Adaptive Data Visualizations Framework (ADVisE)

Kickoff Meeting

Nicosia, 22/02/17

Agenda

Welcome	09:45 – 10:00
Introduction of ADVisE by Project Coordinator	10:00 – 10:30
Introduction of Project Partners	10:30 – 11:00
Project Overview and Objectives	11:00 – 11:30
Overview of Work Packages Discussion of WP3, WP4 and WP5	11:30 – 12:30
Lunch Break	12:30 – 14:00
Discussion of WP6 and WP7	14:00 – 15:00
Discussion on the Overall Project Management and Project Coordination	15:00 – 15:30
Open discussion (i.e., project Web-site, logo, other issues)	15:30 – 15:45
Closing remarks	15:45 – 16:00

ADVisE Consortium

University of Cyprus

- (PC) **Prof. George Samaras**, Department of Computer Science
- **Dr. Panagiotis Germanakos**, Department of Computer Science
- **Georgia Kalli**, Department of Computer Science
- **Assoc. Prof. George Spanoudis**, Department of Psychology

UCLan Cyprus

- **Asst. Prof. Panayiotis Andreou**, Department of Computing

National & Kapodistrian University of Athens

- **Assoc. Prof. Costas Mourlas**, Department of Communication and Media Studies

RAI Consultants Ltd.

- **Mr. Olympios Toumazou**

Background

- Modern Business Intelligence (BI) platforms have moved beyond traditional data warehousing to **real-time visual analytics**
  - Facilitate real-time decision support
  - Export data into various standard format artifacts (e.g. tabular forms, graphs, etc.)
- According to IBM, every day we create 2.5 quintillion bytes of data coming from a **variety of sources and in diverse formats**
- Most data visualizations generated today are:
  - Created based on **task and/or data-driven models** and methods
  - Extracted based on data mining algorithms that **do not consider any role-based specifications** and/or **user needs** and **requirements**
  - Follow an **one-size-fits-all approach**, presenting the same visualization type and content to all users **irrespective of their preferences or intrinsic cognitive characteristics**

Problem

Users may be disoriented and loose focus in terms of **navigation** while they might not be able to take fast and accurate **decisions** when performing their daily business activities

Goal and Aims

The complex nature of many information visualizations, objectives and tasks makes it indispensable to **include human intelligence in the data analysis and visualization process** at an early stage, and **enrich the tools and applications with adaptation techniques** and new possibilities for interactions that will bring the human-in-the-loop

Overarching Project Goal

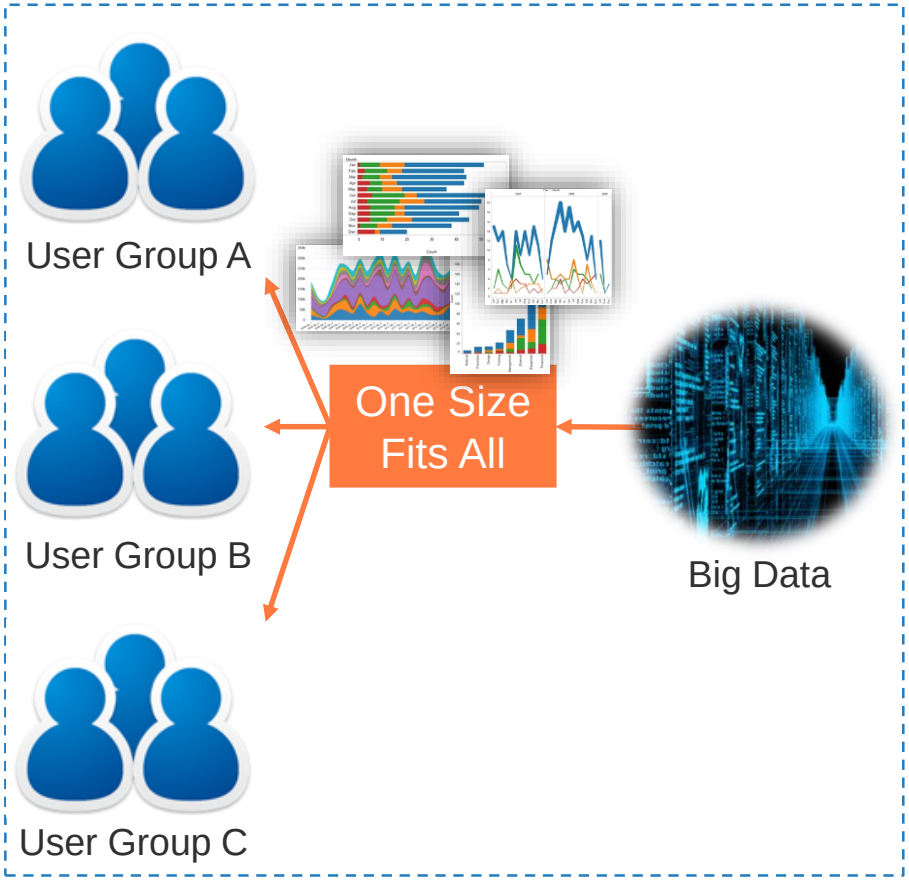
To **enable human-centred adaptive data visualizations** that will **facilitate efficient exploration and analysis** of complex and multivariate business datasets, and will **support and enable more effective decision making** on critical business tasks

Aims

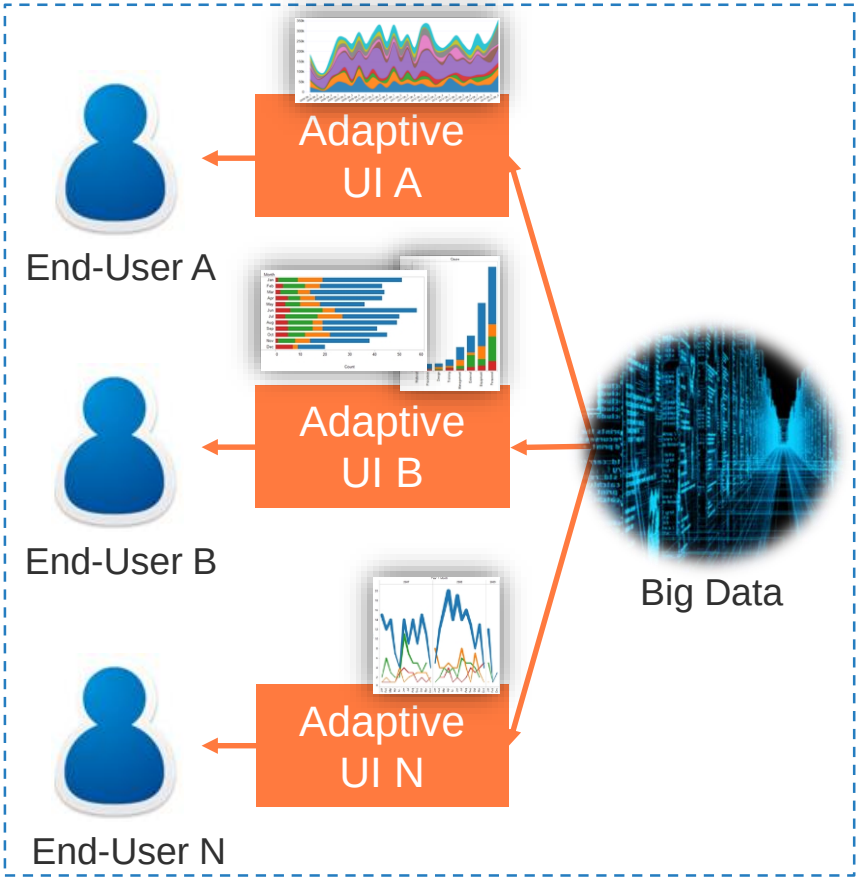
- To **identify the best-fit representation of data for the unique end-users**, based on their user models and the data properties, and provide them with the best-fit personalized conditions
- To design and implement a framework that will have the **inherent ability to transparently adapt its behavior using intelligent techniques and interventions** (handling e.g. different modes, complexity, objects' proximity, scaffolding of data visualizations)

Main Idea

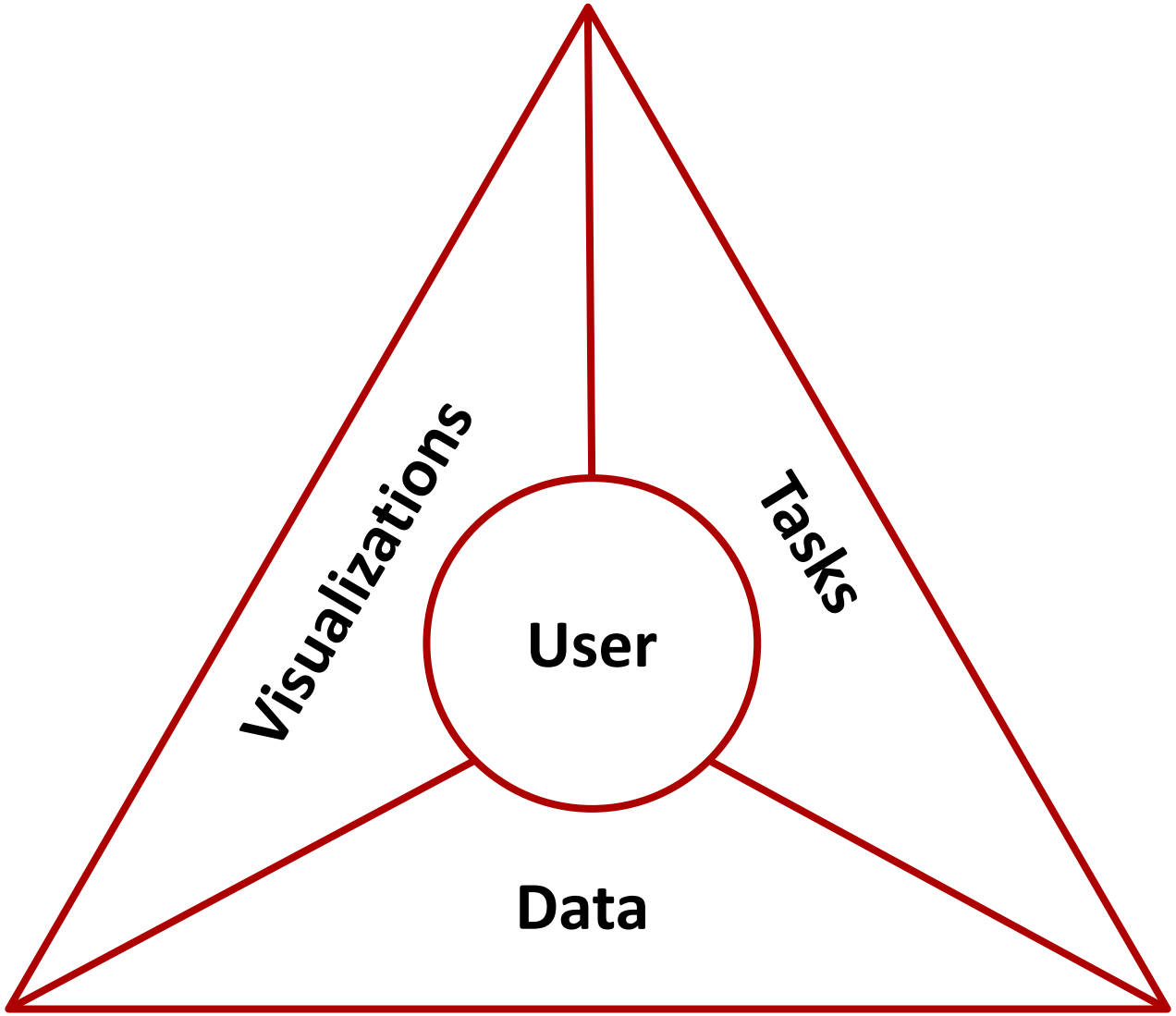
Visual analytics platforms today



ADVisE



High-level Model Parameters



Best-fit Data Visualization

High-level Cognitive Factors

Field-Dependent — Cognitive Style — Field-Independent

More static parameters

Don Richard

Supply Manager

- Business Informatics, MBA
- Good knowledge of statistics
- 45 years old
- 15 years of experience
- 60:40 office:outside

Domain Expertise

Skill Level/Acquisition

Novice
Advanced Beginner
Competence
Proficiency
Expertise

ADVisE

Elementary Cognitive Factors

Speed of Processing

Controlled Attention

Working Memory

Biofeedback

EEG | Heartrate | GSR

Objectives

- To investigate the influence of individual differences in cognitive processing with respect to visual analytics and **formulate an inclusive human-centered user model**
- To **identify potential correlations of cognitive factors** referring to high-level information processes as well as elementary cognitive processes **with different kinds of data visualizations**, in terms of type and complexity (e.g., network diagrams, area and radar graphs, bar and line charts)
- To **analyze and suggest a set of adaptive visualization interventions** that could increase the usability and satisfaction of users based on their role or levels of expertise; and
- To develop and evaluate the **Adaptive Data Visualizations framEwork (ADVisE)** that will dynamically adjust the content and interaction style of data visualizations based on users' individual differences, the data characteristics (e.g., criticality, real-time, historical) and the task at hand (e.g., priority, time constraints).

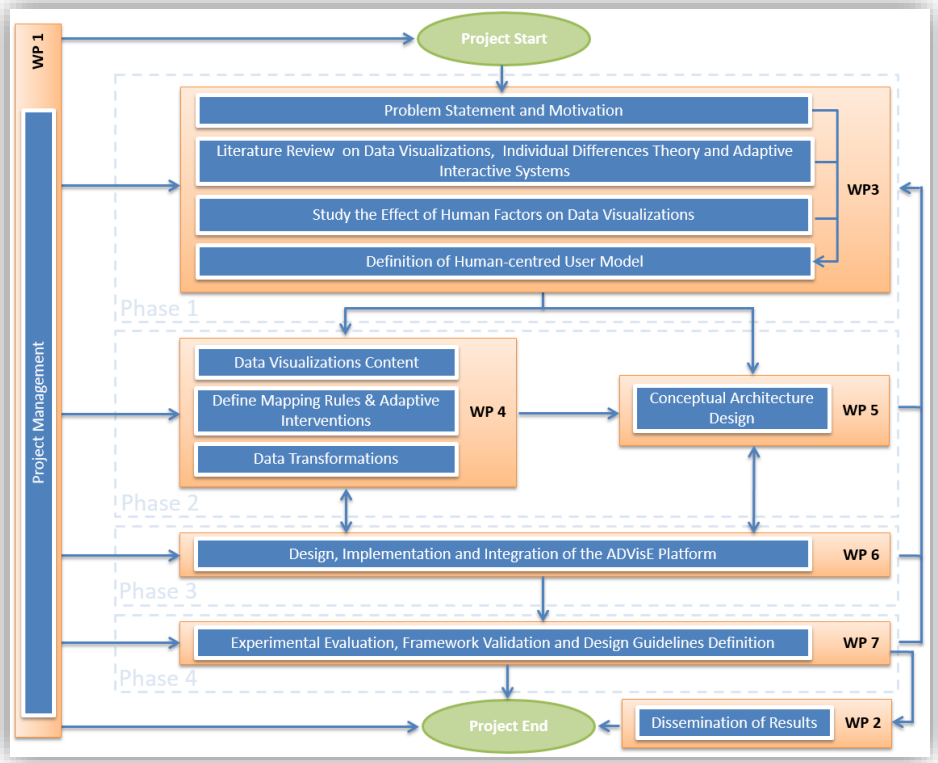
Research Challenges

To identify and **develop enhanced data representations** that will be able to **capture the fuzzy human nature and multi-objective tasks** in terms of providing information in different modalities, navigation patterns and interaction logic thus **allowing for adaptation based on users' cognitive processing abilities, role, expertise and tasks**

- Which parameters and human factors are considered important so to define an inclusive human-centred user model in the context of data visualizations?
- *What*, *how* and *when* data visualizations content can be enriched/ altered and delivered to the end-users?
- What adaptation techniques and interventions are feasible for generating best-fit data visualizations?
- What kind of data mining mechanisms need to be developed to ensure data integration and fusion of various dispersed datasets/ sources?
- How to verify the validity of the theoretical human-centred user model? How to design and conduct experiments for evaluating the framework?

Methodology

- In ADVisE we will follow a **Design-Based Research approach** to ensure the high quality of the conceptual and information model as well as the technical components of the framework
- **Continuous evaluation and iterations between and within the 4 phases** so that our understanding, theory and methodology are continuously evaluated (reflected upon and refined) and this learning is captured throughout the process, producing outputs that are sustainable and exploitable



Overview of Working Packages (WPs)

Work Package Table					
Work Package Number	**Work Package Title**	**Person-months**	**Start Date**	**End Date**	**Deliverable Number**
WP 1	Project Management	3	M01	M24	1,2,3,4,5,6
WP 2	Dissemination of Results and Exploitation	6	M01	M24	7,8,9,10,11
WP 3	Information Visualization Analysis and User Modelling	10	M01	M12	12,13
WP 4	ADVisE Framework Definition	8.5	M03	M15	14,15,16
WP 5	Platform Architecture and Design	6	M06	M16	17,18,19
WP 6	Platform Development and Integration	13	M08	M24	20,21,22
WP 7	Pilot Trials, Experimental Evaluation and Theory Verification	8.5	M10	M24	23,24,25

Overview of WPs Tasks

WP1:

- Task 1.1: Administrative and Financial Management (UCY)
- Task 1.2: Technical Management and Quality Assurance (UCY)
- Task 1.3: Risk Assessment (UCY)

WP2:

- Task 2.1: Dissemination (UCY, UCLAN, NKUA, RAI)
- Task 2.2: Exploitation (UCY, UCLAN, NKUA, RAI)

WP3:

- Task 3.2: Adaptation and Personalization Processes and Techniques (UCY, NKUA)
- Task 3.3: Human-centred User Model Specification (UCY, NKUA)

Overview of WPs Tasks (c/ed)

WP4:

- Task 4.1: Content Generalization/ Specialization Analysis (UCY, NKUA)
- Task 4.2: Data Transformations (UCLAN, UCY, NKUA)
- Task 4.3: Mapping Rules (UCY)
- Task 4.4: Adaptation Engine (UCY, UCLAN)

WP5:

- Task 5.1: Platform Architecture Design and Specification (UCLAN, UCY)
- Task 5.2: Specification and Development of Security and Privacy Infrastructure (UCY, UCLAN)
- Task 5.3: Responsible Industry and Innovation (UCLAN, UCY)

Overview of WPs Tasks (c/ed)

WP6:

- Task 6.1: Components Development (UCY, UCLAN, NKUA)
- Task 6.2: Platform Integration (UCLAN, UCY, NKUA)
- Task 6.3: Platform Testing and Validation (UCLAN, UCY, NKUA, RAI)

WP7:

- Task 7.1: Theory Verification and Human-centred User Model Validation (UCY, UCLAN, NKUA, RAI)
- Task 7.2: Pilot Trial Set-Up and Operation (RAI, UCY, UCLAN)
- Task 7.3: Practical Design Guidelines (UCY, RAI)

List of Deliverables

List of Deliverables			
Deliverable No	**Title**	**Deliverable Type**	**Completion**
D1	B-annual Progress Report	Report	6
D2	Interim Progress Report	Report	12
D3	B-annual Progress Report	Report	18
D4	Final Progress Report	Report	24
D5	Coordination Meetings Report	Report	12
D6	Coordination Meetings Report	Report	24
D7	Project Web-site	Web-site	1-24
D8	Workshop Organization	Report	20
D9	Project Scientific Papers and Conferences Presentations	Report	24
D10	Exploitation Plan and Activities	Report	19-24
D11	Dissemination Material (posters and brochures)	Report	24
D12	Analysis of Existing Information Visualizations and Adaptation Processes and Techniques	Report	6
D13	Human-centered User Modelling Analysis and Specification	Report	12
D14	Semantic Content Schema Specification	Report	15
D15	Visual Analytics and Machine Learning Methods for Data Transformation	Report	15
D16	Adaptation Engine and Personalization Rules	Report	15
D17	Overall Platform Architecture Design	Report	16
D18	Design of the Security and Privacy Infrastructure	Report	16
D19	RRI Framework	Report	16
D20	Development of the operational ADVisE platform	Software	24
D21	Setup and Deployment Specification of the ADVISE platform	Report	18
D22	ADVisE Platform Validation	Report	24
D23	BETA Pilot Experimental Procedure Design and Results	Report	19
D24	Pilot Trial Evaluation Results	Report	24
D25	Human-centred Data Visualizations Guidelines for Researchers and Practitioners	Report	24

Time Frame

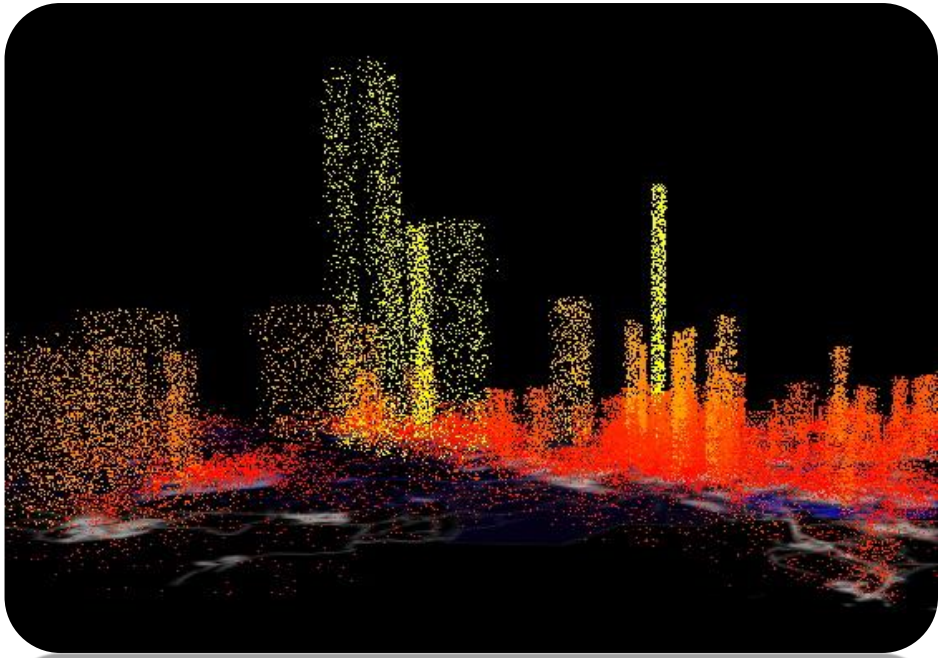
Time Frame																								
Work Package Number / Title	**D U R A T I O N (months)**																							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
WP1. Project Management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WP2. Dissemination of Results and Exploitation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WP3. Information Visualization Analysis and User Modelling	X	X	X	X	X	X	X	X	X	X	X	X												
WP4. ADVisE Framework Definition			X	X	X	X	X	X	X	X	X	X	X	X	X									
WP5. Platform Architecture Design						X	X	X	X	X	X	X	X	X	X	X								
WP6. Platform Development and Integration								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WP7. Pilot Trials, Experimental Evaluation and Theory Verification										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Progress Reports Submitted to UCY						X						X						X						X

Expected Results

- Systematic survey of the **state-of-the-art including the identification of future research areas and challenges** in dealing with complex business data and visualizations
- A **multi-dimensional human-centered user model** that will be composed of parameters that reflect individuals' information processing, decision making, problem solving and learning
- A **set of personalization rules and adaptive interventions** that couple the human and machine data analysis and recommend the best-fit data visualizations to the end-users
- A **set of intelligence data mining techniques** that will enable processing of both real-time and historical data, their integration into a unified information model, which can be then queried upon for extraction of key business knowledge that will produce multi-purpose data visualizations
- An **extensible and open adaptive data visualizations framework** that realizes and connects the various multi-purpose components and methods

Expected Results (c/ed)

- **Evaluation results of numerous ecological valid experimental studies** conducted iteratively throughout the life-cycle of the project
- A **set of innovative practical design guidelines** suggesting how visual analytics can be enriched with personalization techniques and adaptive interventions and produce alternative interactive data visual designs that consider user's individual differences as the core filtering parameters



Source: Patrick Collings

Benefits and Impact

- Given the users' diversified requirements, needs and perceptual preferences as well as the size, diversity and processing overhead of big data sets, it is expected that this research will **yield flexible best-fit data visualizations and methods that will support the unique end-users during the interaction process**
- The impact, especially in situations that entail complex and demanding business scenarios, will be significant since in this case it is hard to define *a priori* a set of appropriate interaction behaviors that relate to given tasks with visualization, as well as to their suboptimal counterparts, that support open ended or exploratory tasks

Added Value

The **seamless integration of the computational tools and human-centered data visualization methods**, an open problem that has not been addressed, to our knowledge, by any research team

Proof-of-Concept

Purpose, a small study to examine whether

- There is a correlation between information/ cognitive processing and the ability to navigate over data visualizations

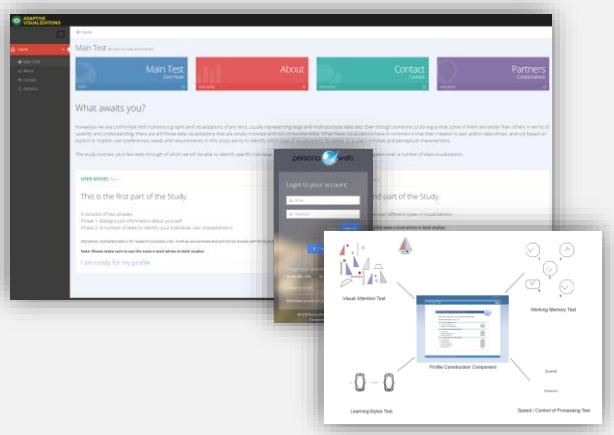
Sample, in total 21 participants

- 15 female and 6 male
- Ages between 18 and 26

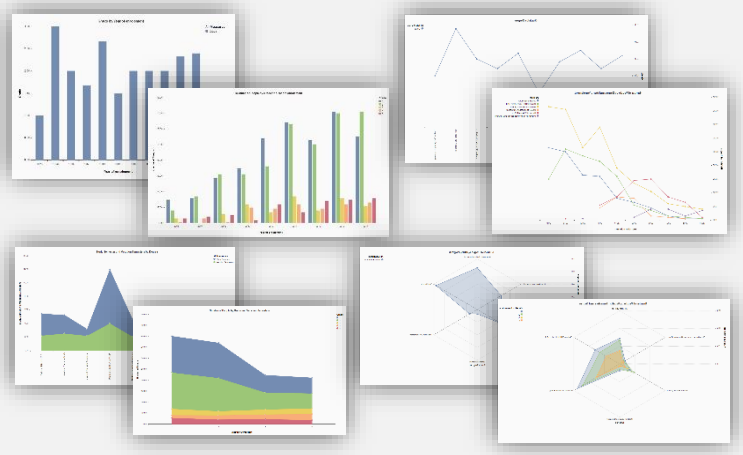
Method

- User model and psychometric factors elicitation
- Within the subjects approach. All subjects navigated over 4-types of visualizations (one easy and one difficult one of each type) answering some simple questions
- Dependent variables: Accuracy and time spent

The Environment - User Model



The 4-types of data visualizations



Proof-of-Concept (c/ed)

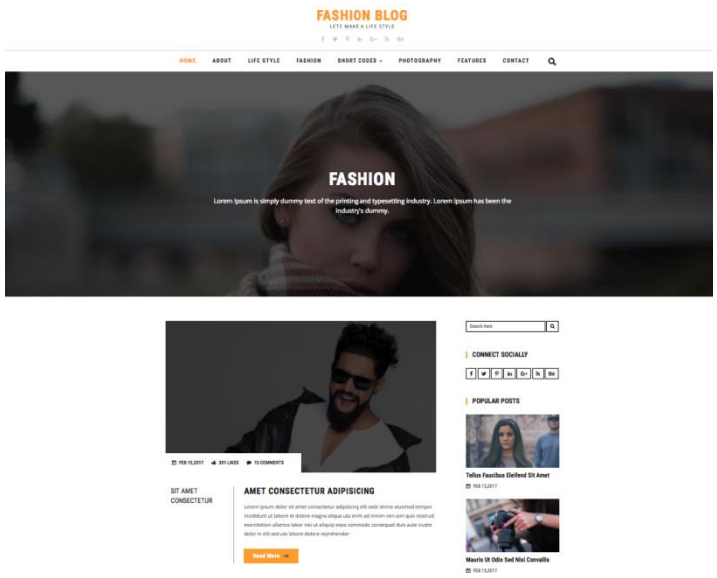
Preliminary main findings (analysis still in progress)

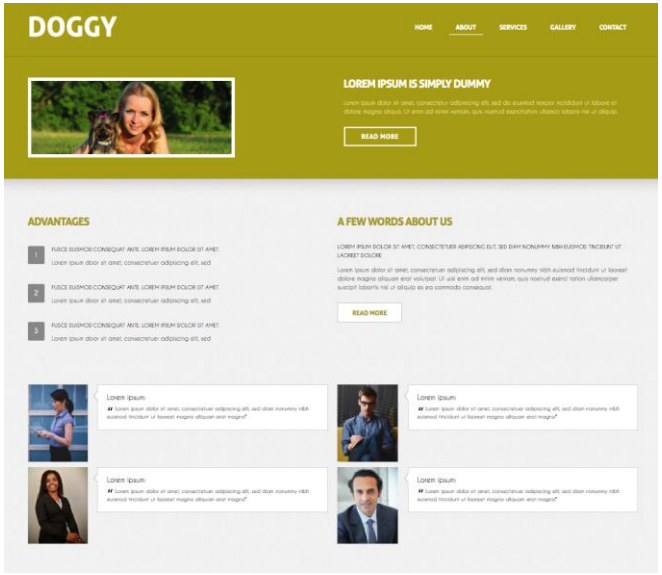
- Controlling the factor of Cognitive Style, we saw a correlation of accuracy and speed of the visual working memory group when interacting with the difficult radar graph condition. An unpaired t-test showed that people with **high visual working memory could perform significantly better ($p<0.02$) compared to people with low visual working memory**
- **Same effect** has been observed while subjects interacting with the **difficult line condition** (with no statistical significance)

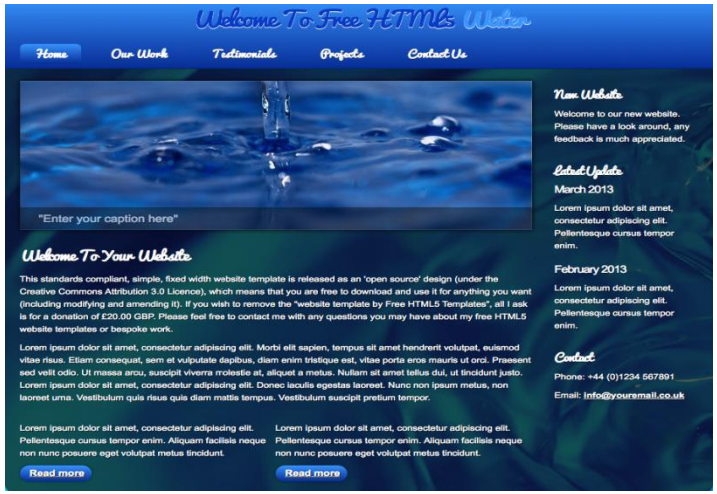
Aftermath

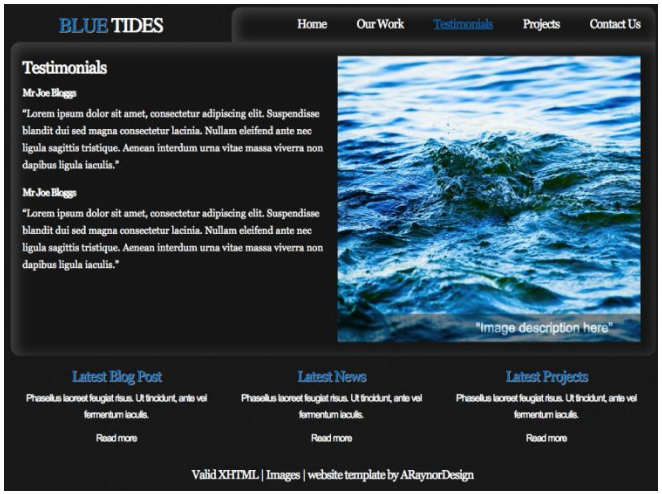
It seems, even though at early stages, that the cognitive parameters associated with information processing are positively correlated with the type and complexity of data visualizations, influencing the navigation and decision making (solving tasks) of users during interaction

ADVisE Website Template









ADVisE Logos

1 

2 

3 

4 

Thank you for your attention