

# Meta-modeling ecosystems



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# Metamodel for the definition of technological ecosystems focusing on knowledge management

# Hi!

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# 1. Introduction

# 1.1 Knowledge management (I)

According to Castells, the Knowledge Society is a society in which the conditions of knowledge generation and information processing have been substantially altered by a technological revolution centred on information processing, knowledge generation and information technology.

Knowledge Society → Learning Society



## 1.1 Knowledge management (II)

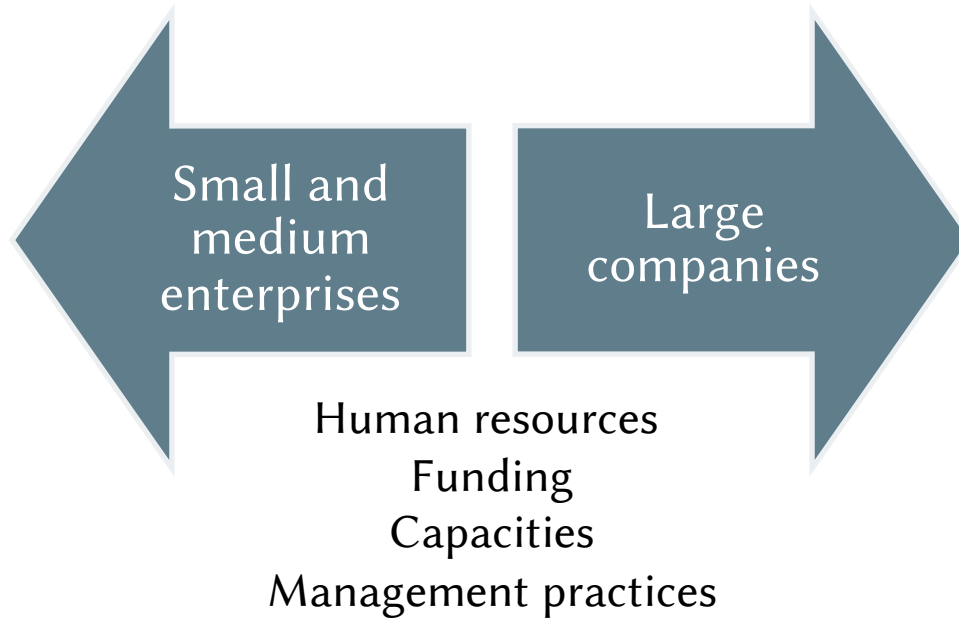
The evolution of the Information Society into the Knowledge Society is directly related to the evolution of information systems

Knowledge management emerges as a competitive advantage in any type of organisation (Nonaka and Takeuchi, 1995)

## 1.1 Knowledge management (III)

- ◎ Knowledge management is not only associated with managing knowledge as a resource, but also with managing the business processes that are carried out using that resource

# 1.1 Knowledge management (IV)





# 1.1 Knowledge management (V)

- ① Knowledge management systems provide the necessary tools to support processes and facilitate access to and re-use of knowledge (Natali and Falbo, 2002)
- ① Different models of knowledge management have emerged that focus on the human factor and place technology as another element within the model (Rubio, Ocón, Galán, Marrero and Nelson, 2004; Fidalgo-Blanco, Sein-Echaluce and García-Peñalvo, 2014)





## 1.2 The technological ecosystem (I)

- © Technological ecosystems emerge to solve knowledge management problems in heterogeneous contexts, being considered the evolution of traditional information systems (Laudon and Laudon, 1991; Langefors, 1977)
- © The ecosystem metaphor comes from the area of biology and has been transferred to the area of technology to reflect the evolutionary nature of software systems.



## 1.2 The technological ecosystem (II)

A set of organisms or biotic factors, the physical environment they inhabit or abiotic factors, and the relationships both between organisms and between organisms and the environment.

Natural ecosystem



## 1.2 The technological ecosystem (III)

- ◎ In a technological ecosystem, there is a set of people and software components that play the role of organisms; a set of elements that allow the ecosystem to function (hardware, networks, etc.); and a set of information flows that establish the relationships between the software components and between them and the people involved in the ecosystem





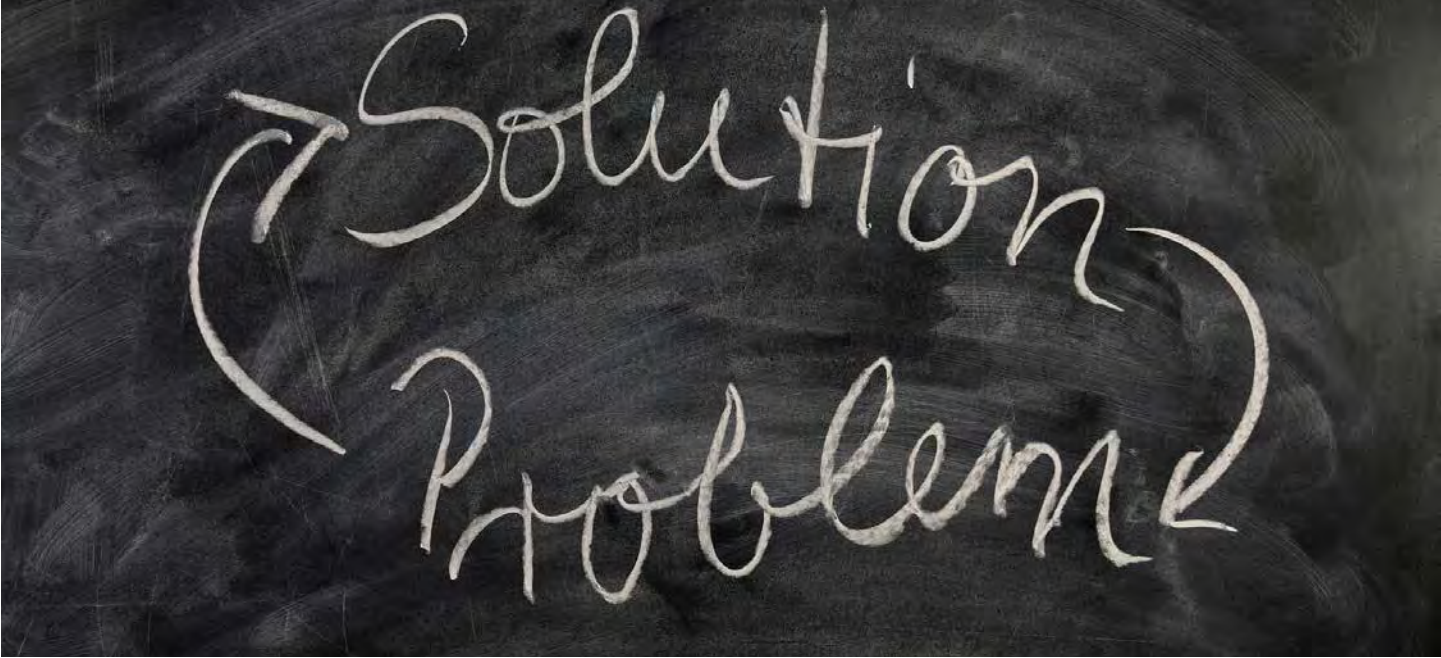
## 1.2 The technological ecosystem (IV)



Ecosystems must be able to combine some of the tools that already exist for managing knowledge, such as CMSs and repositories, and they must be able to incorporate emerging tools as well as eliminate those that are obsolete or not used by users



They must also be able to incorporate emerging tools, as well as eliminate those that are obsolete or not used by users





## 1.2 The technological ecosystem (V)



Despite the advantages, this type of development presents a great deal of complexity

It requires knowing and selecting the right systems and services; achieving a high degree of integration and cohesion; allowing the ecosystem to evolve and adapt to the changing needs of the environment and users



## 2. Example of a real technological ecosystem





## GRIAL Ecosystem (I)

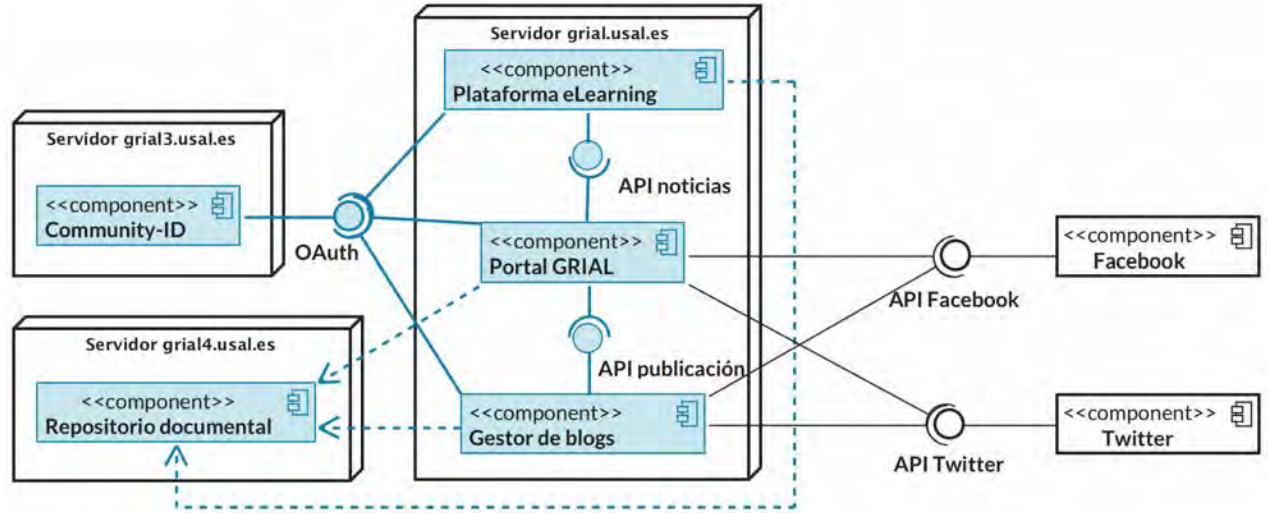


- ◎ Since 2010 in continuous evolution
- ◎ Internal and external knowledge management
- ◎ Sustainability of the research group



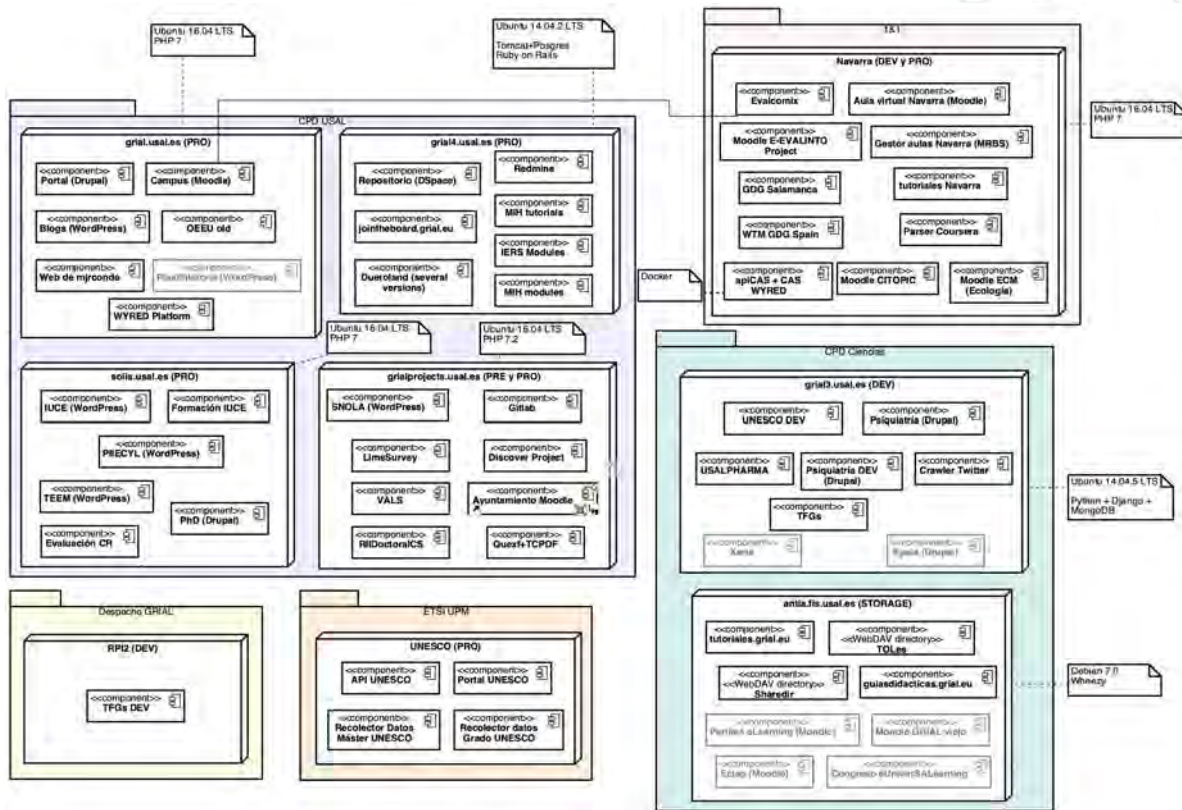
# GRIAL Ecosystem (II)

## Initial situation



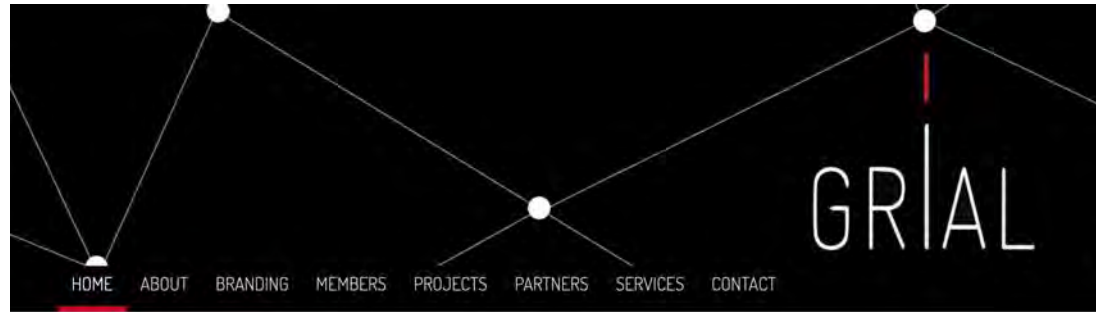
# GRIAL Ecosystem (III)

## 🎯 Current situation



# GRIAL Ecosystem (IV)

Public portal <https://grial.usal.es>



## Recent news

### Llamada a trabajos VII Jornadas Iberoamericanas de Interacción Humano-Computador

Submitted by admin on Mon, 22/03/2021 - 23:44



**HCI 2021**  
São Paulo - Brazil

por la Universidade Presbiteriana Mackenzie (São Paulo).  
Read more 41 reads

Las VII Jornadas Iberoamericanas de Interacción Humano-Computador es un evento anual que se encuentra en su séptima edición, siendo la primera vez que se organiza en Brasil. Este evento tendrá lugar entre el 8 y el 10 de septiembre de 2021, la participación de los autores será en formato online, organizado

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Tweets by @grial\_usal

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Llamada de trabajos del International Conference of Research in Education - IRED'21

Los retos de la investigación educativa post-pandemia iared2021.grial.eu/llamada-a-trab...

# GRIAL Ecosystem (V)

© Websites management system <https://agora.grial.eu>



The screenshot shows the top section of the GRIAL website. On the left is the GRIAL logo, a black circle with 'GRIAL' in white, followed by the text 'Research Group in Interaction and Elearning University of Salamanca'. On the right are the navigation links 'Actividades' and 'Contacto'. The main content area features a large image with a bokeh effect of orange and yellow circles. Overlaid on the right side of this image is the text: 'Divulgación Científica de GRIAL', 'Espacio dedicado a las actividades del Grupo de Investigación GRIAL para acercar la ciencia a la sociedad', and 'QUIÉNES SOMOS >'. The background of the entire slide is a light gray network diagram with nodes and connecting lines.

Research Group in  
Interaction and Elearning  
University of Salamanca

Actividades Contacto

## Divulgación Científica de GRIAL

Espacio dedicado a las actividades del Grupo de Investigación  
GRIAL para acercar la ciencia a la sociedad

QUIÉNES SOMOS >

# GRIAL Ecosystem (VI)

© Virtual campus <https://polis.grial.eu>

The screenshot displays the GRIAL Virtual Campus website. At the top left, the GRIAL logo is accompanied by the text "Research Group in Interaction and E-learning University of Salamanca". The main header features the stylized text "everything is connected" in a glowing, handwritten font. On the right side, there is a login section titled "Access to the platform" with input fields for "Username" and "Password", a "Log in" button, and a link for "Forgotten your username or password?". Below the main content, there are four white boxes with black borders, each containing a logo and text:

- Erasmus+ European Projects:** Includes the European Union flag logo and the text "Private management space for research projects coordinated by GRIAL." with a "Read More" button.
- Virtual Campus:** Includes the University of Salamanca logo and the text "GRIAL training services certified by the University of Salamanca." with a "Read More" button.
- TOL ACLOG:** Includes the Spanish Government logo and the text "VIII Curso Básico de Enseñanza en Entornos Virtuales de Aprendizaje. Fase a distancia." with a "Read More" button.
- Creative Commons:** Includes the Creative Commons BY-NC-SA license icons and the text "Licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License" with a "Read More" button.

# GRIAL Ecosystem (VII)

🕒 Documental repository <https://repositorio.grial.eu>

The screenshot shows the GRIAL repository website. At the top, there is a navigation bar with 'GRIAL', 'Home', 'Browse', and 'Help' links, a search bar, and a 'Sign on to' button. Below the navigation bar, the main heading is 'GRIAL repository' with the subtitle 'Research Group in InterAction and eLearning of the University of Salamanca'. A 'More info' button is located below the subtitle. To the right is the GRIAL logo. Below the logo is a search bar containing the text 'Repositorio de GRIAL'. The main content area is divided into three sections: 'Communities in DSpace', 'Discover', and 'Date issued'. The 'Communities in DSpace' section lists three communities: 'W-STEM', 'DEFINES project', and 'E-EVALINTO Project'. The 'Discover' section is a table with columns for Author, Subject, and Date issued. The 'Date issued' section is a table with columns for Date issued and a count.

**Communities in DSpace**  
Choose a community to browse its collections.

- W-STEM**  
Building the future of Latin America: Engaging women into STEM
- DEFINES project**  
A Digital Ecosystem Framework for an Interoperable NETWORK-based Society (DEFINES)
- E-EVALINTO Project**  
Evaluation environment for fostering intercultural mentoring tools and practices at school

**Discover**

Author	Subject	Date issued
García-Peñalvo, F. J.	WYRED	2020 - 2021
García-Peñalvo, Francisco J.	eLearning	2010 - 2019
García-Holgado, A.	Universidad de Salamanca	2000 - 2009
García Peñalvo, Francisco J.	EU	1990 - 1999
Conde-González, M. Á.	Youth	1988 - 1989
Vázquez-Ingelmo, A.	IQ2020	
WYRED Consortium	STEM	
Fidalgo-Blanco, A.	MIH	
Sesane Pardo, Antonio M.	Higher education	

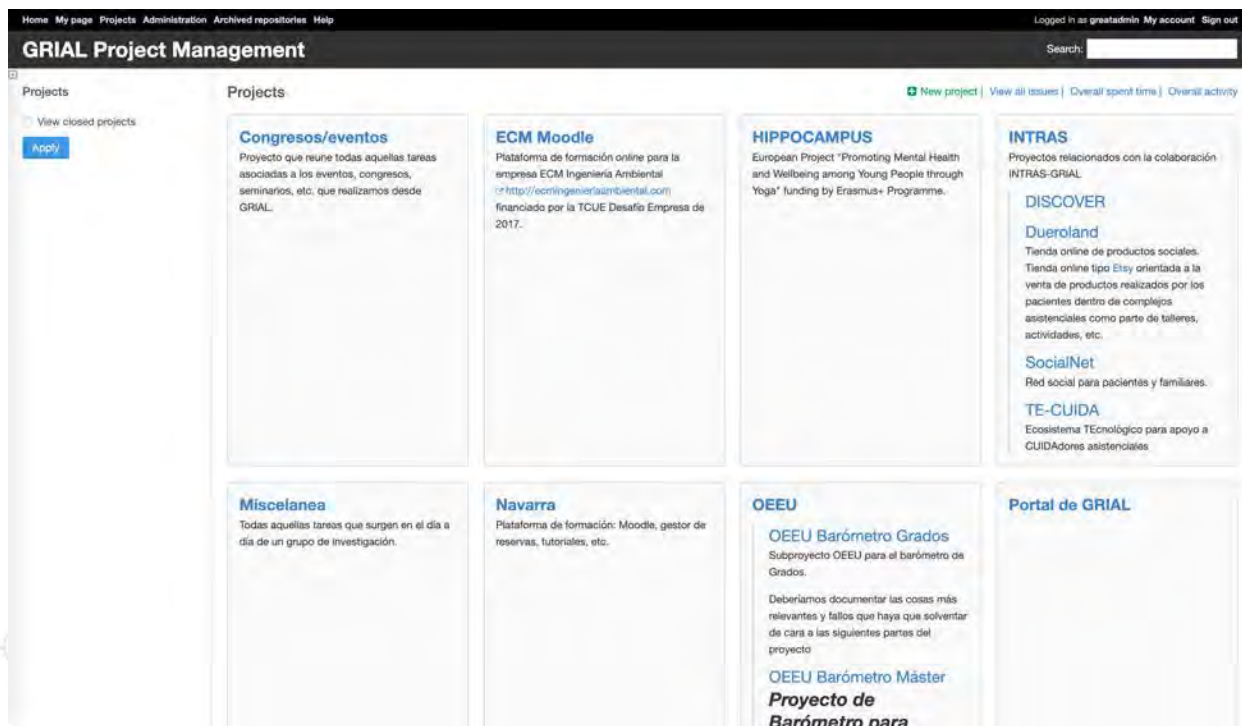
**Date issued**

Date issued	Count
2020 - 2021	329
2010 - 2019	1709
2000 - 2009	66
1990 - 1999	5
1988 - 1989	1



# GRIAL Ecosystem (VIII)

Project management <https://redmine.grial.eu>



The screenshot displays the GRIAL Project Management interface. At the top, there is a navigation bar with links for Home, My page, Projects, Administration, Archived repositories, and Help. The main header reads "GRIAL Project Management" and includes a search bar. Below the header, the "Projects" section is visible, with a sidebar on the left containing a "View closed projects" option and an "Asp" button. The main content area is a grid of project cards:

- Congresos/eventos**: Proyecto que reúne todas aquellas tareas asociadas a los eventos, congresos, seminarios, etc. que realizamos desde GRIAL.
- ECM Moodle**: Plataforma de formación online para la empresa ECM Ingeniería Ambiental (<http://ecmingenieriaambiental.com>) financiado por la TCUE Desafío Empresa de 2017.
- HIPPOCAMPUS**: European Project "Promoting Mental Health and Wellbeing among Young People through Yoga" funding by Erasmus+ Programme.
- INTRAS**: Proyectos relacionados con la colaboración INTRAS-GRIAL.
  - DISCOVER**: Tienda online de productos sociales. Tienda online tipo Etsy orientada a la venta de productos realizados por los pacientes dentro de complejos asistenciales como parte de talleres, actividades, etc.
  - SocialNet**: Red social para pacientes y familiares.
  - TE-CUIDA**: Ecosistema Tecnológico para apoyo a CUIDADORES asistenciales
- Miscelanea**: Todas aquellas tareas que surgen en el día a día de un grupo de investigación.
- Navarra**: Plataforma de formación: Moodle, gestor de reservas, tutoriales, etc.
- OEEU**
  - OEEU Barómetro Gradós**: Subproyecto OEEU para el barómetro de Gradós. Debemos documentar las cosas más relevantes y fallos que haya que solventar de cara a las siguientes partes del proyecto
  - OEEU Barómetro Máster**: **Proyecto de Barómetro para**
- Portal de GRIAL**

# GRIAL Ecosystem (IX)

© Survey tool <https://limesurvey.grial.eu>

The screenshot shows the GRIAL Survey Tool administration interface. At the top, the title "GRIAL Survey Tool" is on the left, and navigation links for "Configuración", "Encuestas", "Encuestas activas (7)", and a user profile "admin" are on the right. The main content area features the GRIAL logo (a black circle with "GRIAL" in white) and a welcome message: "Esta es la interfaz de administración de LimeSurvey. Comience a elaborar su encuesta aquí." Below this, a status message reads: "Última pregunta vista: Q013Q032 : Indica el grado de acuerdo/desacuerdo con las sig...". The interface is organized into six functional tiles arranged in a 2x3 grid:

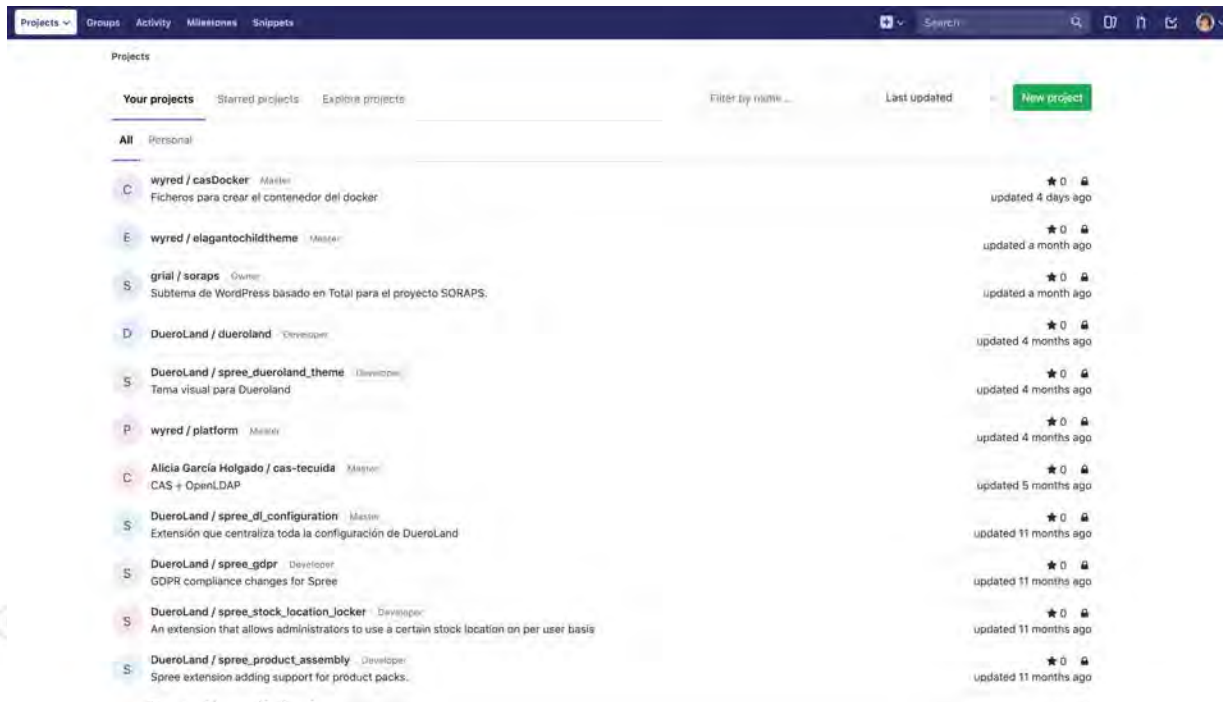
- Crear encuesta**: Represented by a plus sign icon, with the subtext "Crear una nueva encuesta".
- Listar encuestas**: Represented by a list icon, with the subtext "Listar encuestas disponibles".
- Configuración global**: Represented by a wrench icon, with the subtext "Editar configuración global".
- ComfortUupdate**: Represented by a shield icon, with the subtext "Manténgase protegido y actualizado".
- Conjuntos de etiquetas**: Represented by a tag icon, with the subtext "Editar los conjuntos de etiquetas".
- Editor de plantillas**: Represented by a pencil icon, with the subtext "Editar plantillas de Limesurvey".

At the bottom of the interface, there is a LimeSurvey logo and version information: "LimeSurvey Versión 2.64.7+170404".



# GRIAL Ecosystem (IX)

© Version Manager <https://gitlab.grial.eu>



The screenshot displays the GitLab version manager interface. At the top, there is a navigation bar with tabs for 'Projects', 'Groups', 'Activity', 'Milestones', and 'Snippets'. Below this, the main content area is titled 'Projects' and includes sub-tabs for 'Your projects', 'Starred projects', and 'Explore projects'. A search bar and a 'New project' button are also visible. The main list of projects is organized into a table with columns for project name, description, and last updated date. The projects listed include:

Project Name	Description	Last Updated
wyred / casDocker	Ficheros para crear el contenedor del docker	updated 4 days ago
wyred / elegantchidtheme		updated a month ago
grial / soraps	Subtema de WordPress basado en Total para el proyecto SORAPS.	updated a month ago
DueroLand / dueroland		updated 4 months ago
DueroLand / spree_dueroland_theme	Tema visual para DueroLand	updated 4 months ago
wyred / platform		updated 4 months ago
Alicia García Holgado / cas-tecuida	CAS + OpenLDAP	updated 5 months ago
DueroLand / spree_d_configuration	Extensión que centraliza toda la configuración de DueroLand	updated 11 months ago
DueroLand / spree_gdpr	GDPR compliance changes for Spree	updated 11 months ago
DueroLand / spree_stock_location_locker	An extension that allows administrators to use a certain stock location on per user basis	updated 11 months ago
DueroLand / spree_product_assembly	Spree extension adding support for product packs.	updated 11 months ago



# 3. Architectural pattern

## 3.1 Analysis of real ecosystems (I)

- The template must provide solutions to real problems of learning ecosystems in order to improve this type of technological solutions
- The analysis of several real case studies has been carried out in order to obtain a problem domain model
- The technique used to study the different ecosystems has been the analysis of Weaknesses, Threats, Strengths and Opportunities (SWOT) (Hill and Westbrook, 1997)

	ASPECTOS NEGATIVOS	ASPECTOS POSITIVOS
ORIGEN INTERNO	<p>-D-</p> <p>DEBILIDADES</p> <p>Carencias y limitaciones desfavorables propias</p>	<p>-F-</p> <p>FORTALEZAS</p> <p>Características y habilidades favorables propias</p>
ORIGEN EXTERNO	<p>-A-</p> <p>AMENAZAS</p> <p>Factores externos desfavorables</p>	<p>-O-</p> <p>OPORTUNIDADES</p> <p>Factores externos favorables</p>

## 3.1 Analysis of real ecosystems (II)

- © The selected case studies were developed before the start of this doctoral thesis

	2009	2010	2011	2012	2013
1. University of Salamanca	■				
2. GRIAL		■	■	■	■
3. TRAILER				■	■

## 3.1 Analysis of real ecosystems (III)

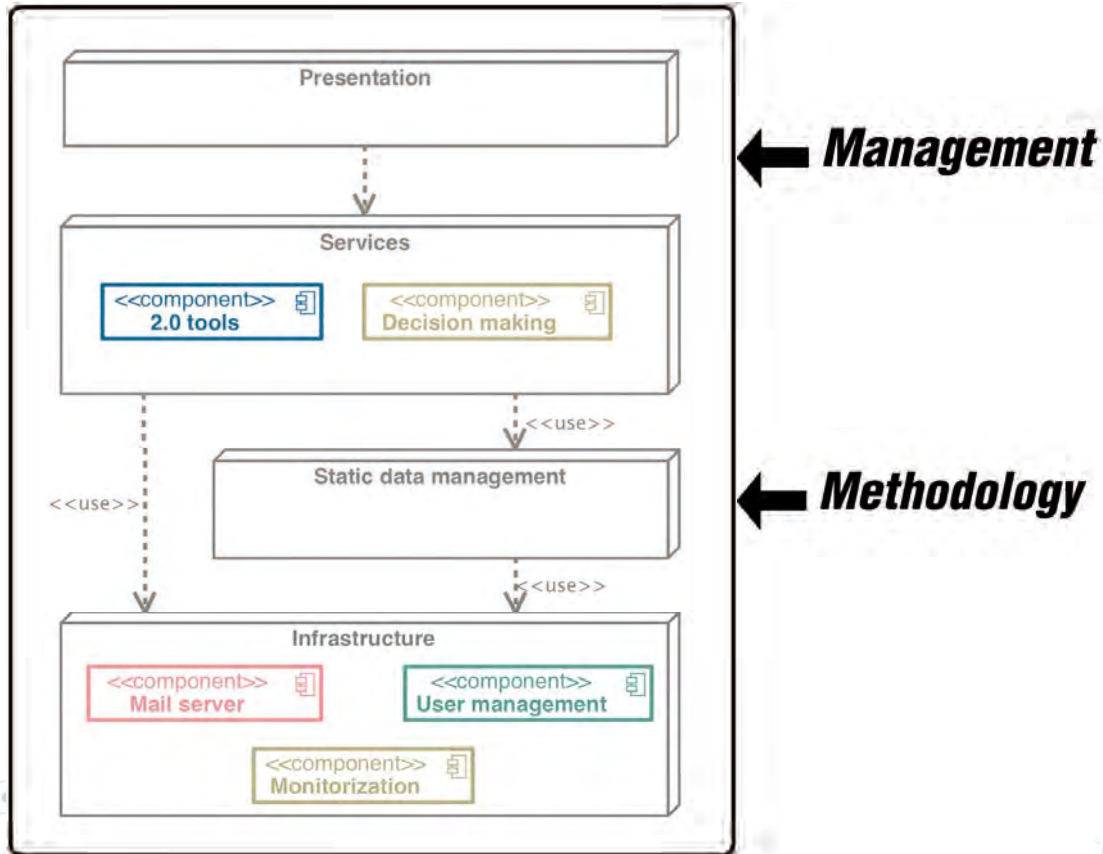
- Comparative analysis of the characteristics analysed in each of the selected case studies

	Universidad	GRIAL	TRAILER
Methodology			
Noverlty			
Users			
Information			
Integration			
Movility			
Social			
Evolution			
Decision-making			
Re-use			
Open source			
Development			
Deployment			

## 3.2 Characteristics of technology ecosystems

- ◎ **Solid methodological**, project and risk management foundation
- ◎ Clear definition of the processes and workflows needed to manage the ecosystem
- ◎ **Centralised user management** of both data and authentication
- ◎ **Centralised management of static data**
- ◎ Transparent integration of components to ensure flexibility and adaptability of the system to changes, i.e. a plan for **ensuring the evolution of the ecosystem must be in place**
- ◎ Enhancement of the **reusability** of ecosystem components
- ◎ **Integration at the level of presentation** that conveys uniqueness
- ◎ Strong **social component** that allows integration with social tools
- ◎ Support for **decision-making and for the analysis of information flows**, which take place both within the ecosystem and from outside and vice versa.
- ◎ Use of **open source software** as a basis for the development of the ecosystem components in order to benefit from the advantages of this type of software
- ◎ Definition of the necessary training and immersion strategies and plans **to facilitate the acceptance of the ecosystem** by its end users

### 3.3 Definition of the architectural pattern

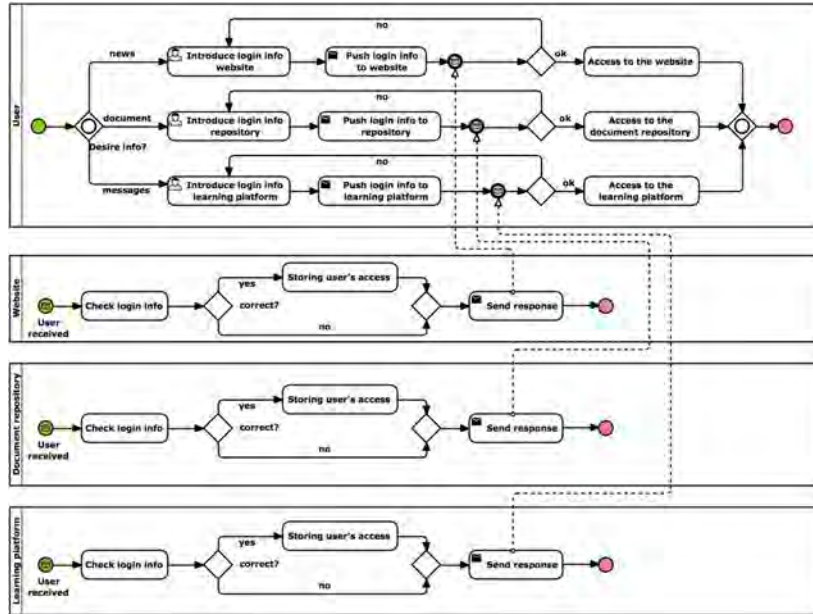


## 3.4 Validation of the architectural pattern (I)

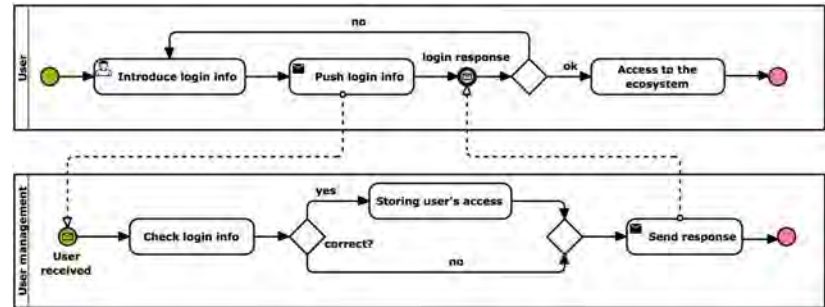
- ① Although the standard is based only on the analysis of several real technological ecosystems, it is necessary to carry out a validation process
- ① The process has been divided into three phases
  - ① Problems related to similar knowledge management processes have been selected and grouped and modelled in BPMN diagrams
  - ① The same business processes have been modelled by applying the architectural pattern
  - ① The pattern has been tested in several real case studies



# 3.4 Validation of the architectural pattern (II)



No pattern



Applying the pattern

## 3.4 Validation of the architectural pattern (III)

Application of the validated pattern in real cases

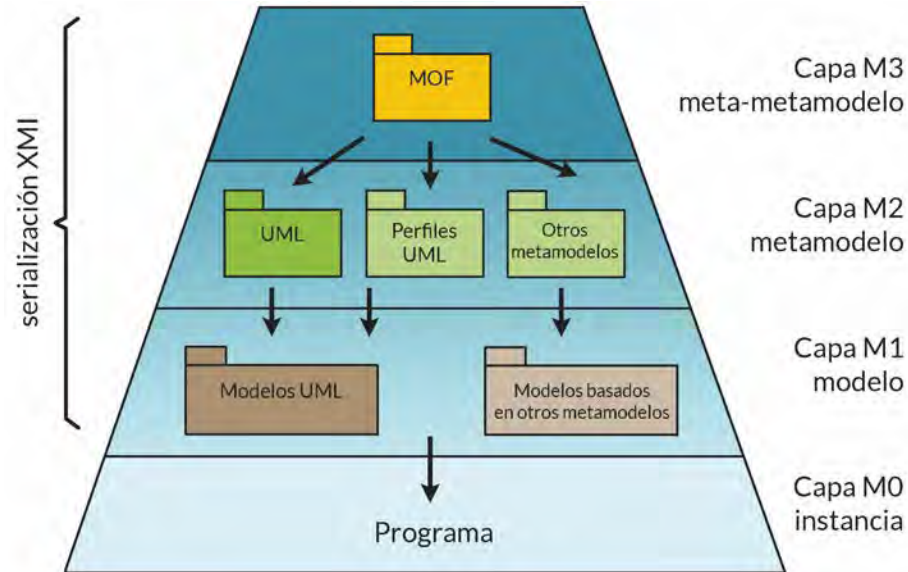
	2013	2014	2015	2016	2017	2018
1. INAP ecosystem	■	■	■	■		
2. PhD ecosystem		■	■	■	■	■
3. WYRED ecosystem					■	■

# 4. Metamodel

## 4.1 Model-driven development (I)

- ◎ There is work on modelling software ecosystems, but most approaches are not supported by a methodology that uses the standards defined by OMG
- ◎ Franco-Bedoya, Ameller, Costal and Franch (2017), as other authors (Barbosa and Alves, 2011; Sadi and Yu, 2015), state that the development of analysis and modelling techniques is one of the main challenges of open-source software ecosystems
- ◎ Model Driven Development (MDD) is a software engineering approach that involves the application of models and modelling technologies to increase the level of abstraction at which developers create and evolve software (Hailpern, 2006)
- ◎ MDA is OMG's approach to implement MDD using the set of standards for visualizing, storing and exchanging designs and software models

## 4.1 Model-driven development (II)



## 4.2 Metamodel definition (I)

- ◎ The learning ecosystem metamodel is a model of the M2 layer of the four-layer architecture, i.e. it is an instance of the MOF
- ◎ It is defined on the basis of the architectural pattern in order to model learning ecosystems that follow the pattern, so that in the process of defining the ecosystem a solution is given to the problems detected during the analyses carried out in real ecosystems
- ◎ The metamodel is a platform-independent model, i.e. a PIM (Platform-Independent Model)

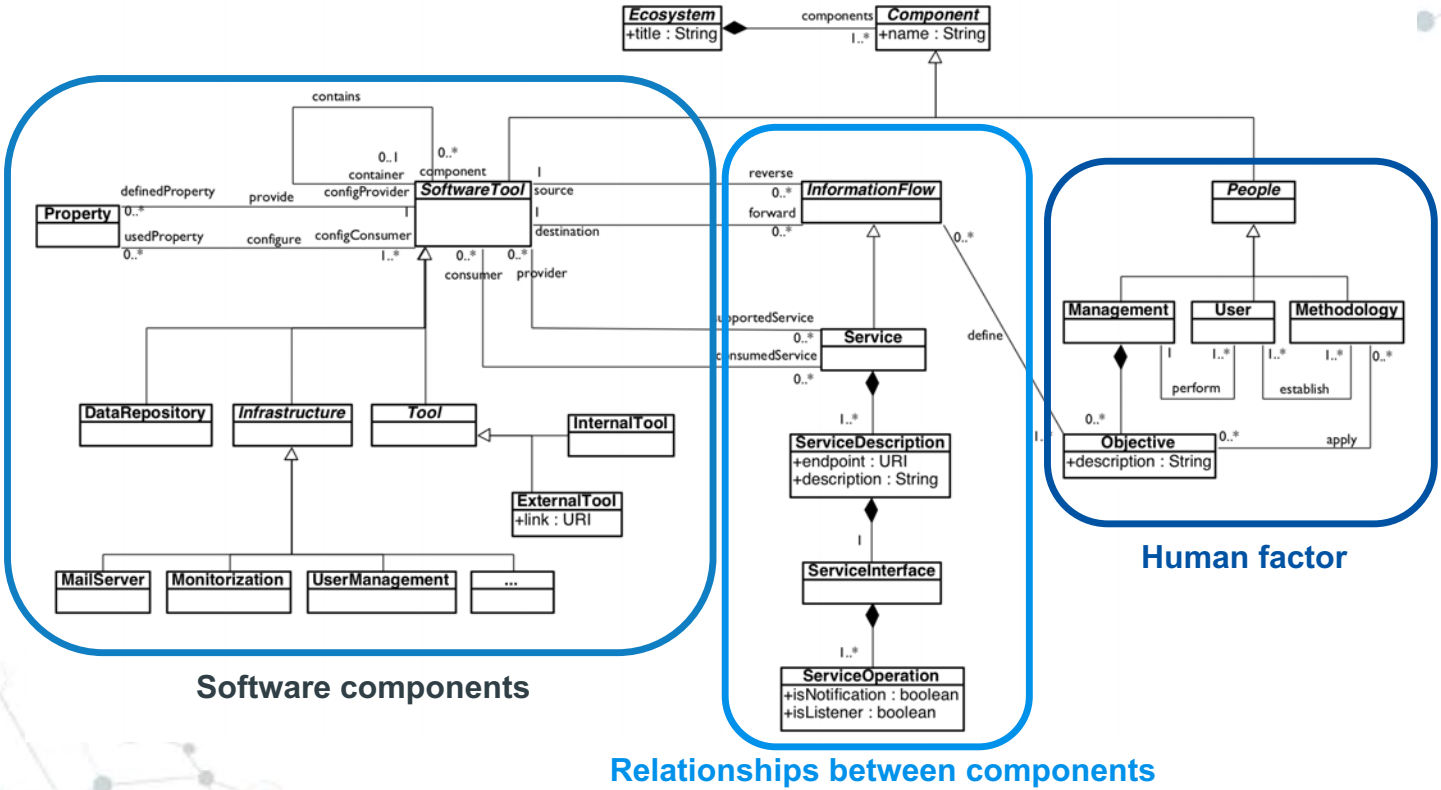
## 4.2 Metamodel definition (II)

- ◎ The high-level requirements of the learning ecosystem metamodel are the following (García-Holgado and García-Peñalvo, 2017)



- The metamodel will capture the high-level description of the components of the learning ecosystem
- The metamodel will capture the human factor as part of the learning ecosystem
- The metamodel shall allow capturing the information flows between the components of the learning ecosystem
- The metamodel shall allow capturing the configurations of the software components

# 4.2 Metamodel definition (III)



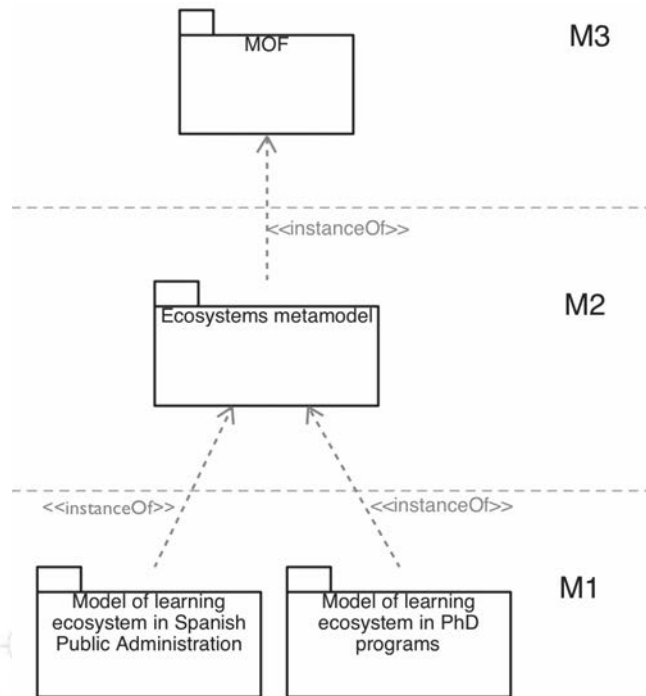


## 4.2 Metamodel definition (IV)

### 4 OCL constraints

```
context Ecosystem inv:  
self.components -> select(c |  
c.oclIsTypeOf(MailServer)) -> size() = 1 and  
self.components -> select(c |  
c.oclIsTypeOf(Monitorization)) -> size() = 1 and  
self.components -> select(c |  
c.oclIsTypeOf(UserManagement)) -> size() = 1 and  
self.components -> select(c |  
c.oclIsTypeOf(InternalTool)) -> notEmpty and  
self.components -> select(c |  
c.oclIsTypeOf(Management)) -> notEmpty and  
self.components -> select(c |  
c.oclIsTypeOf(Methodology)) -> notEmpty and  
self.components -> select(c |  
c.oclIsTypeOf(User)) -> notEmpty
```

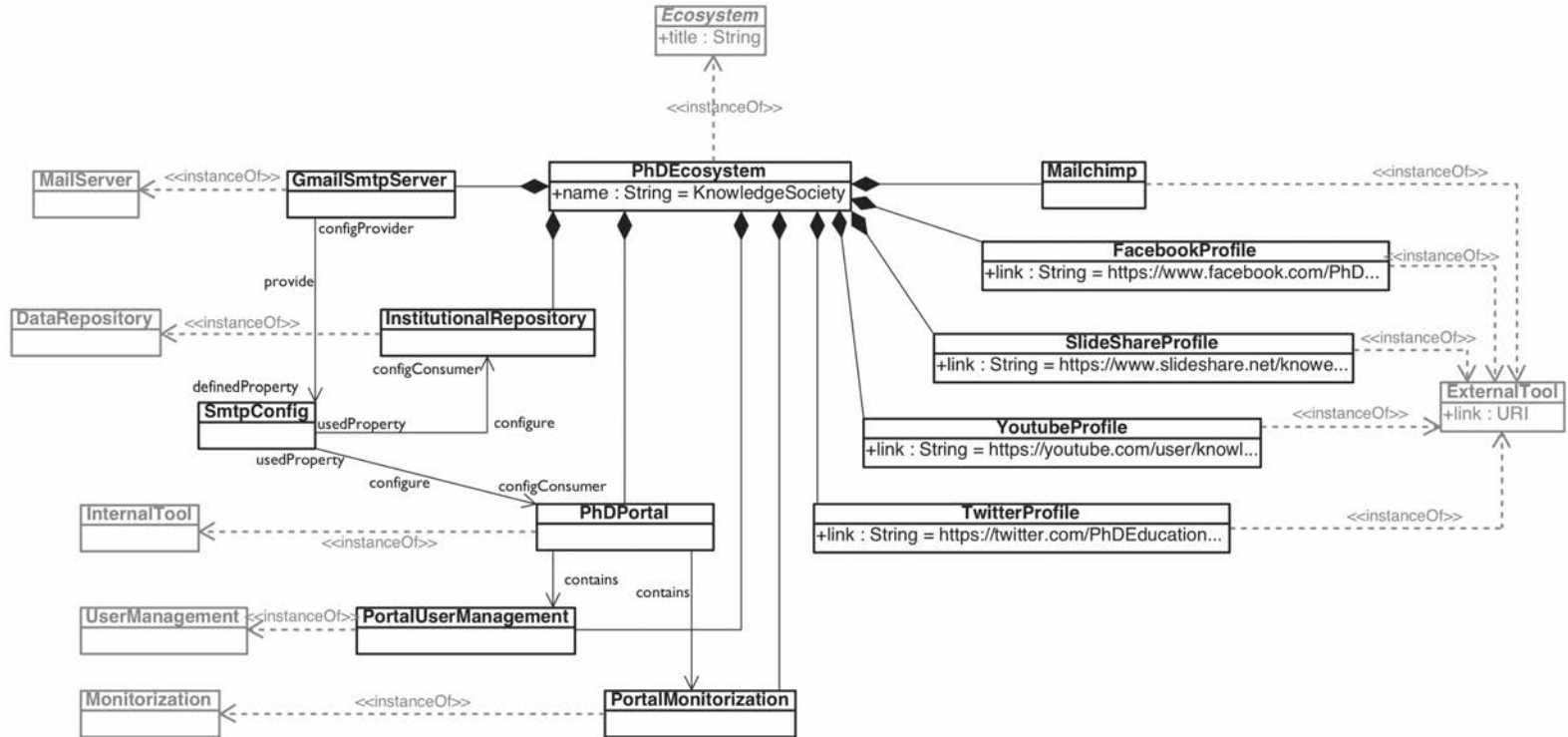
## 4.3 Case studies (I)



- ◎ The learning ecosystem metamodel has been tested in two case studies in order to verify that it allows the definition of real learning ecosystem models
- ◎ Two of the learning ecosystems used to validate the architectural pattern have been taken and their corresponding model has been defined from the metamodel

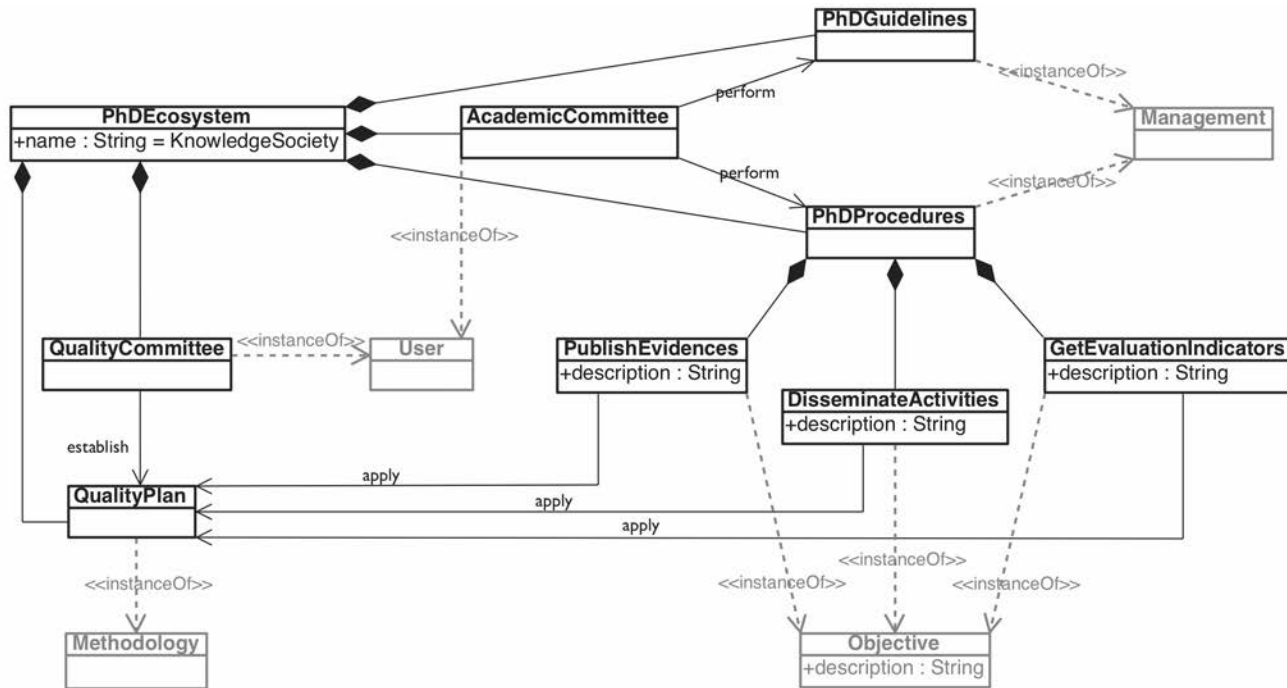
# 4.3 Case studies (II)

Ecosystem for Knowledge Management in a Doctoral Programme: Software Component View



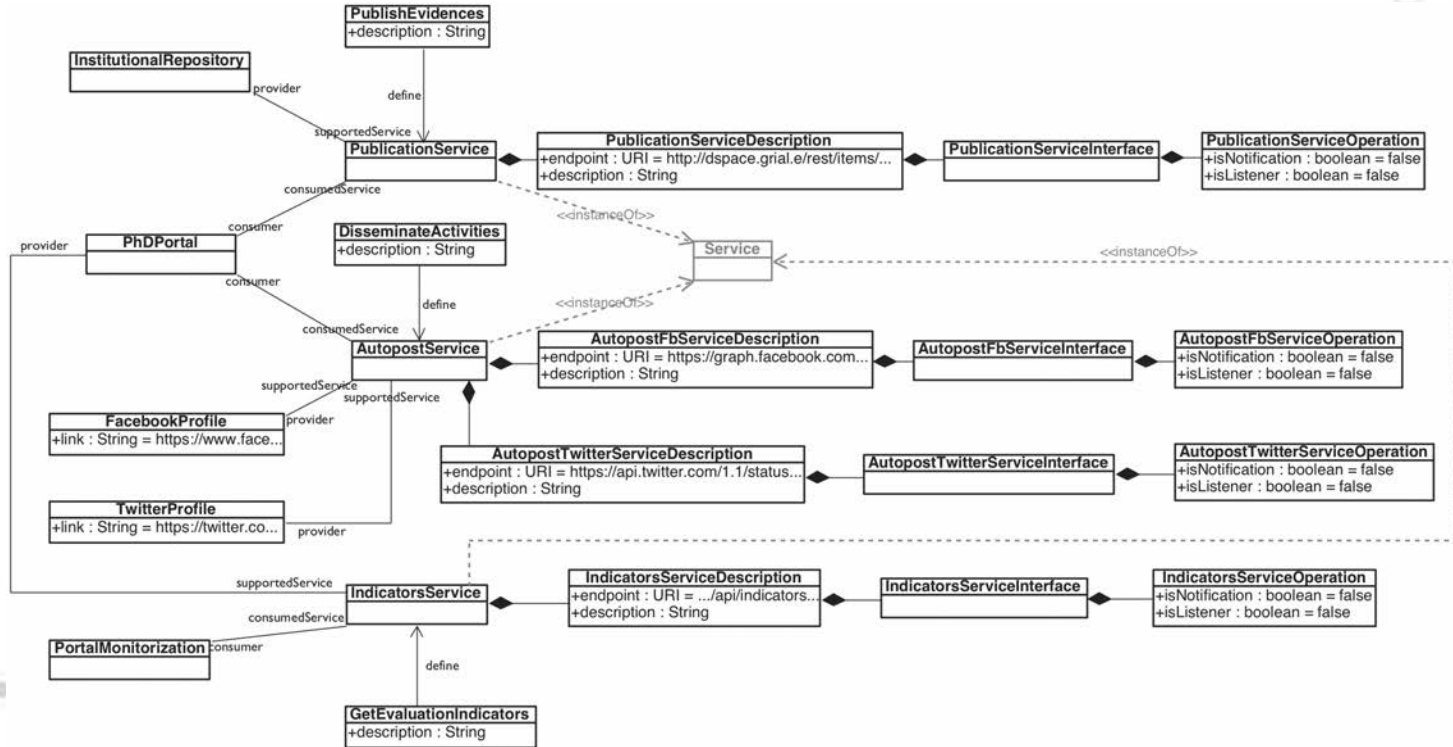
# 4.3 Case studies (III)

Ecosystem for Knowledge Management in a Doctoral Programme: The Human Factor View



# 4.3 Case studies (IV)

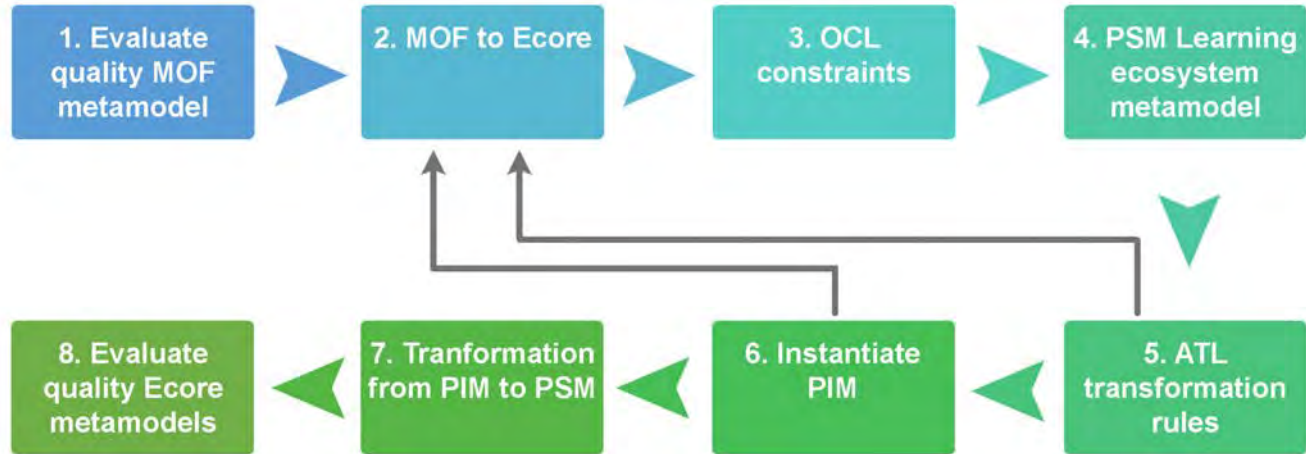
Ecosystem for Knowledge Management in a Doctoral Programme: View Relationships between Components



## 4.4 Metamodel validation (I)

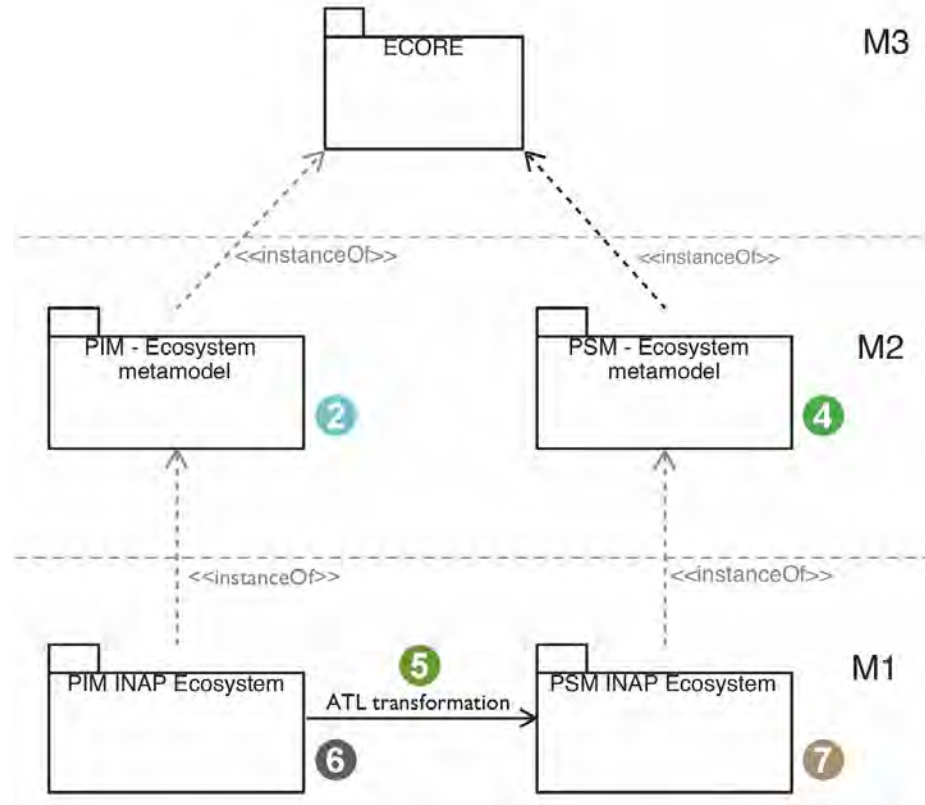
- ◎ To ensure the validity of the process it is necessary that transformations between models are performed using tools rather than manually as has been done in the two case studies described in the previous section
- ◎ There are no stable tools that support the MDA standards
- ◎ Ecore and the tools provided by Eclipse have been used

## 4.4 Metamodel validation (I)



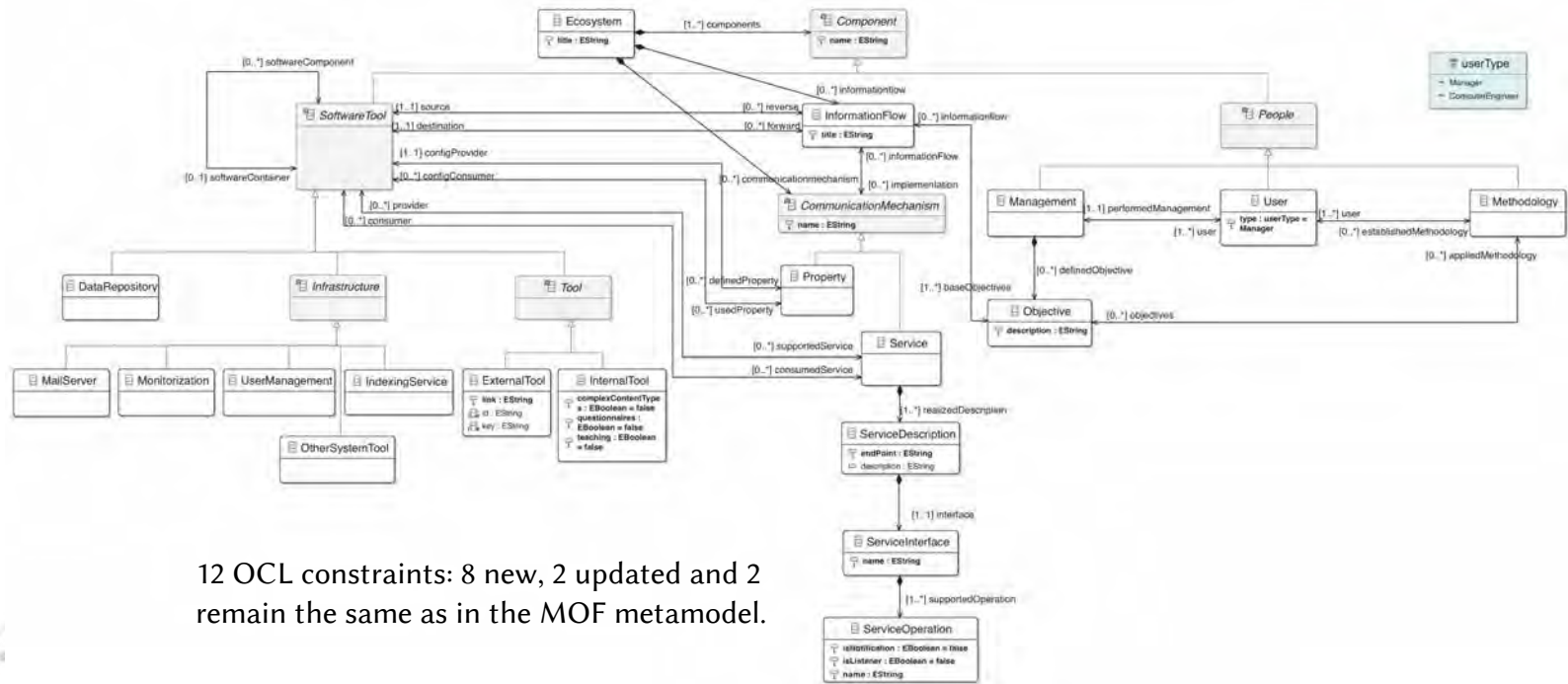


## 4.4 Metamodel validation (II)



# 4.4 Metamodel validation (III)

Learning Ecosystem Metamodel in Ecore



12 OCL constraints: 8 new, 2 updated and 2 remain the same as in the MOF metamodel.



# 4.4 Metamodel validation (V)

Transformation from PIM to PSM using ATL rules

PIM (learning ecosystem metamodel)	PSM (to define learning ecosystems)
<b>Software tools</b>	
Ecosystem	Ecosystem
DataRepository	Dspace
MailServer	Hakara
Monitorization	Prometheus
UserManager	CASoverLDAP
IndexingService	ApacheSolr
InternalTool	Moodle
	LimeSurvey
	WordPress
	Drupal
ExternalTool	Facebook
	Twitter
SoftwareTool	Plugin

## 4.4 Metamodel validation (VI)

### Quality of metamodels

- ◎ The validation process has two phases aimed at assessing the quality of the metamodels
- ◎ The quality assessments have been verified according to the quality framework proposed by López-Fernández, Guerra and de Lara (2014)
- ◎ A set of 30 features that basically correspond to syntactic rules that metamodels must follow
- ◎ The metamodels defined in Ecore, both the PIM and the PSM, meet all the quality criteria



# 5. Examples of ecosystems implementing the metamodel

## 5.1 INAP Ecosystem (I)



National Institute of Public Administration (INAP)

Knowledge management within the Spanish Public Administration

- training of public employees
- the selection of various Corps and Scales of public employees attached to the Ministry of Finance and Public Administrations
- and the promotion of research and studies on government and the different levels of public administration from an interdisciplinary perspective



## 5.1 INAP Ecosystem (II)

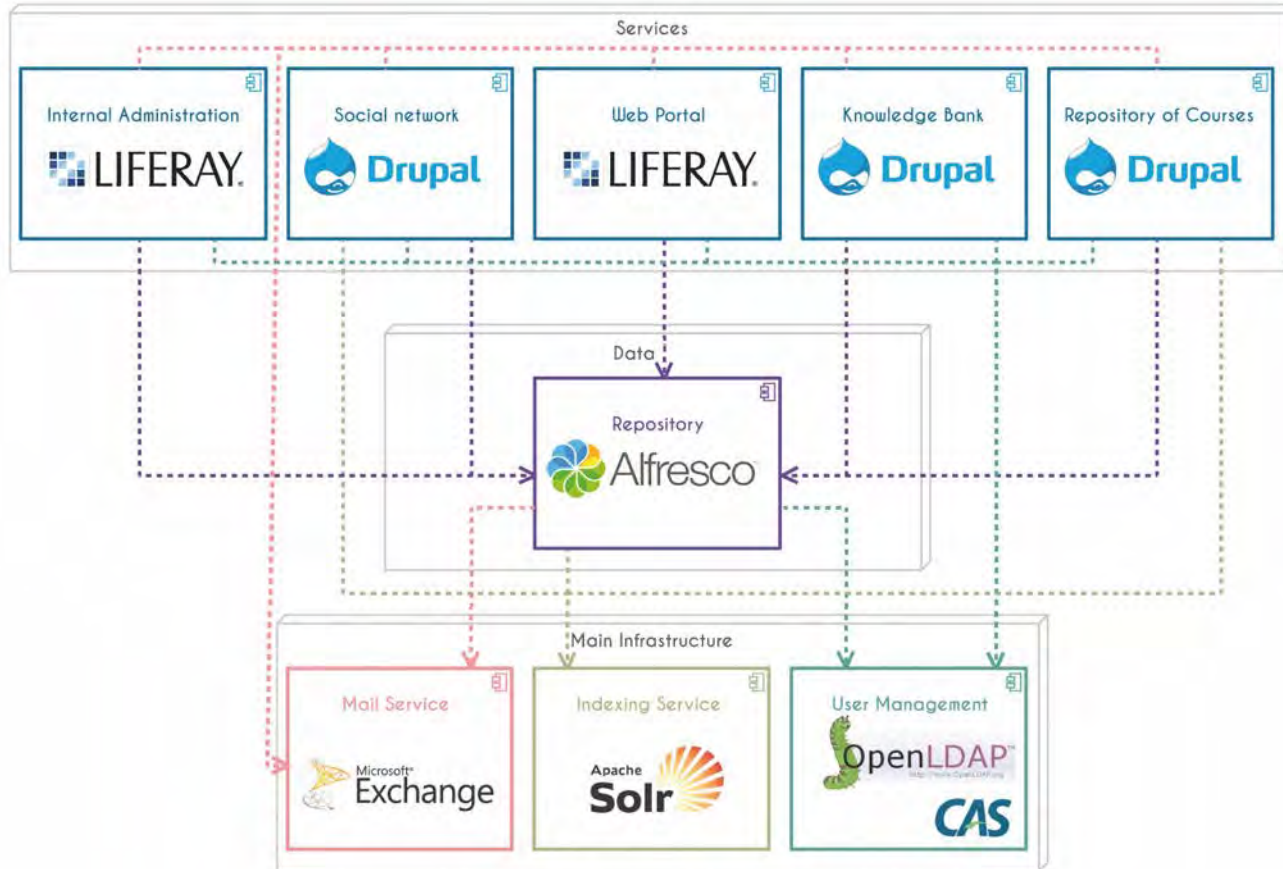


Technological ecosystem since 2012

Main objective: to generate knowledge through collaboration between employees of different public bodies.

- Create a space accessible from any public organisation without compromising information security
- Provide procedures and tools with which the user can publish some of the knowledge generated to enforce the transparency law that allows public access to government information
- Support integration with other existing tools to make all institutions and bodies part of the project and collaborate in its evolution
- Provide the user with information about other users with similar interests, promoting social learning and collaboration among users of the system
- Facilitate decision-making and the analysis of information flows in order to improve the system and adapt it to the needs of the Public Administration
- Establish information flows and mechanisms to support the four stages of the knowledge life cycle within the Spanish Public Administration: Socialisation, Externalisation, Combination, Internalisation

# 5.1 INAP Ecosystem (III)



# 5.1 INAP Ecosystem (IV)

© Public portal <http://www.inap.es>



# 6.1 Ecosistema del INAP (V)

🕒 Practices community <https://social.inap.es>

**INAP SOCIAL**

## Conecta, contribuye y comparte

La Red Social Profesional de la Administración Pública

**ACCESO USUARIOS**

Regístrate | Recordar contraseña

Accede a la información de protección de datos y las condiciones de uso

En el caso de incidencias técnicas, diríjase a [al.incidencias@inap.es](mailto:al.incidencias@inap.es)

En ella encontrarás **personas afines en intereses y experiencias profesionales.**

Podrás establecer tu propia **red de contactos, participar en las comunidades** que mejor se ajusten a tu perfil y **compartir conocimiento, experiencias y oportunidades.**

**INAP Social** se completa con el Banco de Conocimientos más importante de la Administración al que tendrás acceso desde la propia Red.

ADMINISTRACIÓN PÚBLICA  
Copyright © 2019

INAP  
INSTITUTO NACIONAL DE

# 6.1 Ecosistema del INAP (VI)

© Institutional Knowledge Bank <https://bci.inap.es>

The screenshot displays the homepage of the BCI (Banco de conocimientos) website. The header features the BCI logo and the text 'Banco de conocimientos INAP' with the tagline 'COLECCIONAR, CONECTAR, INNOVAR, APRENDER'. It also includes the Spanish government coat of arms and the INAP logo, along with a search bar. The main content area is titled 'Banco de conocimientos' and contains a search bar labeled 'Buscador del banco de conocimientos' with a 'Buscar' button. Below this is a section for 'Búsqueda por áreas temáticas' with six thematic cards: 'Círculo de conocimiento', 'Desarrollo sostenible', 'Experiencias de aprendizaje', 'Conocimiento Institucional', 'Redes de conocimiento', and 'Banco de Innovación de las administraciones públicas'. On the right side, there are links to 'Cómo funciona el BCI', 'Iniciar sesión', 'Contribuye al BCI', 'INAP SOCIAL', 'Red Social del INAP', 'Centro de Estudios Jurídicos', 'Repertorio Jurídico-Científico del CEJ', 'CEJPC', and 'BD legislación extranjera DOCEX'. The footer contains links for 'Accesibilidad', 'Guía de navegación', 'Nota Legal', 'Acerca de BCI', and 'Contacto', along with the copyright notice '© Instituto Nacional de Administración Pública 2013'.



# 5.1 INAP Ecosystem (VII)

🕒 Course repository <https://compartir.inap.es>



The screenshot displays the 'Repositorio de cursos' (Course Repository) page of the Instituto Nacional de la Administración Pública (INAP). The page features a header with the INAP logo and the text 'Repositorio de cursos Instituto Nacional de la Administración Pública'. Below the header, there is a central blue box containing the following content:

- Inicio de sesión** (Login): A section with the text 'Serás redirigido a la página de acceso del INAP' (You will be redirected to the INAP access page) and a button labeled 'Acceso usuarios' (User access).
- Solicitud de acceso** (Access request): A section with the text 'Si desea acceder a la aplicación puede solicitarlo al administrador de su organismo. En caso de querer darse de alta como administrador de organismo, puede solicitarlo a través del correo electrónico [sai.direccion@inap.es](mailto:sai.direccion@inap.es)' (If you want to access the application, you can request it from the administrator of your organization. In case of wanting to register as an administrator of the organization, you can request it through the email address [sai.direccion@inap.es](mailto:sai.direccion@inap.es)).

At the bottom of the page, there is a footer with the text: 'INSTITUTO NACIONAL DE ADMINISTRACIÓN PÚBLICA Copyright © 2019. Todos los derechos reservados. [Privacidad](#)' (INSTITUTO NACIONAL DE ADMINISTRACIÓN PÚBLICA Copyright © 2019. All rights reserved. [Privacy](#)).

## 5.2 PhD ecosystem (I)

- ◎ Doctoral Programme Training in the Knowledge Society of the University of Salamanca  
(<http://usal.es/webusal/node/30026>)
- ◎ Born in the University Institute of Education Sciences (IUCE - <https://iuce.usal.es>)
- ◎ To present the teaching-learning processes as authentic motors of the so-called Knowledge Society, in order to be able to discuss and generate new knowledge in this line and under a symbiosis with the most advanced technological advances

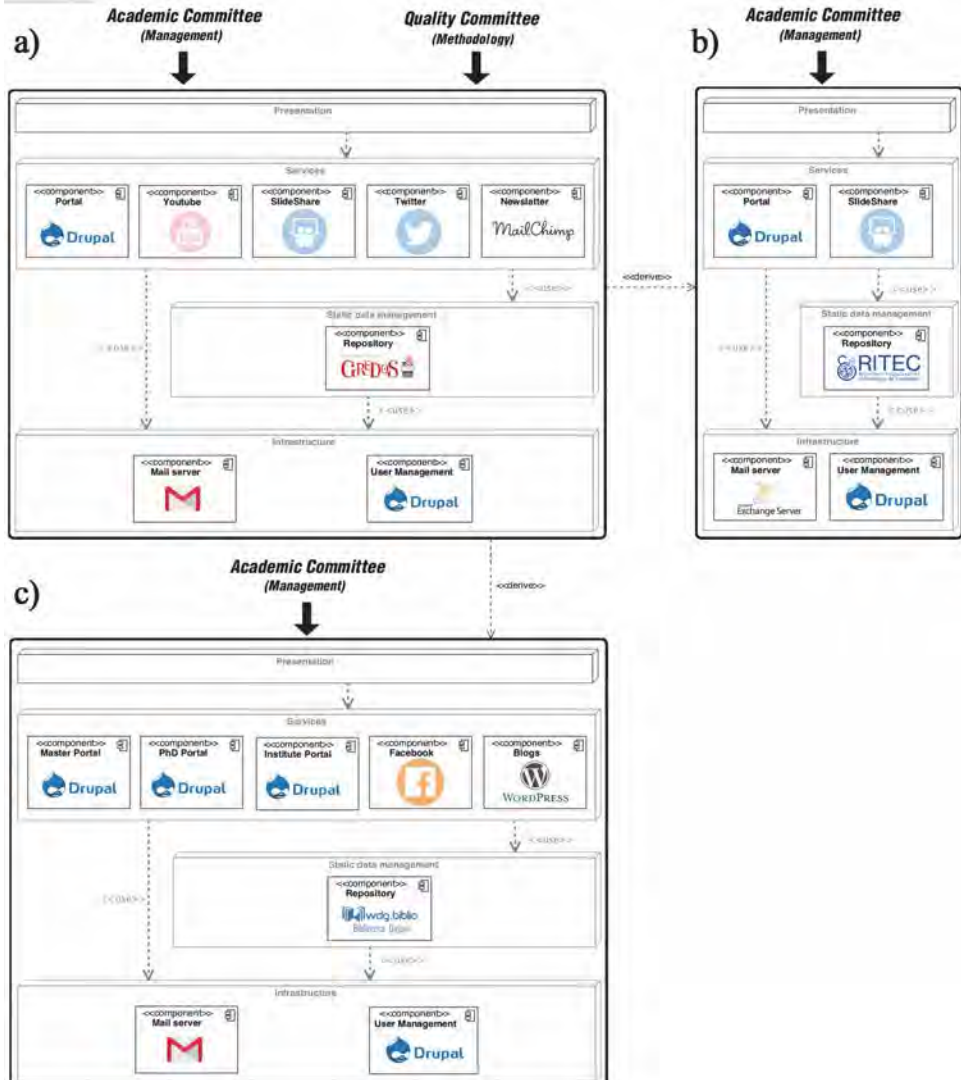




## 5.2 PhD ecosystem (II)

- Objectives of the technology ecosystem
  - To support the internal management of the Doctoral Programme
  - To allow the monitoring of doctoral students enrolled in the Doctoral Programme, in order to keep an updated portfolio of their progress throughout the development of their doctoral thesis
  - To provide visibility to all the knowledge generated by doctoral students as part of their training process as researchers
  - To serve as a communication channel to transmit information of interest to the members of the PhD Programme
  - To support the quality processes of the Doctoral Programme

# 5.2 PhD ecosystem (III)



## 5.2 PhD ecosystem (IV)

© PhD portal <https://knowledgesociety.usal.es>



Doctoral Programme Education in the Knowledge Society  
University of Salamanca

HOME INFORMATION QUALITY MEMBERS SEMINARS PUBLICATIONS THESIS CALENDAR MEDIA REPOSITORY HELP

Search

Conyocatorias contratos predoctorales y contratos posdoctorales  
Submitted by PhD on 07/25/2019 – 20:39  
Con fecha del 15 de julio se ha publicado en la página web de investigación <https://investigacion.usal.es/investigacion/programas-propios> las convocatorias de los Programas propios II y III.

Read more

IV Semana Doctoral EKS  
Submitted by PhD on 07/24/2019 – 13:54  
La cuarta edición de la Semana Doctoral del Programa Formación en la Sociedad del Conocimiento tendrá lugar desde el 14 de octubre hasta el 25 de octubre de 2019 en el Instituto Universitario de Ciencias de la Educación (IUCE) de la Universidad de Salamanca.

Read more

IV Semana Doctoral Formación en la Sociedad del Conocimiento 2019-2020

El Portal del Programa de Doctorado Formación en la Sociedad del Conocimiento considerado como una buena práctica de Gestión en la USAI

Semana Doctoral EKS

- IV Semana Doctoral 14-25 Octubre 2019 **NUEVA EDICIÓN**
- III Semana Doctoral 22-31 Octubre 2018
- II Semana Doctoral 15-24 Enero 2018
- I Semana Doctoral 5-11 Octubre 2016

Streaming

PhDEducationKS

Próximos seminarios

Acceso a los recursos de información electrónicos de la Universidad de Salamanca

Docentes: José Antonio Merlo Vega, Tránsito Ferreras Fernández  
Helena Martín Rodero (2ª edición)  
Próxima edición:  
10/25/2019 – 16:00 to 20:00

Introducción a los Métodos mixtos

## 5.2 PhD ecosystem (V)

- ◎ Tecnológico de Monterrey (Mexico)
- ◎ Doctoral Programme, specifically the Doctorate in Educational Innovation coordinated by the School of Humanities and Education
- ◎ Most of the social tools have been removed, the repository has been changed, although both are based on the same open source tool, DSpace, and the mail server has been replaced by the mail server provided by the institution

## 5.2 PhD ecosystem (VI)

© <https://escueladehumanidades.tec.mx/dee>



The screenshot shows the top navigation bar of the website. It features the logo of Tecnológico de Monterrey on the left, followed by the text 'PROGRAMA DE DOCTORADO EN INNOVACIÓN EDUCATIVA' and 'Portafolio digital'. Below this is a horizontal menu with the following items: INICIO, INFORMACIÓN, MIEMBROS (highlighted in a dark blue box), NOTICIAS, SEMINARIOS, TESIS, PUBLICACIONES, EVIDENCIAS, CALENDARIO, REPOSITORIO, and COMENTARIOS.

Inicio / Miembros

### Miembros

Recursos gráficos

Directora del programa del DEE



Katherina Gallardo Córdova (Directora)

Coordinadora del programa del DEE



Marisol Martínez Adame (Coordinadora)

Profesores del claustro académico



## 5.2 PhD ecosystem (VII)

⦿ <http://escueladehumanidades.tec.mx/deh/>



The screenshot shows the top navigation bar of the website. It features the logo of Tecnológico de Monterrey on the left, followed by the text 'PROGRAMA DE DOCTORADO EN ESTUDIOS HUMANÍSTICOS'. Below this is a horizontal menu with the following items: INICIO, INFORMACIÓN, MIEMBROS, NOTICIAS, SEMINARIOS, EVIDENCIAS, PUBLICACIONES, TESIS, CALENDARIO, REPOSITORIO, and COMENTARIOS.

Conferencia "Derechos humanos y procesos de detención de migrantes en la frontera sur de México: un análisis de la burocracia y las políticas migratorias"

ENVIADO POR JESÚS ALBERTO SALAS CORTÉS (MTY) EL 9 JUNIO 2018 - 20:49

Con: Alethia Fernández de la Reguera Ahedo

14 de junio

16:00 horas

Edificio CEDES piso 1 sala 2

Grupos de Investigación



[Leer más](#)

Conferencia: "Del Talmud a Shakespeare y de regreso: la esencialidad del estudio de las humanidades en el siglo XXI."

ENVIADO POR JESÚS ALBERTO SALAS CORTÉS (MTY) EL 8 JUNIO 2018 - 00:01

Con: Israel Diamant

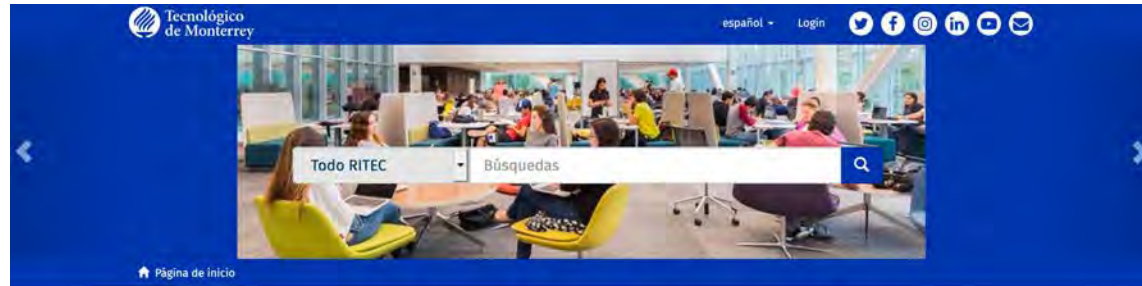
Miércoles 13 de junio

16:00 horas

Edificio CEDES piso 1 sala 2

## 5.2 PhD ecosystem (VIII)

© <https://repositorio.tec.mx>



- Enviar Tesis
- Carta de autorización
- Infográfico
- Guía Rápida
- Listar
  - Todo RITEC
- Mi cuenta
  - Acceder
- Descubre
  - Autor
  - Materia
  - Tipo
  - Formato

### Repositorio Institucional del Tecnológico de Monterrey

El Repositorio Institucional del Tecnológico de Monterrey (RITEC) preserva, organiza y garantiza la visibilidad y acceso a la producción científica, los recursos y objetos de aprendizaje generados por la comunidad académica de la Institución. Así como el patrimonio documental y artístico que se encuentra bajo su resguardo y que está disponible en Acceso Abierto.

### Comunidades en RITEC

Elija una comunidad para listar sus colecciones

Institucional

Novus

Patrimonio Cultural

Producción Académica

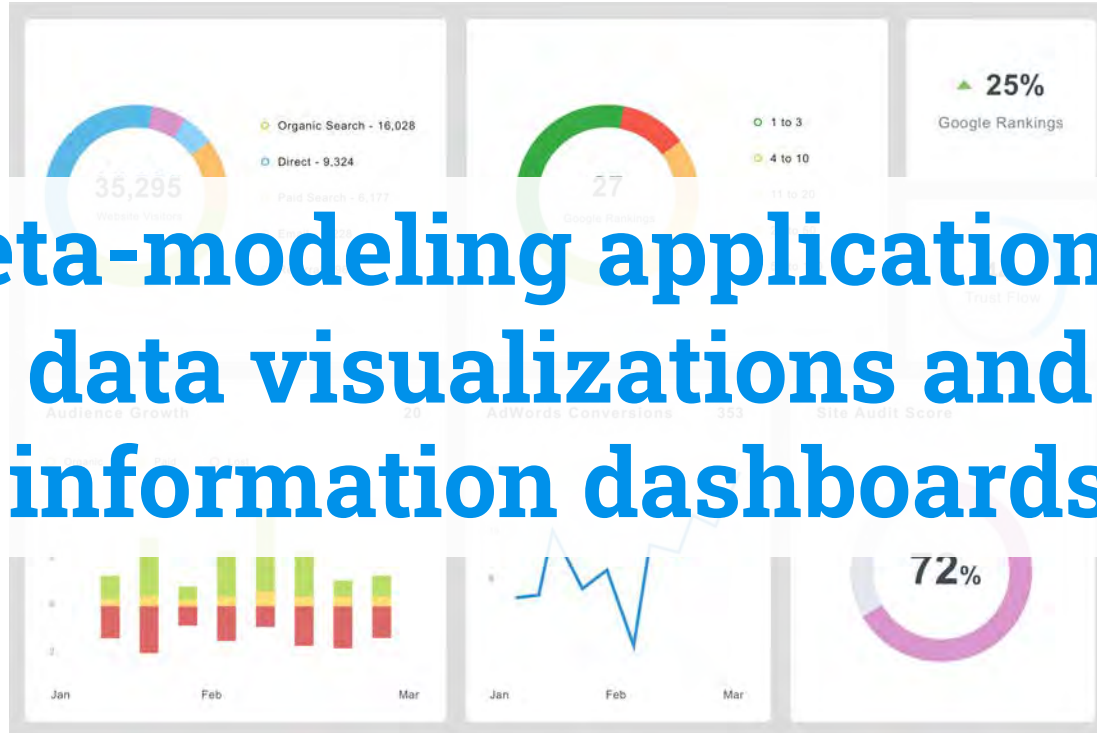
Producción Científica

Tesis

### Añadido Recientemente



# Meta-modeling application on data visualizations and information dashboards





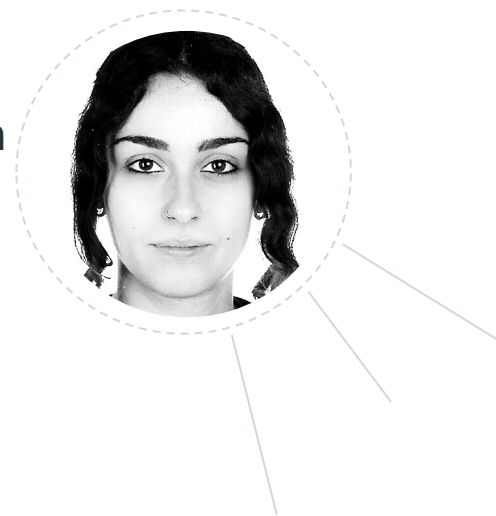
# Hi!

## I'm Andrea Vázquez Ingelmo

Computer Science PhD student  
Researcher/Developer at GRIAL Research  
Group

[andreavazquez@usal.es](mailto:andreavazquez@usal.es)

[@and\\_v\\_i](#)



# Outline

- ◎ Dashboards and data visualization
- ◎ Building the meta-model
  - Domain engineering
- ◎ The complete meta-model
- ◎ Dashboards generation
  - Software product lines
- ◎ Applications



1.

# **Dashboards and data visualizations**

Motivation

# Visualizations



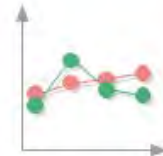
Pie



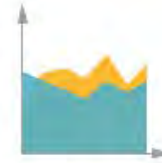
Bar



Column



Line



Area



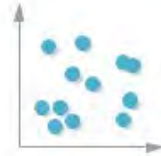
Doughnut



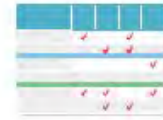
Bubble Chart



Spider and Radar



Scatter



Comparison Chart



Stacked bar chart



Gauges

# Visualizations



pie chart



venn diagram



concentric diagram



circular chart



bubble chart



bubble race chart



line chart



area chart



scatter plot



sunburst chart



fan chart



windrose chart



bar chart



tape diagram



gantt diagram



tree map



grid



periodic table



arc diagram



sankey chart



chord chart



radar chart



polar grid



spiral graph



timeline



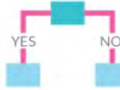
flow chart



binary tree



mind map



decision tree



block scheme

# Dashboards

## What Do We Talk About When We Talk About Dashboards?

Alper Sarikaya, Michael Correll, Lyn Bartram, Melanie Tory, and Danyel Fisher



Fig. 1: Klipfolio's Social Media Manager Dashboard (DB065 from our example corpus, left) is a traditional dashboard, with large numbers representing key metrics, and tiled graphs of real-time data. The UNCHR Refugees/Migrants Emergency Response dashboard (DB117, right) also is a juxtaposition of key metrics and simple visualizations, but includes annotations and guided narrative elements. Are both dashboards? Do design principles meant for one transfer to the other?

**Abstract**—Dashboards are one of the most common use cases for data visualization, and their design and contexts of use are considerably different from exploratory visualization tools. In this paper, we look at the broad scope of how dashboards are used in practice through an analysis of dashboard examples and documentation about their use. We systematically review the literature surrounding dashboard use, construct a design space for dashboards, and identify major dashboard types. We characterize dashboards by their design goals, levels of interaction, and the practices around them. Our framework and literature review suggest a number of fruitful research directions to better support dashboard design, implementation, and use.

**Index Terms**—Dashboards, literature review, survey, design space, open coding





# Dashboards



Fig. 4: Exemplar dashboards selected from our seven derived clusters. Clusters **1** and **5** demonstrate dashboards specifically targeting decision-making, while clusters **3** and **4** target awareness on behalf of the consumer. Cluster **2** targets the somewhat novel quantified self and scenario (smart-home dashboard), while **6** represents dashboards tailored for general-purpose communication. Cluster **7** captures some novel extensions to traditional dashboards.



# Data visualization

**COMPLEXITY**

Design  
decision  
tasks

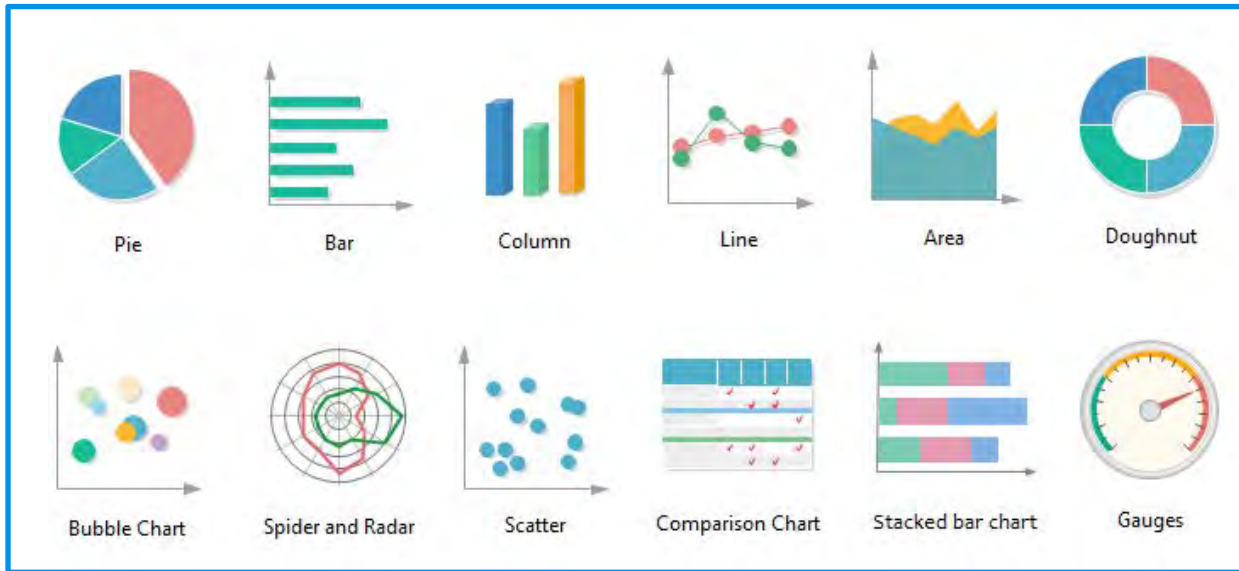
Target  
audience  
Interaction  
Aesthetics

Data sources

A decorative network diagram in the top-left corner, consisting of various sized grey circles connected by thin grey lines, forming a complex web structure.

**However, we find  
commonalities within variety**

# Data



# Visual marks



Pie



Bar



Column



Line



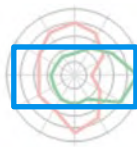
Area



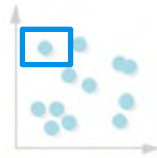
Doughnut



Bubble Chart



Spider and Radar



Scatter



Comparison Chart



Stacked bar chart



Gauges

# Scales



Pie



Bar



Column



Line



Area



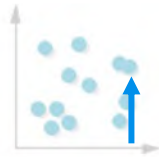
Doughnut



Bubble Chart



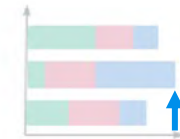
Spider and Radar



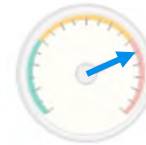
Scatter



Comparison Chart



Stacked bar chart




Gauges



**Feature abstraction to obtain  
a generic “skeleton”**



- 
- ↓ Development times
  - ↑ Design decisions traceability
  - ↑ Product customization
  - ↑ Code reusability
  - ↑ Flexibility



A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid, some hollow) connected by thin lines, forming a complex web structure.

**How?**



2.

# Building the meta-model

Domain engineering

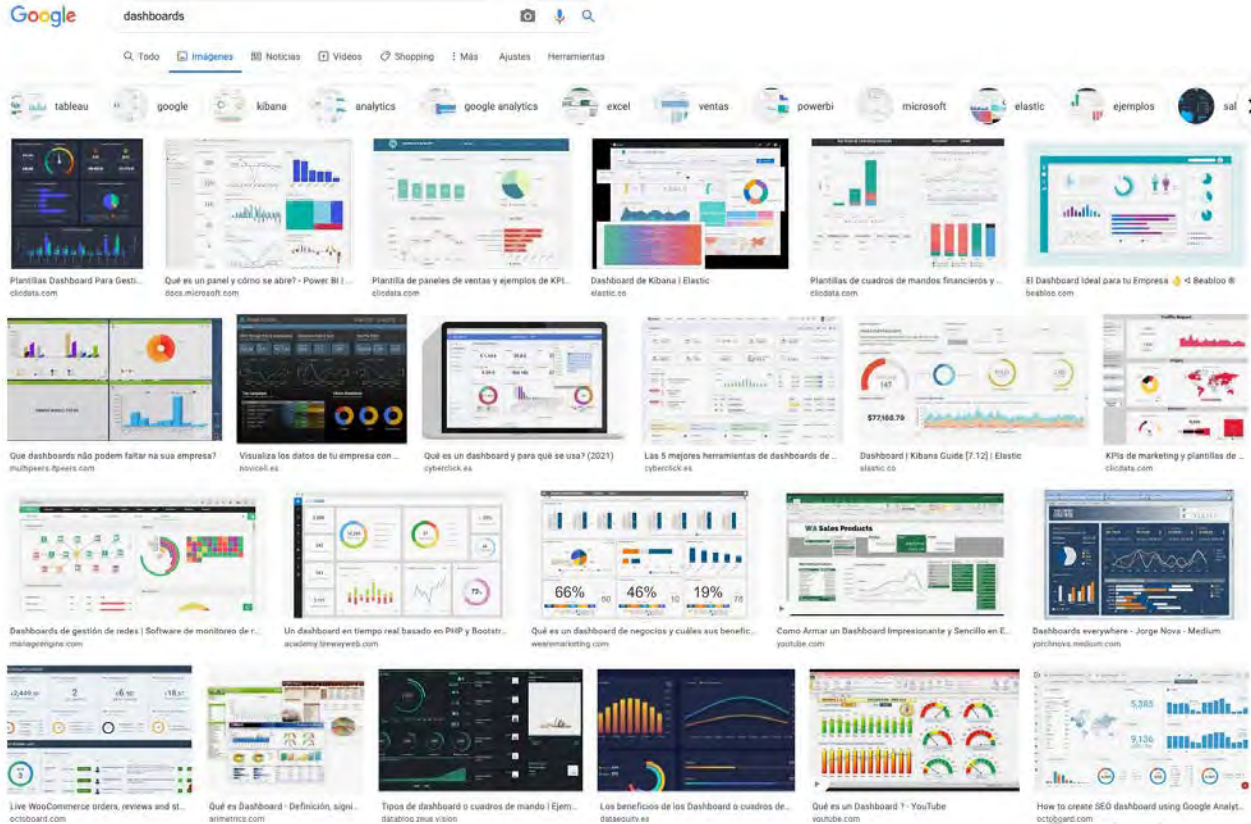


## Domain engineering

Categorize and identify common components or features within a domain

**Goal:** reuse domain knowledge to produce new software products

# Domain



# Domain

Searching for abstract and technology-independent features

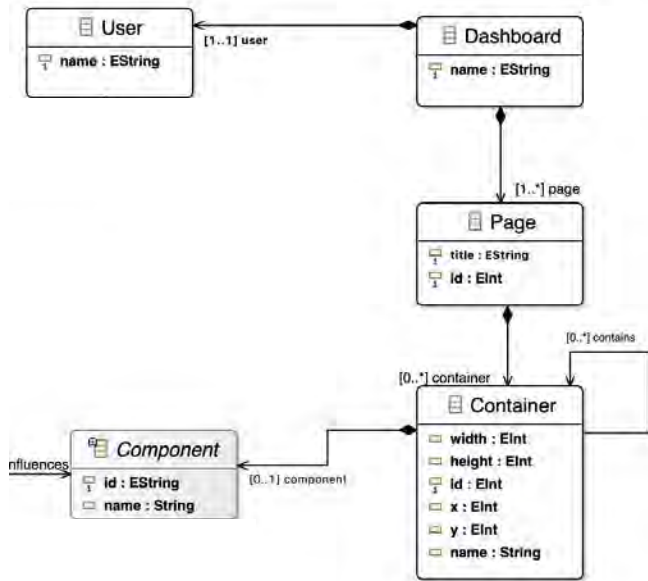


# Commonalities

- Users
- Data sources
- Pages
- Containers
- Components
  - Visualizations
  - Resources
  - Controls
  - Interactivity

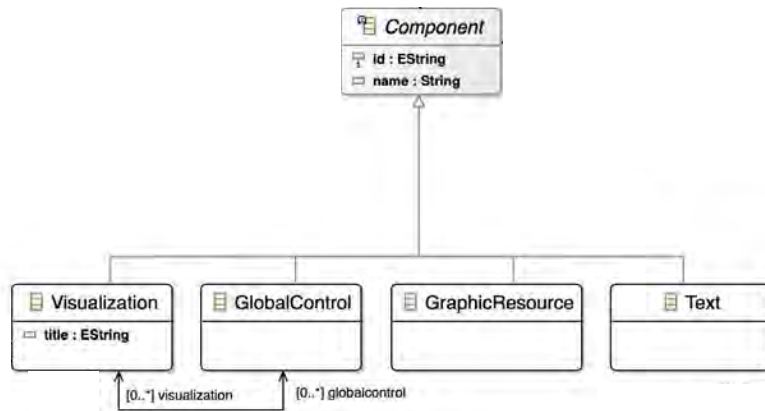






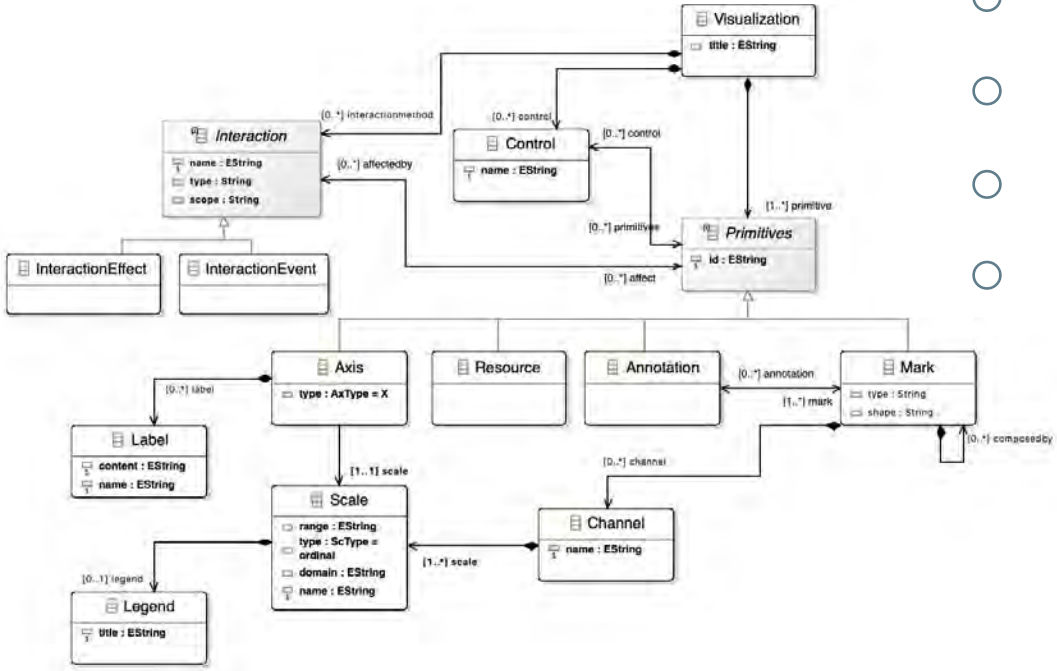
- Users
- Pages
- Containers
- Components



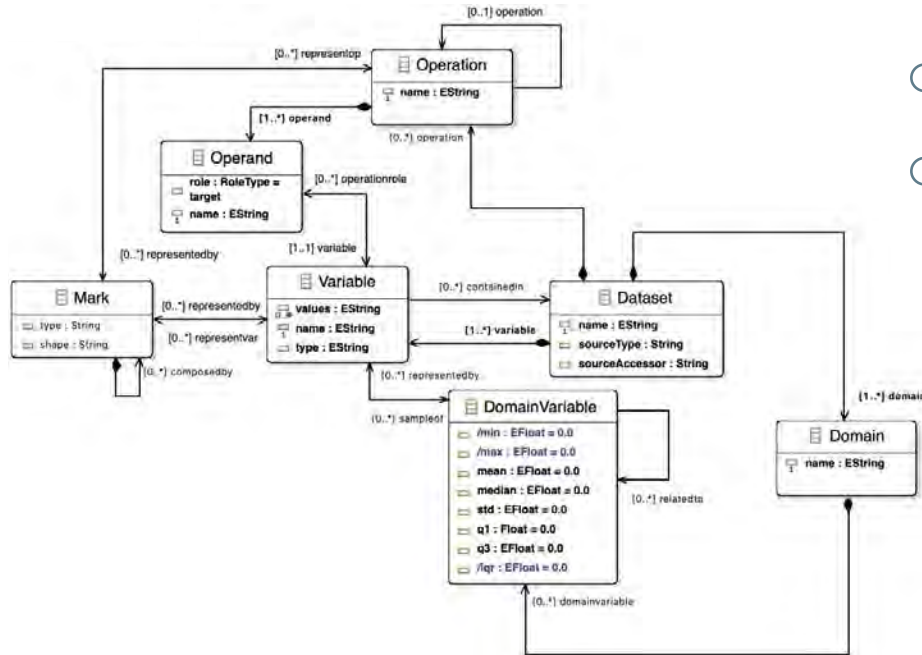


- Components
  - Visualizations
  - Controls
  - Resources
  - Text

- Visualizations
  - Annotations
  - Marks
  - Axes
  - Scales
  - Channels (color, position, etc.)
  - Interaction



- Data
  - Datasets
  - Data domain
  - Variables
  - Operations





A decorative network diagram in the top-left corner, consisting of interconnected nodes and lines, rendered in a light gray color.

3.

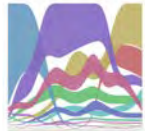
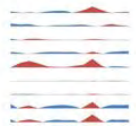
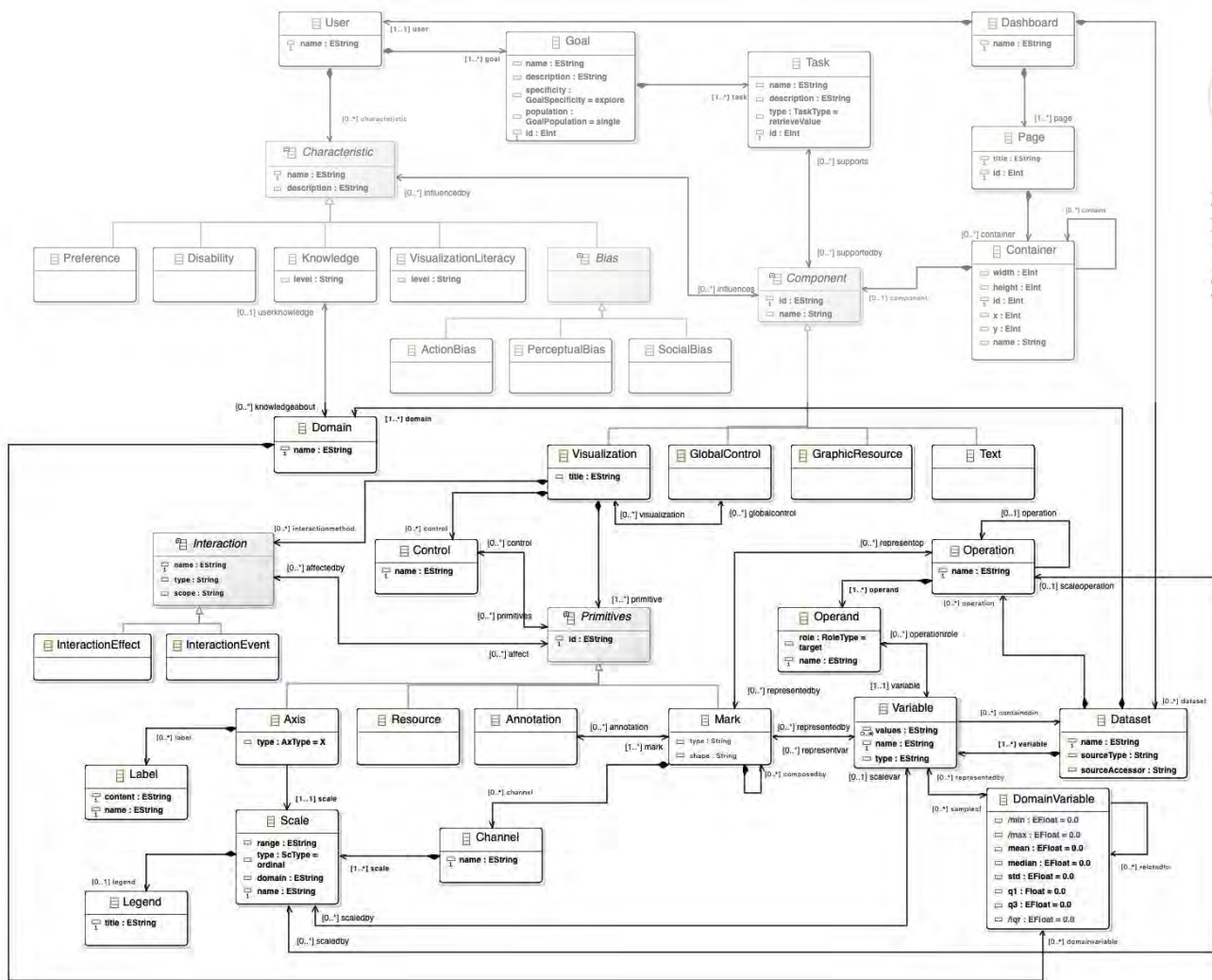
# Meta-model

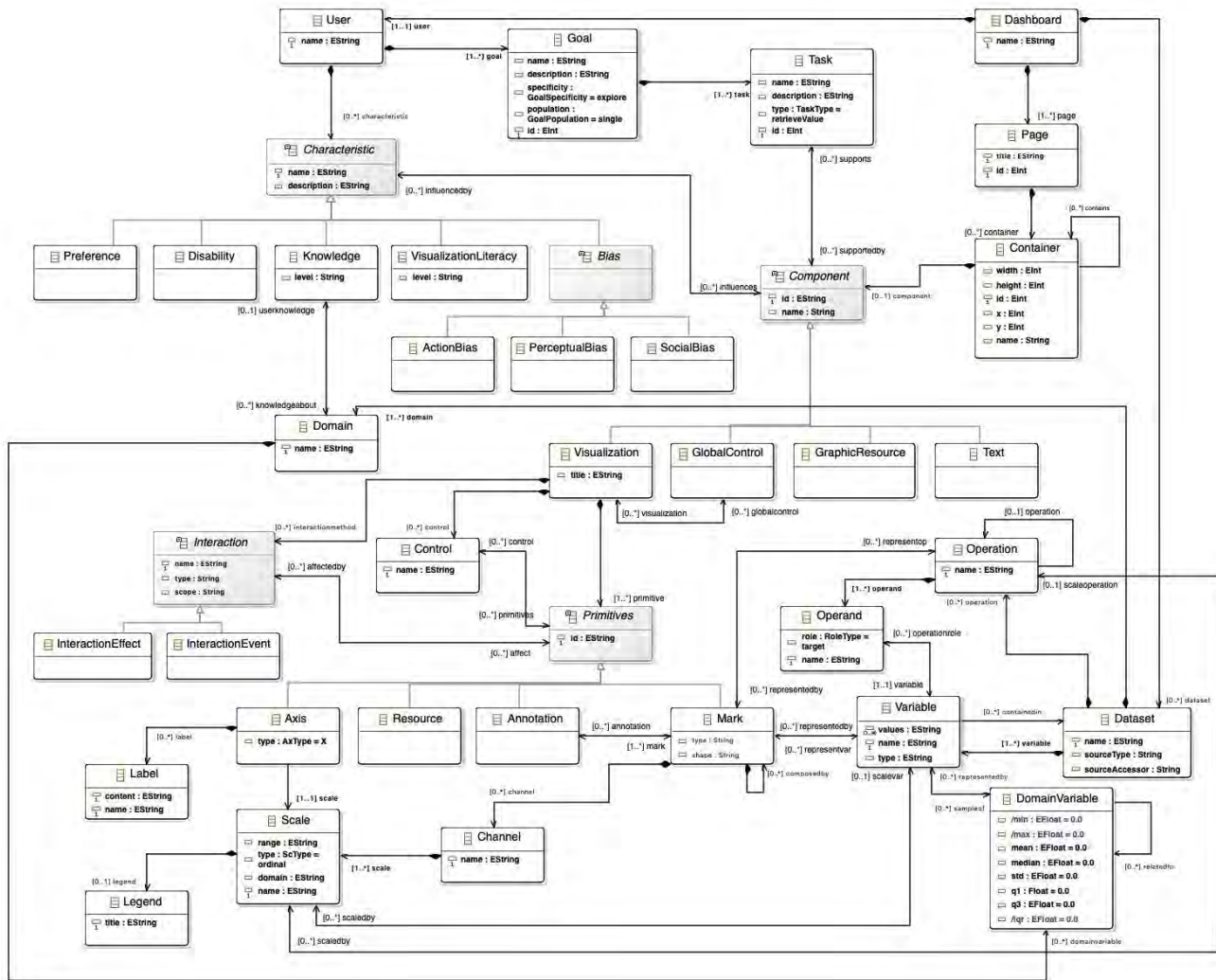
Final product











A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid grey, some hollow white) connected by thin grey lines, forming a complex web structure.

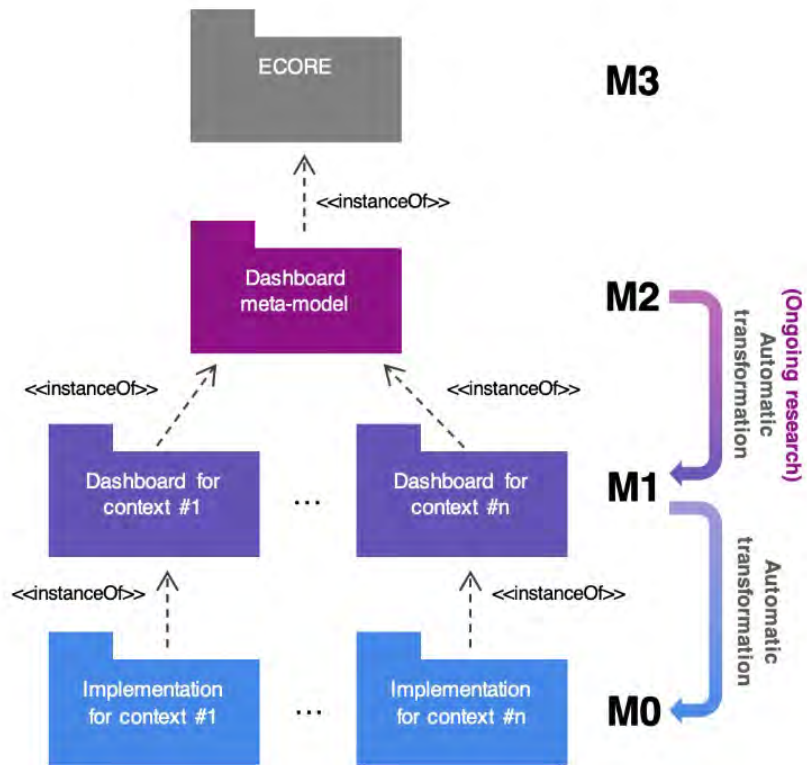
**Now what?**

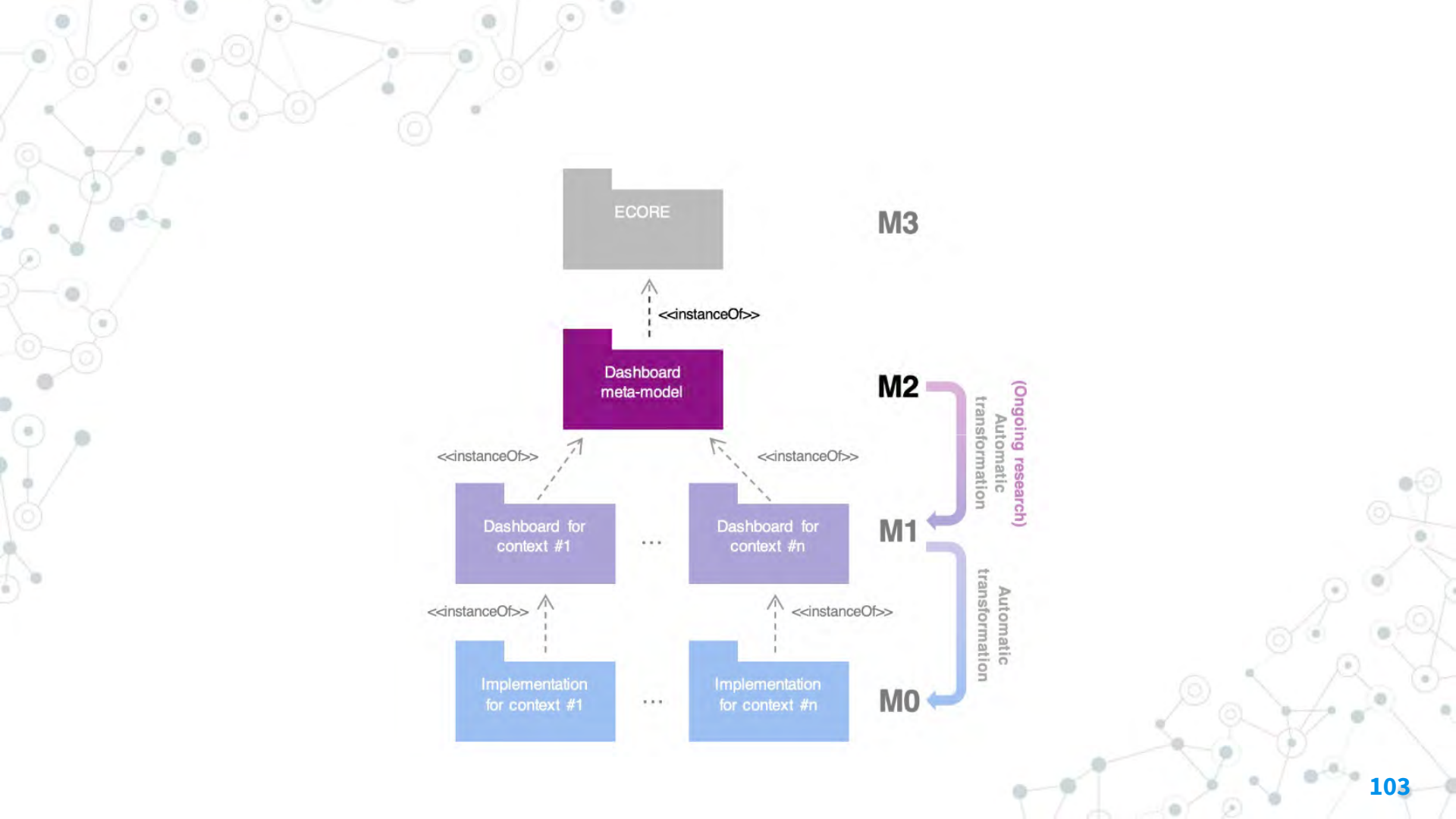


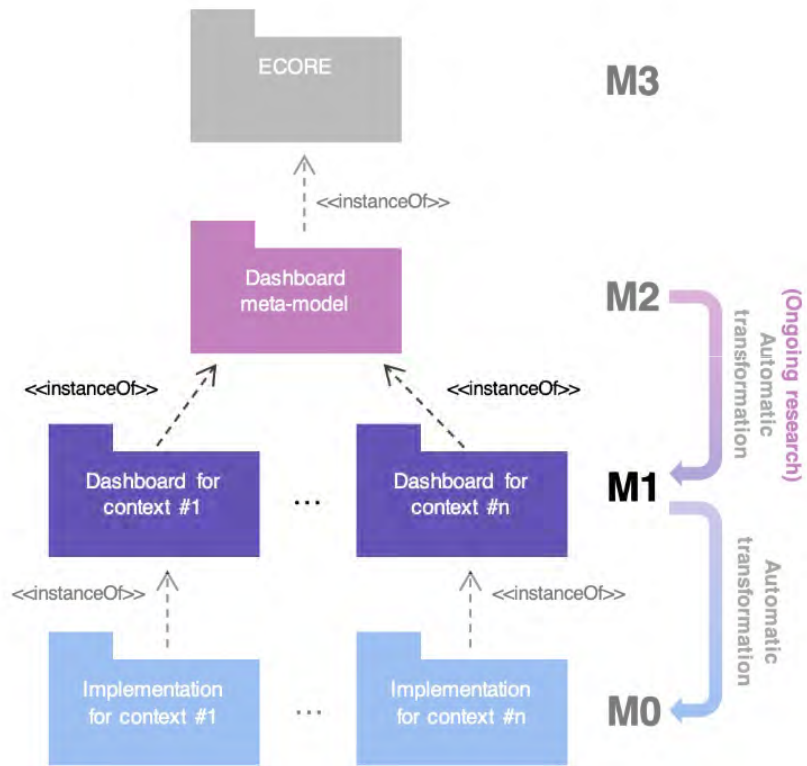
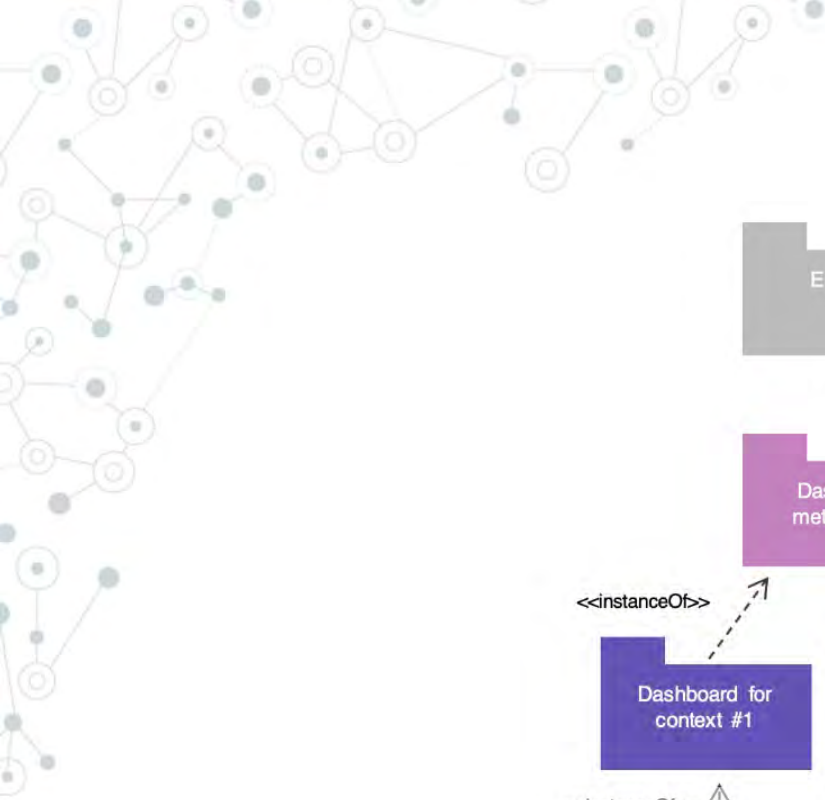
4.

# **Dashboards generation**

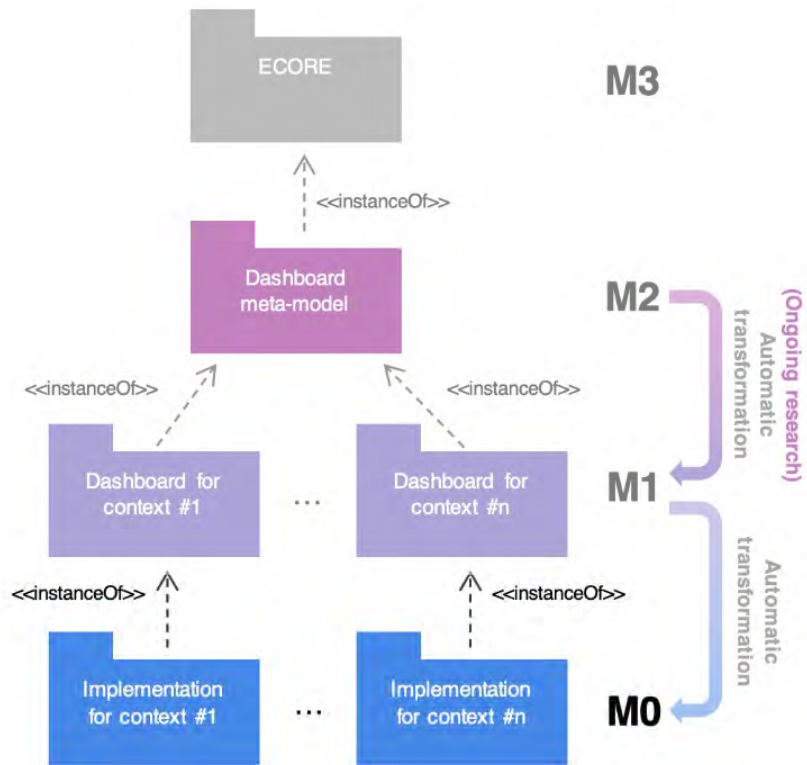
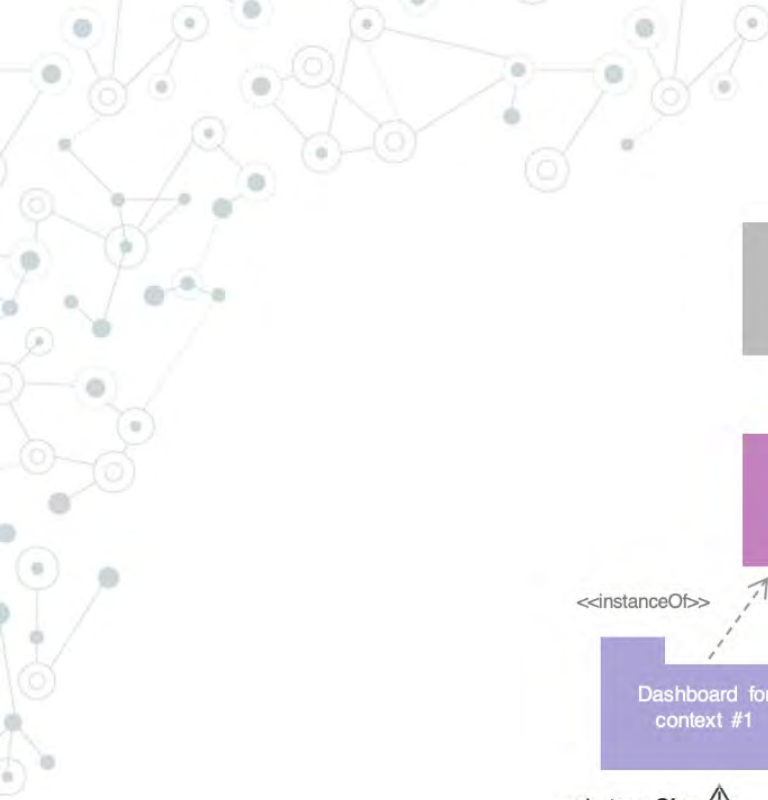
Software product lines











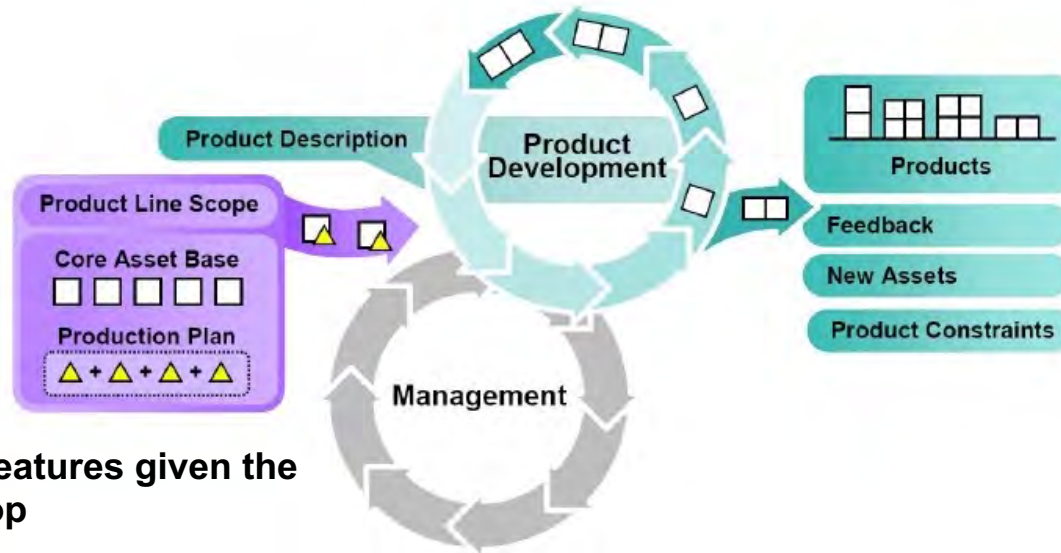


## Software product lines

Systematic reuse of software assets to build new products belonging to the same family

**Goal:** reduce development times and costs

## Generation of a customized product

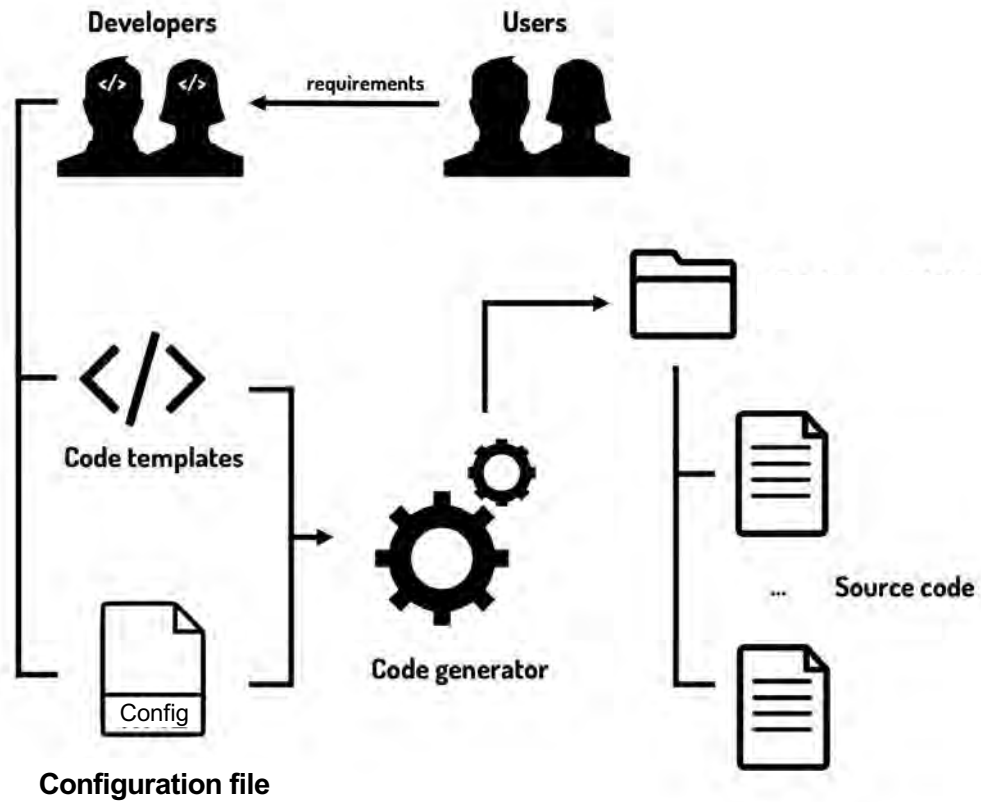


**Selection of the features given the product to develop**



## Variability points

- Core assets based on the meta-model
- Feature specification through configuration files
- Code generation through code templates



## Macros call

```
{{ global_reference.variable_definition() }}  
{{ zoom_functionality.zoom_variable_definition('xScale', 'yScale', 'xAxis',  
'yAxis', 'xLineVal', 'yLineVal', 'vis_id') }}
```

## Base code

```
function my(selection) {
```

```
  selection.each(function () {  
    var tooltipScatterDiagram = d3.select("body").append("div")  
      .attr("class", "tooltip")  
      .attr("id", "compare-tooltip")  
      .style("display", "none")  
      .style("opacity", 0);
```

```
    {{ chart_title.render_chart_title() }}  
    {{ control_bar.render_control_bar() }}  
    {{ render_structure.render_component_structure() }}  
    {{ control_panel.render_control_panel('query_handler', 'vis_id') }}  
    {{ export_functionality.export() }}  
    {{ overview_tooltip.create_overview_tooltip('vis_id') }}  
    {{ axis_functionality.render_axis_handlers('xText', 'yText', 'vis_id') }}
```

```
    xScale = d3.scaleLinear()  
      .range([0, width]);
```

```
    yScale = d3.scaleLinear()  
      .range([height, 0]);
```

```
    rScale = d3.scaleLog()  
      .range([10, radius]);
```

```
    if (typeof x_min === 'undefined') {
```

```
{% macro export() %}  
{% if Component|check('Exportation') == 'True' %}  
d3.select("#save-{{ Component|@component_id }}")  
  .on("mouseover", function () {  
    d3.select(this).style("cursor", "pointer");  
    d3.select(this).style("opacity", 1);  
  })  
  .on("mouseout", function () {  
    d3.select(this).style("cursor", "default");  
    d3.select(this).style("opacity", 0.3);  
  })  
  .on("click", function () {  
    d3.select(this).style("opacity", 0);  
    saveSvgAsPng(  
      d3.select("#original_svg_{{ Component|@component_id }}")  
        .node(),  
      "{{ Component|@component_id }}" + '.png',  
      {backgroundColor: 'white', scale: 4}  
    );  
  });  
{% endif %}  
{%- endmacro %}
```

Code fragment wrapped within the "export()" macro  
(associated to the "Export" functionality)



## Template

```
function my(selection) {  
  selection.each(function () {  
    var tooltipScatterDiagram = d3.select("body").append("div")  
      .attr("class", "tooltip")  
      .attr("id", "compare-tooltip")  
      .style("display", "none")  
      .style("opacity", 0);  
  
    {{ chart_title.render_chart_title() }}  
    {{ control_bar.render_control_bar() }}  
    {{ render_structure.render_component_structure() }}  
    {{ control_panel.render_control_panel('query_handler', 'vis_id') }}  
    {{ export_functionality.export() }}  
    {{ overview_tooltip.create_overview_tooltip('vis_id') }}  
    {{ axis_functionality.render_axis_handlers('xText', 'yText', 'vis_id') }}  
  
    xScale = d3.scaleLinear()  
      .range([0, width]);  
  
    yScale = d3.scaleLinear()  
      .range([height, 0]);  
  
    rScale = d3.scaleLog()  
      .range([10, radius]);  
  });  
}
```

## Component configuration



## Macro

```
{% macro export_vis %}  
{% if Component.check('Exportation') == 'true' %} CONDITION  
d3.select("#save-{{ Component['component_id'] }}")  
  .on("mouseover", function () {  
    d3.select(this).style("cursor", "pointer");  
    d3.select(this).style("opacity", 1);  
  })  
  .on("mouseout", function () {  
    d3.select(this).style("cursor", "default");  
    d3.select(this).style("opacity", 0.3);  
  })  
  .on("click", function () {  
    d3.select(this).style("opacity", 0);  
    saveSvgAsPng(d3.select("#original_svg_{{ Component['component_id'] }}").node(),  
      "{{ Component['component_id'] }}.png",  
      {  
        backgroundColor: 'white', scale: 4);  
    });  
  });  
{% endif %}  
{% endmacro %}
```

## Generated source code

```
.style("float", "left")  
.style("position", "relative")  
.style("width", width + "px")  
.attr("id", "vis_container_ScatterDiagram_1");  
  
d3.select("#save-ScatterDiagram_1")  
  .on("mouseover", function() {  
    d3.select(this).style("cursor", "pointer");  
    d3.select(this).style("opacity", 1);  
  })  
  .on("mouseout", function() {  
    d3.select(this).style("cursor", "default");  
    d3.select(this).style("opacity", 0.3);  
  })  
  .on("click", function() {  
    d3.select(this).style("opacity", 0);  
    saveSvgAsPng(d3.select("#original_svg_ScatterDiagram_1").node(),  
      "ScatterDiagram_1.png", {  
        backgroundColor: 'white',  
        scale: 4  
      });  
  });  
  
d3.select("body")  
  .append("div")  
  .attr("class", "tooltip")  
  .attr("id", "overview-tooltip-" + vis_id)
```

If the target condition is met, the associated functionality is injected in the final source code



A decorative network diagram in the top-left corner, consisting of interconnected nodes and lines, rendered in a light gray color.

5.

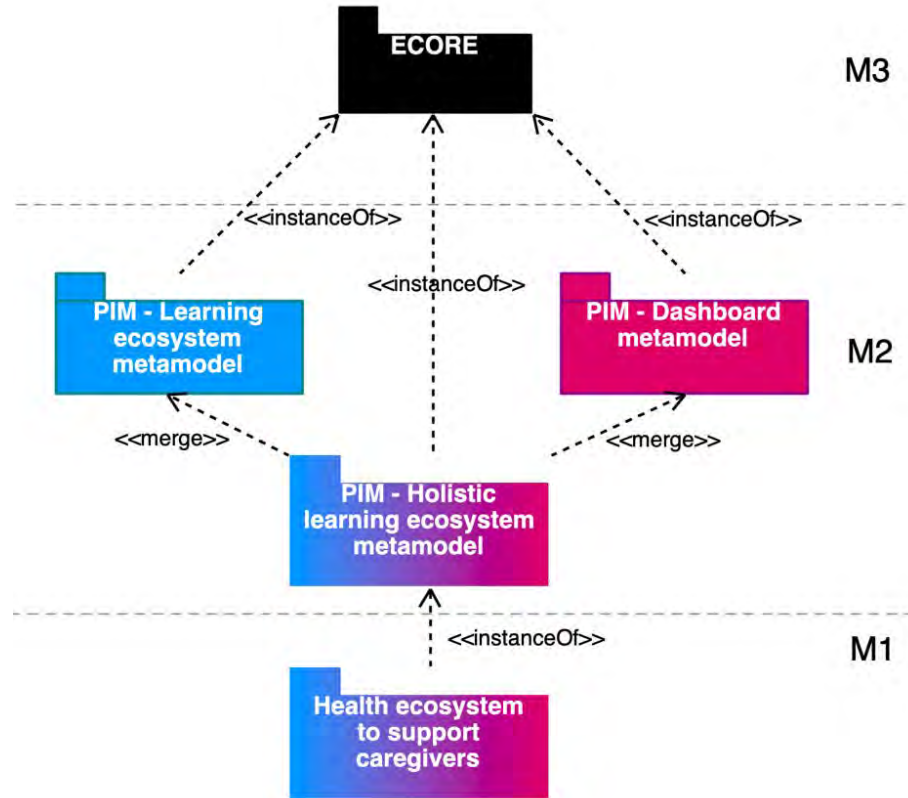
# Applications

Meta-model integration

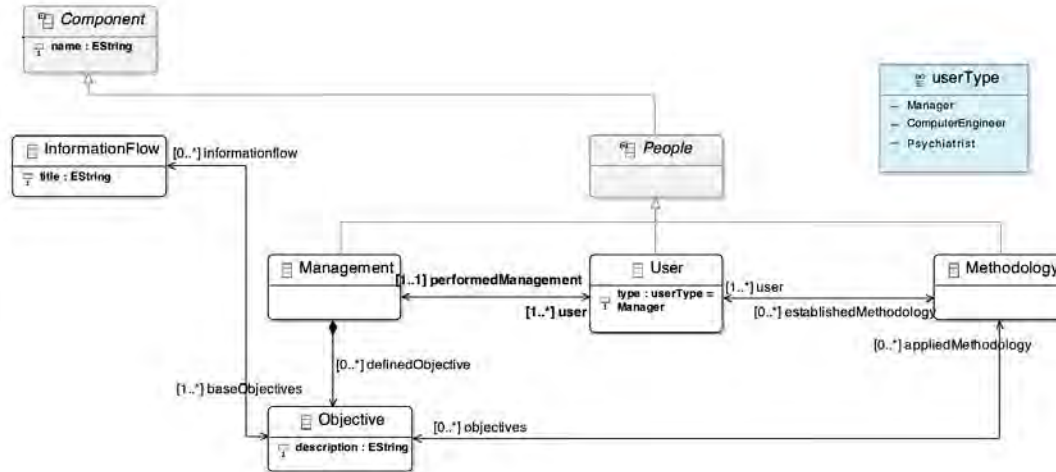
A decorative background consisting of a network of interconnected nodes and lines, resembling a molecular structure or a complex system. The nodes are represented by small circles, some of which are larger and have concentric circles inside. The lines are thin and grey, connecting the nodes in a non-linear, branching pattern. The overall color scheme is light blue and grey, with the main text in a bold, bright blue.

# **HOLISTIC INTEGRATION**

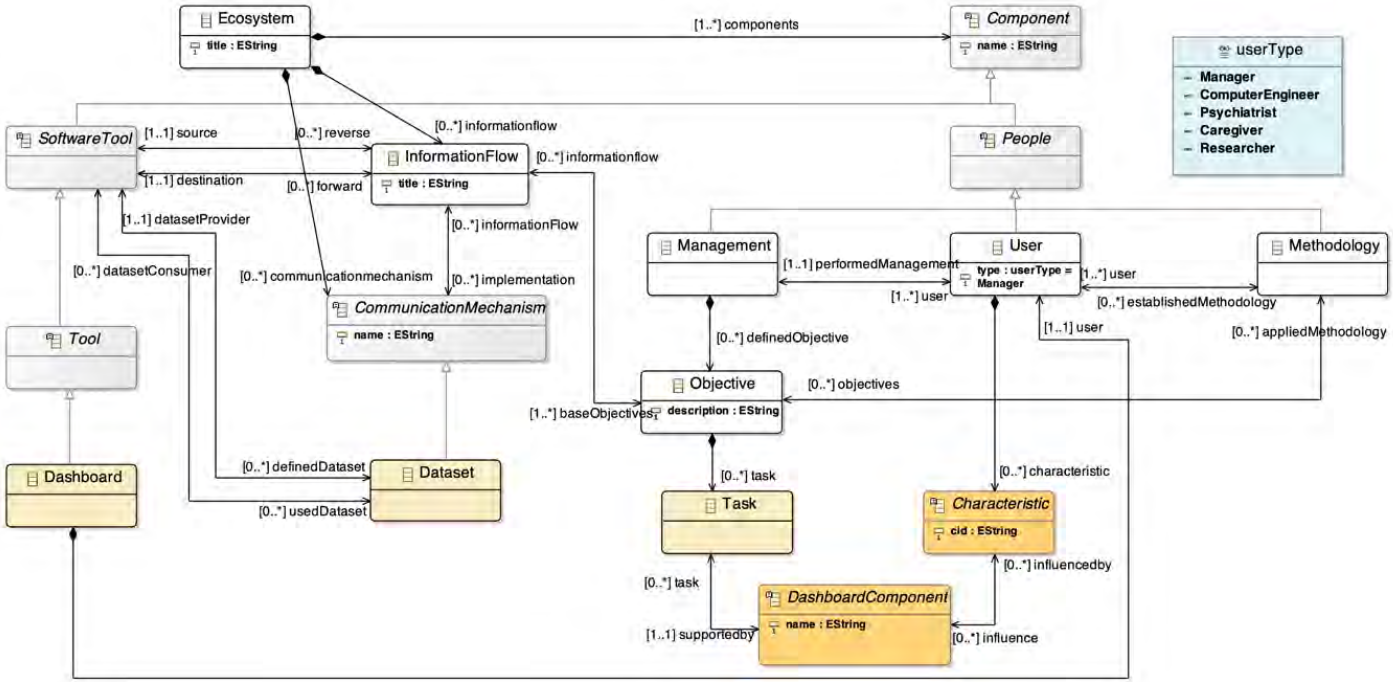
# Integration



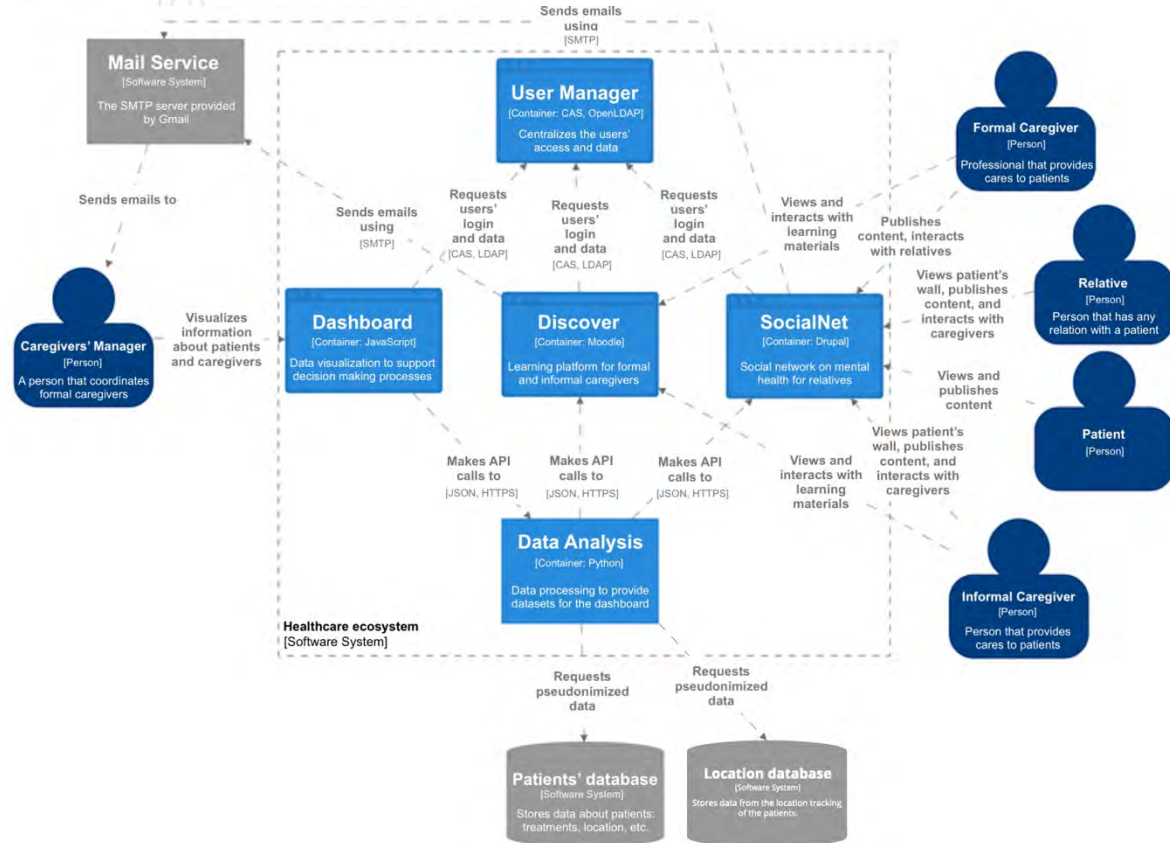
# Human factor



# Meta-model integration



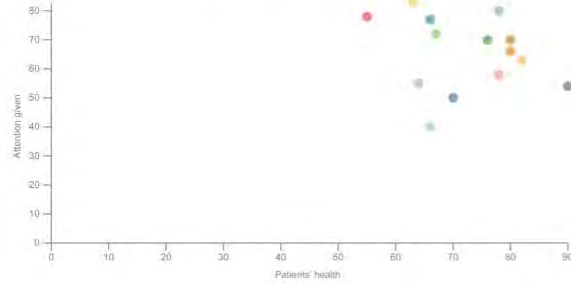
# Architecture



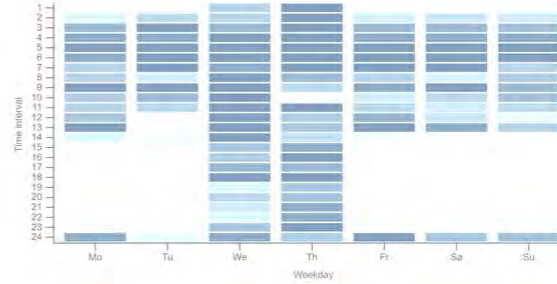
# Dashboard generation

## Test Dashboard

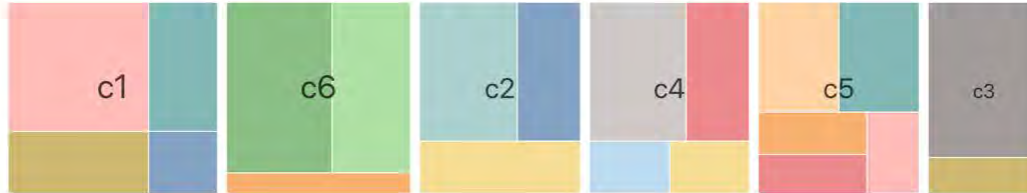
Patient's health v. attention given



Caregivers' workload over time



Caregivers' workload by patient

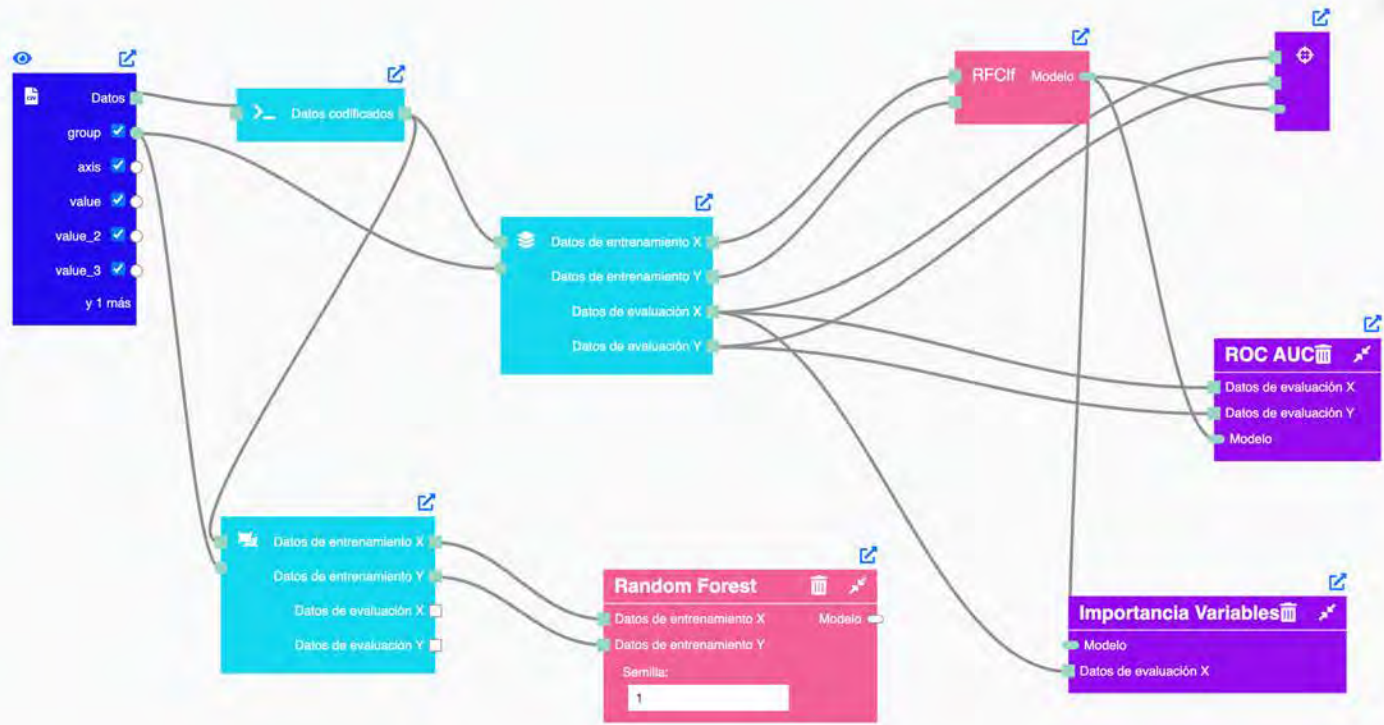






# KOOPA-ML

- Datos
- Procesamiento
  - Rellenar valores perdidos
  - Codificar datos
  - Separar conjuntos
  - Validación Cruzada
- Algoritmos ML
- Evaluación ML
  - Importancia Variables
  - Clasificación
    - ROC AUC
    - Confusion Matrix
    - Accuracy
    - Precision
    - F1
    - Recall
    - Jaccard
  - Regresión
- Ejecutar
- Ver informe de evaluación
- Configurar proyecto
- Guardar proyecto



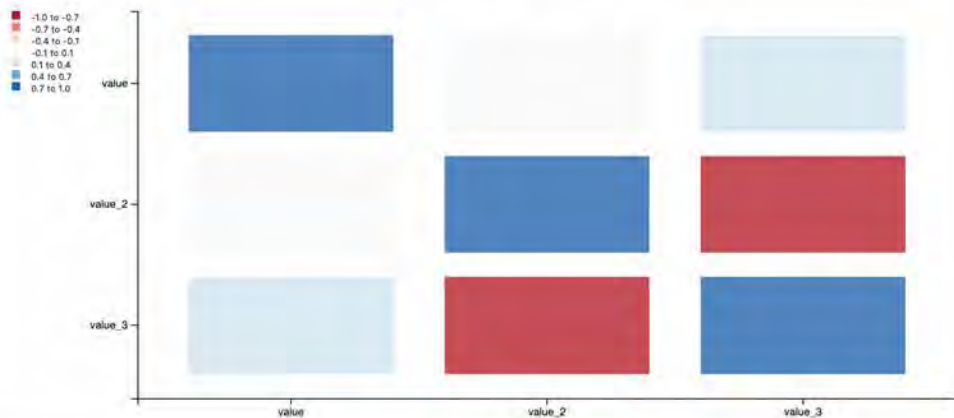
# Sumario de los datos

Dataset

Resumen estadístico

Validación 1

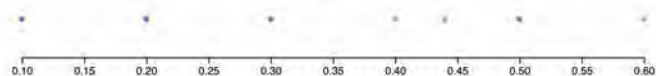
### Correlation Matrix



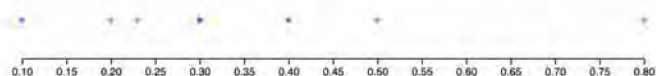
### Variable Group2 distribution



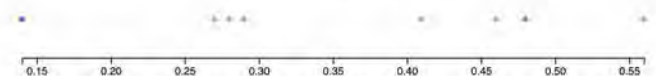
### Variable value\_3 distribution



### Variable value\_2 distribution



### Variable value distribution



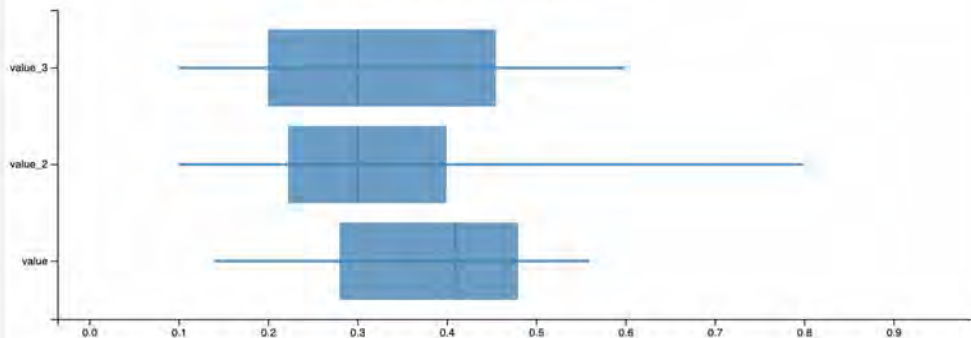
### Variable axis distribution



### Variable group distribution

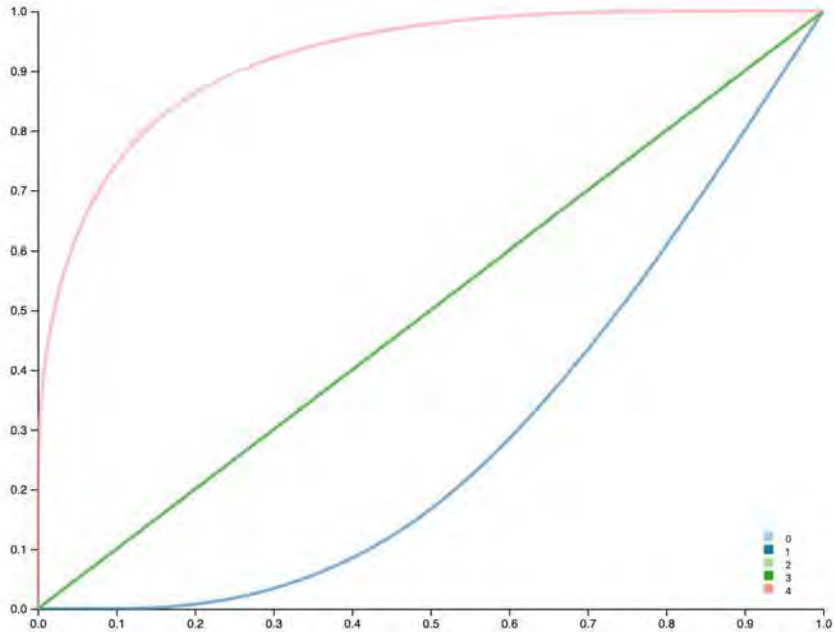


### Numeric variables distribution

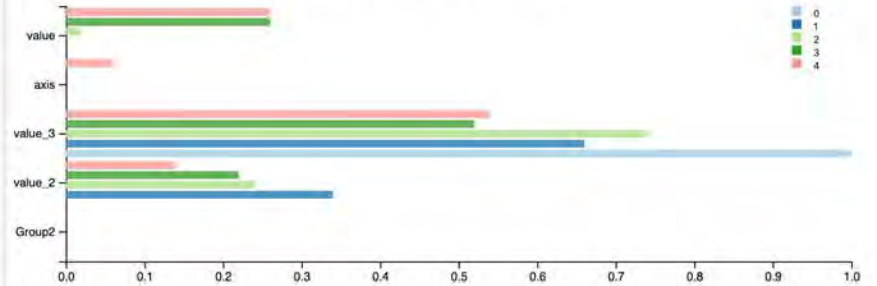


# Sumario de métricas del modelo Random Forest (id: 16)

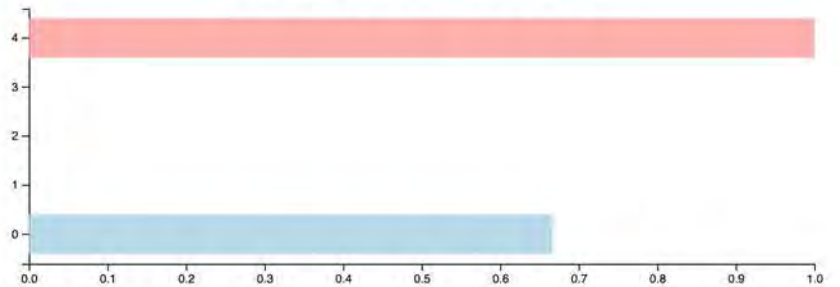
ROC curve



Features importance



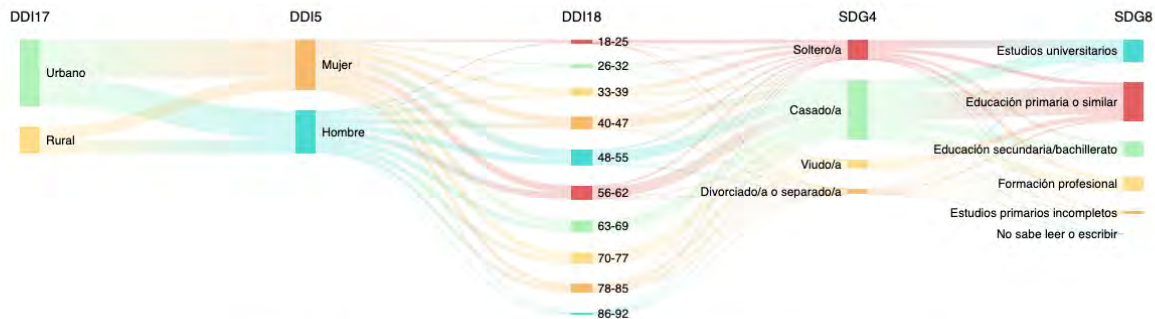
Cross value precision\_binary score





# SALMANTICOR

- 🔴 **FRH4**  
👁 Exfumador (desde hace más 1 año) 0=No; 1=Si
- 🔴 **FRH6**  
👁 Vino 0=No; 1=Si
- 🔴 **FRH9**  
👁 Cerveza 0=No; 1=Si
- 🔴 **FRH12**  
👁 Chupitos 0=No; 1=Si
- 🔴 **FRH15**  
👁 Copas 0=No; 1=Si
- 🔴 **FRH18**  
👁 ¿Tiene usted la TA alta? 0=No; 1=Si; 2=No sabe
- 🔴 **FRH19**  
👁 ¿Toma algún medicamento para la TA? 0=No; 1=Si; 2=No sabe
- 🔴 **FRH20**  
👁 ¿Tiene usted el colesterol alto? 0=No; 1=Si; 2=No sabe
- 🔴 **FRH21**  
👁 ¿Tiene usted el azúcar alto? 0=No; 1=Si; 2=No sabe
- 🔴 **FRH22**  
👁 ¿Ha padecido usted del corazón? 0=No; 1=Si; 2=No sabe
- 🔴 **FRH23**  
👁 ¿Algún familiar suyo ha tenido infarto o angina? 0=No; 1=Si; 2=No sabe



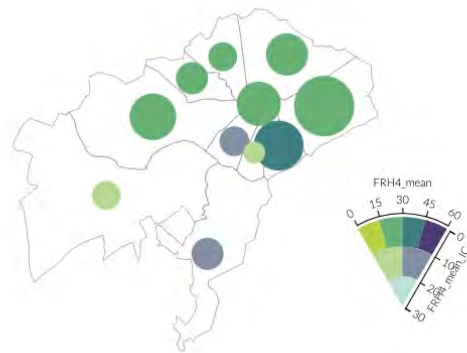
### SALAMANCA - Rural

Media por cada 100 habitantes para la variable FRH6



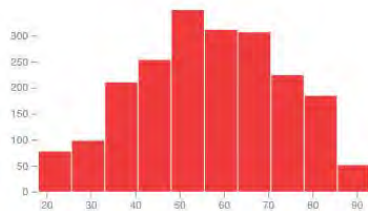
### SALAMANCA - Urbano

Media por cada 100 habitantes para la variable FRH6





Edad



Buscar...

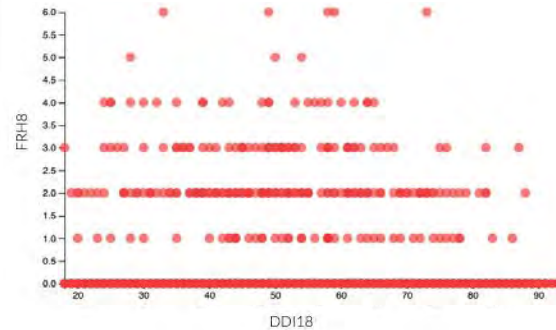
- + DDI5  
Sexo 0=H; 1=M
- + DDI14  
Código postal Hospital
- + DDI15  
E Sing Hospital
- + DDI16  
Municipio Hospital
- + DDI17  
Ambito 0=URBANO; 1=RURAL
- + DDI18  
Edad

Correlación

DDI18

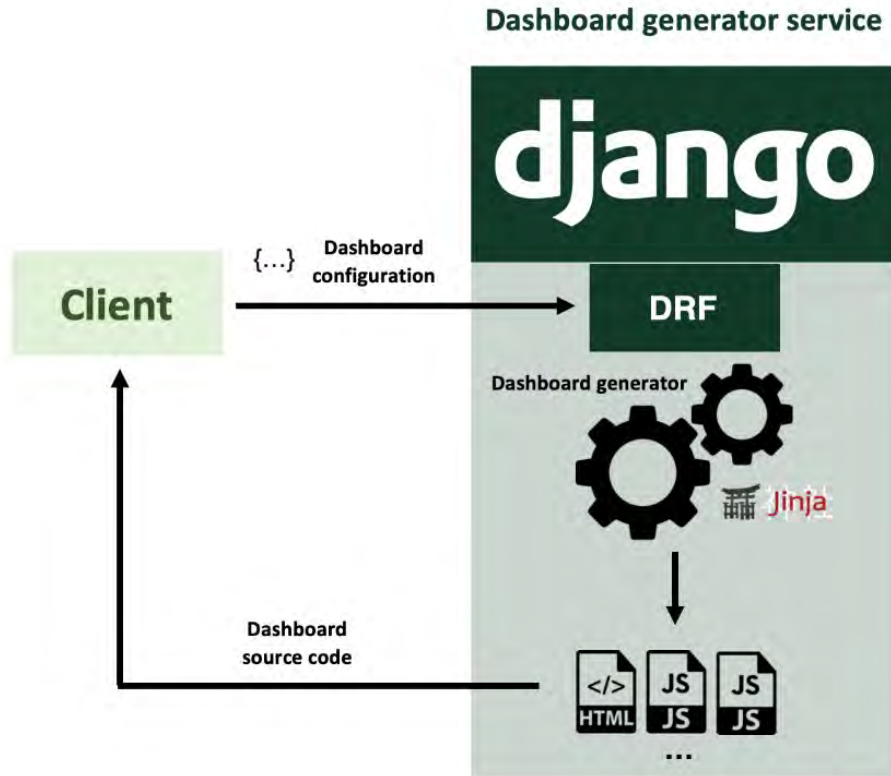
FRH18

Vista previa HTML





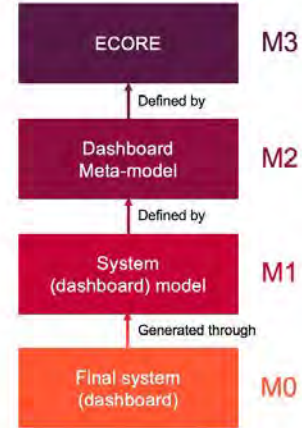
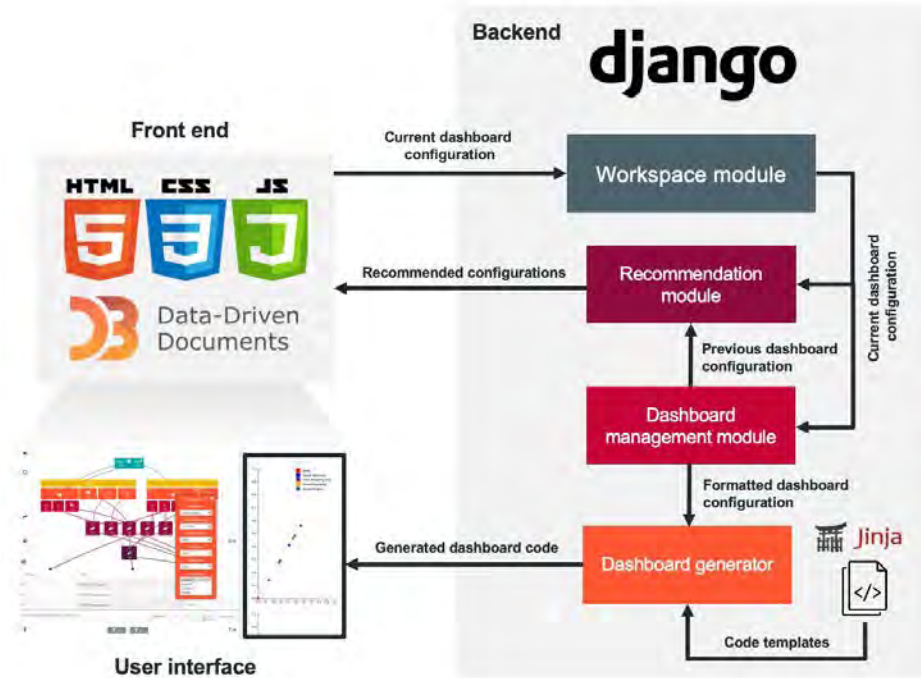
# Architecture



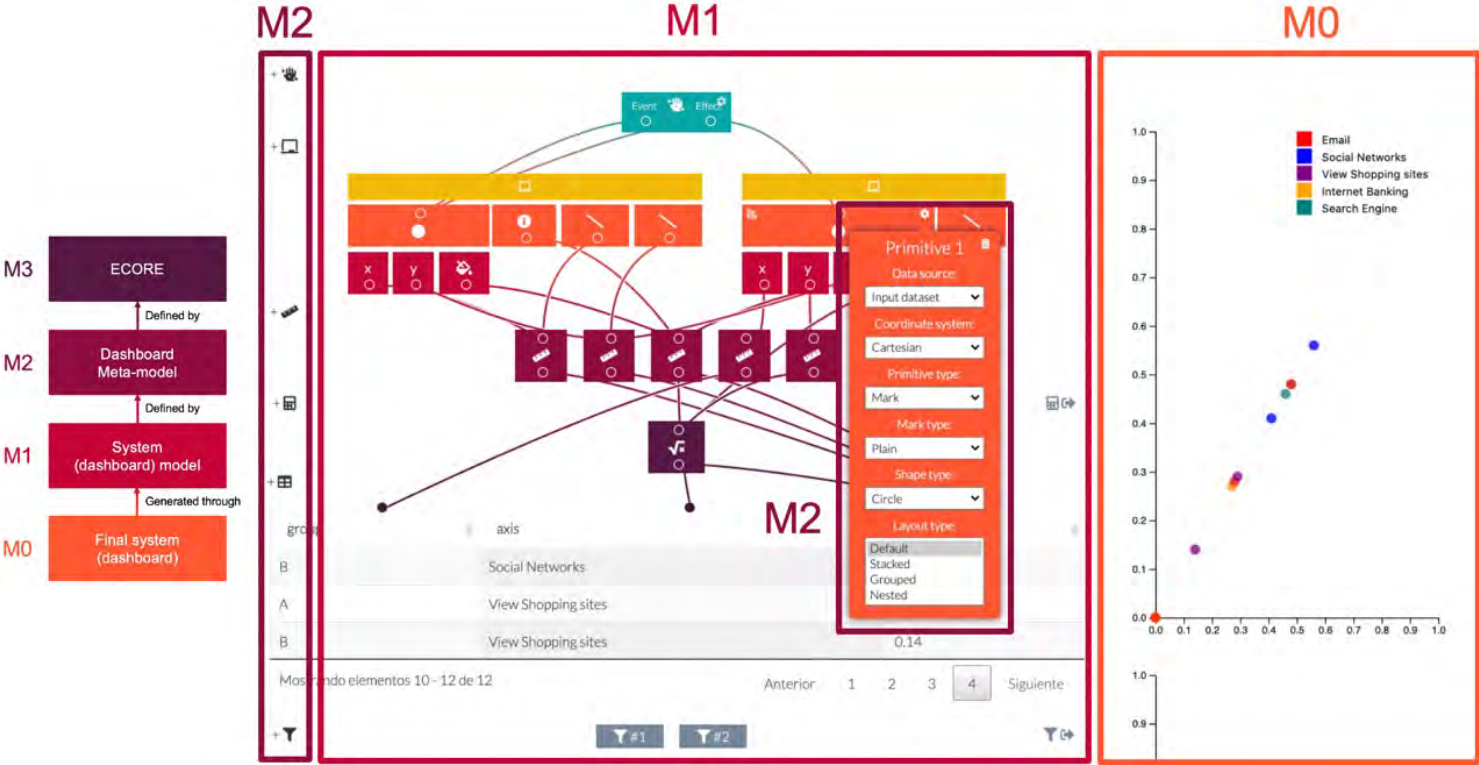


# MetaViz

# Architecture



# Interface



# Interface

+ 🖱️ → Add a new interaction

+ 📄 → Add a new visualization

+ 🛠️ → Add a new scale

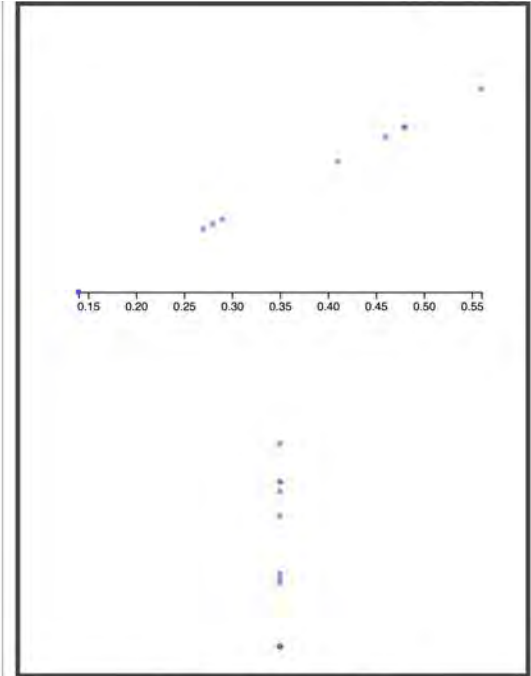
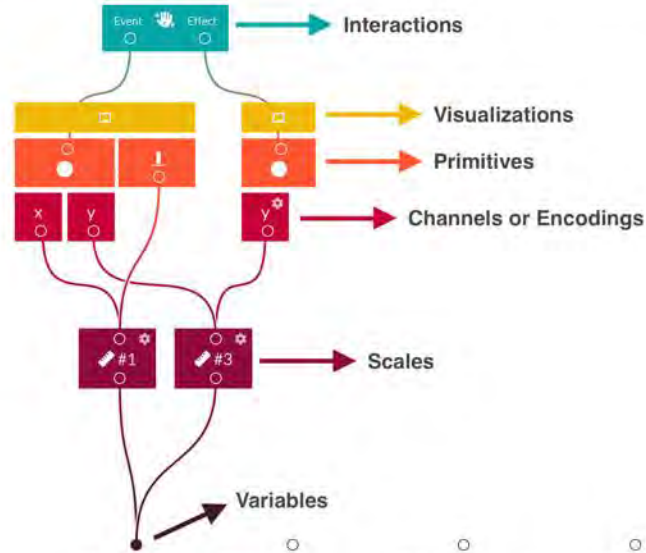
+ 📊 → Add a new dataset

group	axis	value	value_2	value_3	Group2
A	Email	0.48	0.3	0.44	X
A	Social Networks	0.41	0.1	0.5	Z
A	Internet Banking	0.27	0.2	0.6	X

Showing 1 to 3 of 12 entries

First Previous **1** 2 3 4 Next Last

+ ▼ → Add a new filter



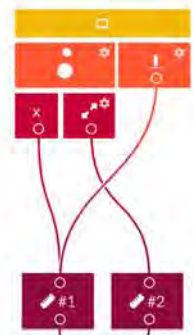
Generated visualizations

+ 🗨

+ 🖼

+ 🖌

+ 🏠

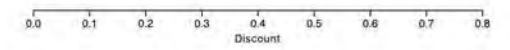


Ship Mode	Sales	Quantity	Segment	Discount	Country	City	State	Postal Code	Region	Category	Sub-Category
First Class	1097.5439999999999	7	Corporate	0.2	United States	Richardson	Texas	75080	Central	Technology	Phones
First Class	190.92	5	Corporate	0.6	United States	Richardson	Texas	75080	Central	Furniture	Furnishings
First Class	45.98	2	Corporate	0.0	United States	Eagan	Minnesota	55122	Central	Technology	Accessories

Showing 1 to 3 of 298 entries

First Previous **1** 2 3 4 5 ... 100 Next Last

### Test 1





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# Thank you!

## Questions?

# Meta-modeling ecosystems



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