



Open Science principles in software product lines: The case of the UVL ecosystem

David Romero-Organvidez, José A. Galindo, Megha Bhushan, Jose-Miguel Horcas, David Benavides



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Open Science principles in software product lines: The case of the UVL ecosystem

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- 1. Variability and Software Product Lines**
 - 2. Yet another language: UVL**
 - 3. UVLHub and Open Science**
 - 4. flamapy**
 - 5. Conclusions**
- 

- 1. Variability and Software Product Lines**
 - 2. Yet another language: UVL**
 - 3. UVLHub and Open Science**
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 - 5. Conclusions**
- 

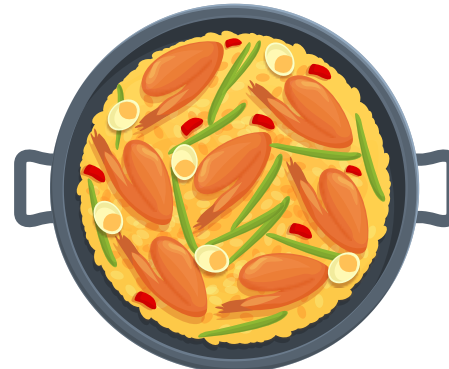
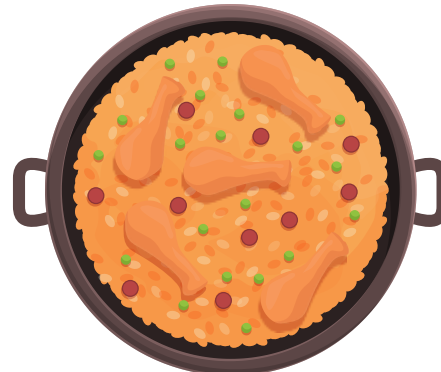
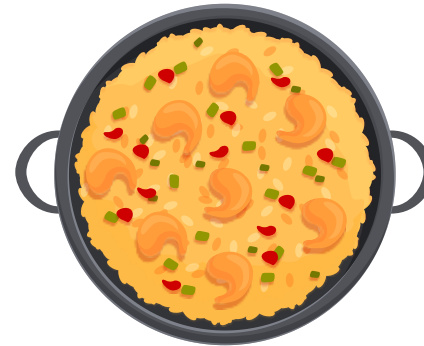
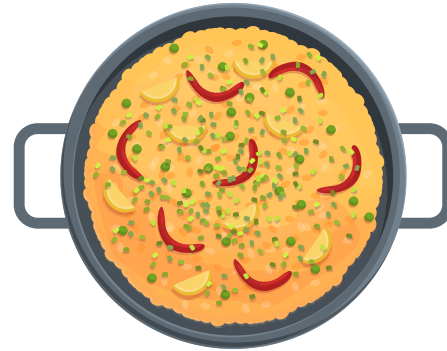
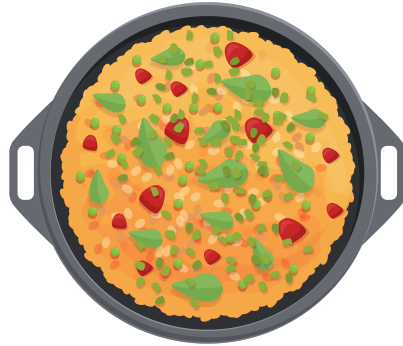
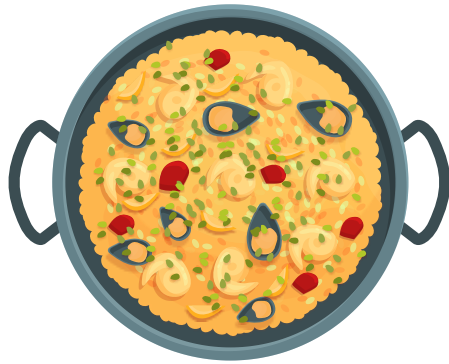
1. Variability and Software Product Lines



Software Product... *what?*

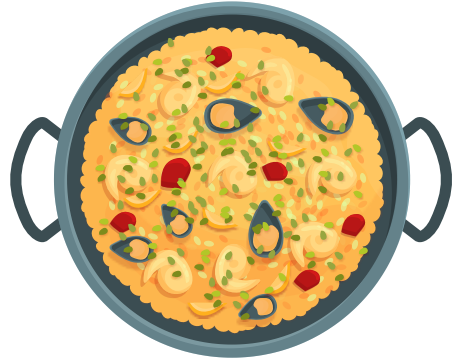
1. Variability and Software Product Lines

Paella!

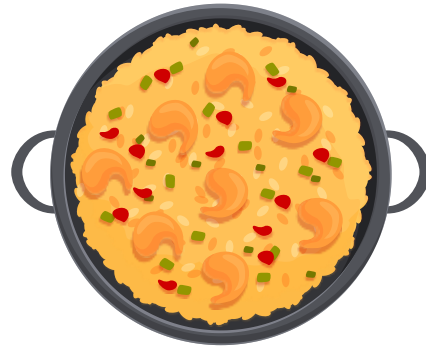


1. Variability and Software Product Lines

Paella!



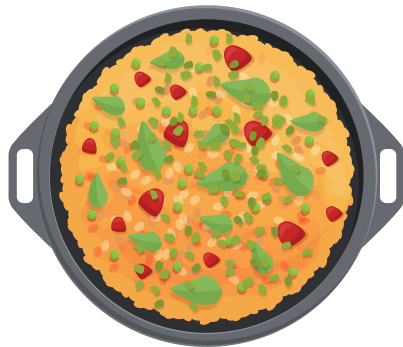
**Paella
valenciana**



**Paella de marisco
(seafood paella)**



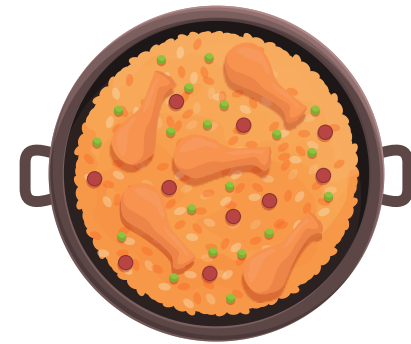
**Paella de verduras
(vegetable paella)**



**Arroz con cosas
(rice with things)**



**Paella de arroz negro
(seafood paella)**



**Paella de pollo
(chicken paella)**

1. Variability and Software Product Lines

Mass production



Mass production

Producing efficiently a large amount of standardized products

1. Variability and Software Product Lines

Mass customization – A set of product



Paella valenciana



Paella de marisco (seafood paella)



Paella de verduras (vegetable paella)



Arroz con cosas (rice with things)



Paella de arroz negro (seafood paella)

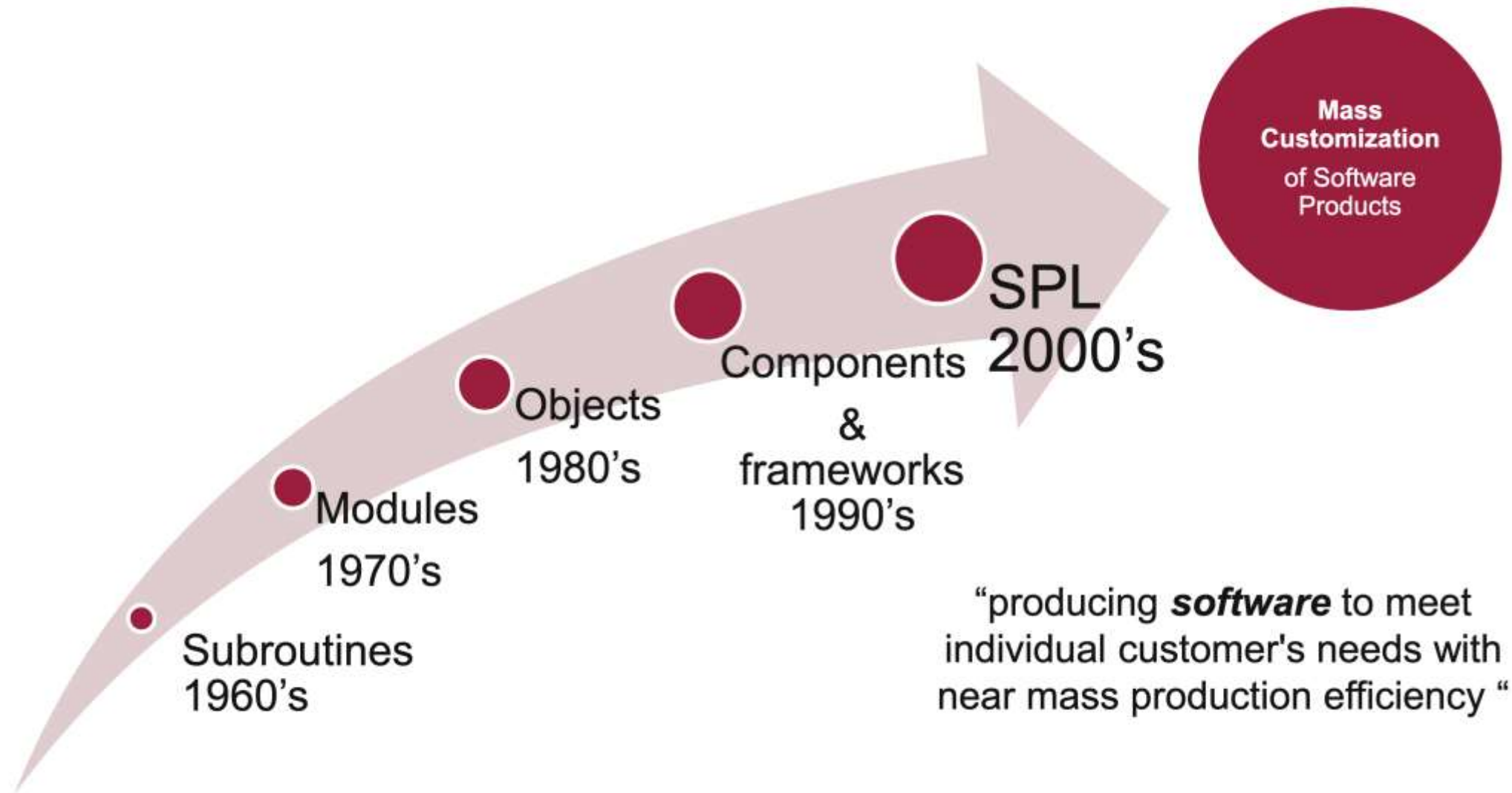



Paella de pollo (chicken paella)



1. Variability and Software Product Lines

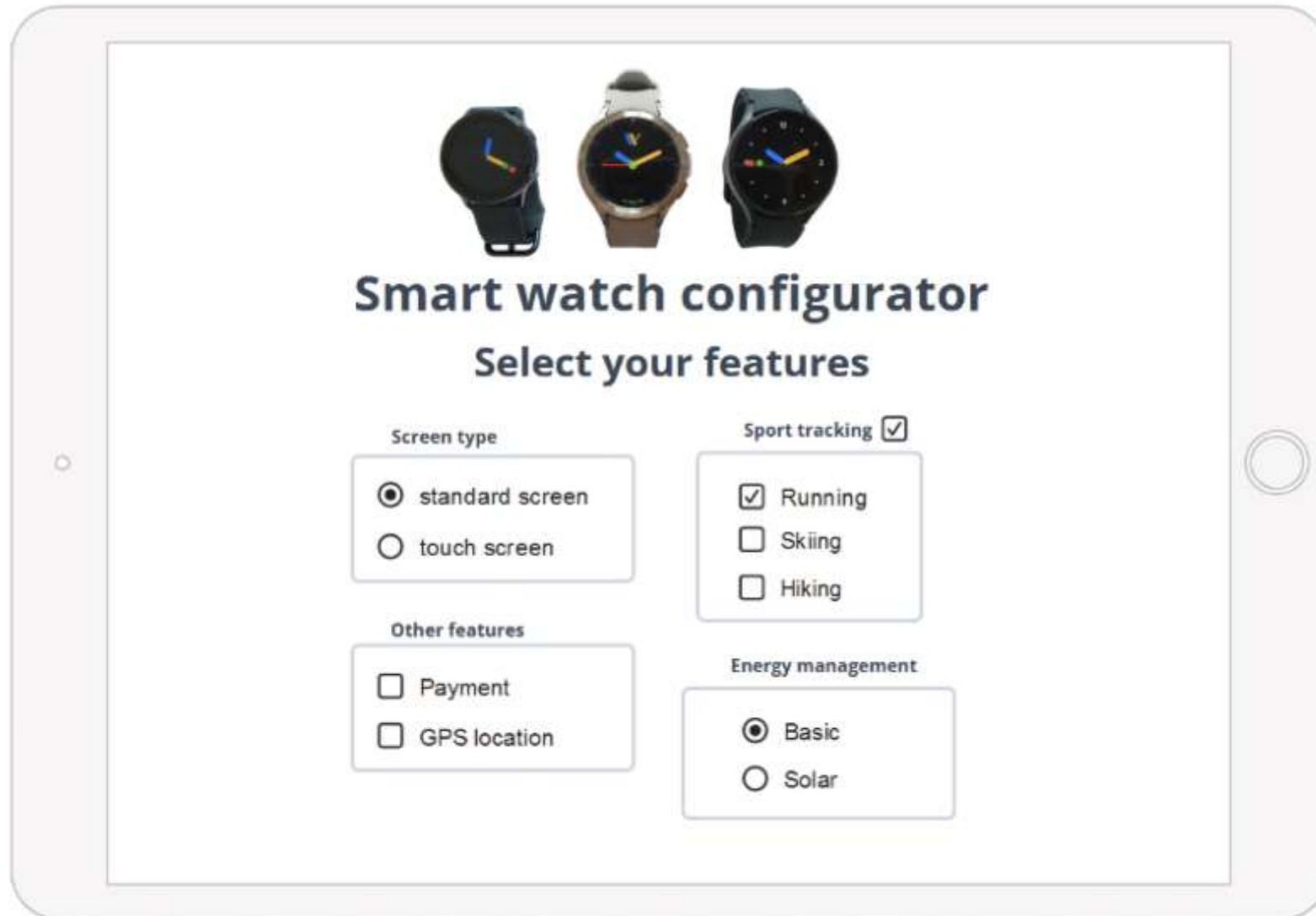
SPL



1. Variability and Software Product Lines
 2. **Yet another language: UVL**
 3. UVLHub and Open Science
 4. flamapy
 5. Conclusions
- 

2. Yet another language: UVL

A typical example



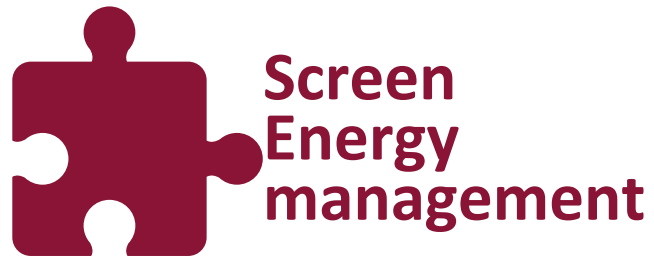
The image shows a tablet displaying a 'Smart watch configurator' interface. At the top, three smartwatches are shown: a black one with a black strap, a gold one with a brown strap, and a black one with a black strap. Below the watches, the title 'Smart watch configurator' is displayed in a large, bold, dark blue font, followed by the subtitle 'Select your features' in a smaller, bold, dark blue font. The interface is divided into four sections, each with a title and a list of options:

- Screen type**:
 - standard screen
 - touch screen
- Other features**:
 - Payment
 - GPS location
- Sport tracking** :
 - Running
 - Skiing
 - Hiking
- Energy management**:
 - Basic
 - Solar

2. Yet another language: UVL

Variability Model

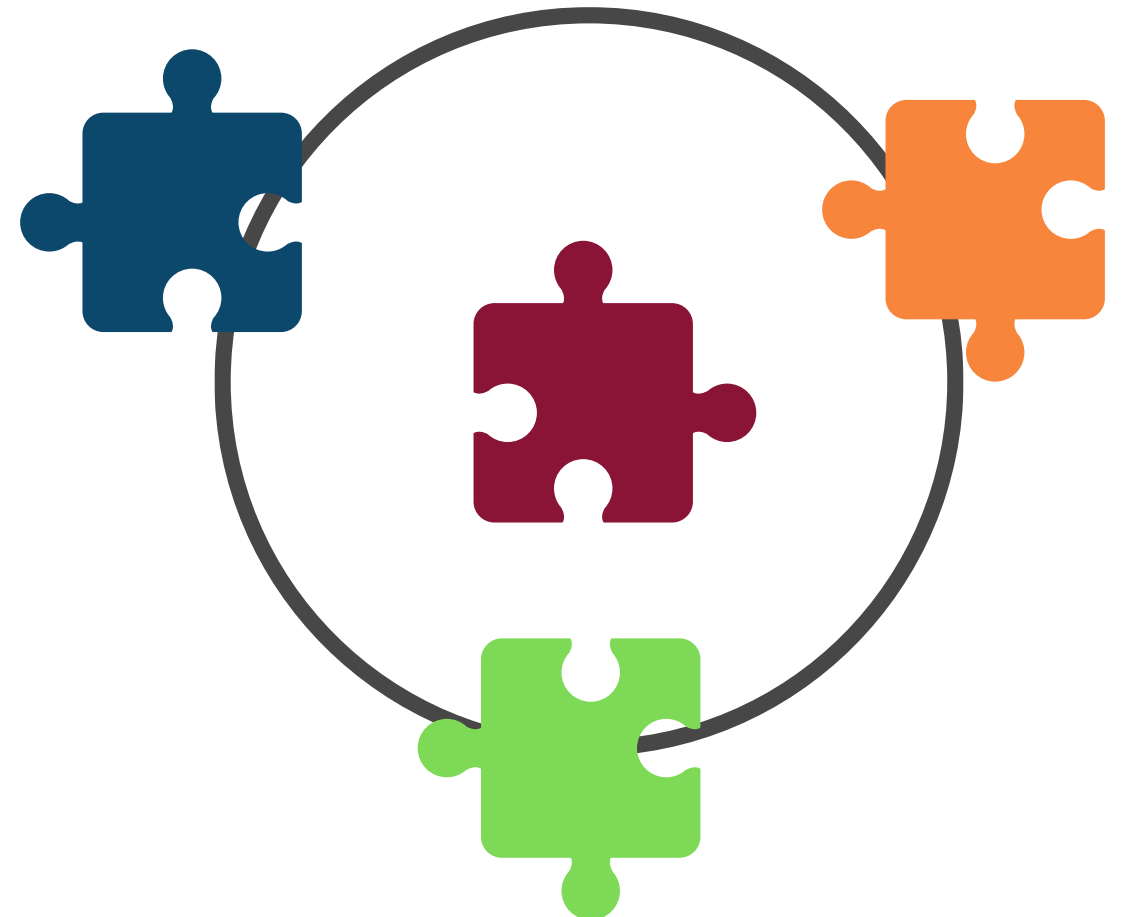
Common features



Variable features



Variability Model

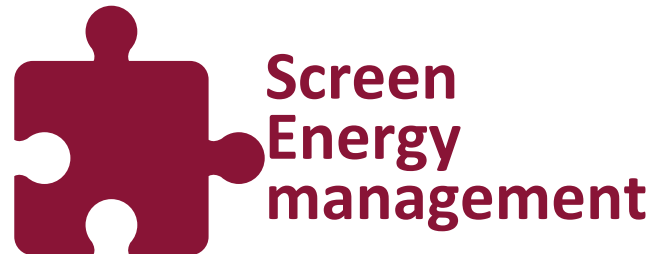


2. Yet another language: UVL

Variability Model



Common features

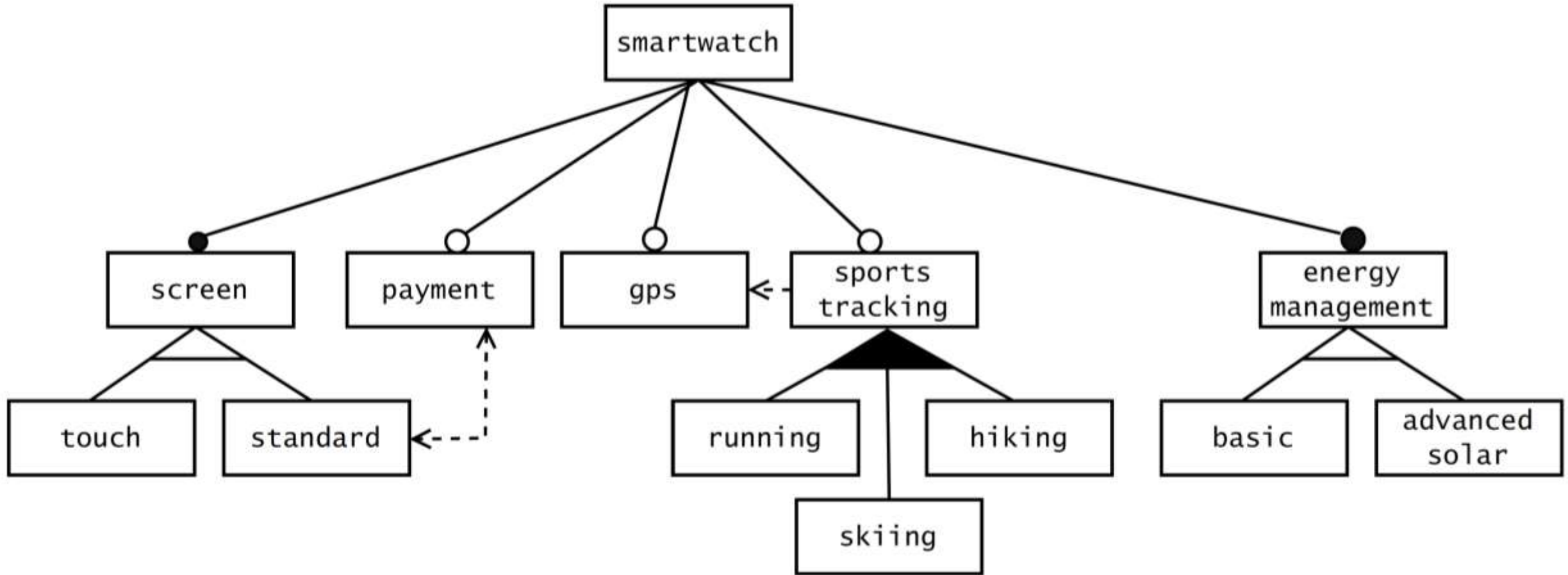


Variable features



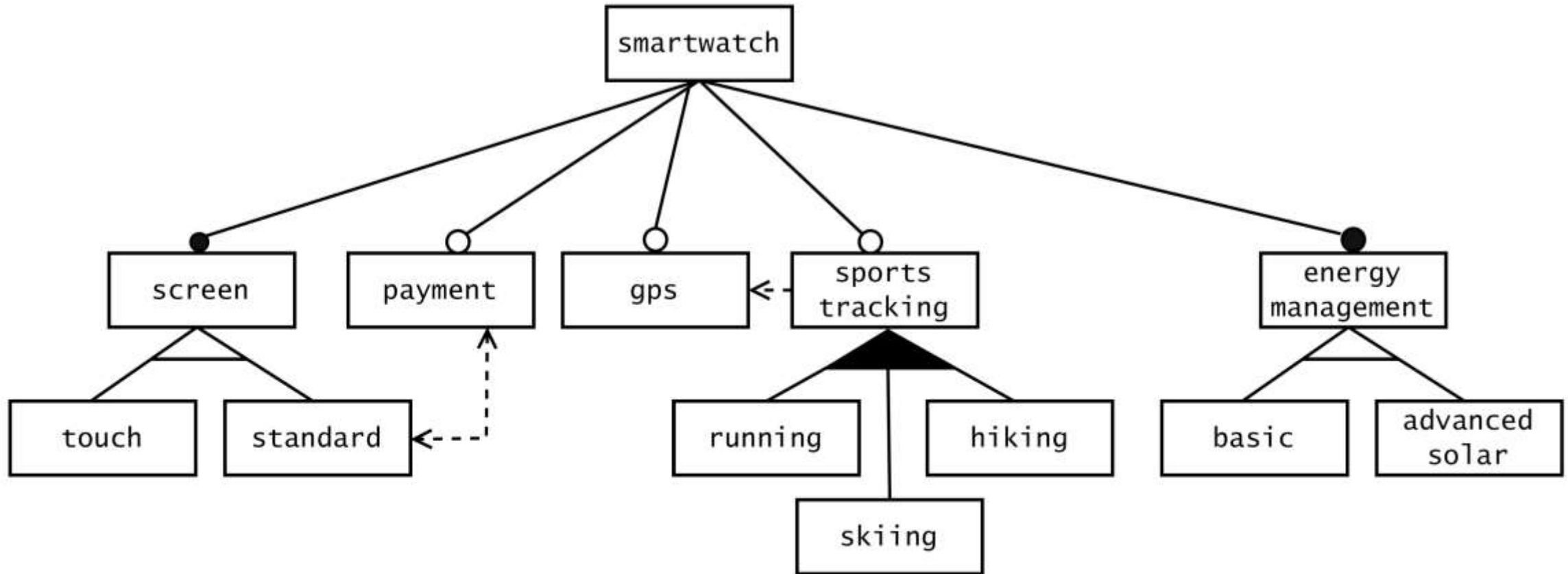
2. Yet another language: UVL

A typical example of feature model



2. Yet another language: UVL

A typical example of feature model



2. Yet another language: UVL

MODEVAR initiative

MODEVAR

International Workshops on Languages for
Modelling Variability



2. Yet another language: UVL



```
namespace smartwatch:  
  
  features  
    smartwatch  
      mandatory  
        screen  
          alternative  
            touch  
            standard  
            "energy management"  
          alternative  
            basic  
            "advanced solar"  
        optional  
          payment  
          gps  
          "sports tracking"  
            or  
              running  
              skiing  
              hiking  
  
  constraints  
    !(payment & standard)  
    "sports tracking" => gps
```

Universal Variability Language

2. Yet another language: UVL

A typical example of UVL (smartwatch)

UVL

```
namespace smartwatch
```

```
features
```

```
smartwatch
```

```
mandatory
```

```
screen
```

```
alternative
```

```
touch
```

```
standard
```

```
"energy management"
```

```
alternative
```

```
basic
```

```
"advanced solar"
```

```
optional
```

```
payment
```

```
gps
```

```
"sports tracking"
```

```
or
```

```
running
```

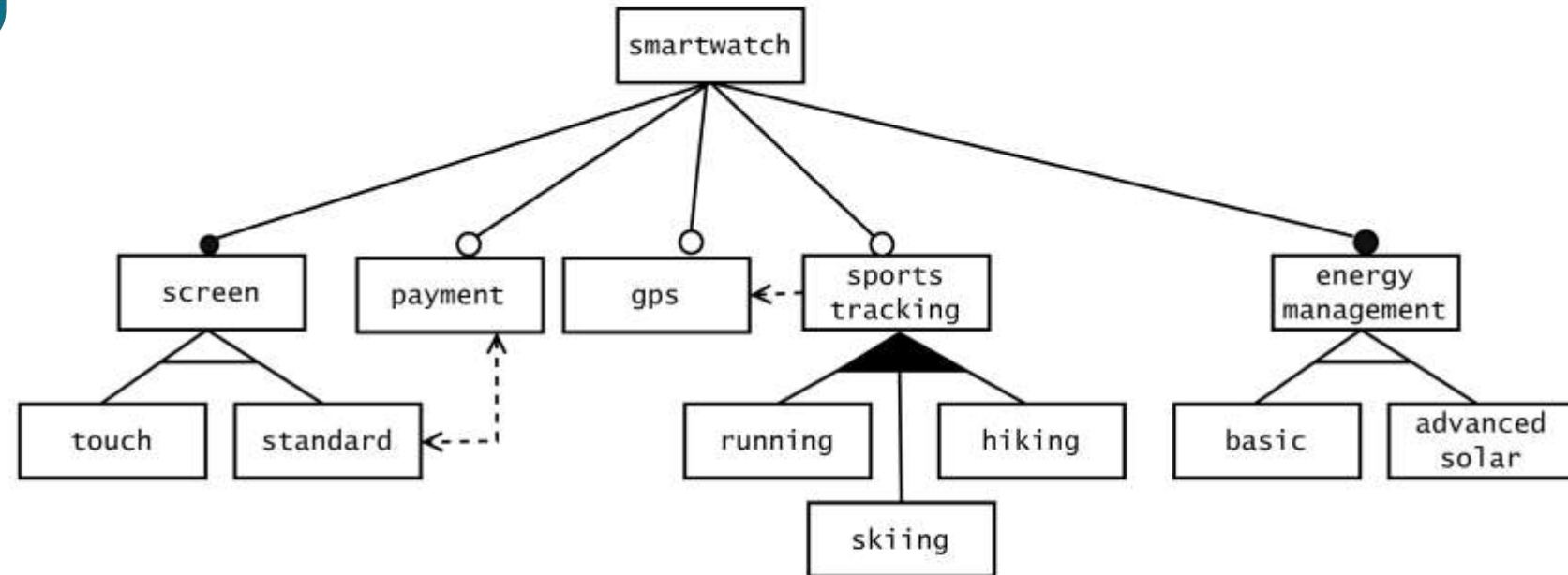
```
skiing
```

```
hiking
```

```
constraints
```

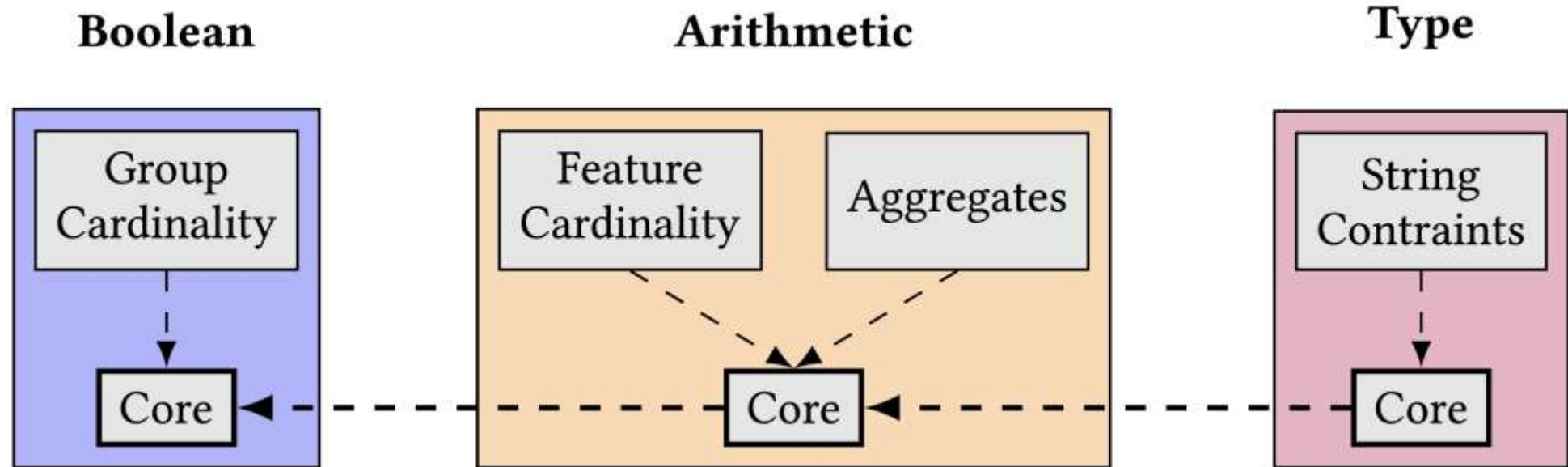
```
!(payment & standard)
```

```
"sports tracking" => gps
```



2. Yet another language: UVL

Language Level



Benavides, David and Sundermann, Chico and Feichtinger, Kevin and Galindo, José A. and Rabiser, Rick and Thüm, Thomas, Uvl: Feature Modelling with the Universal Variability Language. Available at SSRN:

<https://ssrn.com/abstract=4764657> or <http://dx.doi.org/10.2139/ssrn.4764657>

Chico Sundermann, Stefan Vill, Thomas Thüm, Kevin Feichtinger, Prankur Agarwal, Rick Rabiser, José A. Galindo, and David Benavides. 2023. UVL- Parser: Extending UVL with Language Levels and Conversion Strategies. In 27th ACM International Systems and Software Product Line Conference - Volume B (SPLC '23), August 28-September 1, 2023, Tokyo, Japan. ACM, New York, NY, USA, 4 pages. <https://doi.org/10.1145/3579028.3609013>

2. Yet another language: UVL

An example of arithmetic level



features

smartwatch

mandatory

screen

alternative

touch {Power 3}

standard {Power 2}

"energy management" {Power 5}

optional

payment {Power 4}


gps {Power 2}

Integer Watt

"sleep tracking" {Power 2}

constraints

sum(Power) <= Watt

1. Variability and Software Product Lines
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- 

3. UVLHub and Open Science

UVL dataset



3. UVLHub and Open Science

Dataset in science



Lots of datasets!

**They are IMPORTANT
because...**

- Evidence base
- Reproducibility
- New findings
- Collaboration
- Transparency
- Education

3. UVLHub and Open Science

Dataset in science



**Private
repositories**



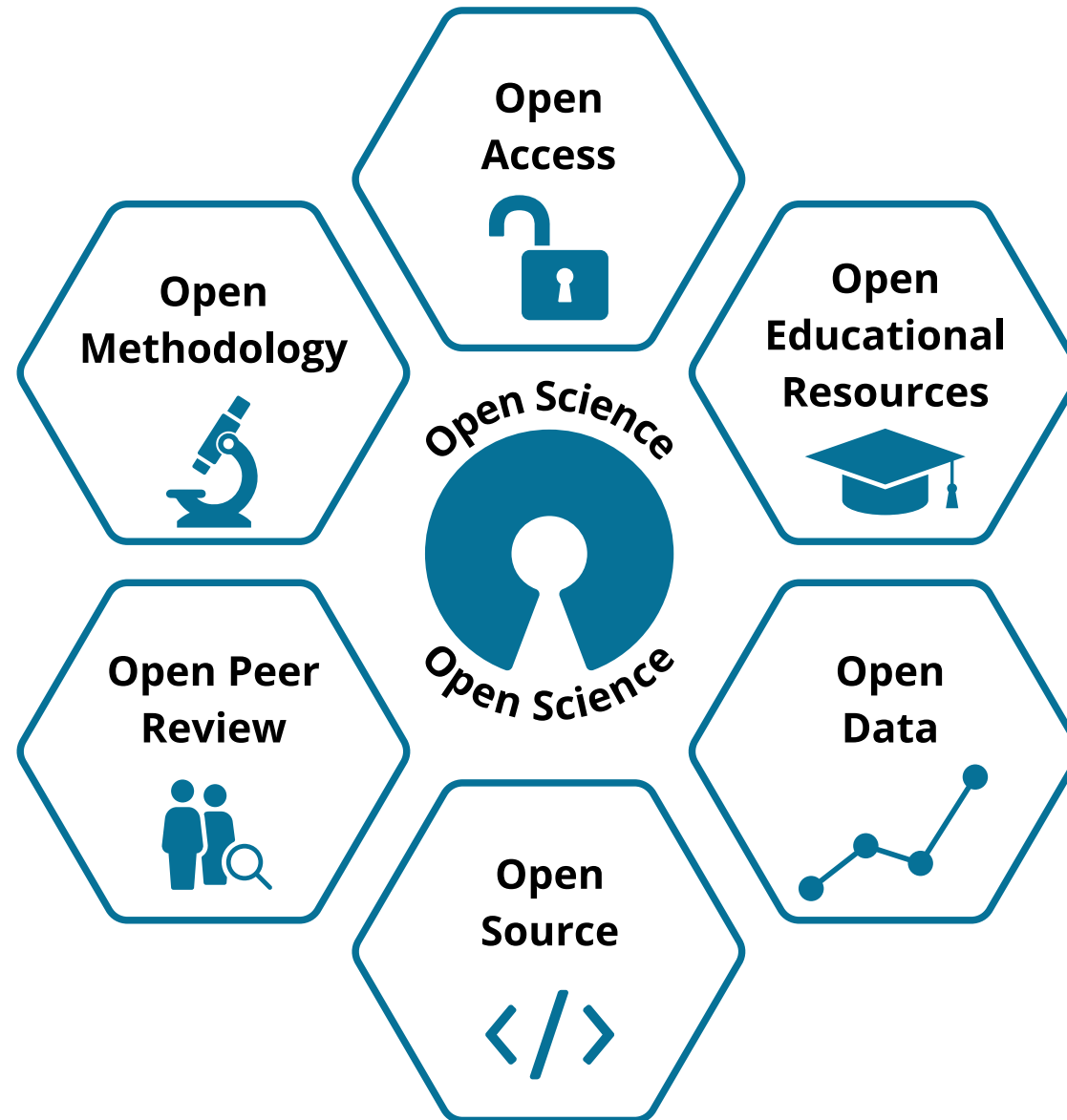
**Lost, corrupt,
incomplete...**



System down

3. UVLHub and Open Science

Key Principles



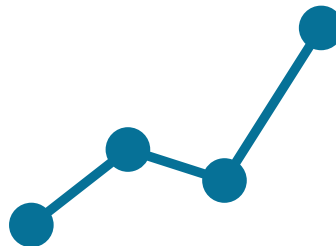
3. UVLHub and Open Science



**Open
Educational
Resources**



**Open
Data**



**Open
Source**



3. UVLHub and Open Science



Can The Open Science provide a solution
to my UVL dataset problem?

3. UVLHub and Open Science

Different initiatives

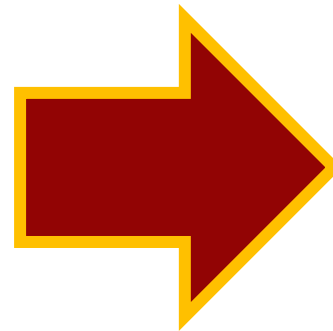


OpenAIRE

Open Access
Infrastructure for
Research in Europe



Research
Data
Management
(CERN)



Open Access
Repository

3. UVLHub and Open Science

Different initiatives



But in Zenodo you can load **ANY**
kind of dataset, not only UVL...

3. UVLHub and Open Science



How do I control that only **UVL datasets** are uploaded?

3. UVLHub and Open Science



A feature model repository
using UVL and
Open Science principles



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UVLHub: A feature model data repository using UVL and open science principles¹

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¹Department of Computer Languages and Systems, University of Seville, Spain
²Institute of Software Engineering and Programming Languages, Ulm University, Germany
³ITS Software, Universidad de Málaga, Spain
⁴ILIS Research Institute, Universität der Saar, Saarbrücken, Germany

ARTICLE INFO

Dataset link: <https://github.com/drogo/uvlhub>
<https://www.artifacthub.io/>

Keywords:
Feature models
Software product line
Variability
Dataset
DOI

ABSTRACT

Feature models are the de facto standard for modelling variability and relationships in features and relationships in software product lines. They are the base artifacts in many engineering activities, such as product configuration, derivation, or testing. Concrete models in different domains exist, however, many are in private or sparse repositories or belong to discontinued projects. The dispersion of knowledge of feature models hinders the study and reuse of these artifacts in different studies. The Universal Variability Language (UVL) is a community effort textual feature model language that promotes a common way of serializing feature models independently of concrete tools. Open access principles promote transparency, accessibility, and collaboration in scientific research. Although some attempts exist to promote feature model sharing, the existing solutions lack open science principles by design. In addition, existing and public feature models are described using formats not always supported by current tools. This paper presents UVLHub, a repository of feature models in UVL format. UVLHub provides a front end that facilitates the search, upload, storage, and management of feature model datasets, improving the capabilities of discontinued proposals. Furthermore, the tool communicates with Zenodo - one of the most well-known open science repositories - providing a permanent save of datasets and following open science principles. UVLHub includes existing datasets and is readily available to include new data and functionalities in the future. It is maintained by three active universities in variability modelling.

1. Introduction

Feature models are widely used for variability modelling in many domains, especially in software product line engineering (Gutierrez et al., 2024). Feature models have been widely adopted in practice and academia since their invention in 1990 (Sochus et al., 2004). Applications of feature models include operating systems (Galindo et al., 2010, 2014; Slocum et al., 2007), content management systems (Fialin et al., 2020); Rodas-Silva et al., 2019) and the automotive industry (Friedberg et al., 2018; Le et al., 2023) among many others. Feature models are

used in those domains for many engineering tasks such as automated analysis (Galindo et al., 2019), sampling (Segura et al., 2007), testing (Segura et al., 2014), debugging (Norian et al., 2011), and even teaching (Webb and Kuzmycz, 1993).

Although widely used, feature models are often shared in private web pages or are spread across different platforms such as code repositories (e.g., GitHub), personal websites, links to the Zenodo repository (Ramachandran et al., 2021) or discontinued projects. In the past, there were some efforts aiming feature model sharing, such as SPLOT (Mendonça et al., 2009), ESPLA (Martinez et al., 2017), and

* Editor: Laurence Duchien.

* Corresponding author.

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¹ ECVAT: <https://pdf.semanticscholar.org/feature-models-to-the-world.html>.

<https://doi.org/10.1016/j.jss.2024.112150>

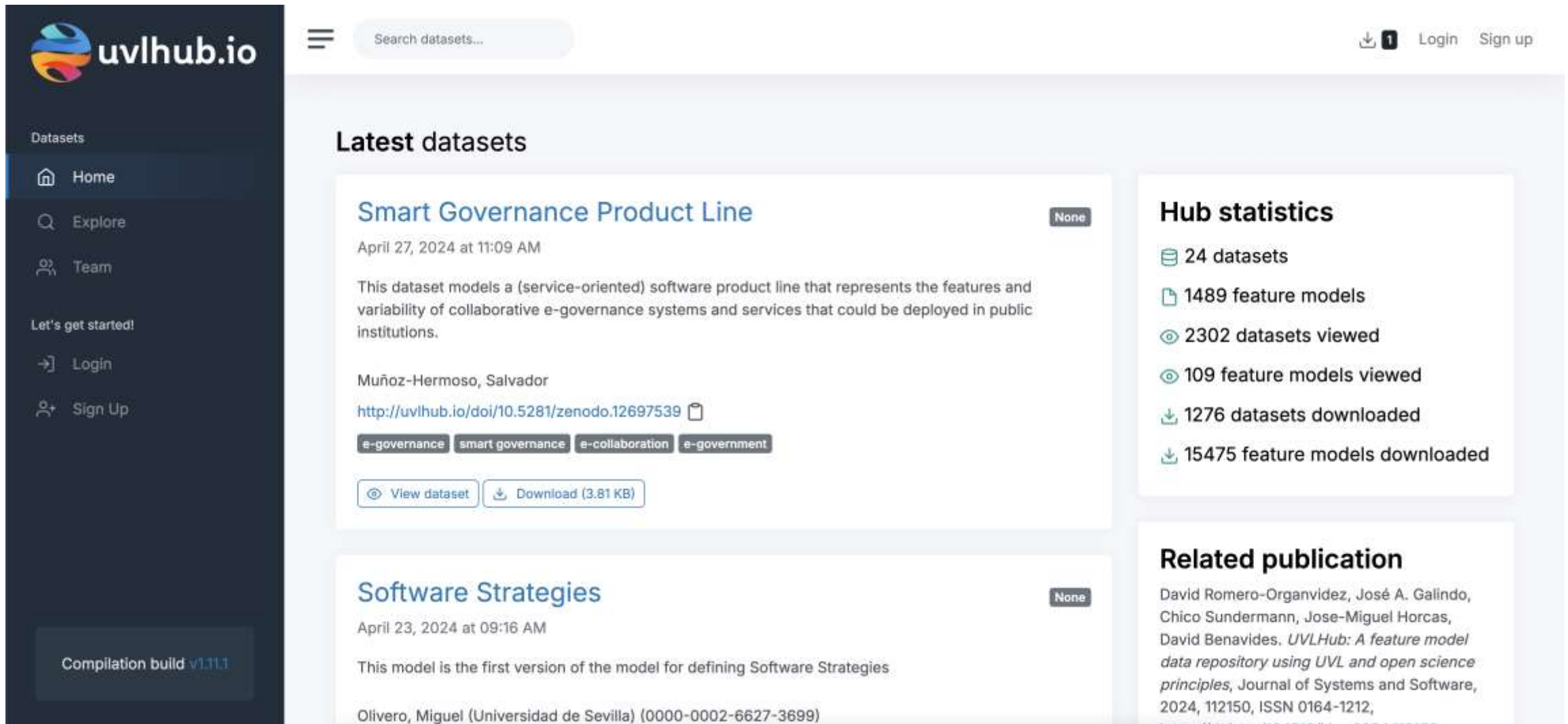
Received 27 July 2023; Received in revised form 18 February 2024; Accepted 24 June 2024

Available online 1 July 2024

0164-1212/© 2024 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

3. UVLHub and Open Science

Sneak peek



The screenshot displays the UVLHub website interface. On the left is a dark sidebar with the UVLHub logo and navigation options: Home, Explore, Team, Login, and Sign Up. The main content area features a search bar at the top and a 'Latest datasets' section. The first dataset listed is 'Smart Governance Product Line' by Muñoz-Hermoso, Salvador, dated April 27, 2024. It includes a description, a DOI link, and tags for 'e-governance', 'smart governance', 'e-collaboration', and 'e-government'. Below the description are buttons for 'View dataset' and 'Download (3.81 KB)'. The second dataset is 'Software Strategies' by Olivero, Miguel, dated April 23, 2024. To the right of the dataset listings is a 'Hub statistics' box showing: 24 datasets, 1489 feature models, 2302 datasets viewed, 109 feature models viewed, 1276 datasets downloaded, and 15475 feature models downloaded. Below the statistics is a 'Related publication' section with a citation for David Romero-Organvidez et al. (2024).

uvlhub.io

Search datasets...

Download 1 Login Sign up

Latest datasets

Smart Governance Product Line

None

April 27, 2024 at 11:09 AM

This dataset models a (service-oriented) software product line that represents the features and variability of collaborative e-governance systems and services that could be deployed in public institutions.

Muñoz-Hermoso, Salvador

<http://uvlhub.io/doi/10.5281/zenodo.12697539>

e-governance smart governance e-collaboration e-government

View dataset Download (3.81 KB)

Software Strategies

None

April 23, 2024 at 09:16 AM

This model is the first version of the model for defining Software Strategies.

Olivero, Miguel (Universidad de Sevilla) (0000-0002-6627-3699)

Hub statistics

- 24 datasets
- 1489 feature models
- 2302 datasets viewed
- 109 feature models viewed
- 1276 datasets downloaded
- 15475 feature models downloaded

Related publication

David Romero-Organvidez, José A. Galindo, Chico Sundermann, Jose-Miguel Horcas, David Benavides. *UVLHub: A feature model data repository using UVL and open science principles*, Journal of Systems and Software, 2024, 112150, ISSN 0164-1212, <https://doi.org/10.1016/j.jss.2024.112150>

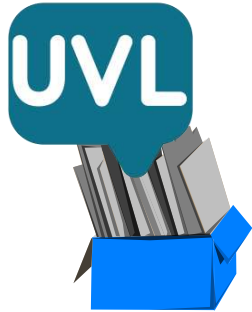
3. UVLHub and Open Science



3. UVLHub and Open Science



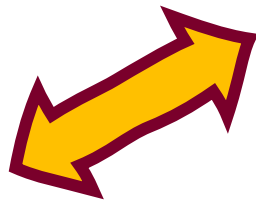
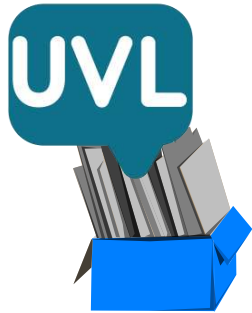
3. UVLHub and Open Science



3. UVLHub and Open Science



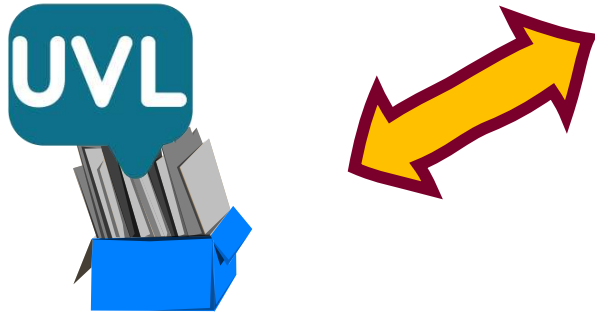
uvlhub.io



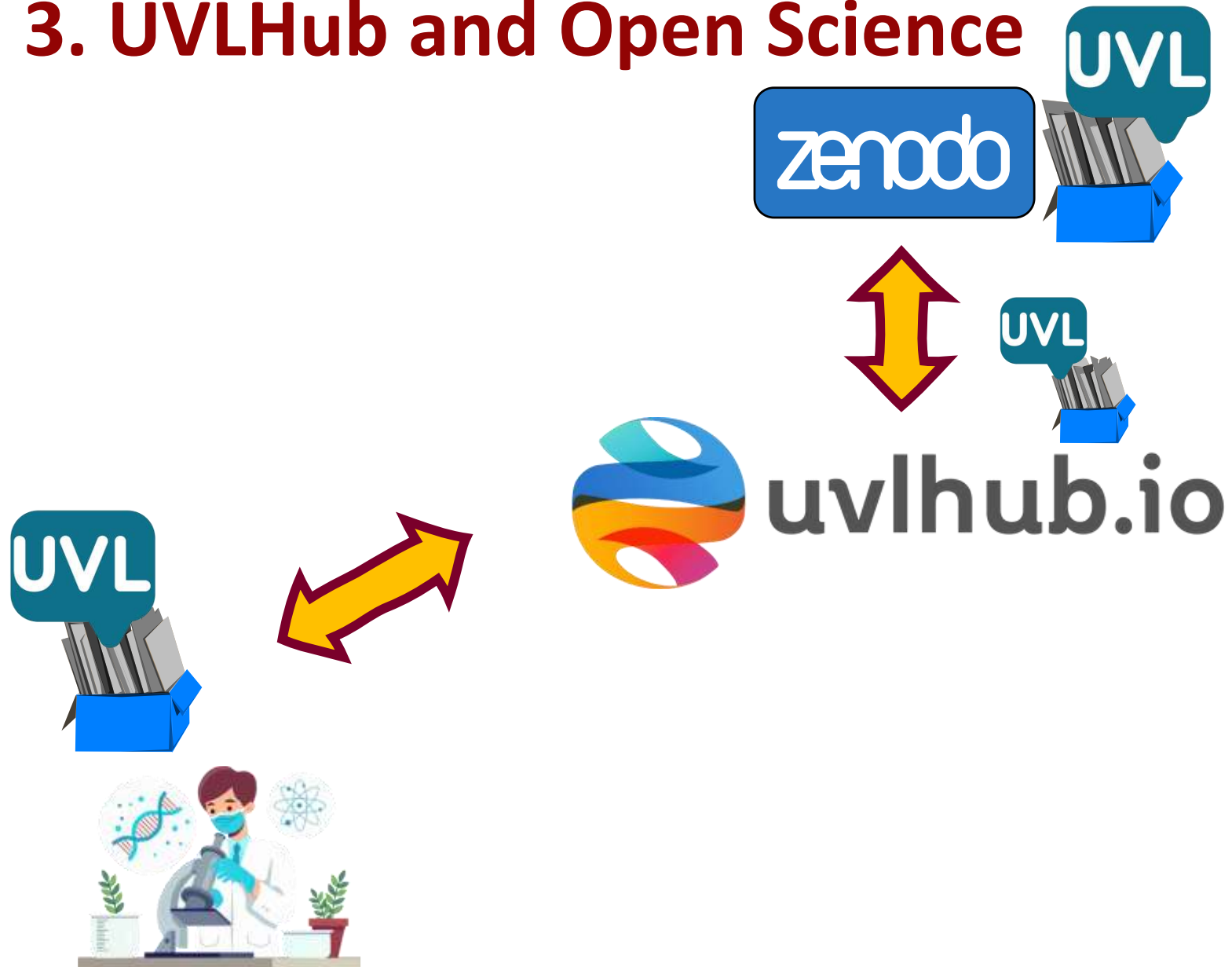
3. UVLHub and Open Science



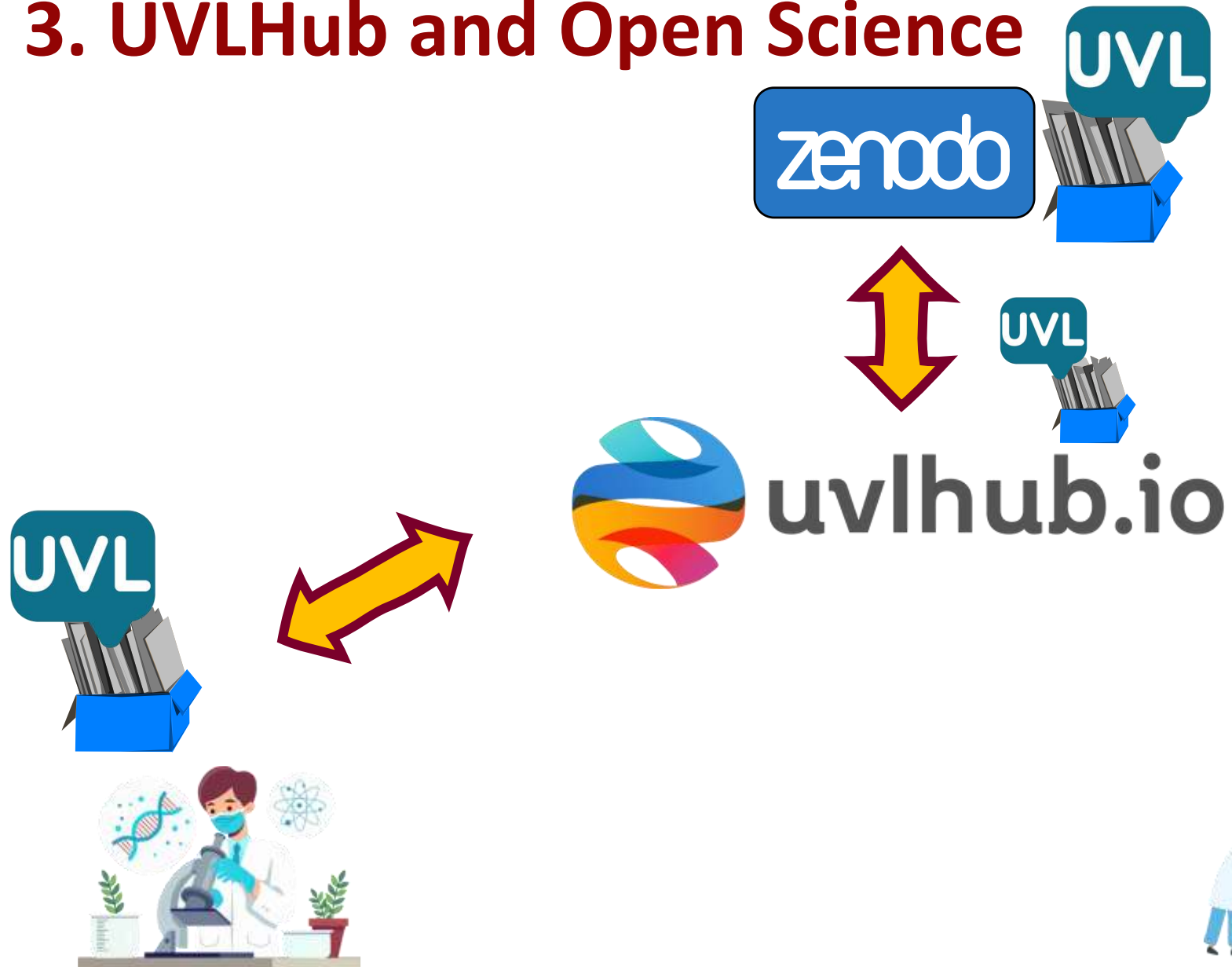
uvlhub.io



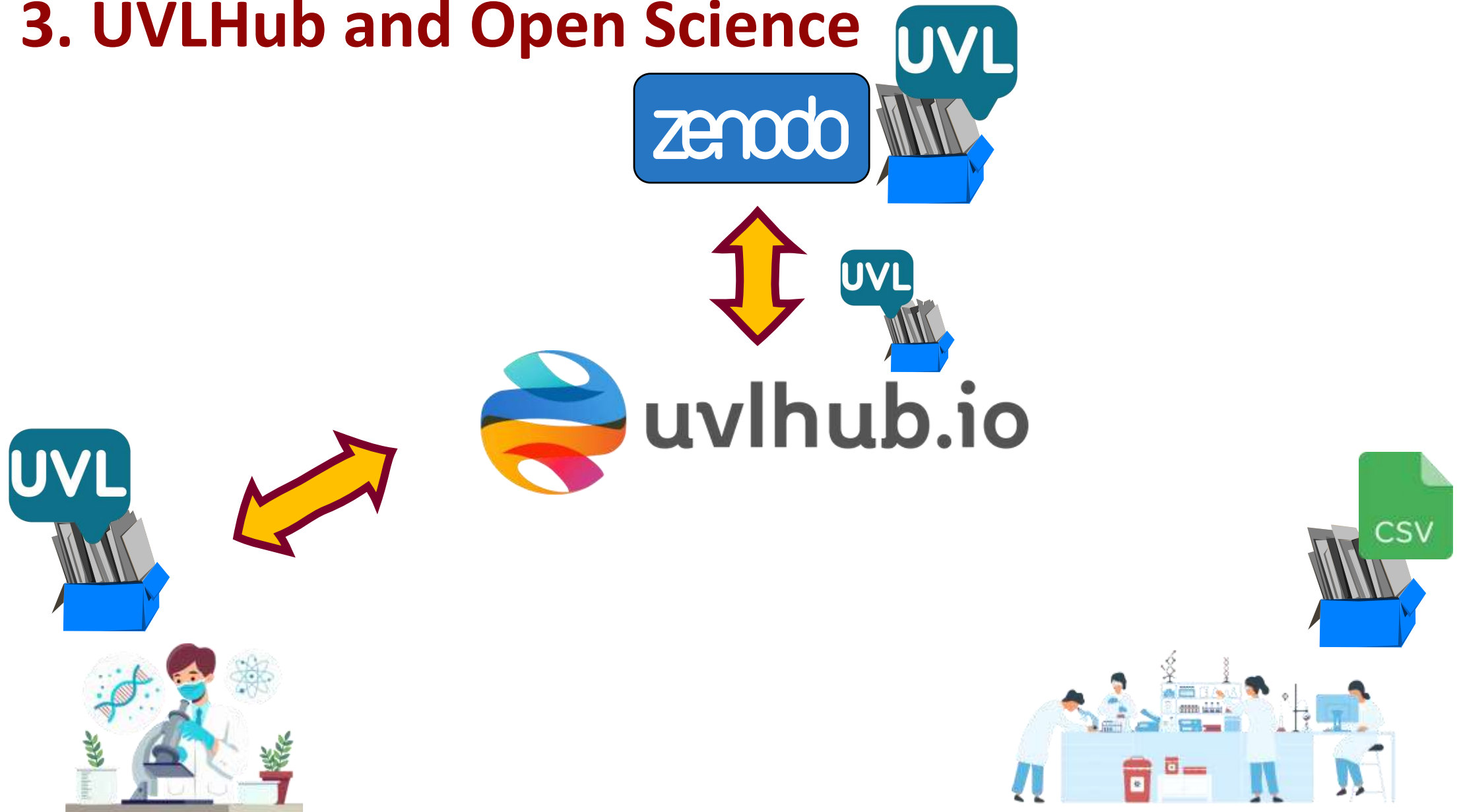
3. UVLHub and Open Science



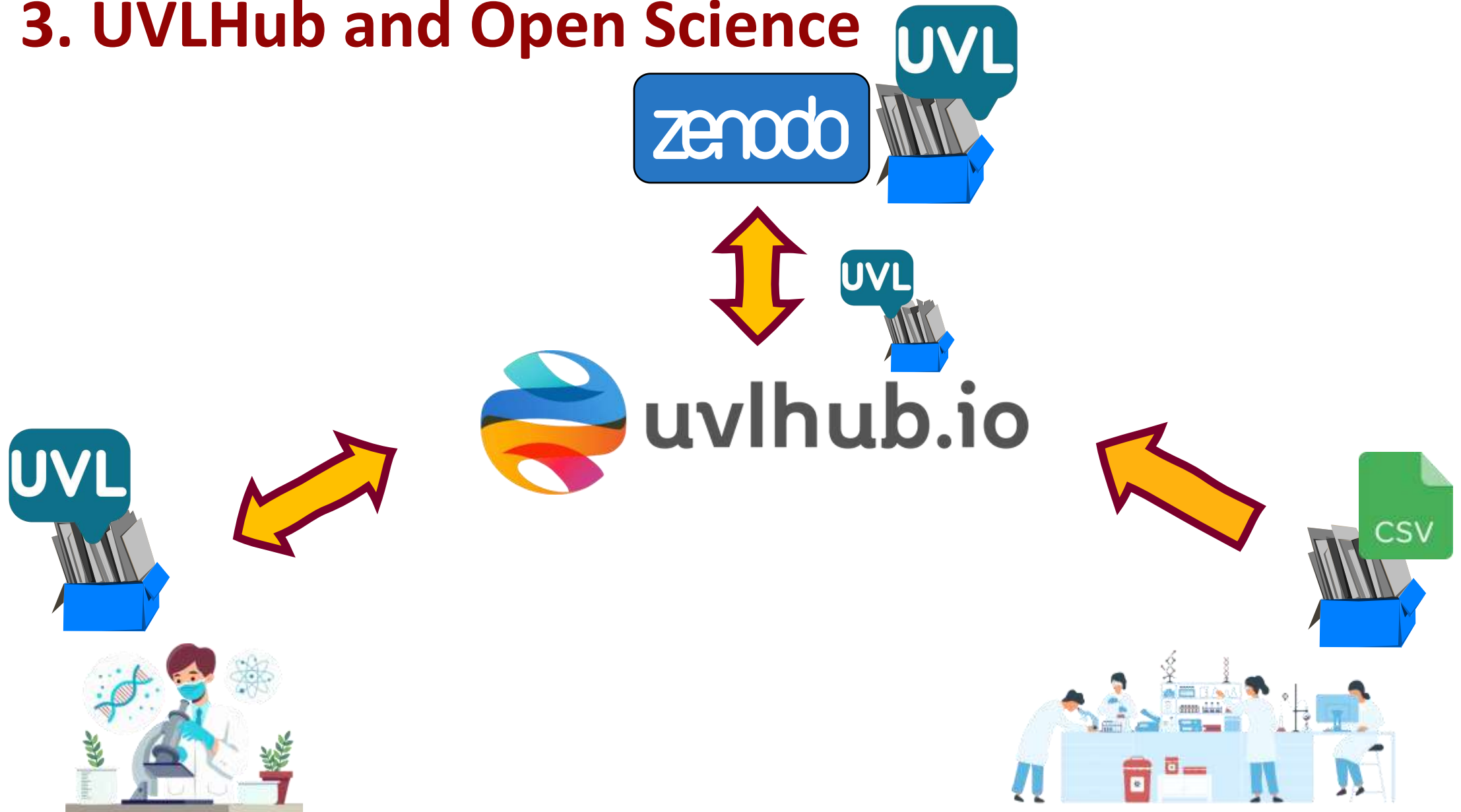
3. UVLHub and Open Science



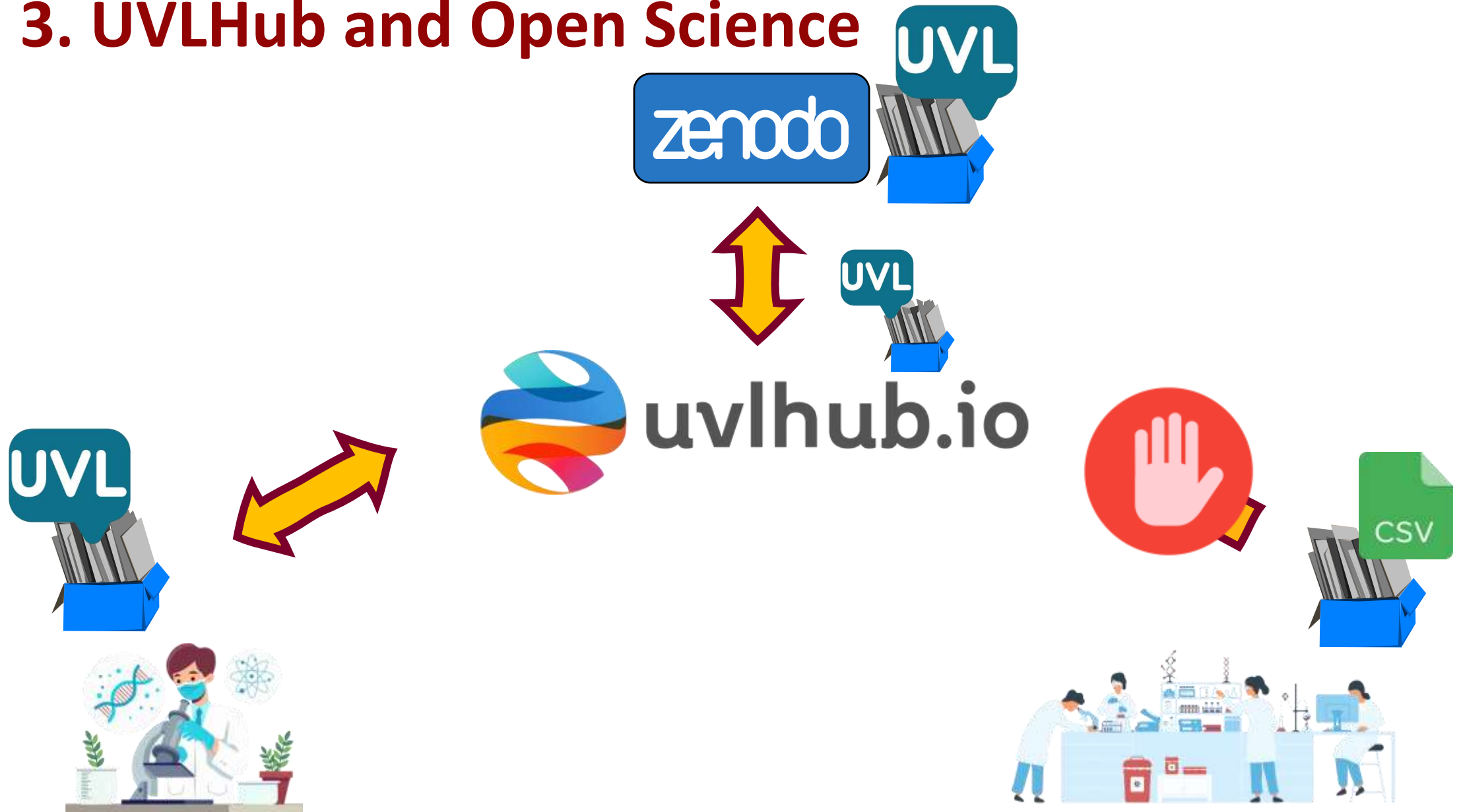
3. UVLHub and Open Science



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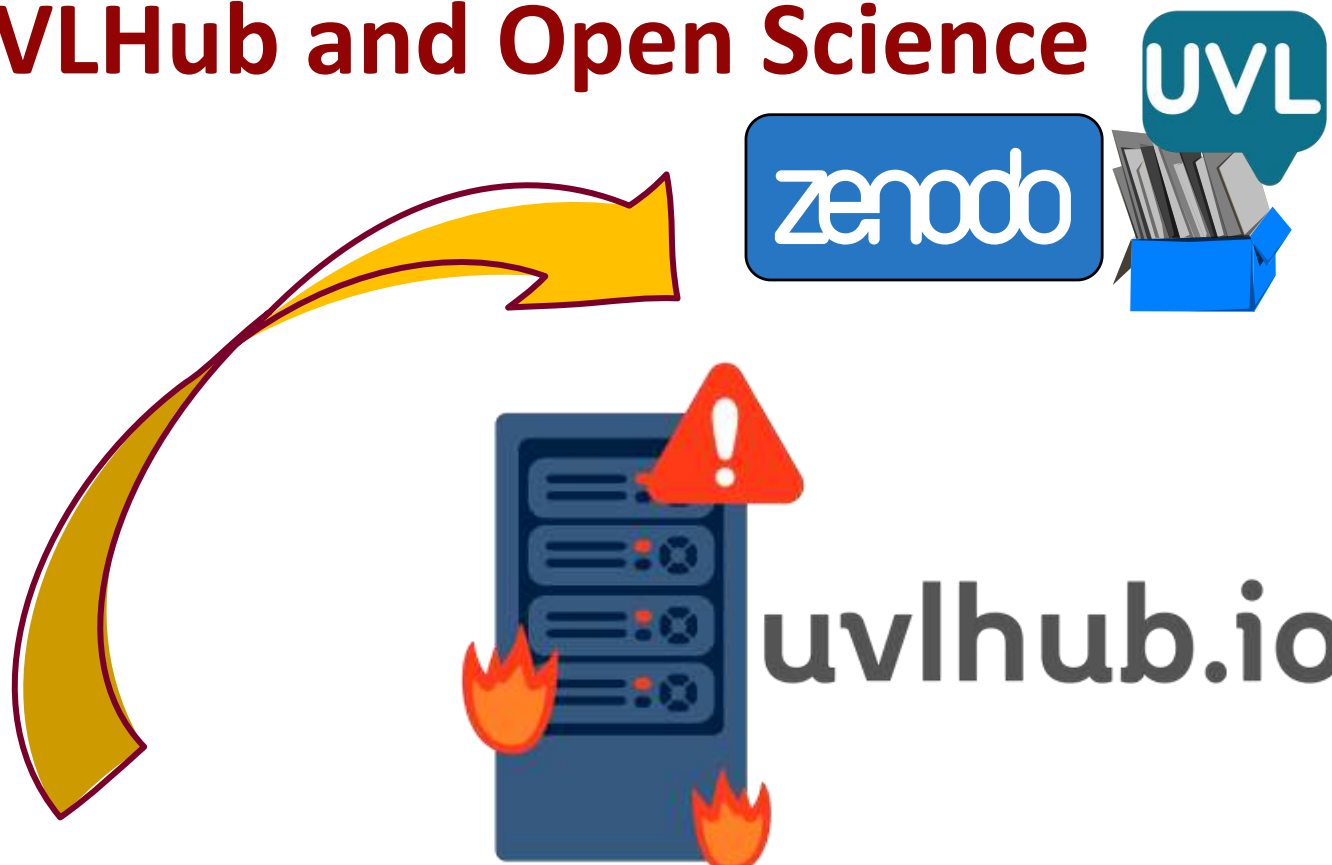
3. UVLHub and Open Science



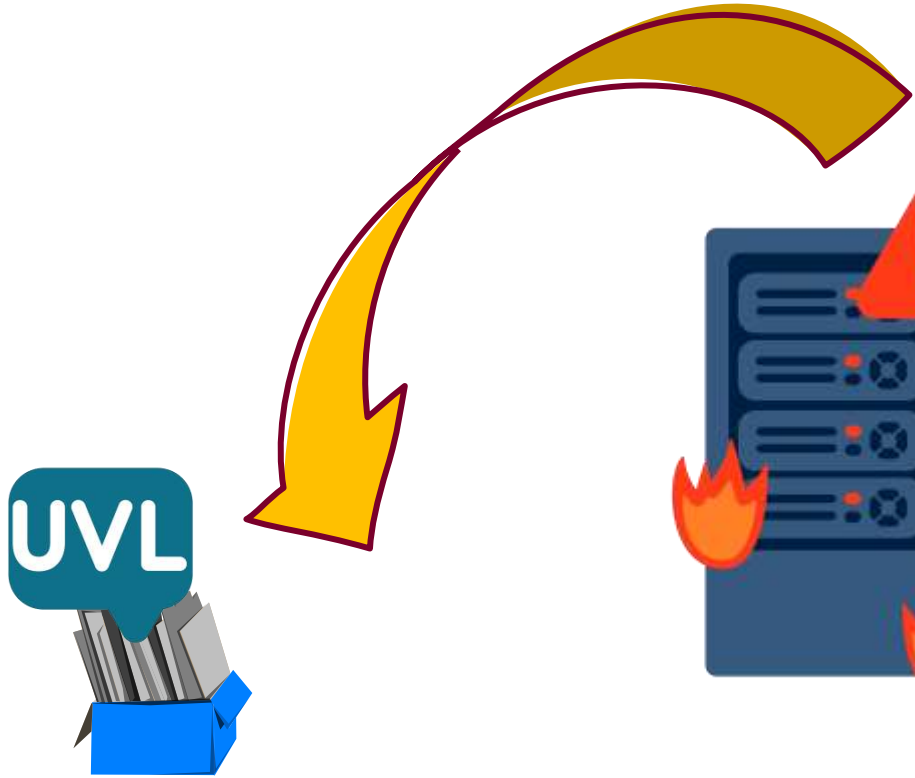
3. UVLHub and Open Science



3. UVLHub and Open Science



3. UVLHub and Open Science

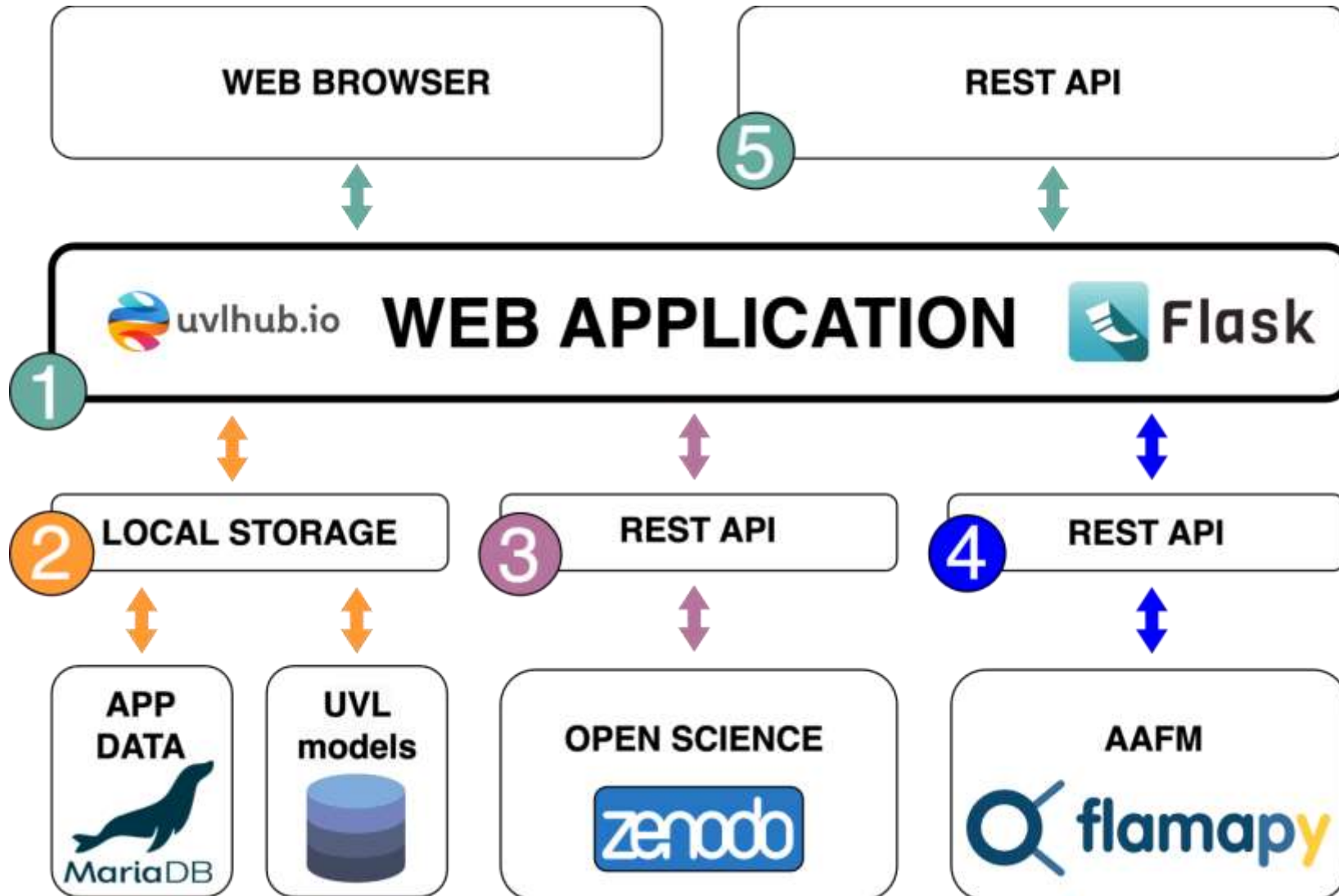


uvlhub.io



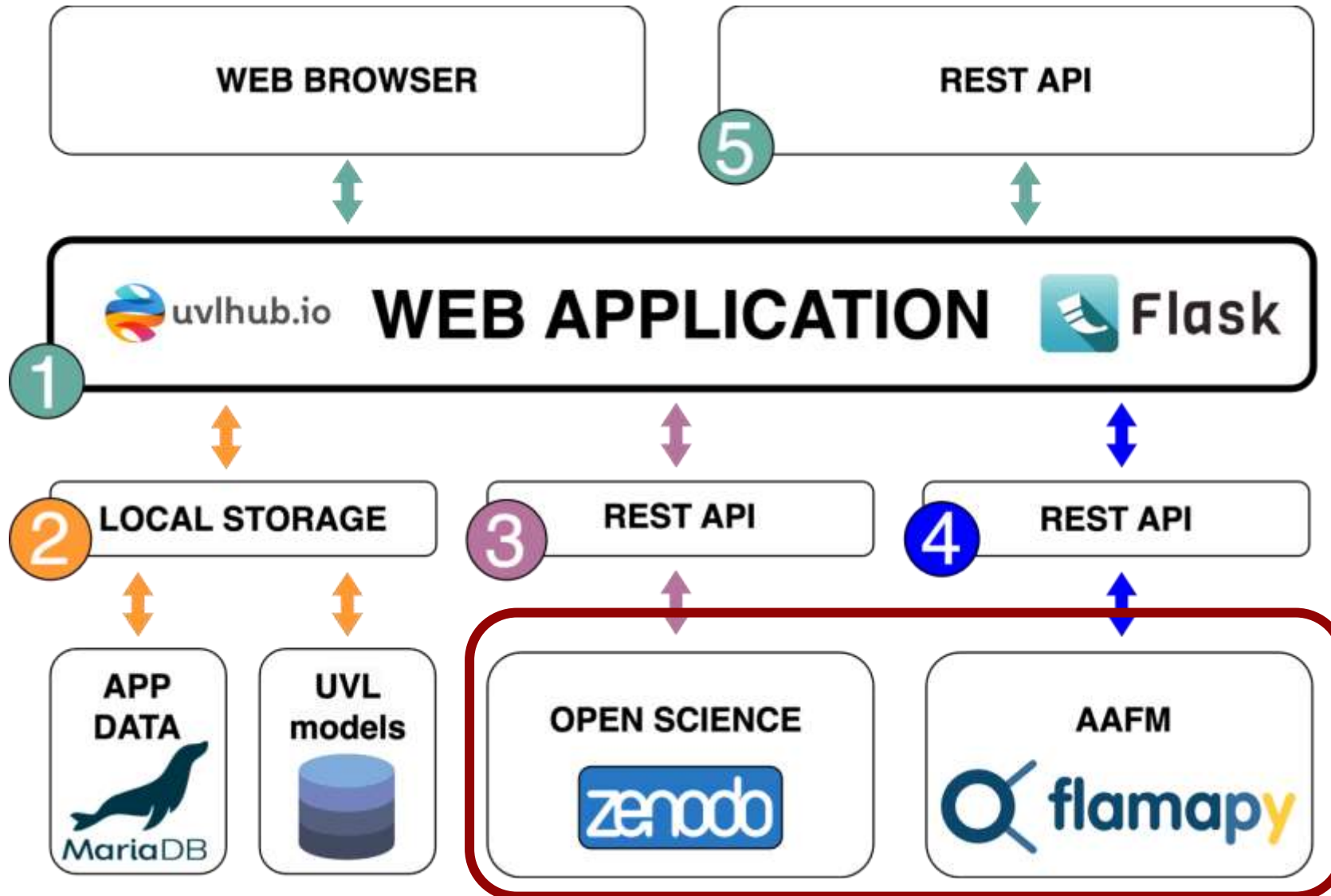
3. UVLHub and Open Science

Architecture



3. UVLHub and Open Science

Architecture




3. UVLHub and Open Science

Thanks to the uvlhub layer, I have...



I can adapt it to other contexts

- **Filtering**
- **Analysis**
- **Search**
- **Business rules**
- **Domain-specific features**

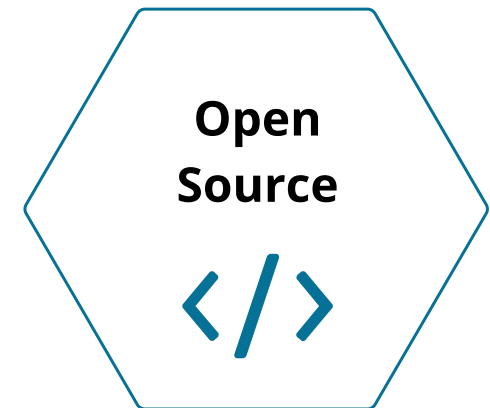
1. Yet another language: UVL
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 4. **flamapy**
 5. Conclusions
- 

4. flamapy



The cutting-edge Python-based tool for
Automated Analysis of Feature Models using UVL
and more

flamapy.org



4. flamapy

A tool and a framework

As a tool

Allows to
analyze feature
models

Multiple
interfaces

As a framework

Adapt it to
what you need

Integrate it in
your tools

Open
Source



4. flamapy

Supported formats

```
include
  Boolean.group-cardinality
  Arithmetic.aggregate-function
  Arithmetic.feature-cardinality
  Type

features
  Sandwich
    mandatory
      Bread {Calories 100, Sugar 20}
    optional
      Sauce
        or
          Ketchup {Calories 40, Sugar 35}
          Mustard {Calories 25, Sugar 5}
      Cheese
        [0..2] // Group cardinality
        Cheddar {Calories 60}
        Gouda {Calories 50}
        Goat {Calories 35}
      Pickle cardinality [1..3] // Feature cardinality

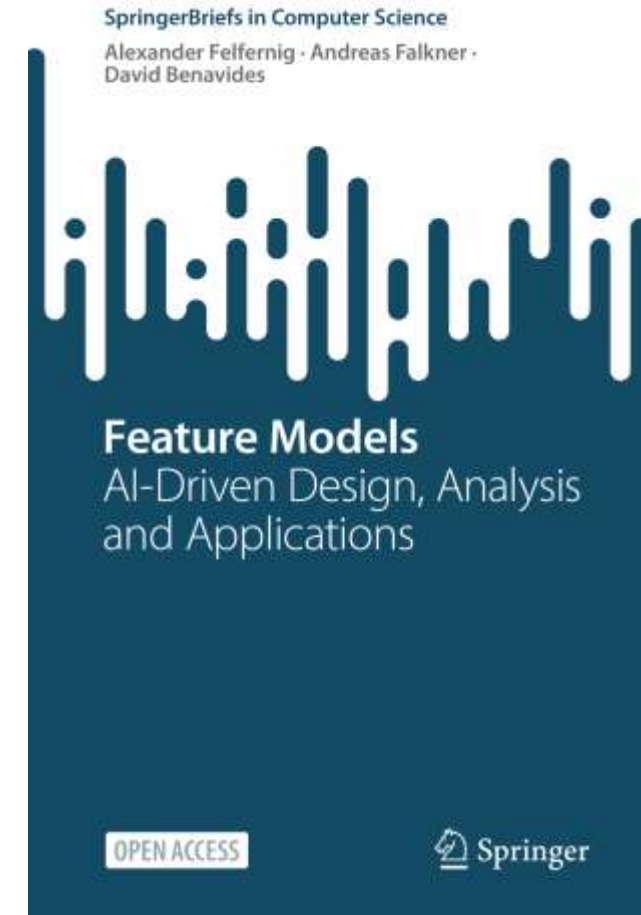
constraints
  Ketchup => Cheese
  Bread.Sugar + Ketchup.Sugar + Mustard.Sugar < 60 // Attribute constraints
  sum(Calories) < 160 // Attribute aggregate
```


- **UVL**
- Fama XML
- Feature IDE
- Glencoe
- Others
 - CNF, JSON, ...

4. flamapy

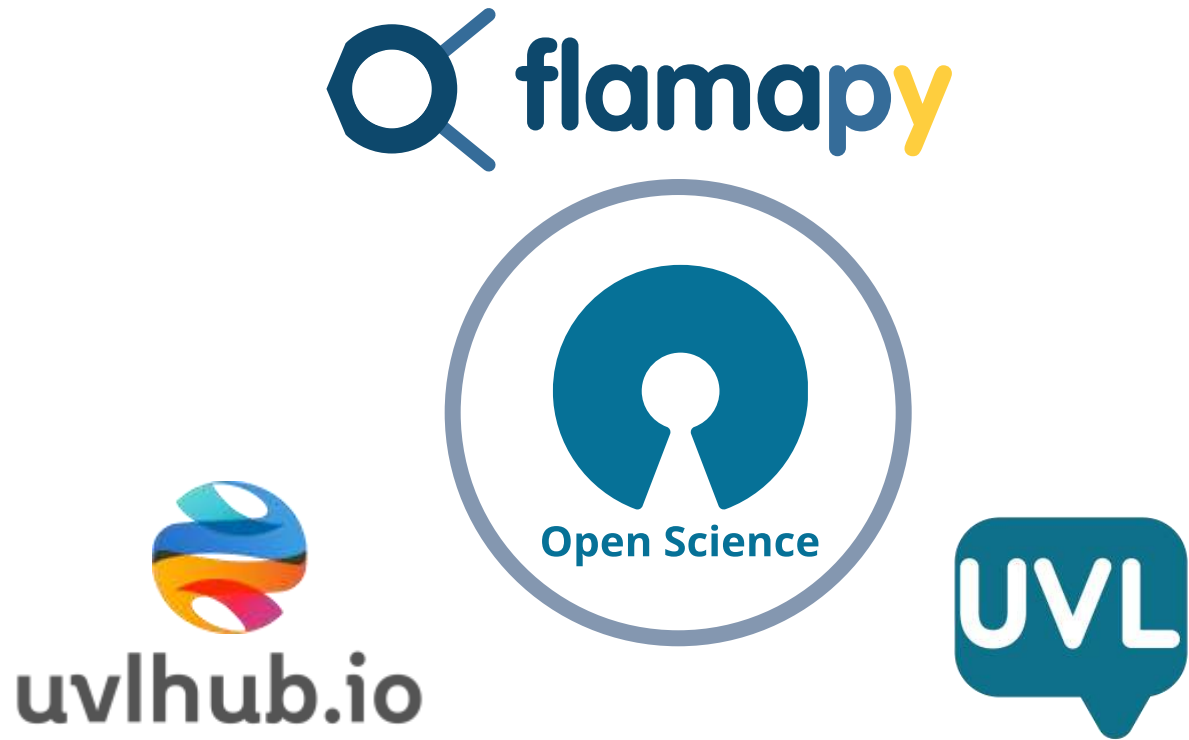
Analysis operations

Atomic Sets	Average Branching Factor	Commonality	Configurations
Number of Configurations	Conflict Detection	Core Features	Count Leafs
Dead Features	Estimated Number of Configurations	False Optional Features	Feature Ancestors
Filter	Leaf Features	Max Depth	Satisfiable
	Satisfiable Configuration	Unique Features	



1. Yet another language: UVL
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 5. **Conclusions**
- 

5. Conclusions



- **UVL** as a new textual language
- Using **UVLHub** for model sharing
- Analysing models with **flamapy**
- Following the **Open Science** approach



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