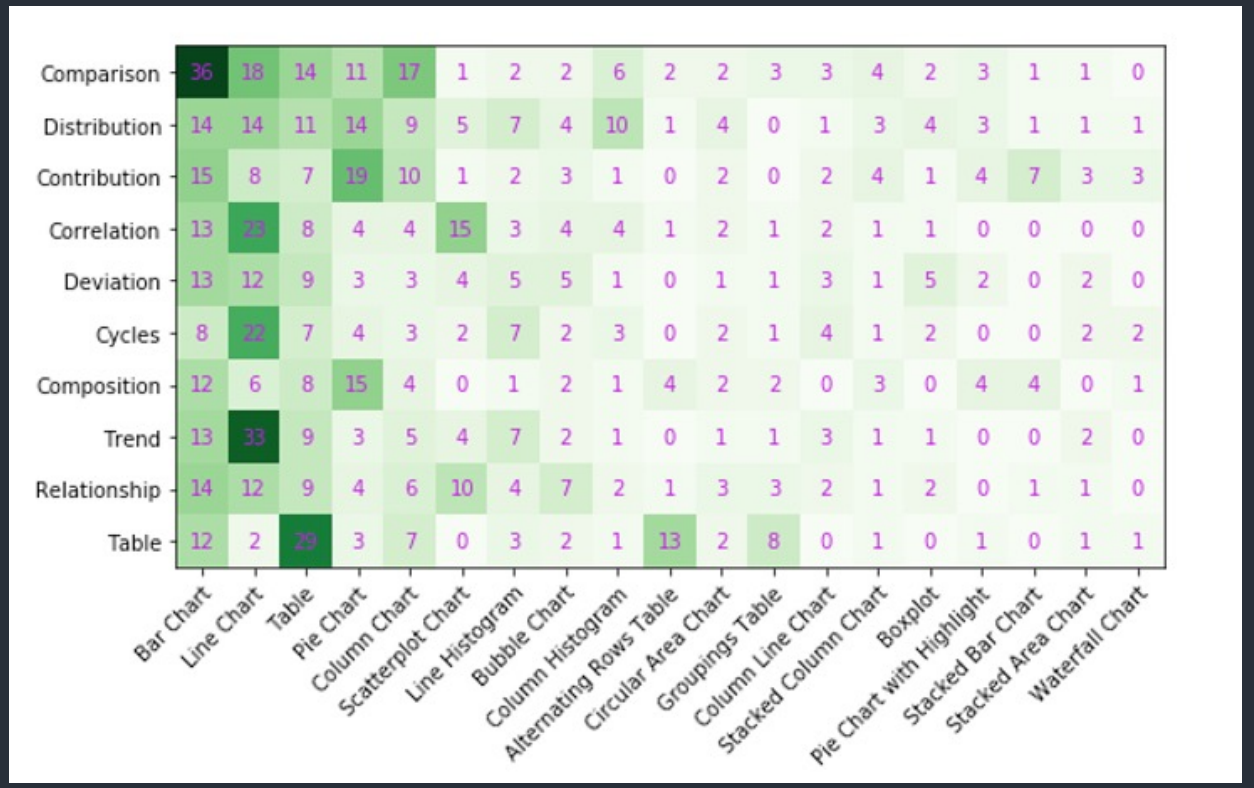
RQ1

Visualizations Used for the Defined Tasks?

Visualization Complexity?



Visualization Usage per Task Type?



Simplest Visualizations

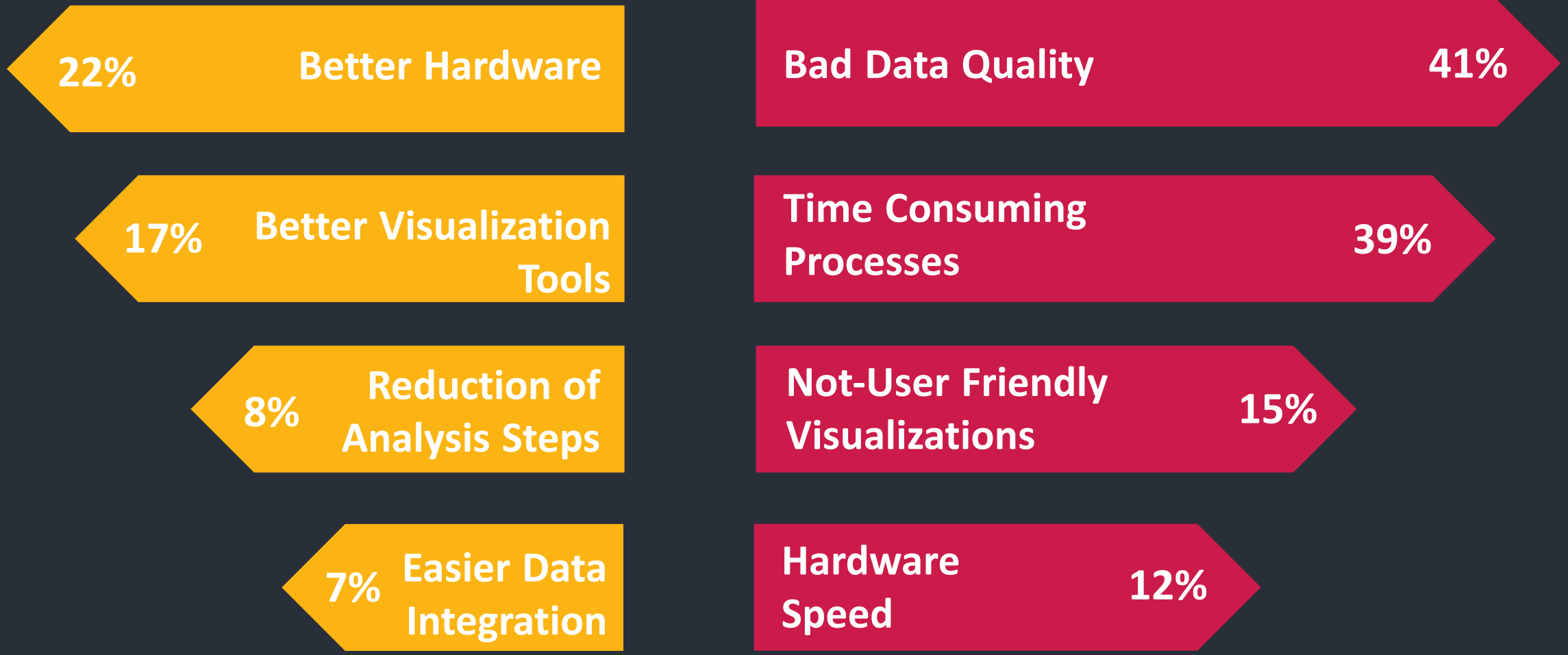
1. Pie Charts and Bar Charts (95%)
2. Column Charts (86%)
3. Line Charts (71%)

Complex Visualizations

1. Radar Charts (59%)
2. Bubble Charts (54%)
3. Gantt Charts and Heatmaps (47%)

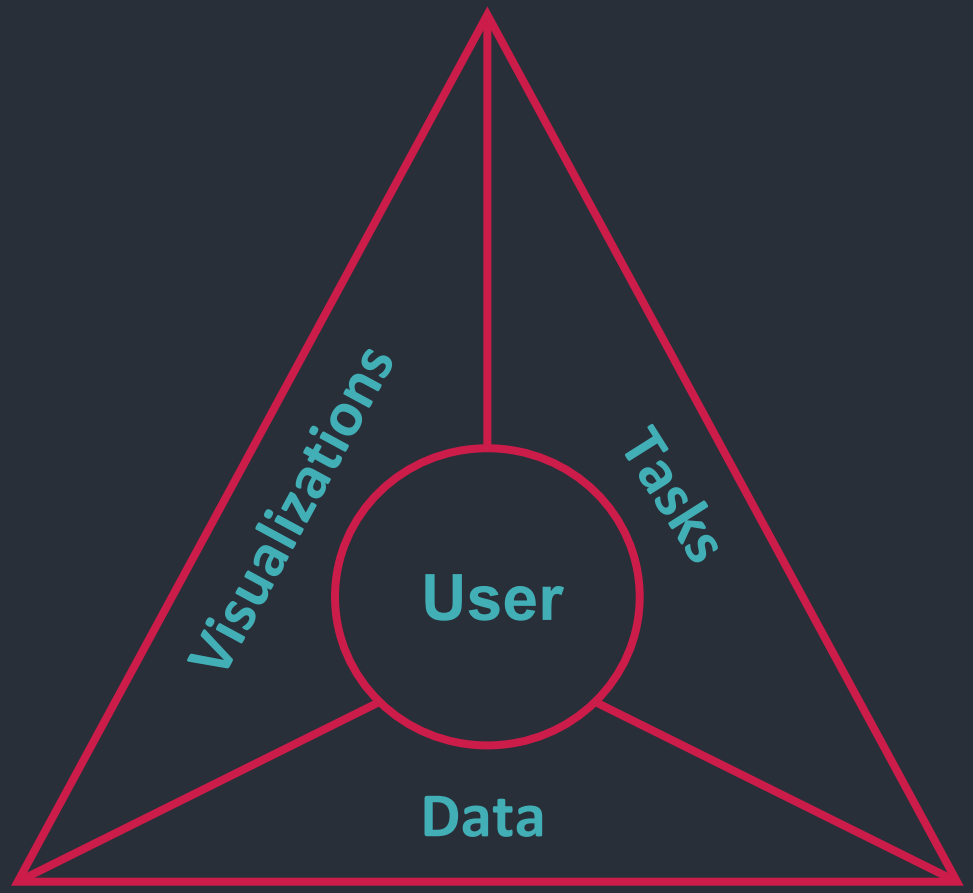
RQ2

Business Domain Needs and Challenges



RQ3

Human-centered Model



Business Context

User Dimension:

- Functioning context / business role?
- Domain expertise and experience?
- Cognitive abilities?
- Requirements / needs?

Visualizations Dimension:

- Which are used in the business domain?
- Their task compatibility?
- How can each be altered for adaptation?

Data Dimension:

- Data integration mechanisms
- Size, type, acquisition and dynamicity of data

Tasks Dimension:

- Units of work towards a business goal
- Usually based on business role
- Difference from other domains?

Amyrotos, C., Andreou, P., Germanakos, P.. 2021. **Adaptive Business Data Visualizations and Exploration: A Human-centred Perspective**. In Proceedings of the 5th HUMANIZE Workshop.

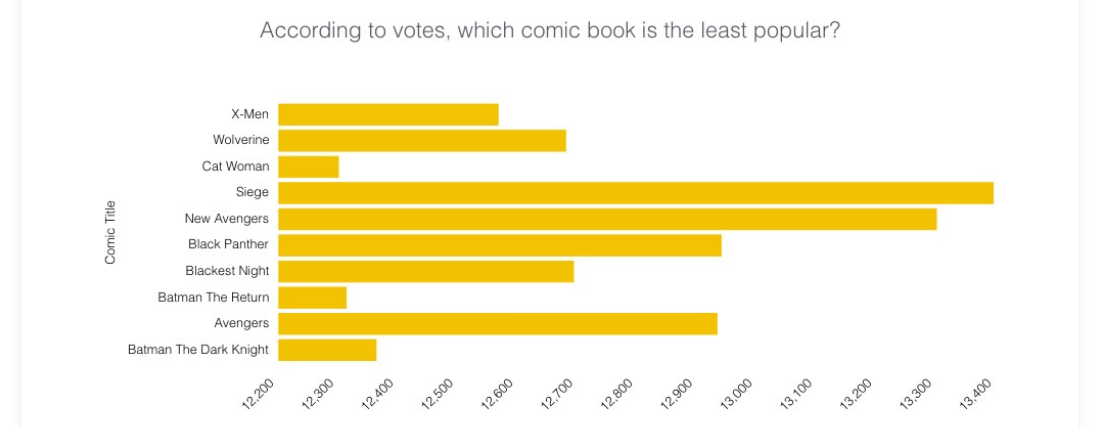
Perceived Expertise Tool in Business Data Analytics

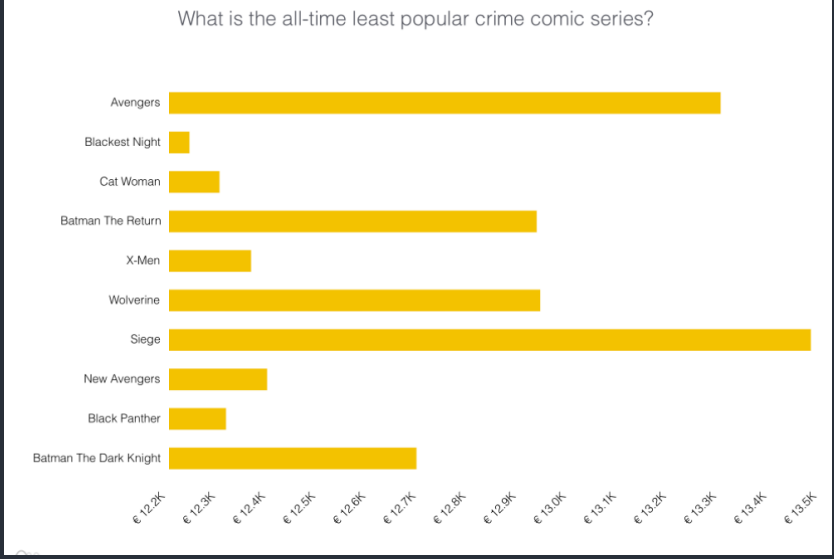
ID	PET Items (1 = strongly disagree; 5 = strongly agree)	Stage
1.	I strictly adhere to taught rules, theories or principles for analyzing my data	Novice
2.	I trust my judgement for evaluating the current data analysis situation (upon receiving a request and prior starting my task), over the taught practices and models for data analysis	Novice
3.	I often perceive current data exploration situations as "familiar" and I use previous relevant cases to tackle them	Adv. Beginner
4.	As an initial reaction during the preparation phase, I usually treat new data analysis requests as separate cases, instead of classifying them in predetermined categories based on my experience	Adv. Beginner
5.	Before I start a data exploration, I usually have an understanding of the intermediate steps (specific methodology/ strategy in mind) that will lead me to my goal	Competent
6.	I have the capability to deal with more than one requests at the same time (multiple activities/ requests) during data analysis	Competent
7.	I have a holistic understanding, based on my experience, of the data analysis that is required for a specific request	Proficient
8.	I usually adapt models or data exploration methods to my current data analysis situation, e.g., indicating deviations from normal patterns (that may apply to repeated data analysis requests)	Proficient
9.	I take the risk of creating alternative exploration paths for analyzing data based on my perception of what is possible and more effective	Expert
10.	I trust my intuition during data analysis	Expert

- ✓ A 10-item "off-the-shelf" instrument, Perceived Expertise Tool (PET), based on Dreyfus & Dreyfus (1980) five-stage model, for measuring the perceived expertise of individuals
- ✓ Preliminary evaluation in the data analytics domain showed that PET has an acceptable internal consistency
- ✓ Significant correlation with affiliated theoretical and domain-specific factors, suggesting the theoretical validity of the proposed instrument
- ❖ May enable the prediction of behaviors that would be beneficial for the creation of related adaptation and personalization techniques

" Germanakos, P., Lekkas, Z., Amyrotos, C., Andreou, P.: **Proposing a Perceived Expertise Tool in Business Data Analytics**. In: Adjunct Proceedings of the 29th ACM Conference on User Modeling, Adaptation and Personalization. pp. 142–149. Association for Computing Machinery, New York, NY, USA (2021).

User Study 2 – Impact of Human Factors on Understanding Visualization Elements





- **Human Factors**
  - Speed of Processing, Control of Attention
  - **Working Memory**, Field Dependent Independent, Perceived Expertise
- **Visualization Elements**
  - Type
  - **Proximity**, Element Size, Color Palette 1, Color Palette 2, Dark Mode, Sorting, Data Labels and Grid Lines

Visual Element	Working Memory Level	Task Complexity	Element Disabled (MS)	Element Enabled (MS)	Performance Gain (%)
Proximity	Low	Low	9197	9428	-2
	High		8881	10656	-17
	Low	Medium	16009	11052	45
	High		15149	11079	37
	Low	High	42665	14724	190
	High		26042	14198	83

User Study 3 – Personalization Impact

Industry: **Consumer and Retail Analytics**

Category: **Soft Drinks**

Role: **Brand Manager for imaginary brand**

Task: **Tackle real business scenarios** of varying complexity

45 Participants

19 Non-Personalized Tasks

19 Personalized Tasks

Adaptation Procedure and Rules

User Study 1
(User Models)

User Study 2
(VisType/Elements Impact)

Rule Ranking

Adaptation Procedure

Chart Type Rules

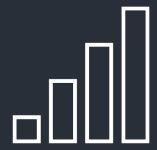
Human Factor	Level	Chart Type	Disable	Enable
WorkingMemoryLevel	High	Bar	28%	72%
WorkingMemoryLevel	Low	Bar	10%	90%
WorkingMemoryLevel	Medium	Bar	21%	79%

Task At Hand

User / User Model

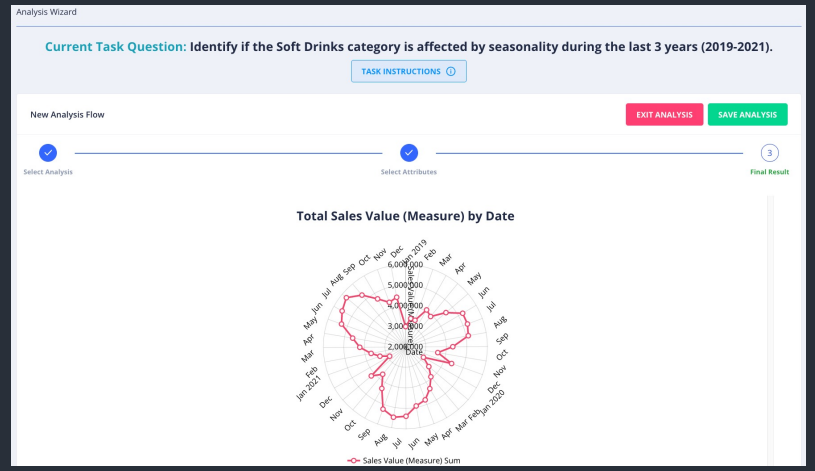
Which Visualization?

Which Elements?
(Ensemble Voting)



Best Fit

Study 3: Impact of personalized visualizations



(average) User Efficiency

~35%

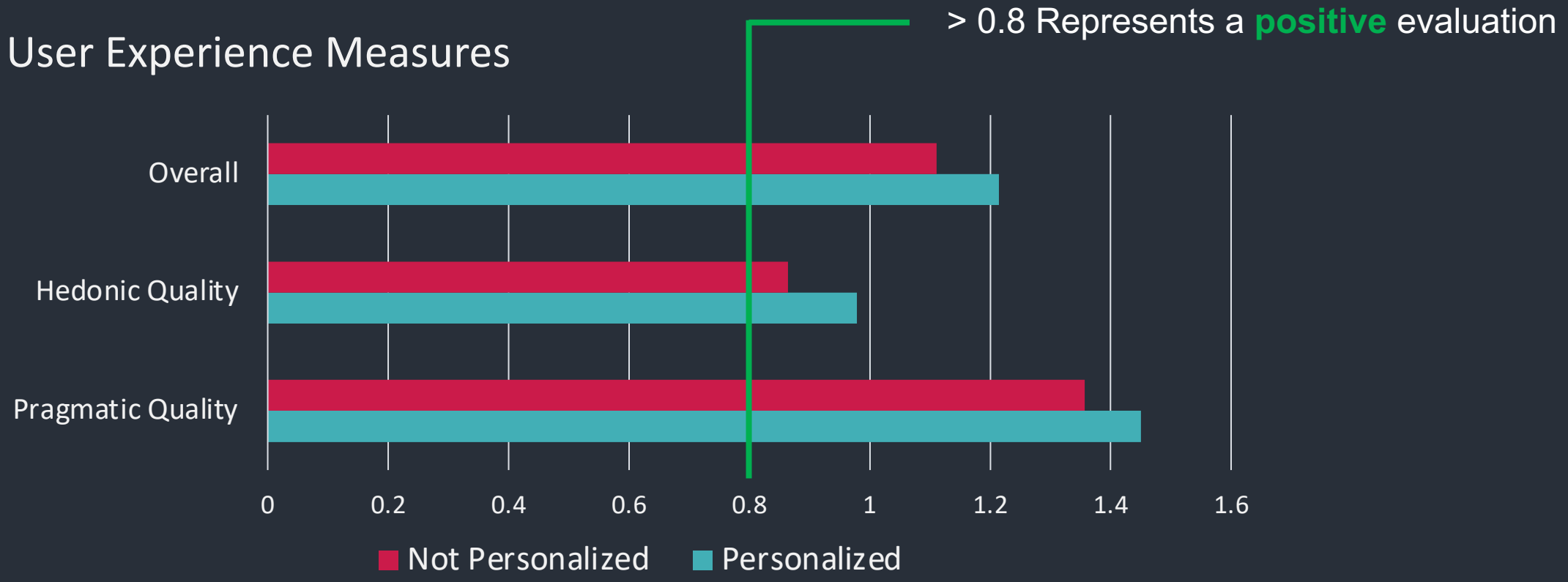
(average) Performance Gain on Tasks

Detect Anomaly **~121%**

Simple Comparison **~29%**

Retrieve Value **~23%**

Personalization - User Experience Effect



TIP: Pragmatic quality focuses on the task-oriented nature of an experience i.e., its efficiency / ease of use, whereas hedonic quality focuses more on the appeal, fun, and originality aspects.

Technological Outcomes

Technological Components

User Modeling

- Seamless experiment setup
- Open/Flexible for new experiment types
- Presents individual and group statistics
- Data retrieval (.csv)

Task Mining

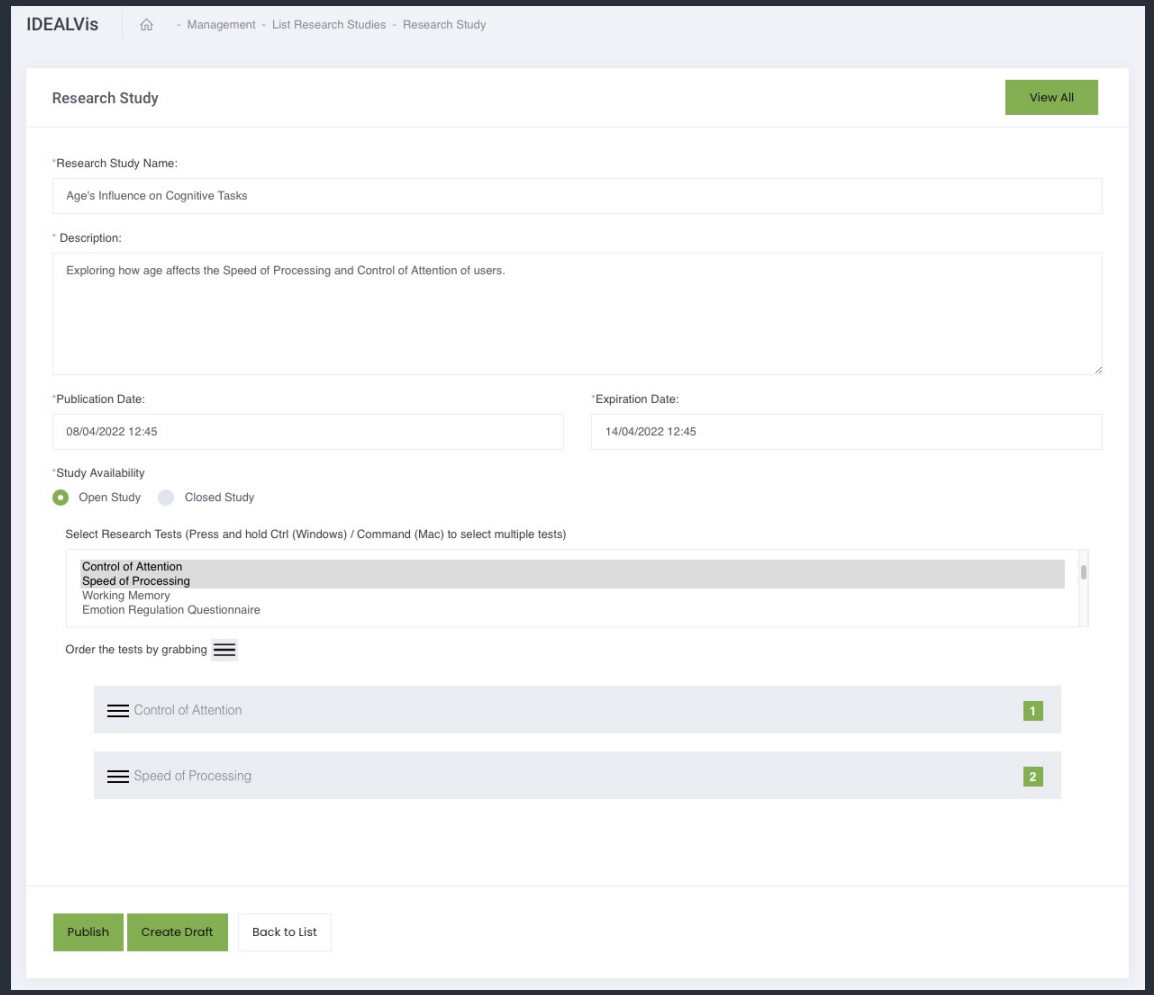
- Records time for each observed component (e.g., chart)
- Can identify bottlenecks in processes

Adaptive Visualizations

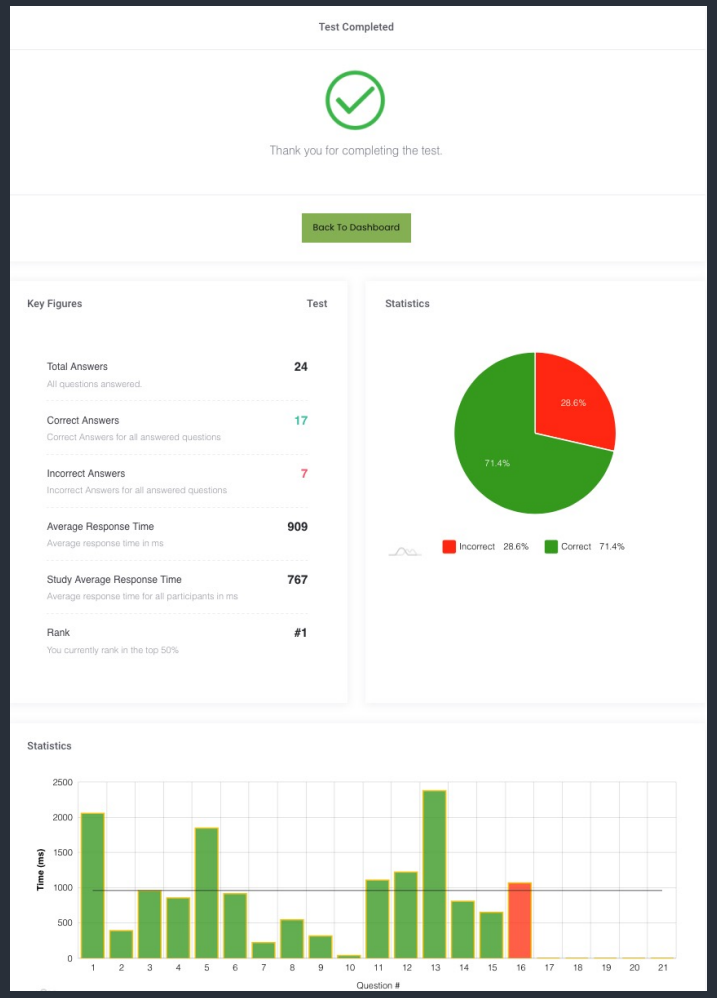
- Customized Adaptation Engine (Ensemble)
- Flexible to include more elements
- Dynamic dashboards
- Persona-based UX

User Modeling

Research study setup

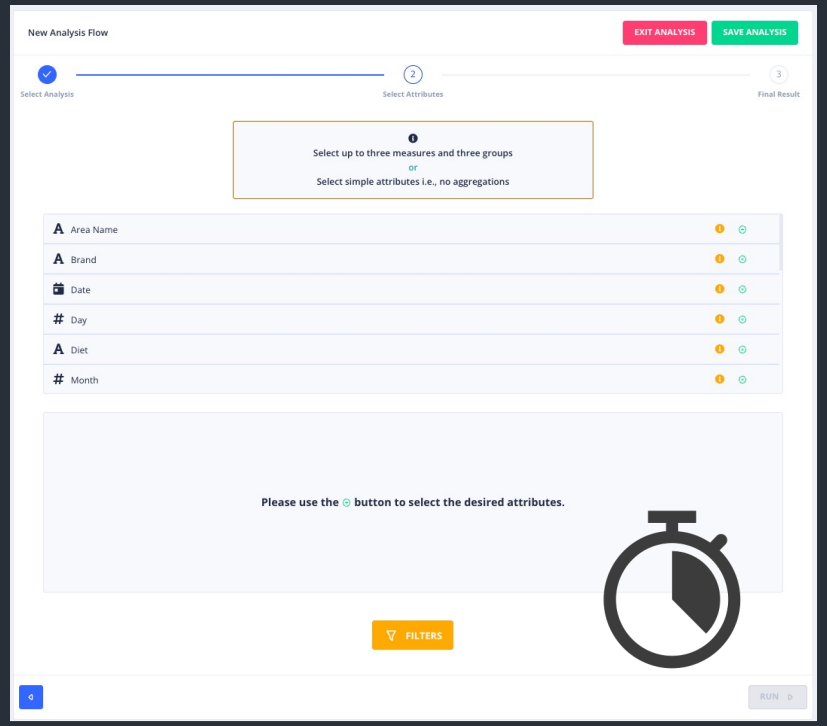


Experiment results



Task Mining

Monitoring/Logging of component active usage



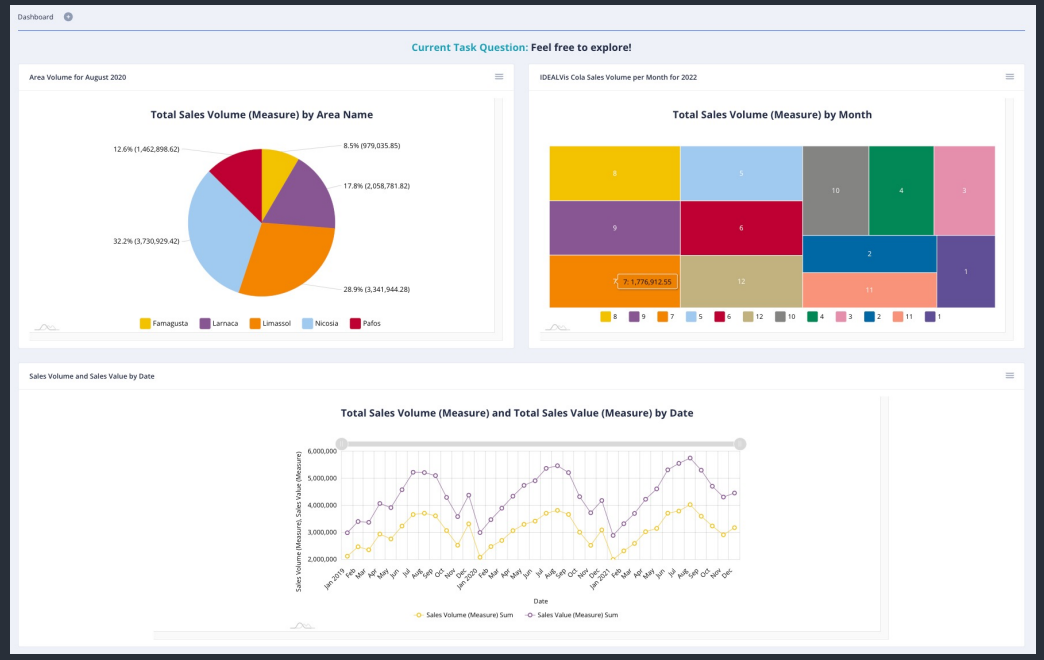
Process Mining

STEP 01 | STEP 02 | STEP 03 | STEP 04 | STEP 05

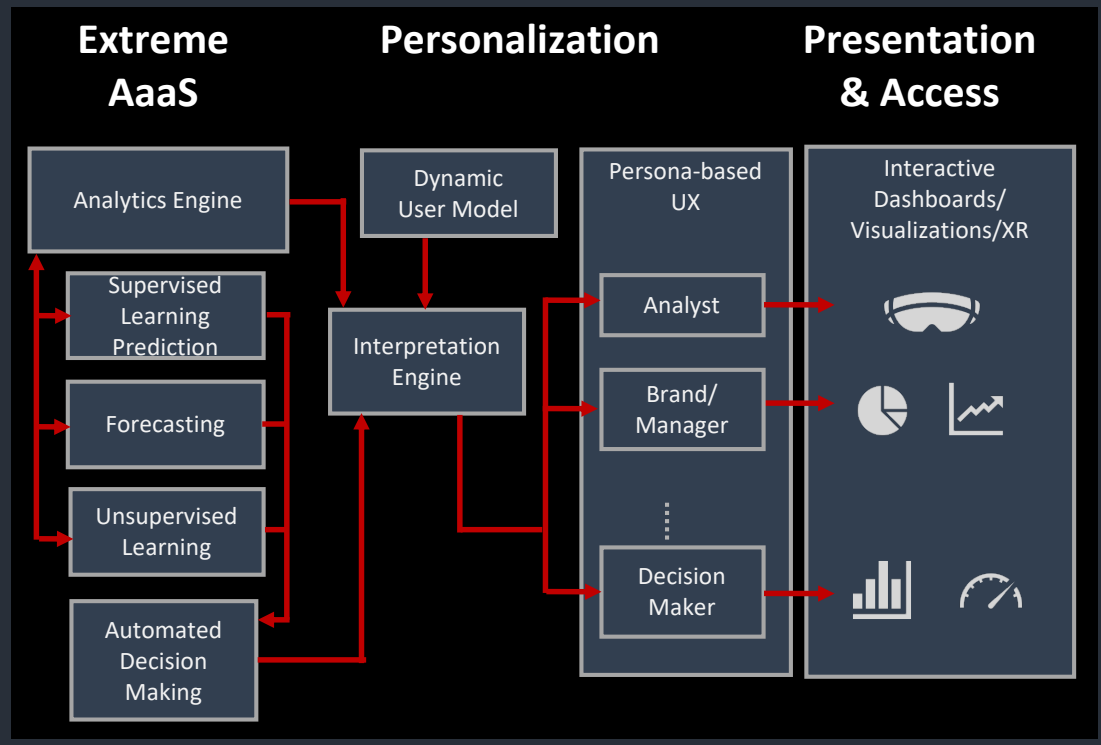
Bottleneck

Adaptive Visualizations

Dynamic dashboards



Personalized UX



Q & A

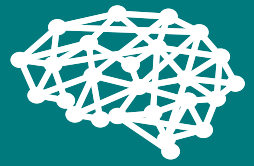
Next Steps

- Unobtrusive Intelligent User Interface (IUI) that ensures a seamless interaction between the users and IDEALVis, context-aware support and service continuity.
- To investigate further human factors (with focus on sensitive groups) and their relationship with current for enhancing the validity and inclusiveness of current human-centred model
- To define qualitative personalized explanations and effective adaptive interventions that will be triggered by the user profiles and the individual differences for tackling complex/critical business tasks
- Application in different industry domains
- Infer cognitive factors based on interaction

Thank you

Business Users

Data Exploration



Machine Learning

User Modeling and Adaptation