
Project CAE-PA: HAZOP2RDF

Subtitle

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22.22.2022



Contents

Introduction	1
Problem Analysis	2
Concept	3
Design program components	3
User interaction scenario	3
Design Command Line Interface	4
Implementation	6
Importer interface	8
Exporter interface	9
Remarks	10
Verification	11
Summary	13
Appendix	14
References	15

List of Tables

List of Figures

0.1	Structure diagram: Command Line Interface	7
0.2	Sequence diagram: Importer interface	9
0.3	Sequence diagram: Exporter interface	10

Introduction

- Introduction
- abstract

This research paper describes a program that handles HAZOP data from an excel spreadsheet. With the described program an easy to handle back-and-forth conversion from HAZOP data in excel Format to RDF format is possible. Furthermore a verification of the HAZOP data takes place and can also be configured.

By analysing the needs of the faculty and working together with process control engineers we developed this application.

Our solution features a command line interface to give users an easy access to our software.

Using our Importer interface the user can import and validate incoming HAZOP data in Excel format and generate RDF graphs from it. They can be locally stored or uploaded to a Fuseki server.

Using our Exporter interface the user can export RDF graphs containing HAZOP data to Excel format. The source for the Exporter interface can either be a locally stored RDF file or an RDF file stored on a Fuseki server.

As a result of our research we conclude that handling HAZOP data in RDF Format is much more convenient than working with excel data because the descriptive format largely increases compatibility between different modular plants.

- RDF problem description

Problem Analysis

- Why Hazop 2 RDF?
- When can it help?
- Whom can it help?

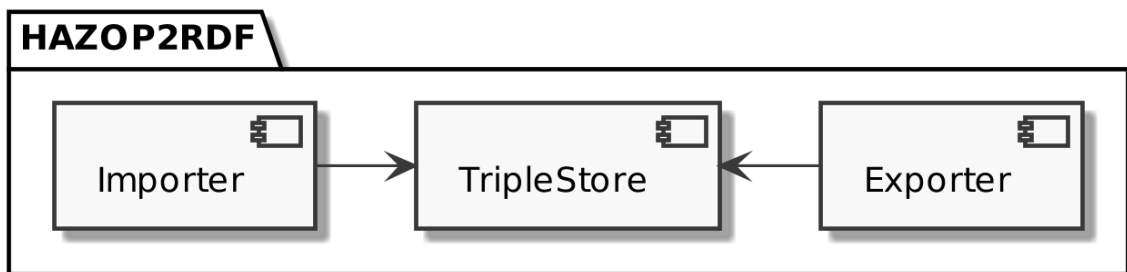
Concept

- How did we solve the problem(framework)
- How did we get to the concept?
- Why did we choose this method of implementing

Design program components

How did we start? What are the main components of the program?

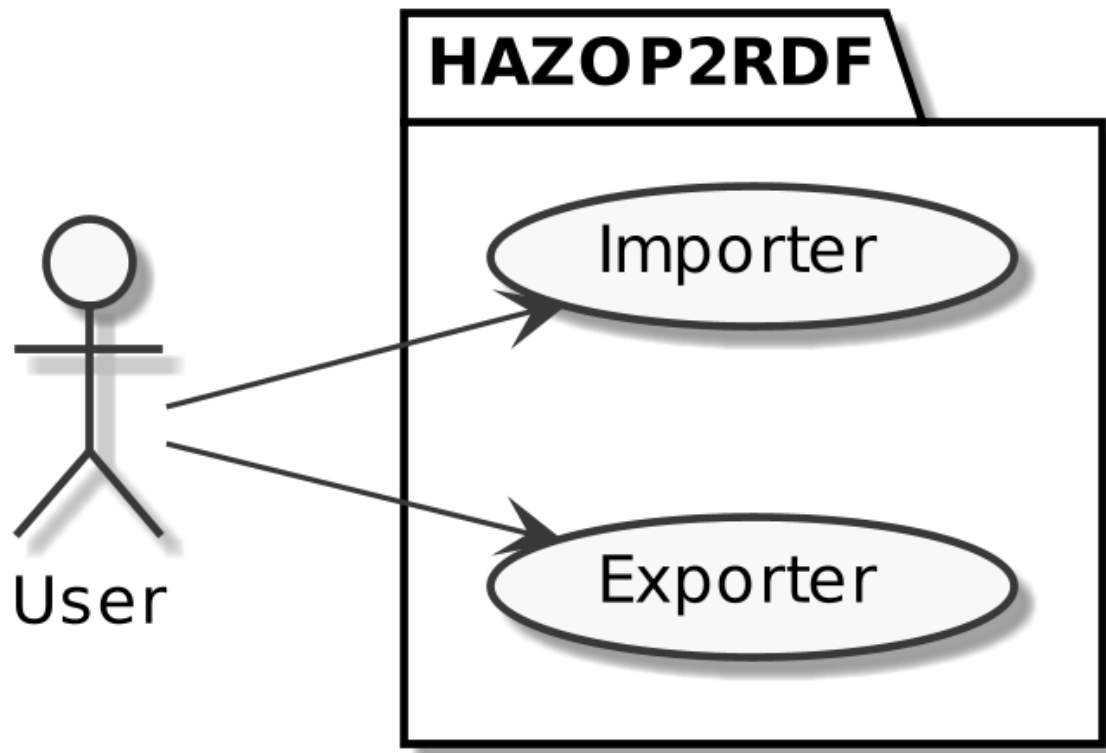
Diagram



User interaction scenario

How should users interact with the program?

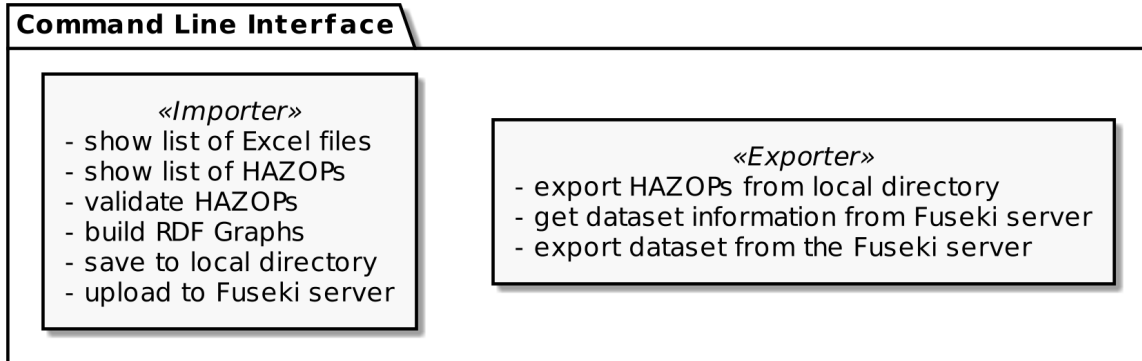
Diagram



Design Command Line Interface

What would the command line interface structure look like?

Diagram



Implementation

We implemented the Command Line Interface using “Click 8.0” (2021) package. It is highly configurable and can build very complex applications. The ComplexCLI utility, we used in our project, combines multiple interfaces in a single Command Line Interface.

The following diagram shows the structure of the Command Line Interface. It contains Importer and Exporter interface, which use services. The services contain utilities needed for the interfaces to perform lower level actions.

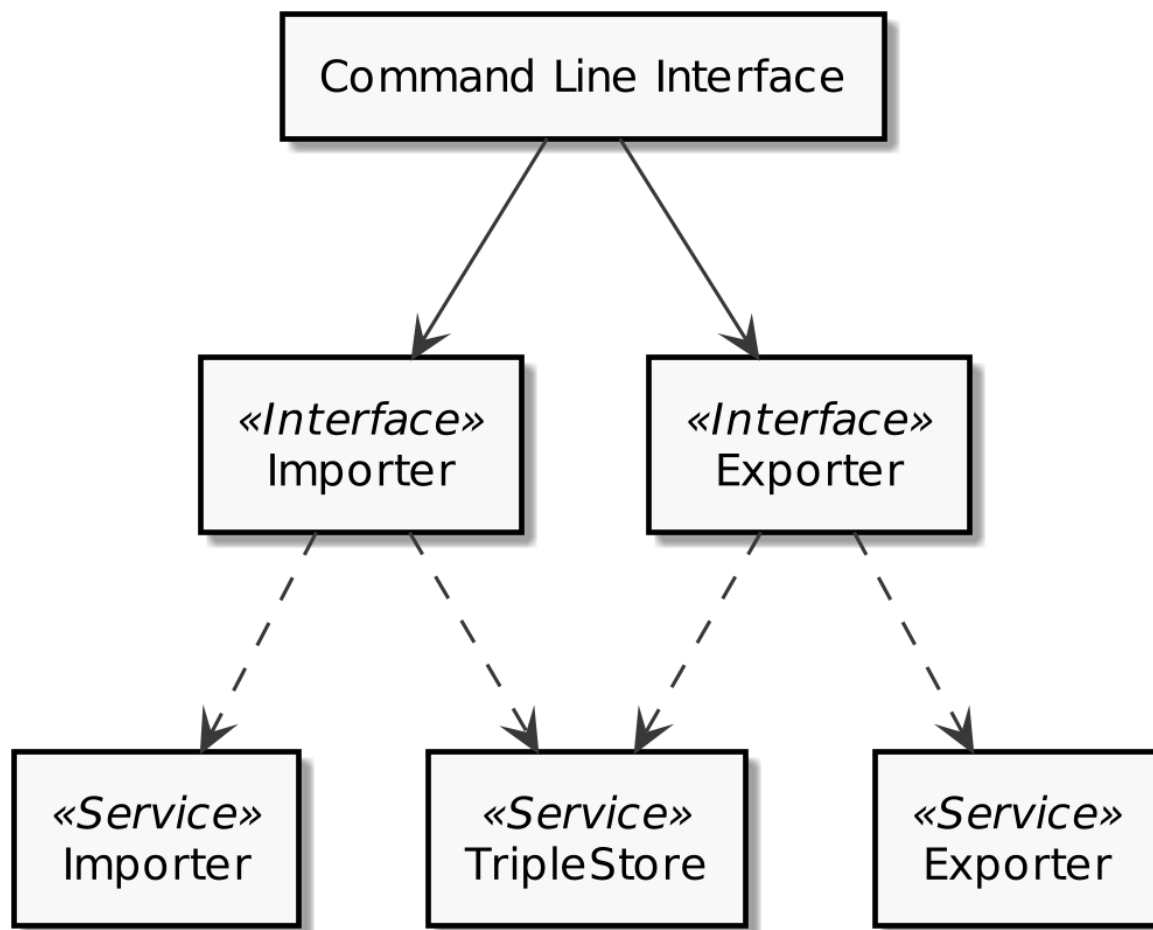


Figure 0.1: Structure diagram: Command Line Interface

Using the Command Line Interface users can interact with our software.

Using our Importer interface the user can import and validate incoming HAZOP data in Excel format and generate RDF graphs from it. They can be locally stored or uploaded to a Fuseki server.

Using our Exporter interface the user can export RDF graphs containing HAZOP data to Excel format. The source for the Exporter interface can either be a locally stored RDF file or an RDF file stored on a Fuseki server.

Importer interface

The main purpose of the Importer interface is to build an RDF graph from incoming Excel data. To build an RDF graph, we carefully read the incoming HAZOP Data and validate it. To validate the data correctly we implemented a config file, which stores all the metadata needed to describe the importing and validating process.

The main command of the Importer interface is `cmd-build-hazop-graphs`, which reads the HAZOP data stored in a local directory and transforms it to an RDF graph. The graph can be consequentially stored locally or uploaded to a Fuseki server. The two other commands `cmd-read-excel-data` and `cmd-read-hazop-data` make it possible for the user to perform steps of the main importer command individually.

The installation of a Fuseki server is optional. If the server is offline, the files cannot be uploaded to the server resulting in an error message which is displayed to the user.

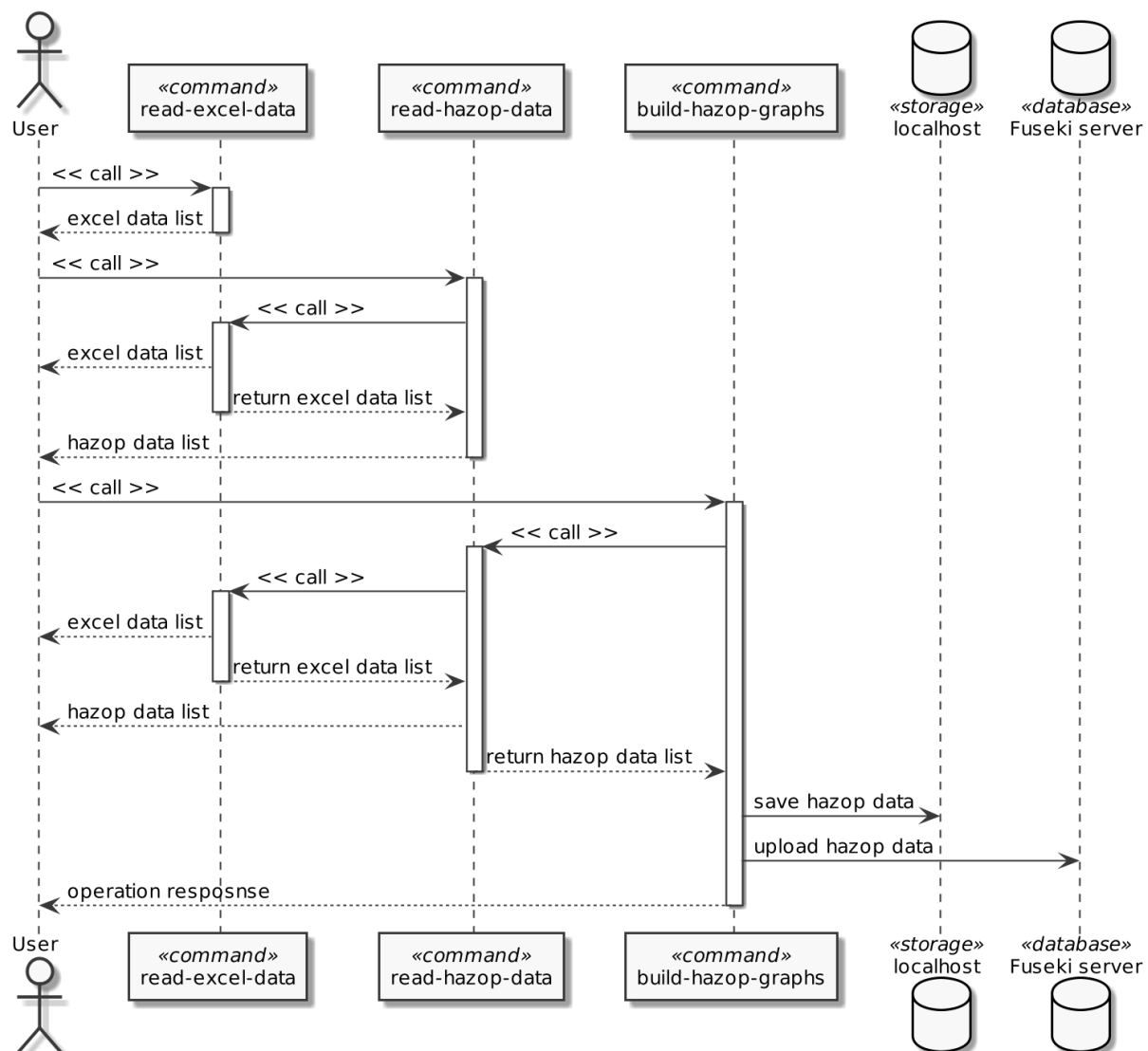


Figure 0.2: Sequence diagram: Importer interface

Exporter interface

After the HAZOP data was successfully imported and stored, the user can convert the RDF graph to Excel format again.

There are two main commands in the Exporter interface for the users to interact with. The user can either export data from an RDF file located in a local directory or from a file located online on a Fuseki server. For the successful export from the Fuseki Server the server needs to

be running.

As a result, the RDF graphs will be stored locally in Excel format again.

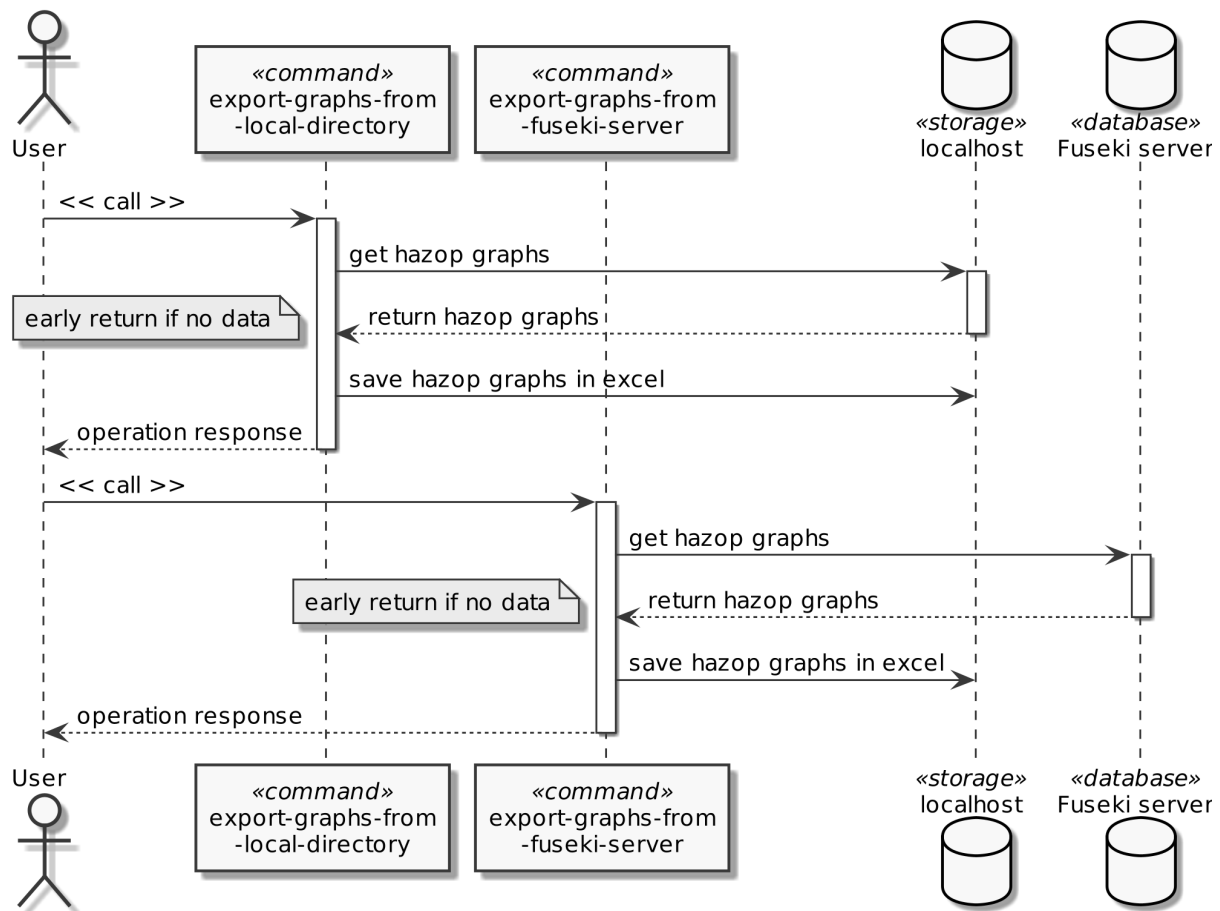


Figure 0.3: Sequence diagram: Exporter interface

Remarks

We developed the HAZOP2RDF Project with version control on GitHub. The program is available for Windows and macOS. We also included a detailed installation guide in the documentation.

Verification

The important part of the project is verification. We designed a test pattern to verificate the results of the program execution. This pattern is simple and extendable and covers the main parts of the program.

In the tests' directory you can find a list of the following files:

- `test_cli.py` - test command line interface initialization
- `test_cmd_importer.py` - test importer interface
- `test_cmd_exporter.py` - test exporter interface

The prime objective of the pattern is consistency. It allows us to apply this pattern to every test we want to implement.

The pattern covers the following test cases:

- execution errors
- execution exceptions
- output verification

The code coverage value varies around $95\pm 2\%$. The value depends on the state of the Fuseki server. It increases if the Fuseki server is running and there is pre-uploaded data on the server.

The coverage report below shows the detailed information about the tests results.

1	----- coverage: platform darwin, python 3.8.2-final-0				
2	Name	Stmts	Miss	Cover	Missing
3	-----				-----
4	src/__init__.py	0	0	100%	
5	src/cli.py	20	3	85%	34-35,
	43				
6	src/commands/__init__.py	0	0	100%	

7	src/commands/cmd_exporter.py	50	6	88%	37, 43,
	48-50, 65				
8	src/commands/cmd_importer.py	66	2	97%	38, 80
9	src/config/__init__.py	0	0	100%	
10	src/config/config.py	3	0	100%	
11	src/services/__init__.py	0	0	100%	
12	src/services/svc_exporter.py	28	0	100%	
13	src/services/svc_importer.py	97	0	100%	
14	src/services/svc_triplestore.py	16	3	81%	37-40
15	-----				
16	TOTAL	280	14	95%	

The user can although generate a coverage report in HTML format and easily discover the missing statements.

There are predefined commands in the Makefile for quick access.

Summary

- Discussion
- Future Work
- Future Projects
- Problems to be solved

PROBLEM: We use a fixed schema to validate the input data, by pattern mismatch the data will be skipped.

TODO: Dynamic schema for accepting dynamic changes.

NEED: Dynamic changes constrains.

PROBLEM: We don't validate the logic of the HAZOP data.

TODO: Validation schema.

NEED: Rules, what are acceptable in HAZOP and what are not.

IMPROVEMENT: TripleStore SOH API (SPARQL over HTML) to an API using Requests or SPARQL-Wrapper packages.

ADVANTAGES: better control over request/response operations, customization.

Appendix

- input excel dataframe, turtle data, output excel dataframe

References

“Click 8.0.” 2021. <https://click.palletsprojects.com/en/8.0.x/>.