# Roadmapping and Navigation in the Ontology Visualization Landscape

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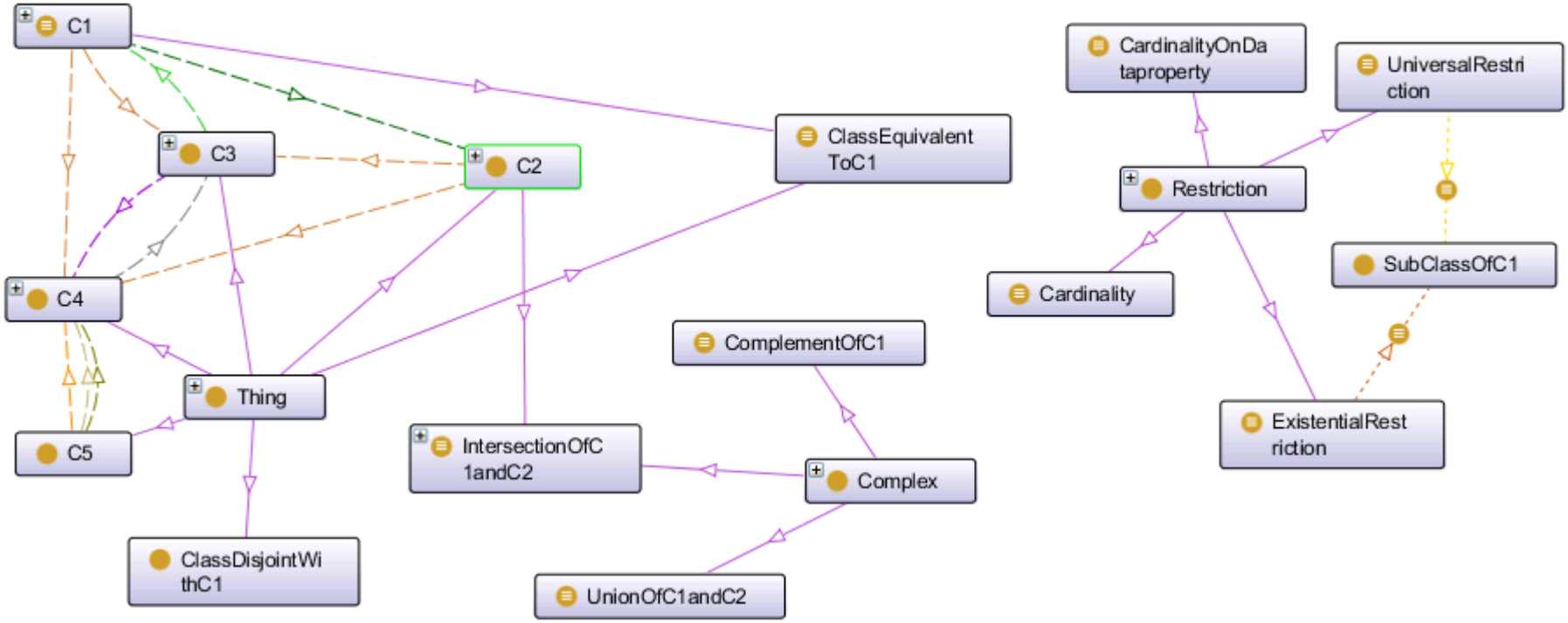
# Introduction

- There are many visualization tools for OWL ontologies
  - They differ in visualization techniques and supported features
- Hypothesis: Different `types' of ontologies (in terms of size and complexity) visualized in different use case scenarios might need different visualization techniques and features

# Different Visualization Techniques - Examples



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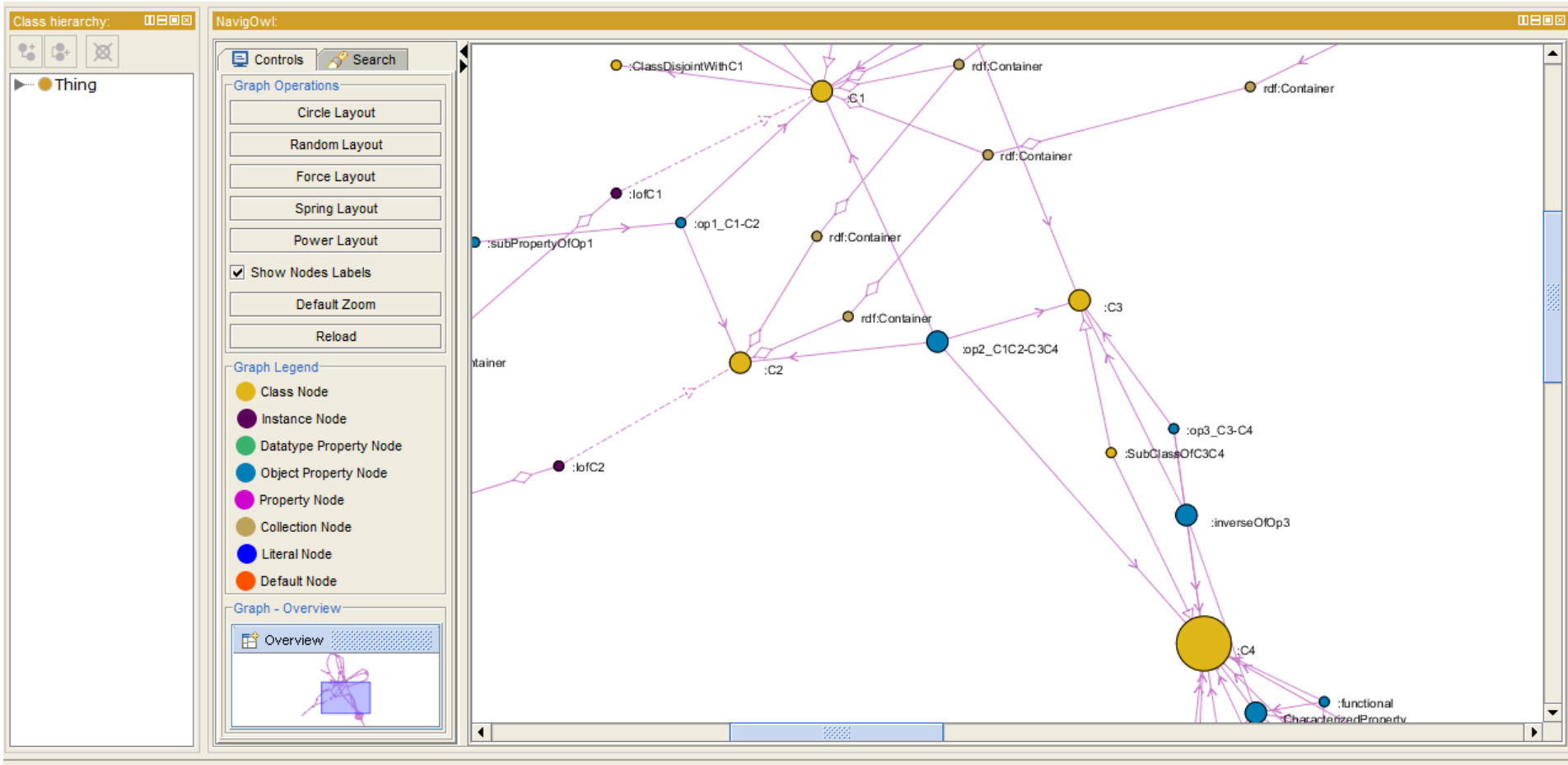

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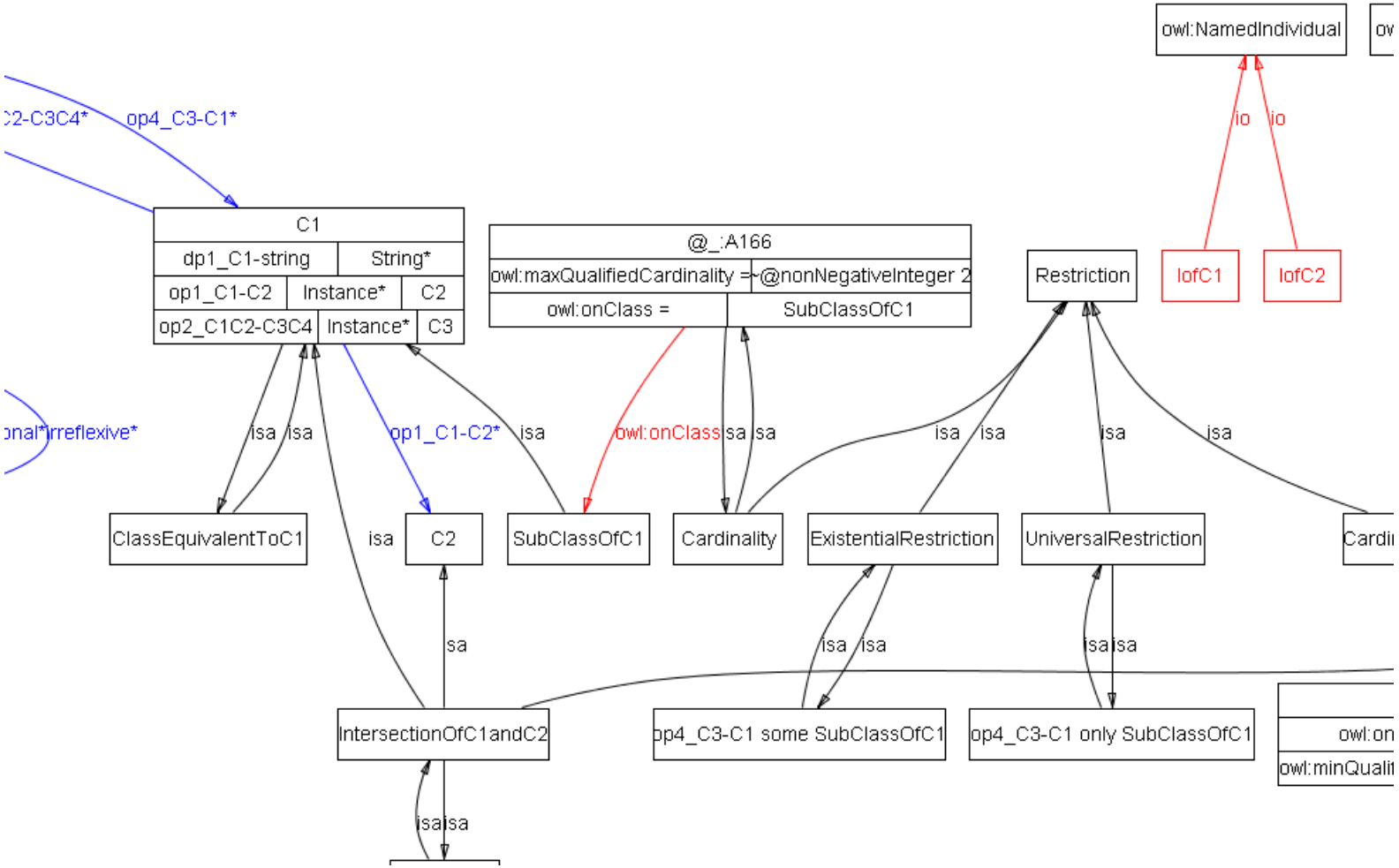

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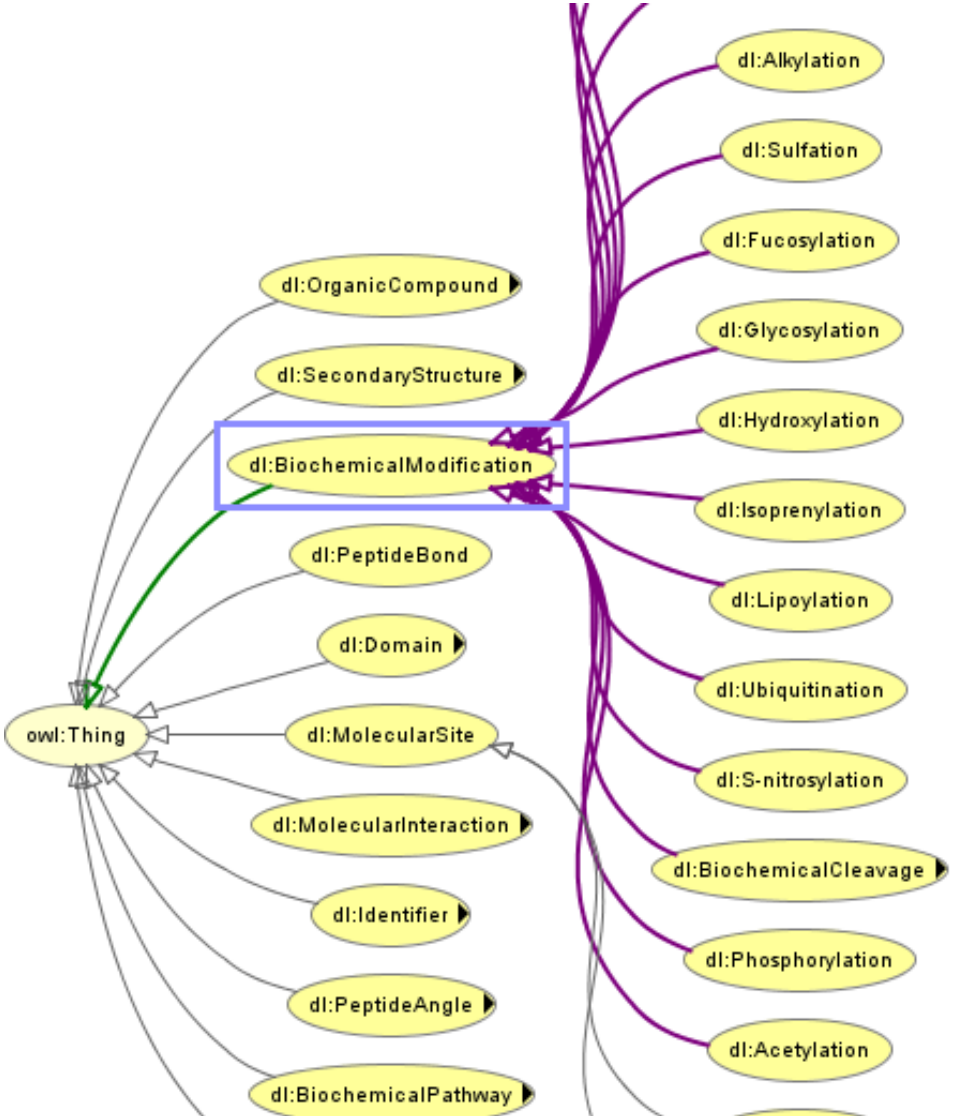

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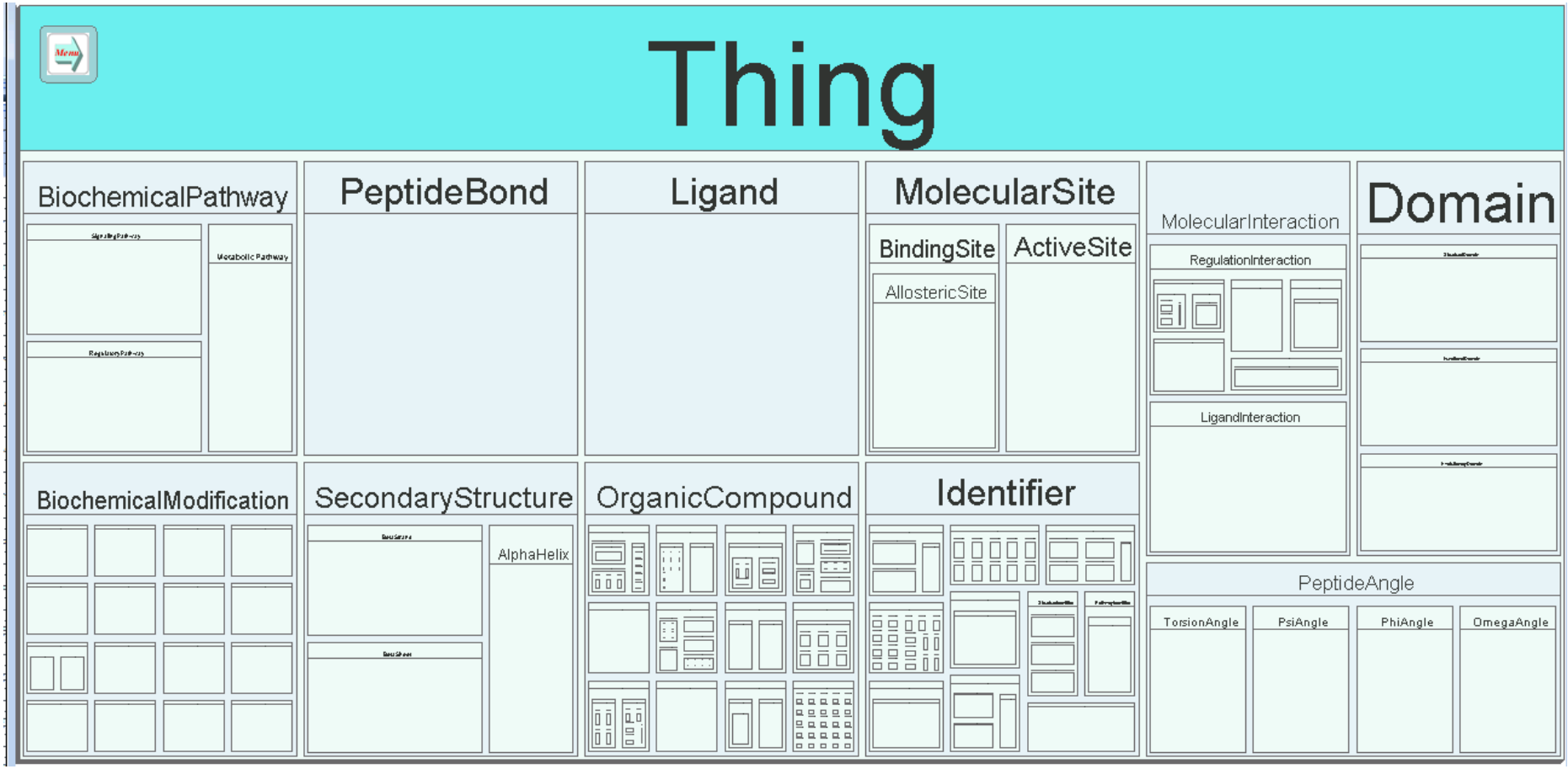


# Different Visualization Techniques - Examples

- …many more techniques exist

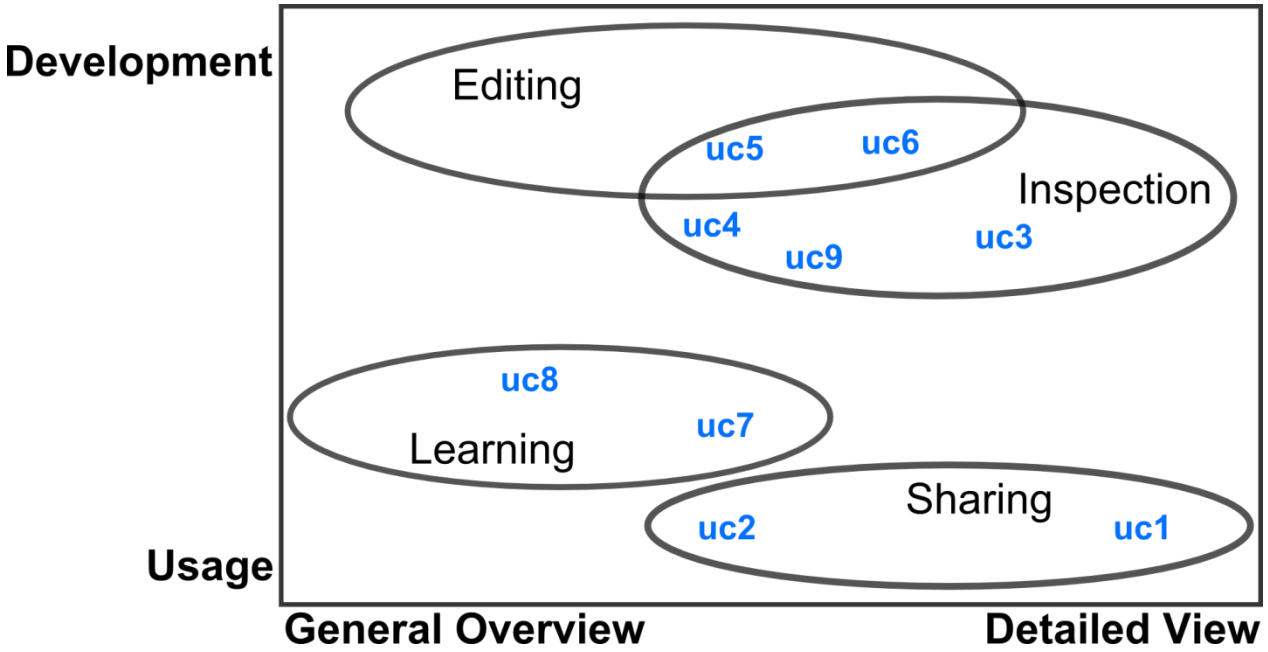
# Goals

- Analyze existing ontology visualization tools
- Develop a recommender that would suggest the most suitable visualization tool based on
  - Purpose of the visualization (use case)
  - Characteristics of the ontology
    - Size
    - Complexity
  - User preferences regarding ontology IDE (e.g. Protégé 4 over Neon Toolkit)
- Evaluate findings from the analysis and the recommender

# What We Did

- We defined `visualization use case categories'
- We identified important interface features for each use case category
- We analyzed several visualization tools regarding
  - Interface features implementation
  - OWL language features support
  - Large ontology visualization

# Ontology Visualization Use Case Categories




- uc1: making screenshots of selected parts of the ontology
- uc2: making screenshots of the overall structure of the ontology
- uc3: checking the model adequacy
- uc4: building a new ontology
- …

# Visualization Tool Features

- F1 Zoom-Out Overview: zooming out to get a summary view of the ontology.
- F2 Radar View: displaying a small `minimap' of the displayed ontology.
- F3 Graphical Zoom: enlarging the displayed graphical elements.
- F4 Focus on Selected Entity: centering the view on a selected entity and its surroundings and hiding other parts of the ontology.
- …
- F17 Graphical Editing: the tool supports creating new entities by, e.g., drawing edges between the displayed nodes.

# Mapping Important Features to Categories

- **Editing**: Pop-up Window, Search, Integration with Editing, Graphical Editing
- **Inspection**: Pop-up Window, Search, Hide Selected Entity, Filter Specific Entity Type and Focus on Selected Entity
- **Learning**: Zoom-Out Overview, Radar View and Incremental Exploration
- **Sharing**: Hide Selected Entity, Drag&Drop User Layout

# Tool Analysis – Considered Tools

| Visualization tool | Plugin for | Editor | Method | Supports | State |
|---|---|---|---|---|---|
| CmapTools | | x | Concept maps | OWL | N/A |
| CropCircles | SWOOP | | Euler diagrams | RDFS | N/A |
| **Entity Browser** | Protégé | x | Indented list | RDFS | Usable |
| GLOW | Protégé 4.x | | Node-link | RDFS | Devel. |
| **Jambalaya** | Protégé 3.x | x | Node-link, Space-filling | OWL | Usable |
| **KC-Viz** | Neon-Toolkit | | Node-link | RDFS | Usable |
| Knoocks | | x | Space-filling, Node-link | RDFS | Devel. |
| Navigowl | Protégé 4.x | | Node-link | RDFS | Devel. |
| **Ontograf** | Protégé 4.x | | Node-link | OWL | Usable |
| **Ontology Visualizer** | Neon-Toolkit | | Node-link | RDFS | Usable |
| Ontoself | | | 3D Node-link | RDFS | N/A |
| Ontosphere | | | 3D Node-link | RDFS | Devel. |
| Ontoviewer | | | 2.5D Node-link | RDFS | N/A |
| **Ontoviz** | Protégé 3.x | | UML | RDFS | Usable |
| OWL VisMod | | x | Space-filling, Node-link | RDFS | N/A |
| OWLeasyViz | | x | Euler diagrams | RDFS | N/A |
| **OWLGrEd** | | x | UML | OWL | Usable |
| **OWLViz** | Protégé 3.x | | UML | RDFS | Usable |
| **SOVA** | Protégé 4.x | | Node-link | OWL | Usable |
| **TGVizTab** | Protégé 3.x | | Node-link | RDFS | Usable |
| **TopBraid** | | x | Node-link | OWL | Usable |

# Tool Analysis - Focus

- Supported interface features
- Support of OWL language features
- Ability to display large ontology

# Interface Features Implemented in Each Tool

| Specific feature | Zoom-out Overview | Radar View | Graphical Zoom | Focus on selected entity | History (undo/redo) | Pop-up Window | Incremental Exploration | Search | Hide selected entity | Filter specific entity type | Fisheye Distortion | Edge Bundles | Drag&Drop Navigation | Drag&Drop User Layout | Clustering Integration with editing | Graphical editing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jambalaya | 1 | | 1 | 1 | | 2 | 1 | 2 | 2 | 2 | 1 | | | 2 | | 2 | |
| KC-Viz | 2 | | 2 | | 2 | 2 | 2 | 1 | 2 | 2 | | | 2 | 2 | 2 | | |
| Ontograf | | | 2 | 2 | | 2 | 2 | 2 | | 1 | | | 2 | 2 | | 1 | |
| Ontology Visualizer | 2 | | 2 | 2 | 2 | | 2 | 2 | | | | | | 2 | | | |
| Ontoviz | | | 2 | | | | | | 2 | | | | 2 | | | | |
| OWLGrEd | 1 | 2 | 1 | | 2 | 2 | | | | | | 1 | | 2 | | 2 | 2 |
| OWLViz | 2 | | 1 | 2 | | 2 | 2 | 1 | 2 | | | | | | | 2 | |
| Protégé Entity B. | 2 | | | | | 2 | 2 | 2 | | | | | | | | 2 | |
| SOVA | 1 | | 2 | | | | | 2 | | 2 | | | 2 | 2 | | | |
| TGVizTab | 1 | | 1 | 2 | | | 2 | 2 | 2 | 2 | 1 | | 2 | | | | |
| TopBraid | | 2 | 1 | | | | | | 2 | | | | | 2 | | | 2 |

# Suitability Scores of Tools for Each Use Case Category – Calculated from Feature Support

| Category | Editing | Inspection | Learning | Sharing |
|---|---|---|---|---|
| Important Features | Pop-up Window + Integration with editing + Search | Filter (both) + Pop-up Window + Search + Focus | Zoom-out Overview + Radar View + Incremental Exploration | Filter selected entity + Drag&drop user layout |
| **Jambalaya** | 23,5 | 30,0 | 12,5 | 17,5 |
| **KC-Viz** | 18,0 | 28,0 | 20,5 | 20,5 |
| **Ontograf** | 20,5 | 25,0 | 12,5 | 12,5 |
| **Ontology Visualizer** | 12,0 | 17,0 | 17,0 | 12,0 |
| **Ontoviz** | 3,0 | 8,0 | 3,0 | 8,0 |
| **OWLGrEd** | 22,5 | 10,5 | 13,0 | 10,5 |
| **OWLViz** | 19,5 | 23,5 | 16,0 | 11,0 |
| **Protégé Entity B.** | 20,0 | 14,0 | 14,0 | 4,0 |
| **SOVA** | 10,5 | 15,5 | 8,0 | 10,5 |
| **TGVizTab** | 12,5 | 27,5 | 15,0 | 12,5 |
| **TopBraid** | 9,5 | 8,5 | 8,5 | 13,5 |

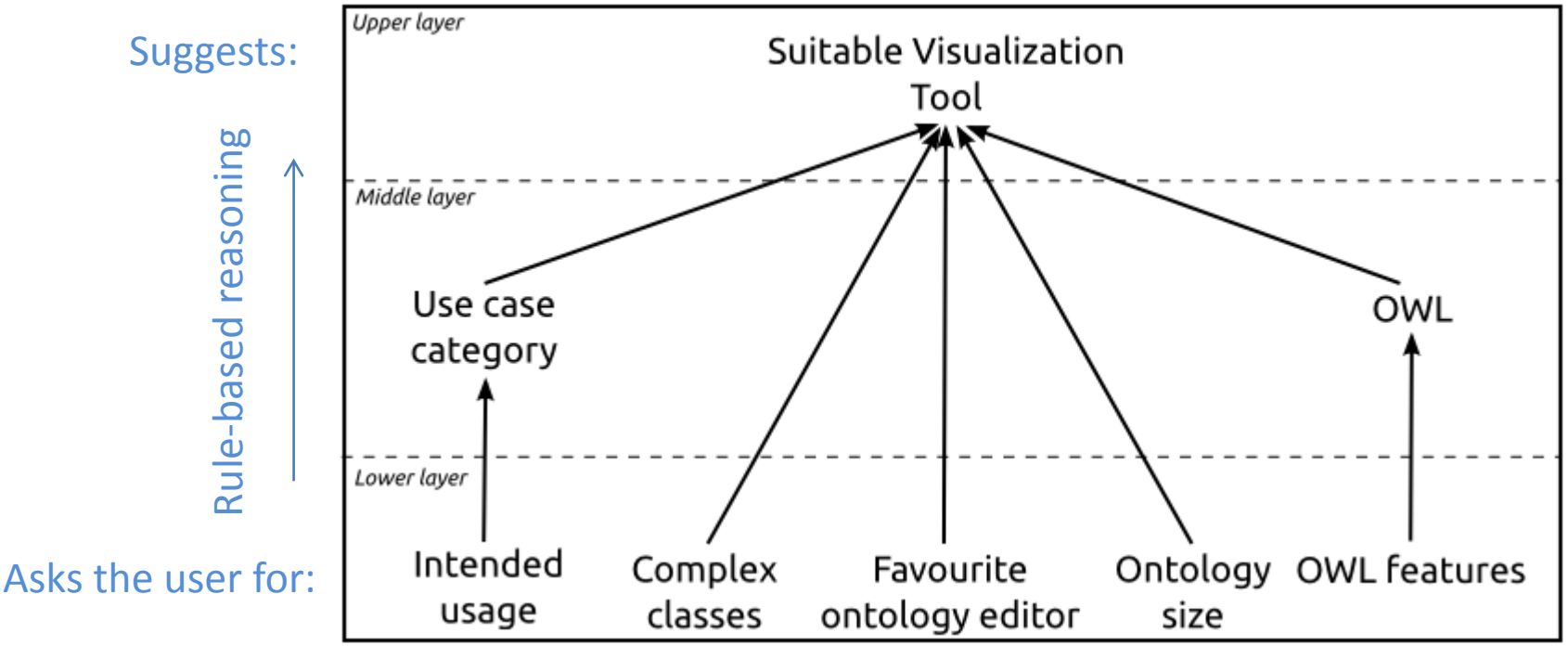
$$ss = \sum ImportantFeatureScores \cdot \alpha + \sum OtherFeatureScores \cdot \beta$$

# OWL Features Supported in Each Tool

| Tool | Classes | Object Prop. | Datatype Prop. | Instances | Annotations | Univ./Exist. Rest. | Cardinality | Enumeration | Intersection | Union | Complement | equivalentClass | disjointWith | subClassOf | Property Char. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jambalaya | x | x | | x | | x | | | | | | x | | x | |
| KC-Viz | x | x | | x | | | | | x | | | | | x | |
| Ontograf | x | x | | x | | x | | x | x | x | x | x | | x | |
| Ontology Visualizer | x | | | | | | | | | | | | | x | |
| Ontoviz | x | x | x | x | | x | x | x | x | x | x | x | | | |
| OWLGrEd | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| OWLViz | x | | | | | | | | | | | | | | |
| Protégé Entity Browser | x | x | x | x | | | | | | | | | | | |
| SOVA | x | x | | x | | x | x | x | x | x | x | x | x | x | x |
| TGVizTab | x | x | | | | | | | | | | | | x | |
| TopBraid | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

# Recommender

- Built as a knowledge base for NEST expert system
  - Compositional rule-based

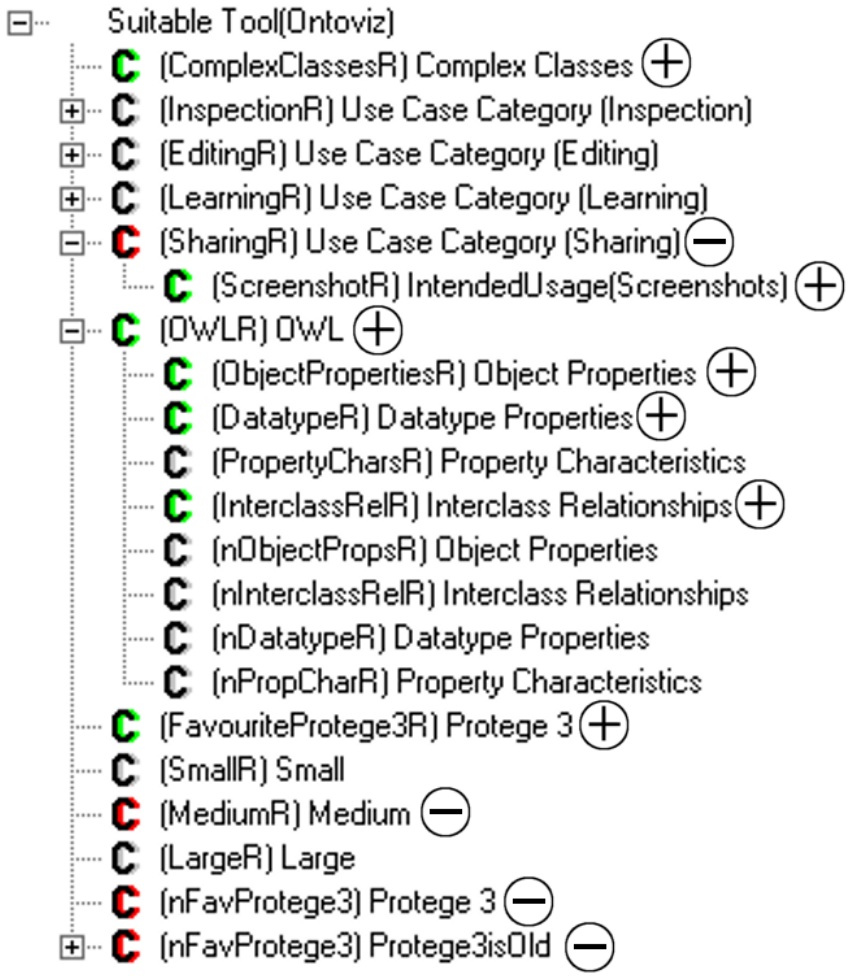


# Example of Recommender Output

| Name | Min weight < | Max weight |
|---|---|---|
| Suitable Tool(Ontoviz) | 1,671 | 1,671 |
| Suitable Tool(TopBraid) | 1,500 | 1,500 |
| Suitable Tool(SOVA) | 1,487 | 1,487 |
| Suitable Tool(OWLGrEd) | 1,426 | 1,426 |
| Protege Entity Browser | 1,209 | 1,209 |
| Suitable Tool(Jambalaya) | 1,034 | 1,034 |
| Suitable Tool(TGVizTab) | 0,963 | 0,963 |
| Suitable Tool(Ontograf) | 0,275 | 0,275 |
| Suitable Tool(KC-Viz) | 0,208 | 0,208 |
| Suitable Tool(OWLViz) | -1,518 | -1,518 |
| Ontology Visualizer | -2,005 | -2,005 |

**(a)**

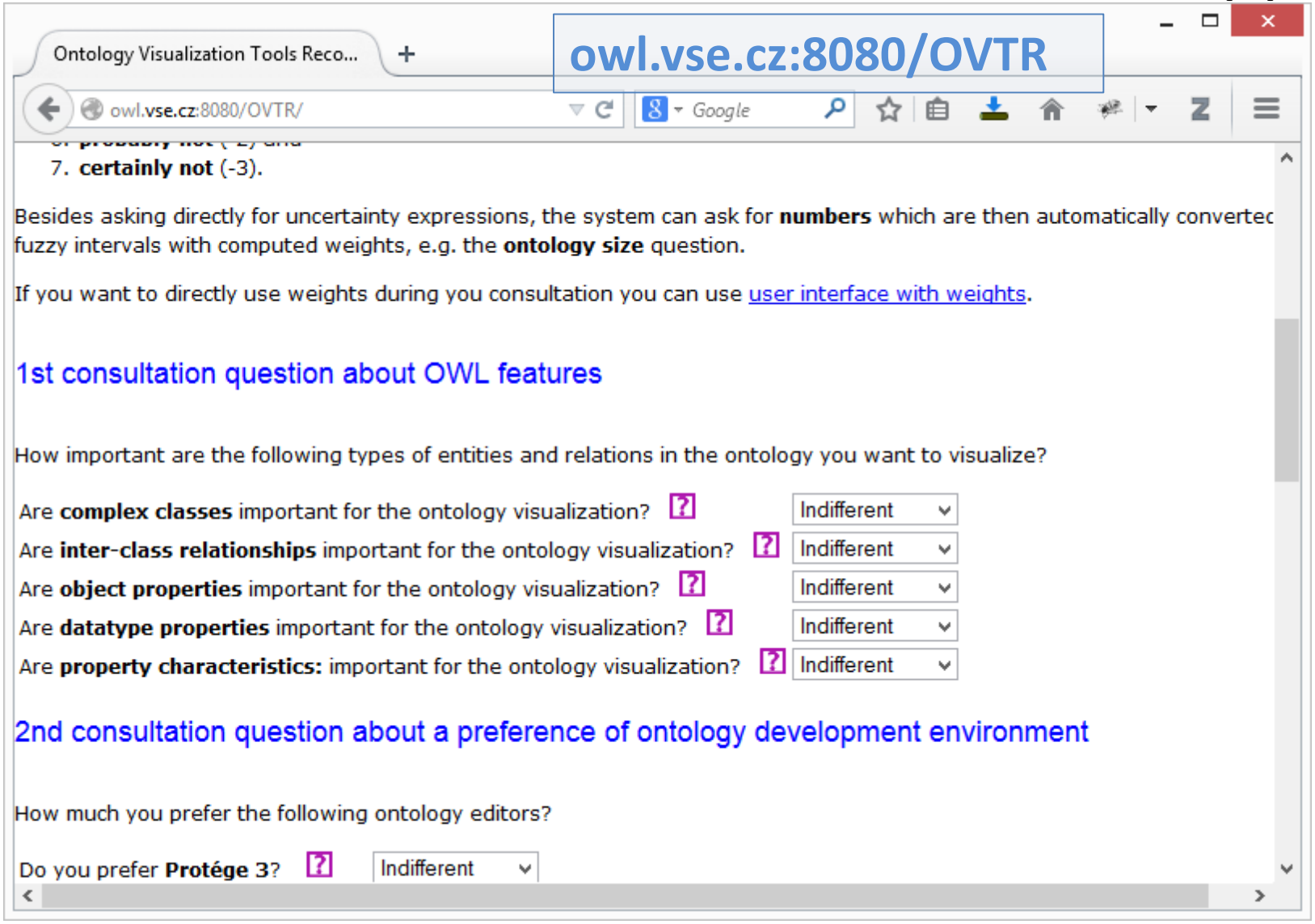
Suggested tools: higher weight means more suitable tool




**(b)**

Explanation of the reasoning

# Recommender Is Available as a Web App



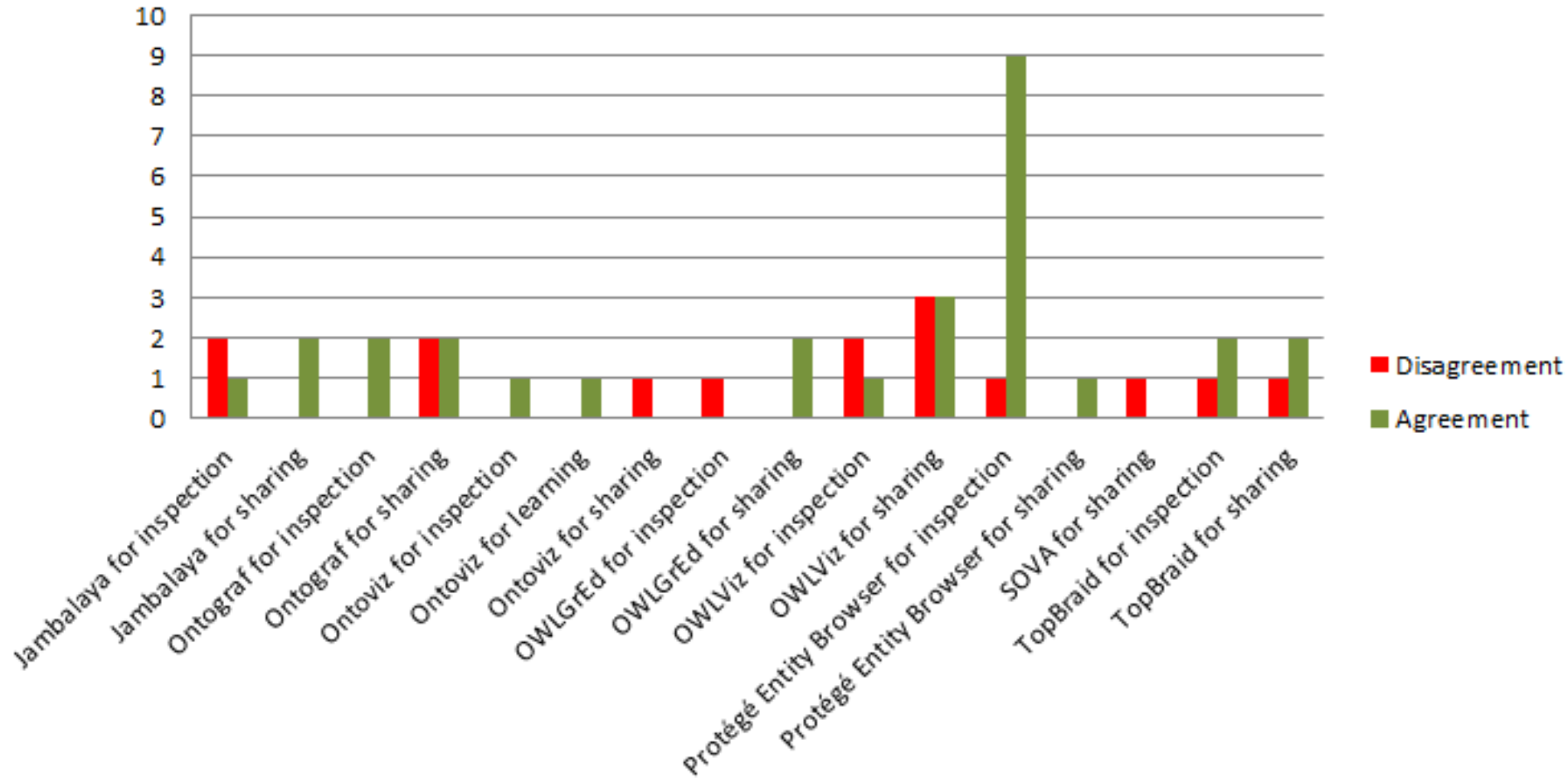
# Evaluation

- Web-based anonymous questionnaire
  - Experience with visualization tools
    - Which?
    - In what use case?
      - Do they agree with its categorization? (to Editing, Inspection etc.)
    - Were they satisfied with the tool?
  - Visualization use case categorization system
    - Does it make sense?
  - Weak&strong aspects of the tools
    - Do they agree with our findings from the analysis?
  - Running consultation with the recommender
    - Are they satisfied with the resulting recommendation?

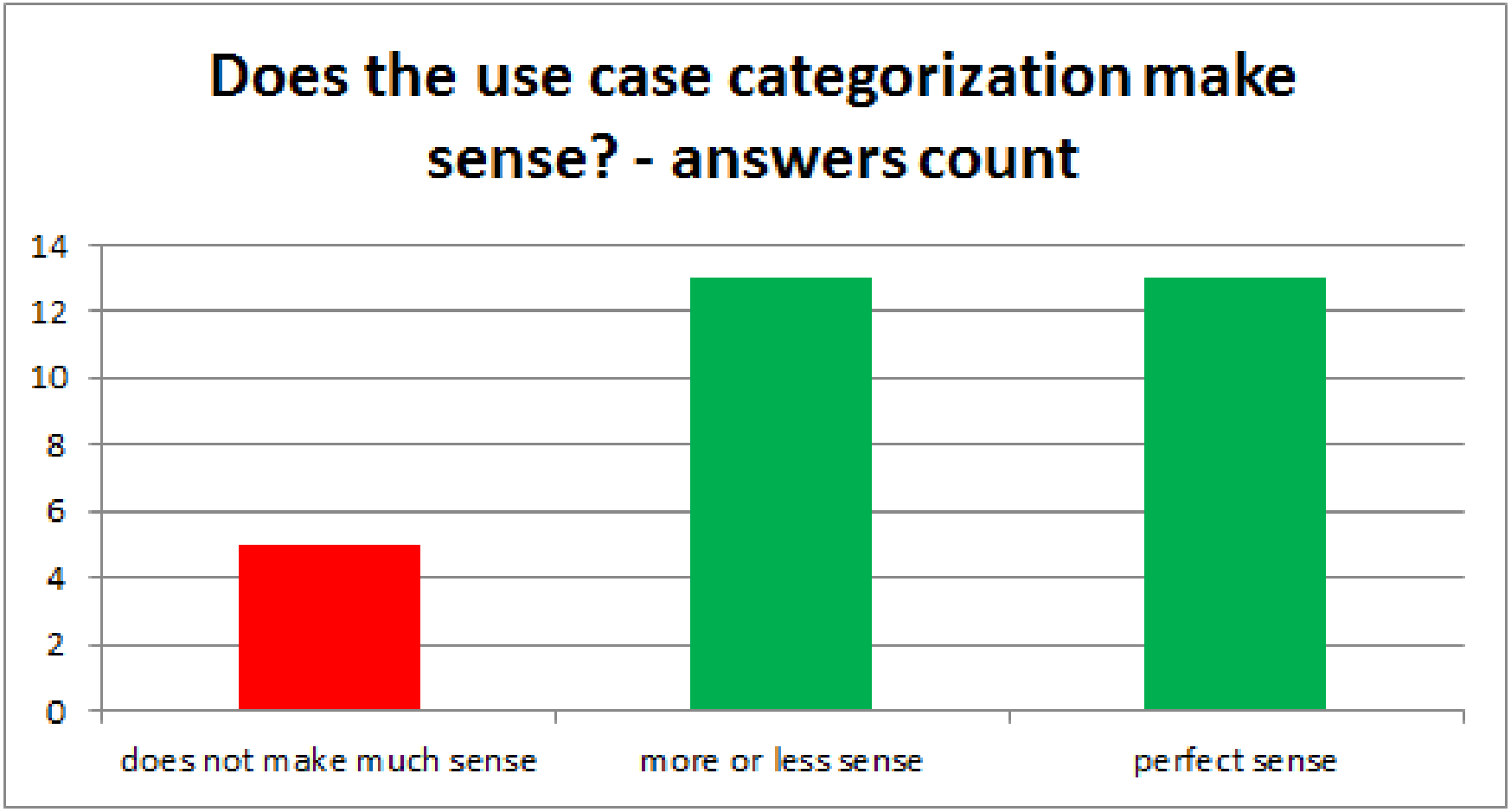
# Evaluation

- We asked people from the domain of ontology engineering and also directly some developers of the visualization tools
- 32 respondents
  - 3 skipped the consultation with the recommender

# Counts of Answers Agreeing/Disagreeing with the Suitability of the Tools for Various Use Case Categories



# Evaluation Results



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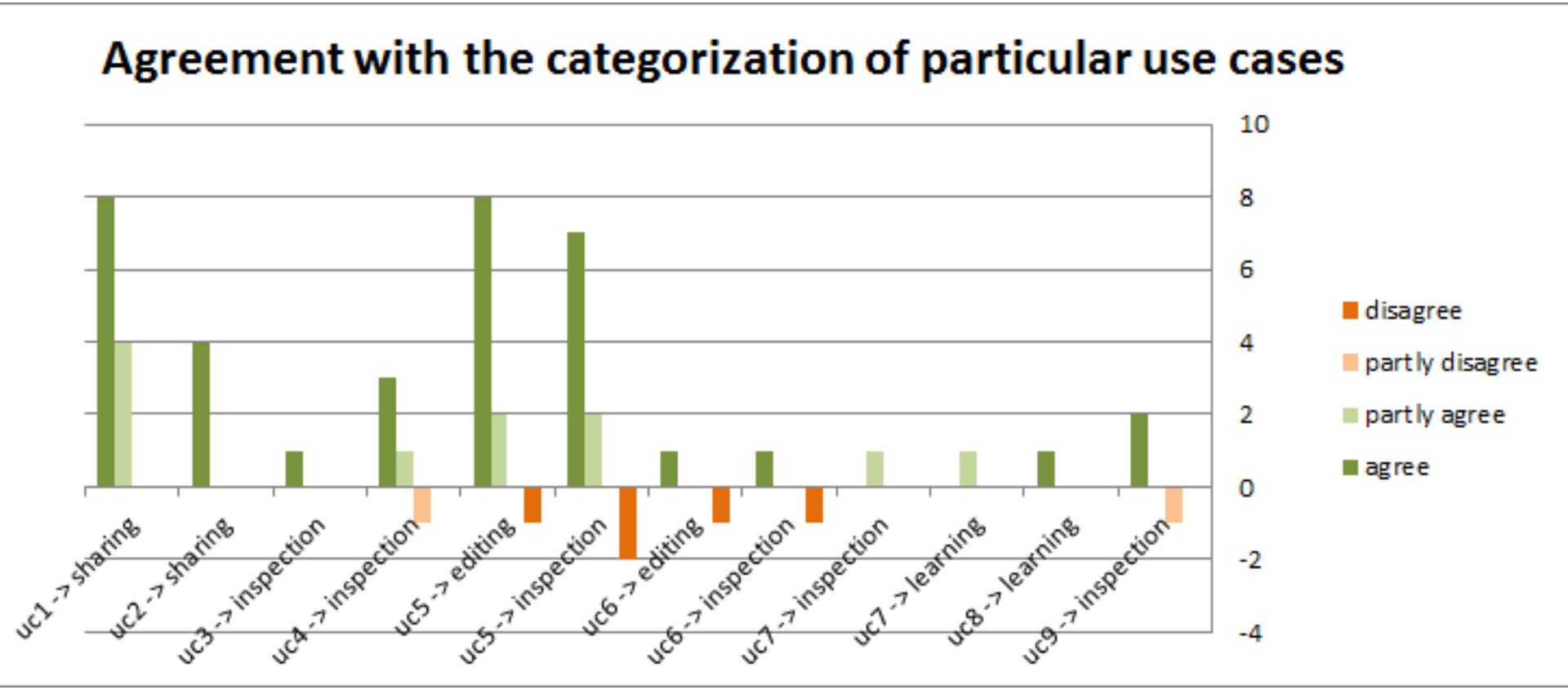
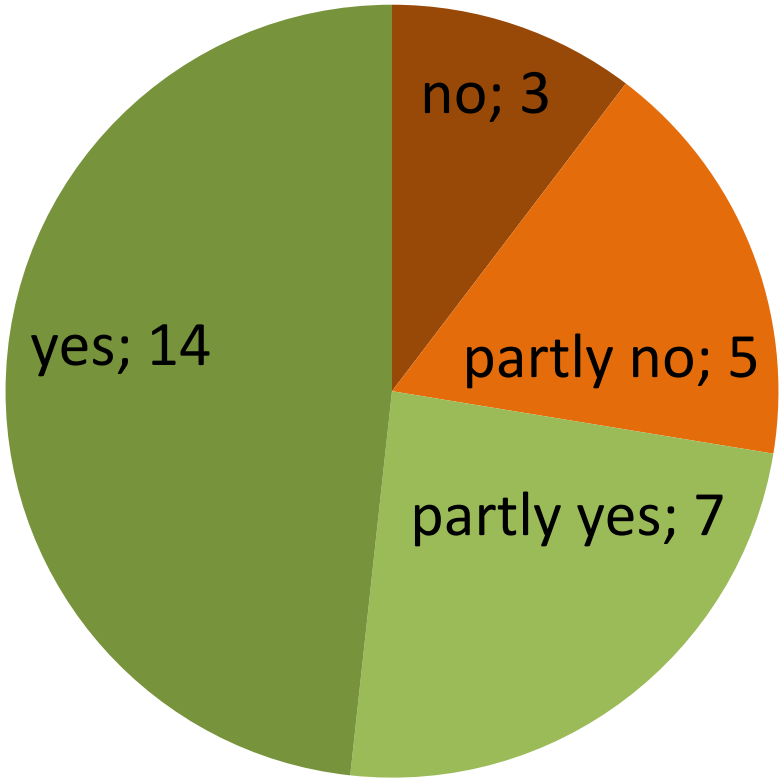


# Satisfaction with the Consultation Results



# Conclusion

- We designed a recommender for ontology visualization tools whose input is
  - Use case: what is the purpose of the visualization
  - Ontology complexity: what OWL features are used
  - Ontology size
- For the use cases, we defined 4 categories
- We measured suitability of each tool for each category according to level of implementation of interface features relevant for that category
- Evaluation via a questionnaire with 32 respondents: they rather agree with
  - Our use case categorization system
  - Suitability of the tools for various use case categories
  - Results given by the recommender

# Thanks for your attention

- Questions?