Karlsruhe Institute of Technology

Universität Bremen

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UNIVERSITY OF APPLIED SCIENCES

Towards an Integrated Information Framework for Service Technicians

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How it should be:

„I need to do maintenance on this ACME machine. The hydraulic pump seems to be dirty. How should I proceed?“

➔Look at
✓acme_machine.pdf on pages 15-16
✓Service report from 10th Sept. 2017

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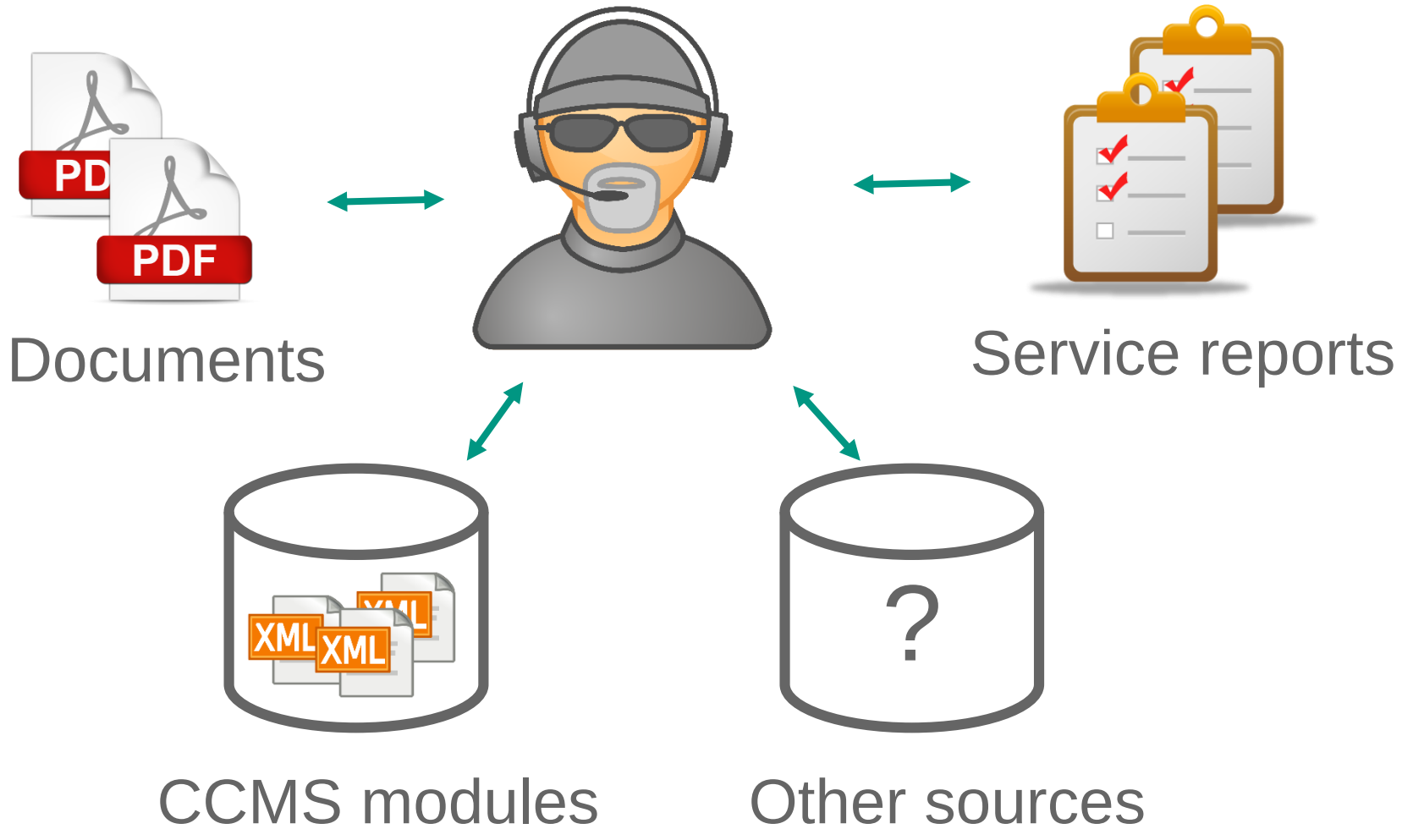
How it actually is



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How we did it

Data source	 Structured Technical Documents	 Unstructured Technical Documents	 Service Reports
Method	Automated classification	Automated segmentation	Semantic Autocompletion
Unified semantic annotation	Component Information type Lifecycle phase	Component Information type Lifecycle phase	Component Lifecycle phase

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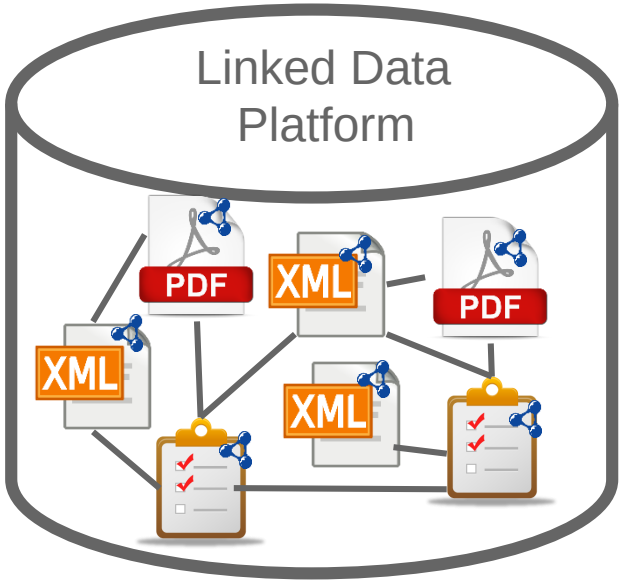

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Contributions

- **Combination of technical documentation and informal reporting**
- Semantics as the overall integration layer
- Maintenance Ontology defines controlled vocabulary
- Supported writing leading to more precise texts
- Machine Learning Classifier modularizes and classifies information from technical manuals

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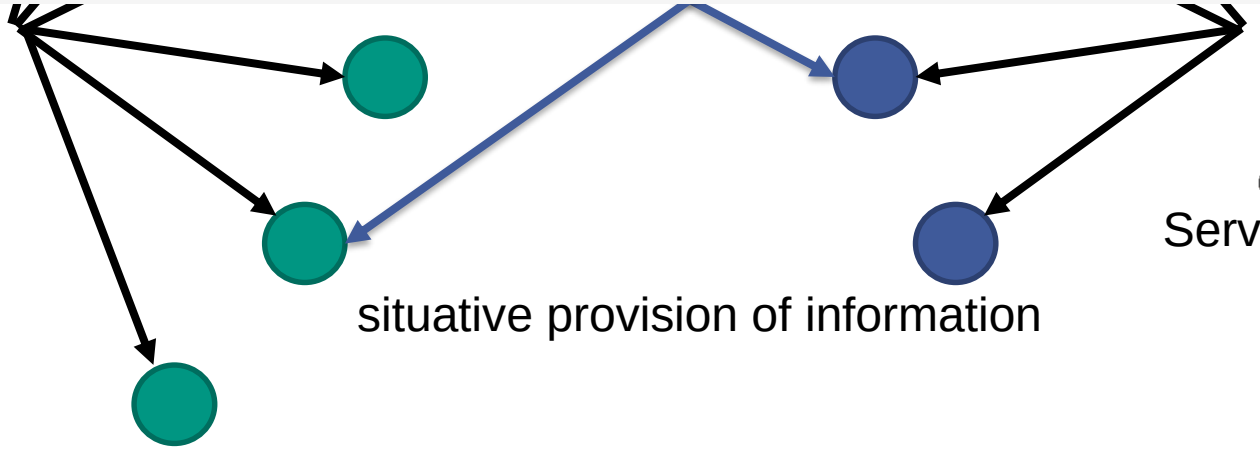
Semantic Document Retrieval

Cyber-physical production systems and digitalization of the value chain in scope of "Industrie 4.0" create data volumes that can now be analyzed with BigData and SmartData technologies. This creates new opportunities to raise predictive information e.g. about optimal maintenance schedules and enables improved service performance.

To comprehensively perceive the benefits of predictive maintenance in services and archive economically optimal use, the value chain of industrial services must be considered as a whole. This is especially interesting, as such services are time and cost intensive and new business models with flat fees ("full service") are increasingly in demand. STEP is concerned with cost efficient and ideal economic planning of such maintenance services.

Based on a to be created vision of industrial services and maintenance in the age of industrie 4.0 new business models, required methods and information demand will be derived, which leads to an economical optimal service plan. STEP will develop technologies, which support innovative planning practices and the provision of assignment related information for the service technician of the future.



Service Technician

situative provision of information

annotations according to domain ontology

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Semantic Autocompletion

Service Technician

Text creation → **Low information content** → **No additional utilization**

- Time pressure and further effort
- Missing instant utility

- Abbreviations, own creations, misnomers
- Little to no details
- Syntax, spelling, and grammar errors

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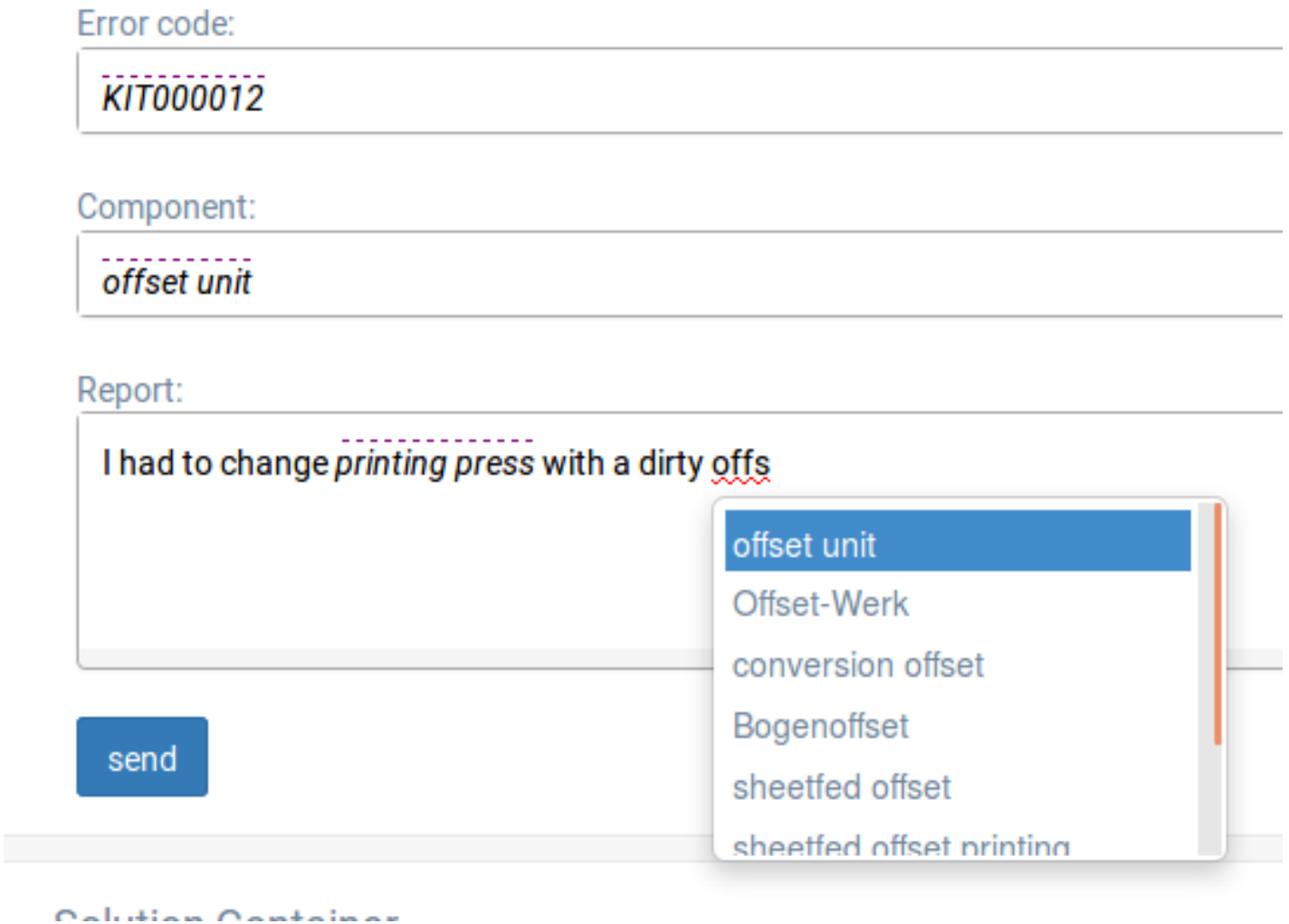
Semantic Autocompletion



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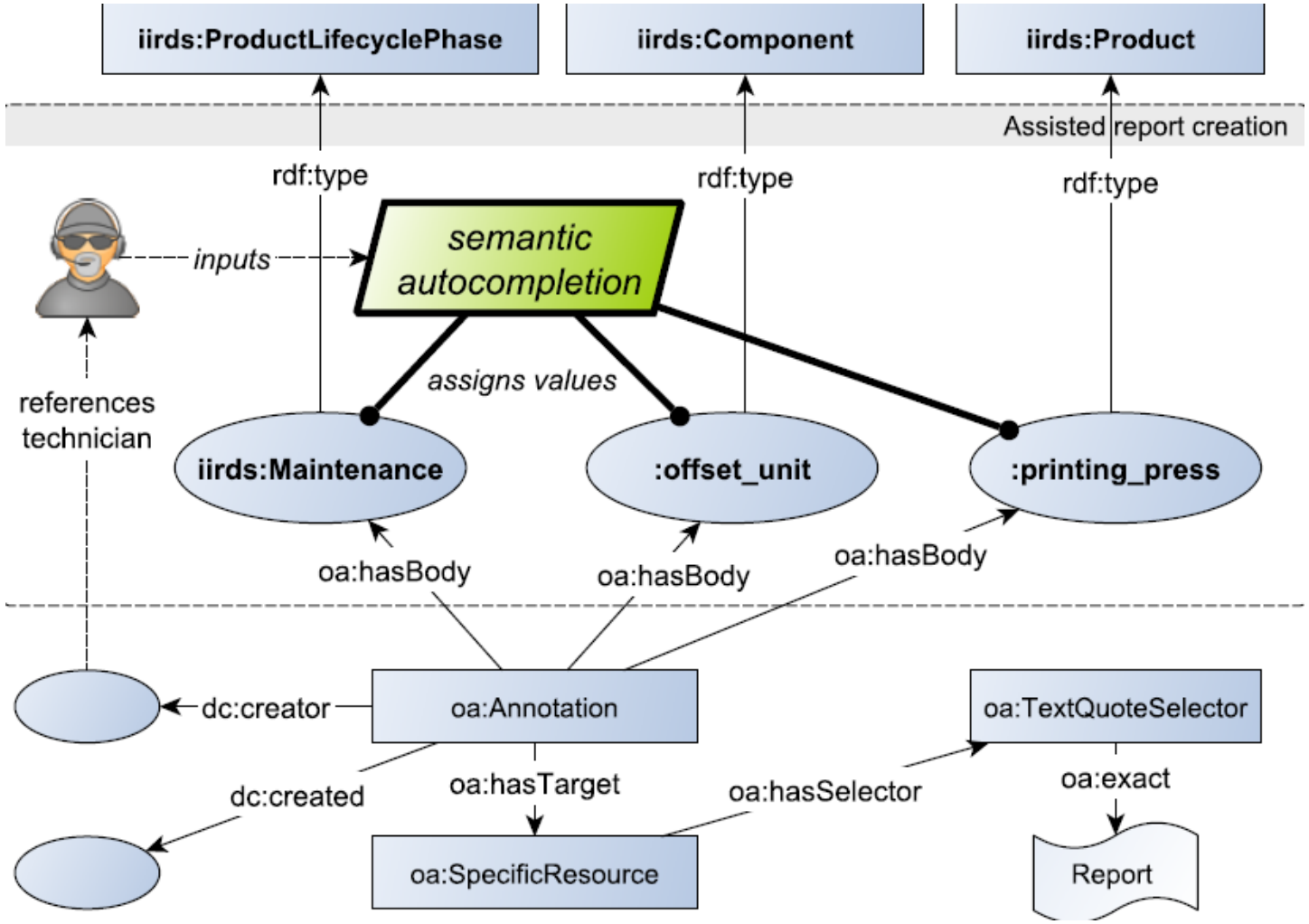

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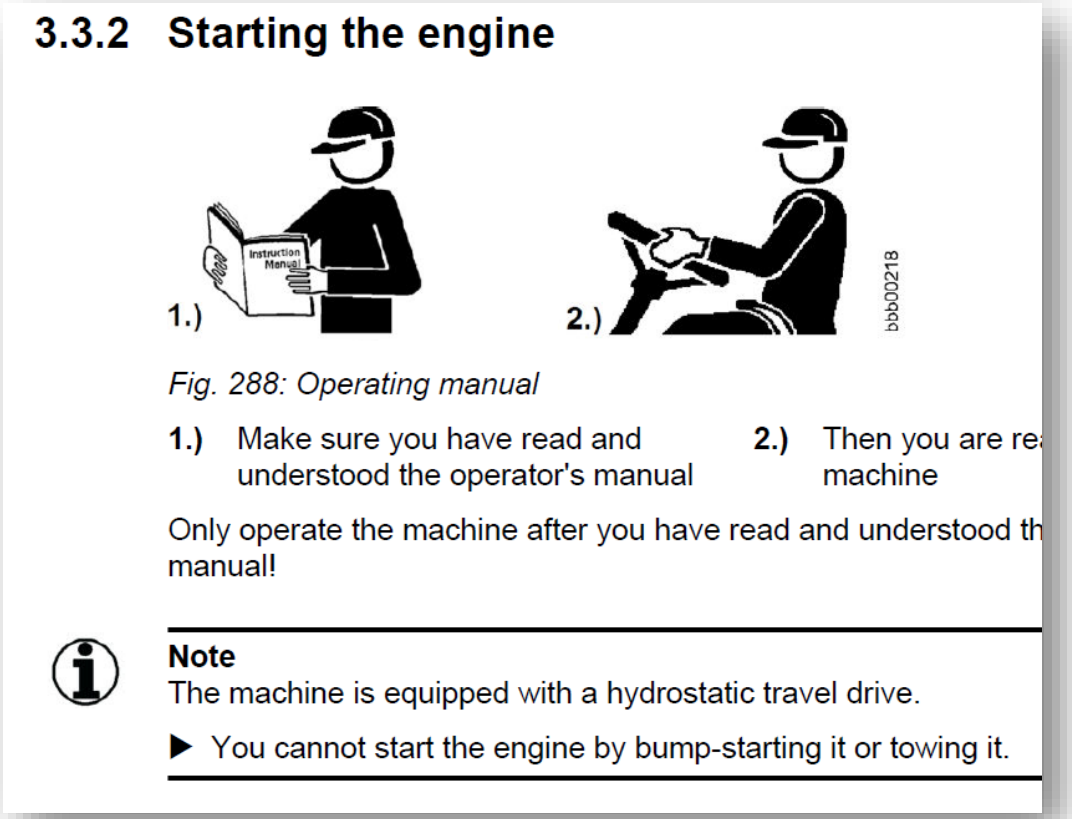
Automated Classifying of TD

- Technical Documentation has special characteristics:
  - Standardized patterns and terminology
  - Size of content components
  - Training and test data
  - Quality requirements

- Adaptions on:
  - Feature selection
  - Weighting method
  - Classification frameworks



3.3.2 Starting the engine

1.) 2.)

bbb00218

Fig. 288: Operating manual

1.) Make sure you have read and understood the operator's manual

2.) Then you are re machine

Only operate the machine after you have read and understood th manual!

Note
The machine is equipped with a hydrostatic travel drive.

▶ You cannot start the engine by bump-starting it or towing it.

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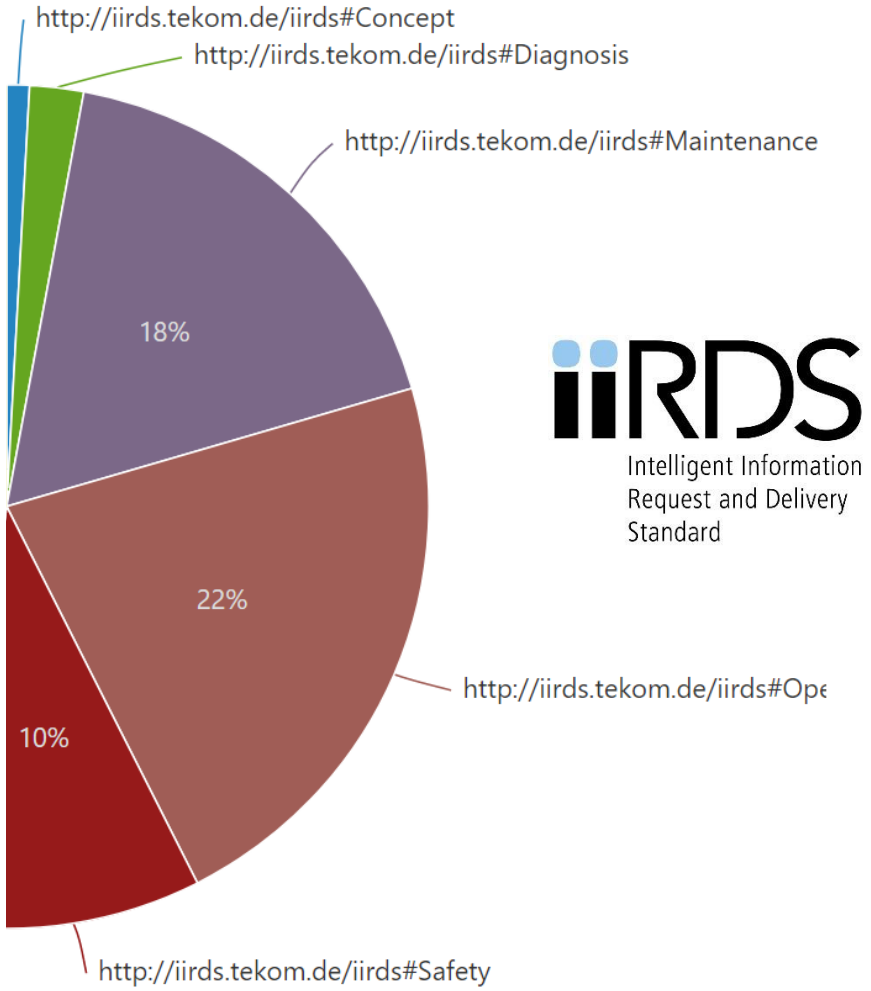
Automated Classifying of TD

- New standard iiRDS provides a RDF schema for annotating Technical Documentation
- Mapping from conventional metadata to instances of iiRDS concepts
- Classifier assigns URI of instance
- ~ 3700 content components as training data (74 words/each)



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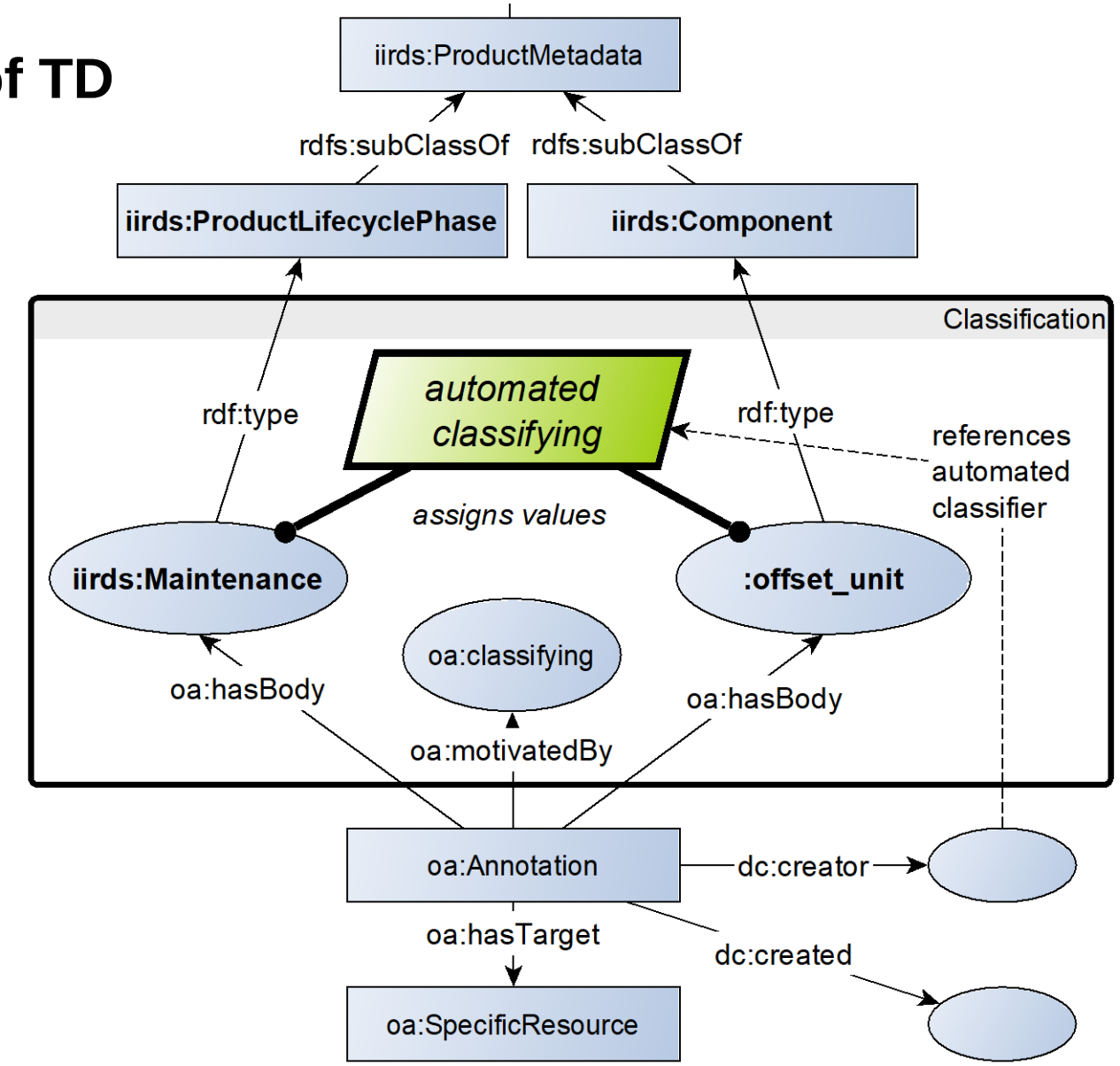
Automated Classifying of TD



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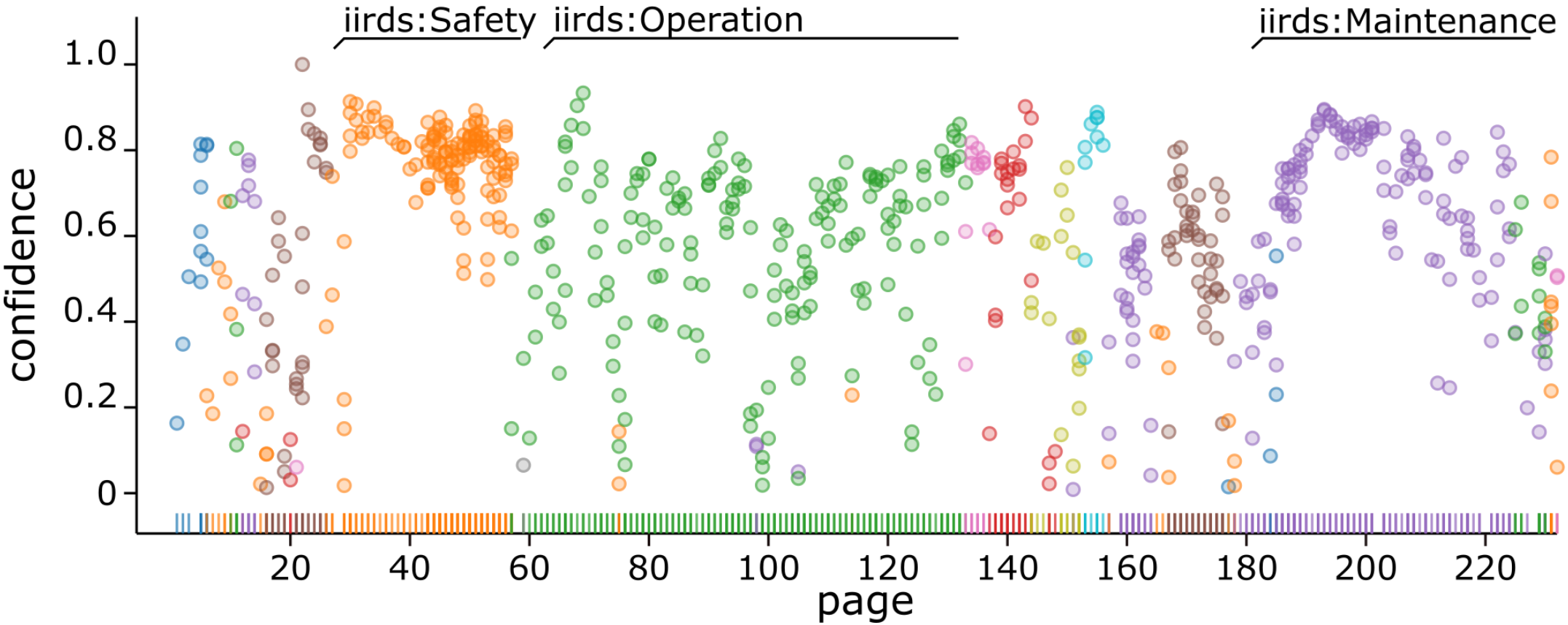
Automated Segmentation



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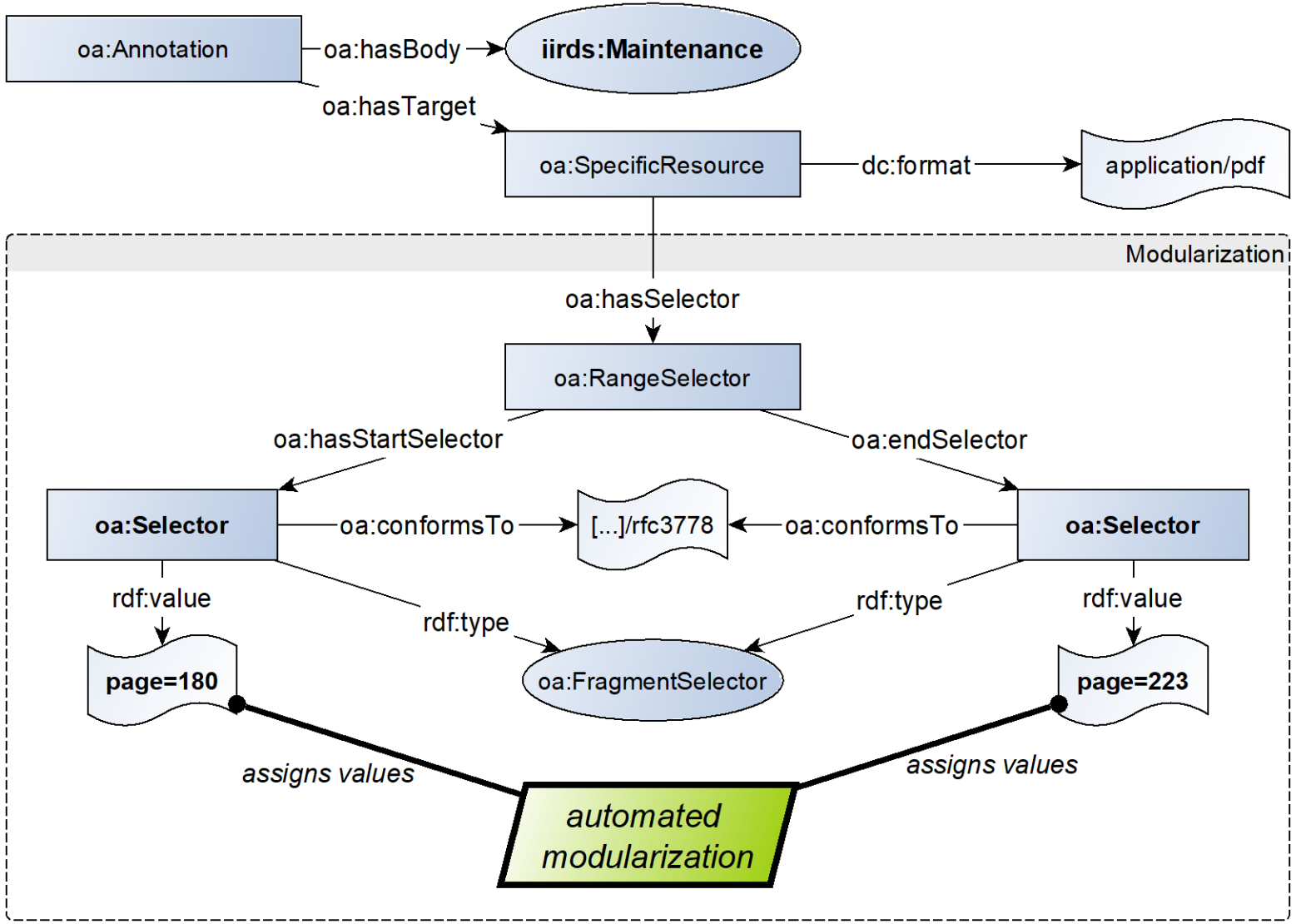
Automated Classifying



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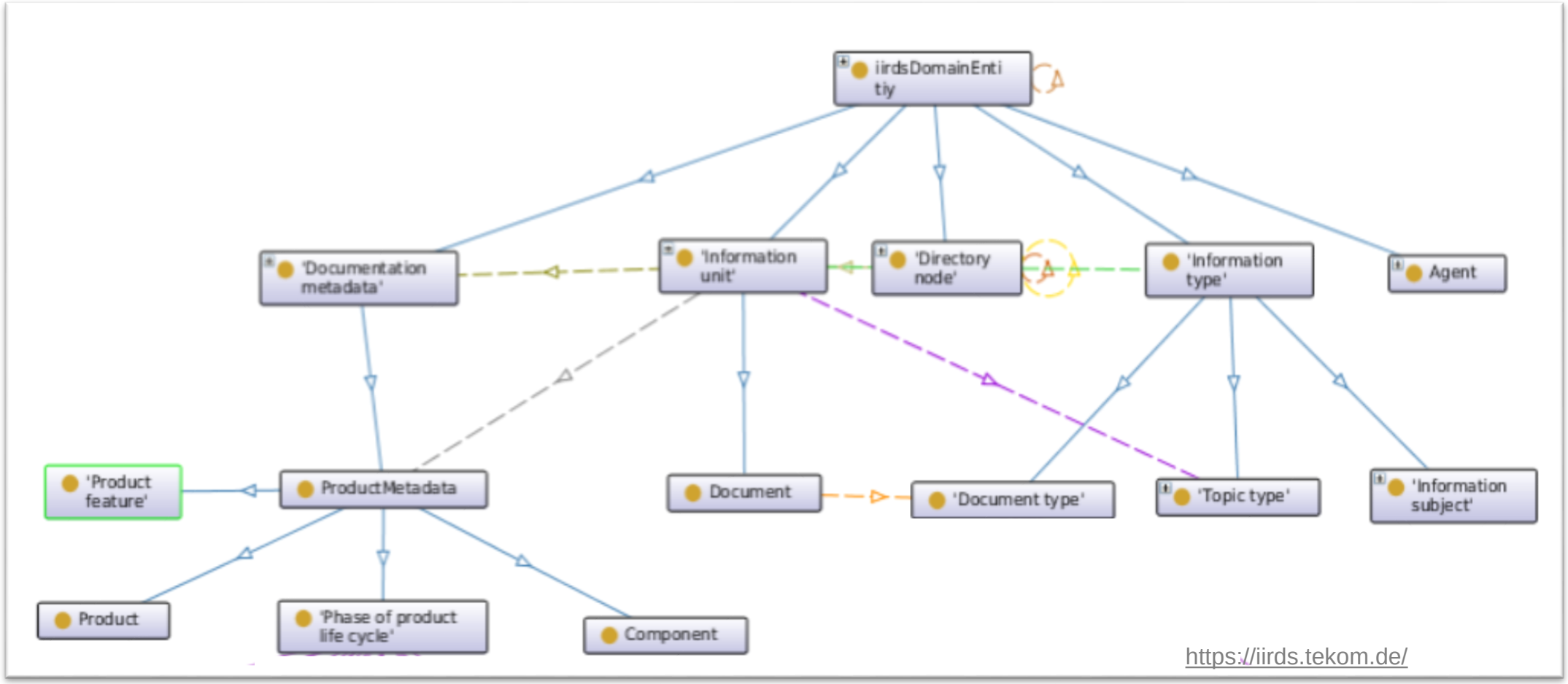
Integration of both approaches

- intelligent information Request and Delivery Standard (iiRDS)



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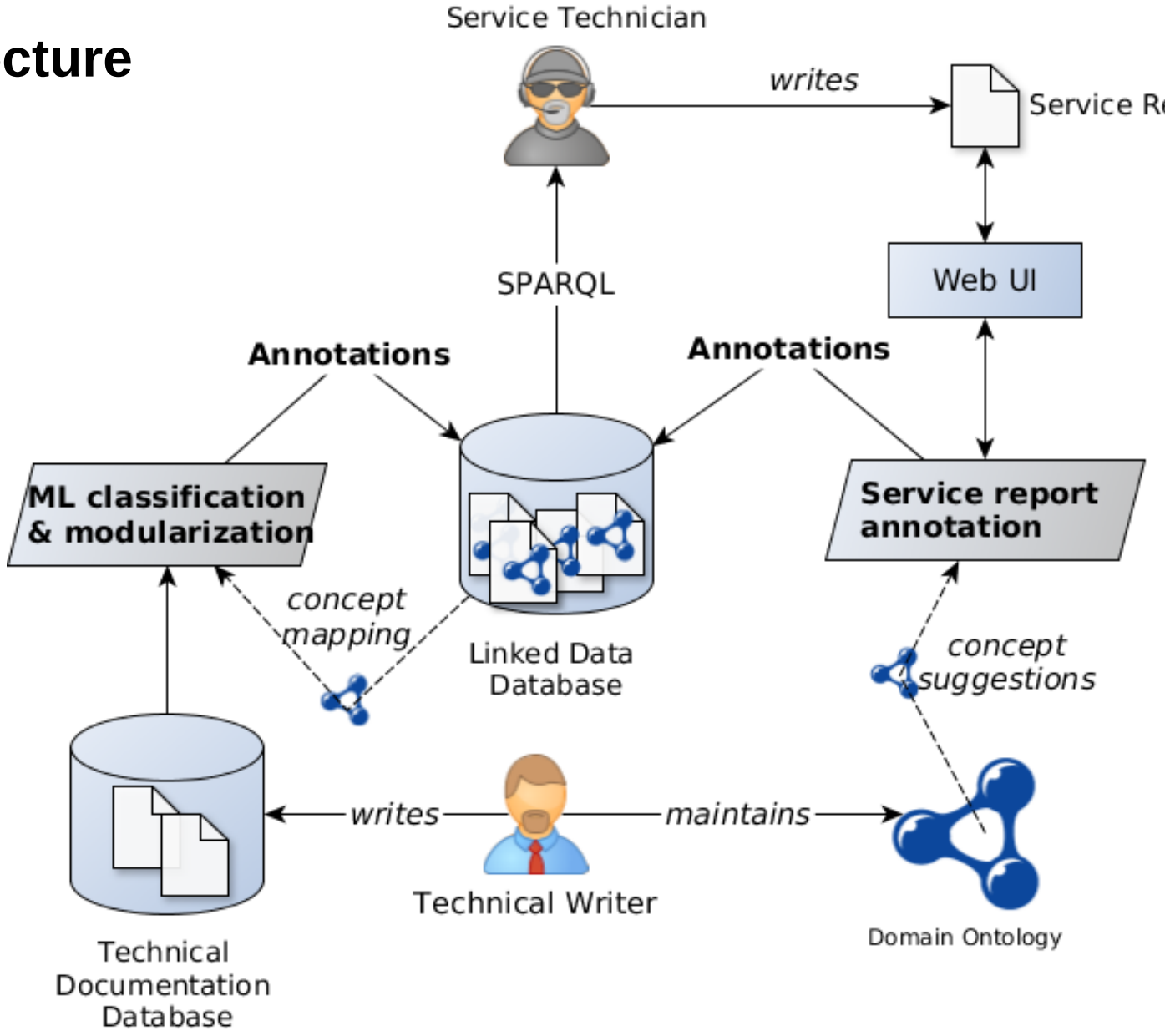
Overall Architecture



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How it should be: Semantic user assistance

„I need to do **maintenance**

on this **ACME** machine.

The **hydraulic pump**

seems to be **dirty**.

How should I proceed?“

→ iirds:ProductLifeCyclePhase:
iirds:Maintenance

→ Product ontology:
ACME

→ iirds:component:
acme:hydraulicPump

→ Full text keyword:
„dirty“

↓

Look at

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Results

		Query 1	Query 2	Query 3	Query 4	Query 5	Query 6	Query 7	Query 8	Query 9	Query 10		Average
Keyword term only	Precision	0,875	0,15	0,189	0,049	0,6	0,148	0,034	0,846	0,069	0,867		0,383
	Recall	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	→	**1**
	F-Measure	0,933	0,26	0,318	0,093	0,75	0,258	0,065	**0,917**	0,128	0,929		0,465
Keywords term and context term	Precision	**1**	**1**	**1**	**1**	0	0	**1**	**1**	**1**	0,75	→	**0,775**
	Recall	0,357	0,561	0,643	0,462	0	0	0,107	0,545	0,143	0,231		0,305
	F-Measure	0,526	**0,719**	**0,783**	0,632	0	0	0,194	0,706	0,25	0,353		0,416
Keyword term and annotation filter	Precision	**1**	**1**	**1**	**1**	**1**	0,667	**1**	**1**	**1**	**1**		0,967
	Recall	0,929	0,541	0,571	0,538	**1**	**1**	0,893	0,182	0,857	0,923		0,743
	F-Measure	**0,963**	0,702	0,727	**0,7**	**1**	**0,8**	**0,943**	0,308	**0,923**	**0,96**	→	**0,803**

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Conclusion

- Unifying approach combining controlled and uncontrolled information modules
  - Formal knowledge
  - Informal, tacit knowledge

Service Technician

Technical Writer

- Reduction of cognitive overhead
- Targeted information access

- Human-centered: Utilize existing process steps to create instant value

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