Protégé Tutorial

Protégé – What and Where

What is Protégé? (from their webpage)

A free, open-source ontology editor and framework for building intelligent systems

Protégé is supported by a strong community of academic, government, and corporate users, who use Protégé to build knowledge-based solutions in areas as diverse as biomedicine, e-commerce, and organisational modelling.

Where to get it: `http://protege.stanford.edu/`

Useful resources

- `http://mowl-power.cs.man.ac.uk/protegeowltutorial/resources/ProtegeOWLTutorialP4_v1_3.pdf`

  NOTE: the manual is for version 4, but the current version is 5.1
- `http://protegewiki.stanford.edu/wiki/Main_Page`

Protégé – What and Where (cont'd)

Specifically, Protégé is

- a java-based application (multi-platform)
- thought for a variety of people (more than 300 thousands users)
- a GUI to help the editing of ontologies

  creation, modification, reasoning, debugging, . . .

Syntax – DL, OWL, Manchester

Protégé uses the Manchester syntax

DL	OWL	Manchester
$\top$	owl:Thing	owl:Thing
$\bot$	owl:Nothing	owl:Nothing
Concept name	Class	Class
Role name	Object property	Object property
$\neg C$	ObjectComplementOf(C)	not C
$C \sqcup D$	ObjectUnionOf(C D)	C or D
$C \sqcap D$	ObjectIntersectionOf(C D)	C and D
$\exists r.C$	ObjectSomeValuesFrom(r C)	r some C
$\forall r.C$	ObjectAllValuesFrom(r C)	r only C
$(\geq n\ r.C)$	ObjectMinCardinality(n r C)	r min n C
$(\leq n\ r.C)$	ObjectMaxCardinality(n r C)	r max n C
$(= n\ r.C)$	ObjectExactCardinality(n r C)	r exactly n C

`https://www.w3.org/TR/owl2-manchester-syntax/`

Syntax – DL, OWL, Manchester – Example

DL

$Person \sqcap \exists hasGender.Male$

$(= 2\ hasWheel.FrontWheel) \sqcap (= 2\ hasWheel.RearWheel)$

OWL (omitting “Object” for succinctness)

IntersectionOf(Person SomeValuesFrom(hasGender Male))

IntersectionOf(ExactCardinality(2 hasWheel FrontWheel) ExactCardinality(2 hasWheel RearWheel))

Manchester

Person and (hasGender some Male)

(hasWheel exactly 2 FrontWheel) and (hasWheel exactly 2 RearWheel)

Convention

- concept names begin with an uppercase letter
- role names begin with a lowercase letter
- CamelBack notation for both concept and role names

An Ontology about Video Games

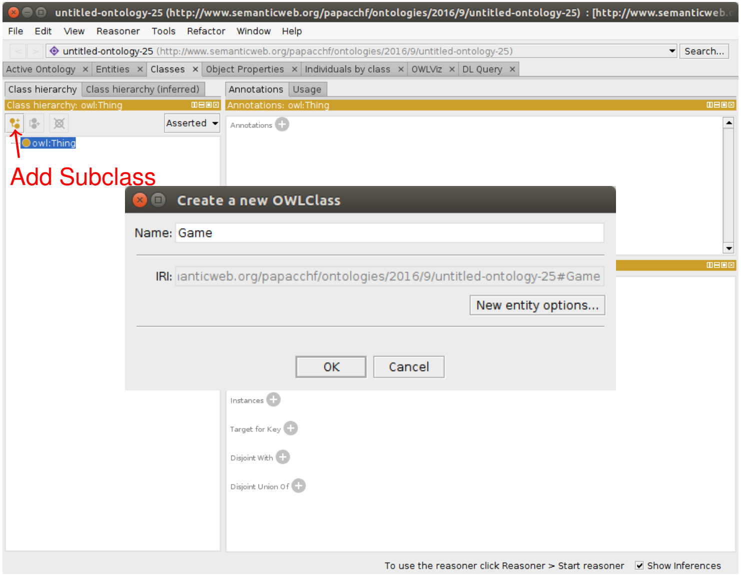
Assume we want to build an ontology about video games as follows.

self-standing	modifiers	relations	definable
- Game	- Genre	hasDifficulty	MultiPlatform
- NamedGame	- SinglePlayer	hasPlatform	PuzzleGame
- LoL	- MultiPlayer	hasGenre	HardGame
- Chess	- Puzzle		NormalGame
- Sudoku	- RolePlayGame		EasyGame
- WoW	- Online		LinuxGame
- Platform	- Difficulty		WindowsGame
- Windows	- Hard		MacOSXGame
- MacOSX	- Normal		...
- Linux	- Easy		

Adding Classes

Make sure to have the "Classes" tab open

Window → Tabs → Classes


untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25) : [http://www.semanticweb.
File Edit View Reasoner Tools Refactor Window Help
untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)
Search...
Active Ontology
Entities
Classes
Object Properties
Individuals by class
OWLViz
DL Query
Class hierarchy
Class hierarchy (inferred)
Annotations
Usage
Class hierarchy: owl:Thing
Annotations: owl:Thing
Asserted
owl:Thing
Annotations
Add Subclass
Instances
Target for Key
Disjoint With
Disjoint Union Of
To use the reasoner click Reasoner > Start reasoner
Show Inferences

Create a new OWLClass

Name: Game

IRI: ıanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25#Game

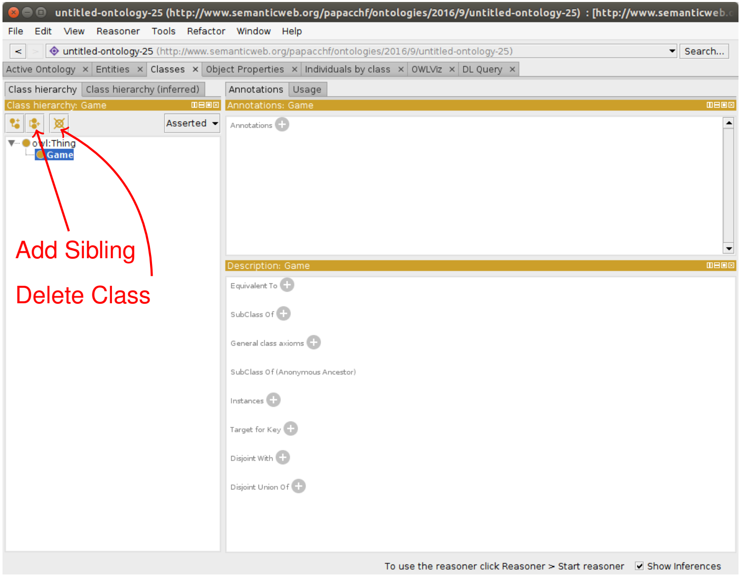
New entity options...

OK Cancel

Adding Classes

Make sure to have the "Classes" tab open

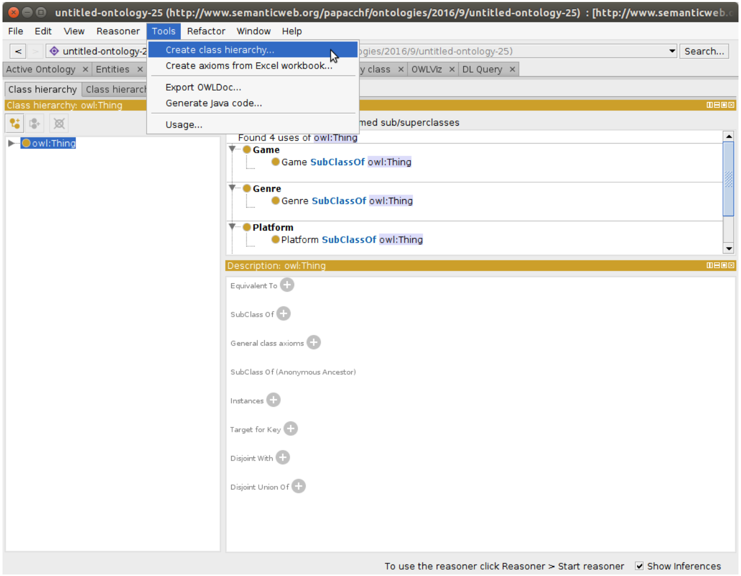
Window $\rightarrow$ Tabs $\rightarrow$ Classes



Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy. . .



Found 4 uses of owl:Thing

Game
Game SubClassOf owl:Thing

Genre
Genre SubClassOf owl:Thing

Platform
Platform SubClassOf owl:Thing

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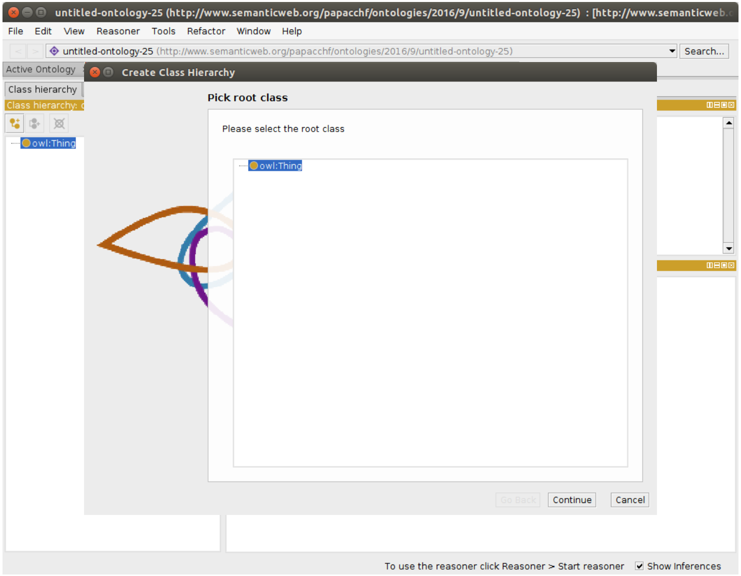
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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)
Search...
Active Ontology
Class hierarchy
Class hierarchy: c
owl:Thing
Create Class Hierarchy
Pick root class
Go Back
Continue
Cancel
Show Inferences

Please select the root class

owl:Thing

To use the reasoner click Reasoner > Start reasoner

Adding Class Hierarchies

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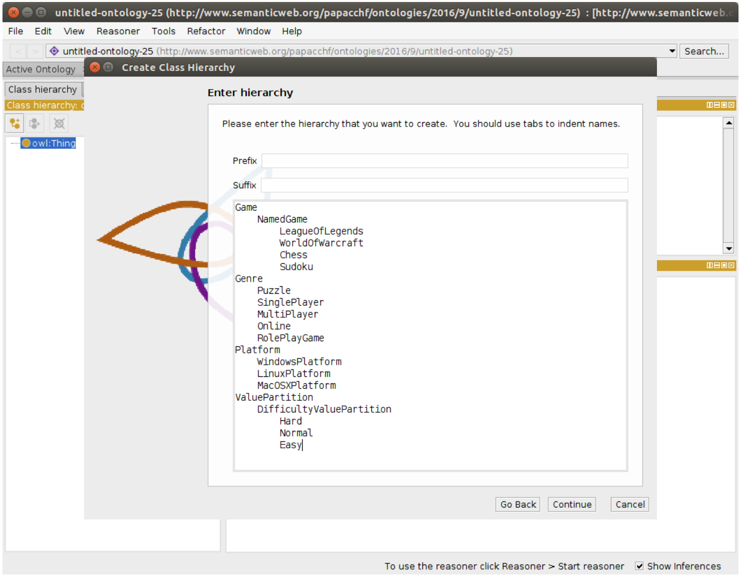
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Search...
Active Ontology
Class hierarchy
Class hierarchy:
owl:Thing
Create Class Hierarchy
Go Back
Continue
Cancel
To use the reasoner click Reasoner > Start reasoner
Show Inferences

Enter hierarchy

Please enter the hierarchy that you want to create. You should use tabs to indent names.

Prefix

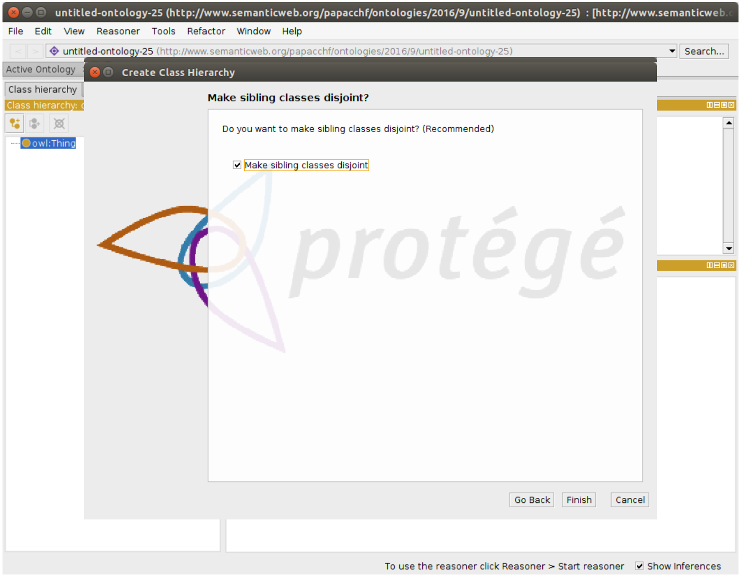
Suffix

```
Game
	NamedGame
		LeagueOfLegends
		WorldOfWarcraft
		Chess
		Sudoku
Genre
	Puzzle
	SinglePlayer
	MultiPlayer
	Online
	RolePlayGame
Platform
	WindowsPlatform
	LinuxPlatform
	MacOSXPlatform
ValuePartition
	DifficultyValuePartition
		Hard
		Normal
		Easy
```

Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy. . .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Create Class Hierarchy

Make sibling classes disjoint?

Do you want to make sibling classes disjoint? (Recommended)

- [x] Make sibling classes disjoint

To use the reasoner click Reasoner > Start reasoner

Adding Class Hierarchies

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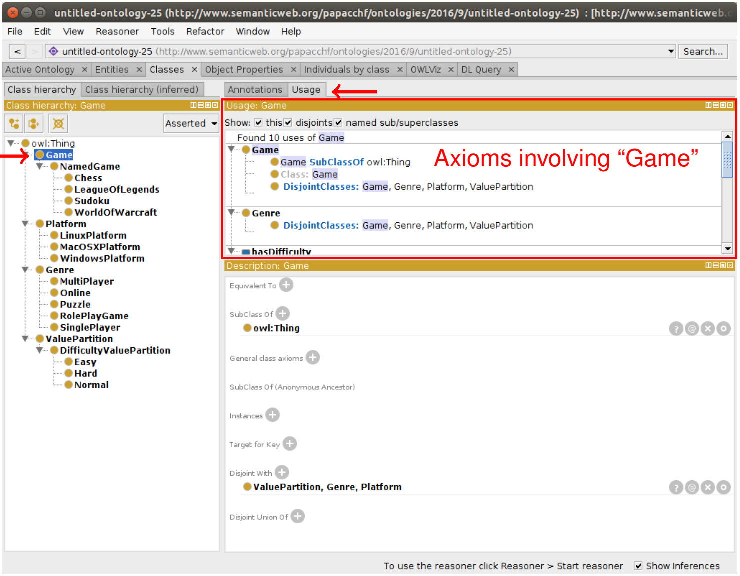
Tools → Create class hierarchy. . .



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Entities
Classes
Object Properties
Individuals by class
OWLViz
DL Query
Class hierarchy
Class hierarchy (inferred)
Annotations
Usage
Class hierarchy: Game
Asserted
Usage: Game
Description: Game
Axioms involving “Game”

```
owl:Thing
  Game
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

Show: ✓ this ✓ disjoints ✓ named sub/superclasses

Found 10 uses of Game

```
Game
  Game SubClassOf owl:Thing
  Class: Game
  DisjointClasses: Game, Genre, Platform, ValuePartition
Genre
  DisjointClasses: Game, Genre, Platform, ValuePartition
hasDifficulty
```

Equivalent To

SubClass Of
- owl:Thing

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

Target for Key

Disjoint With
- ValuePartition, Genre, Platform

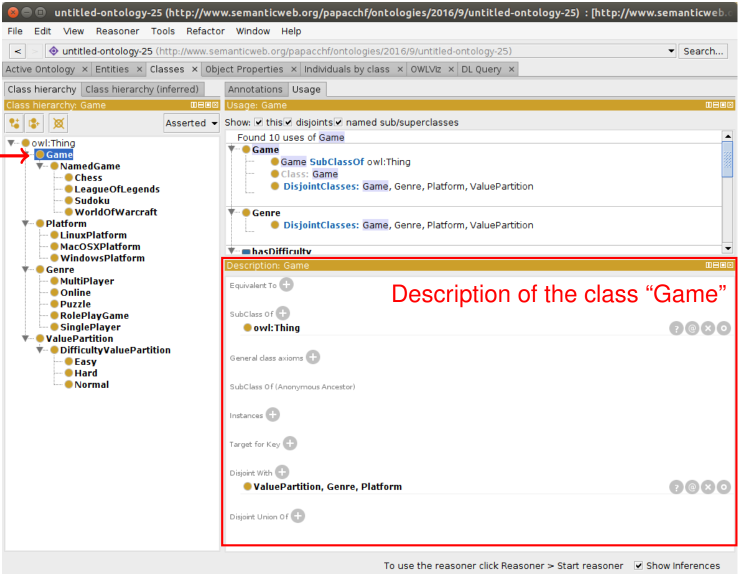
Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy...



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Search...
Active Ontology × Entities × Classes × Object Properties × Individuals by class × OWLViz × DL Query ×
Class hierarchy | Class hierarchy (inferred)
Class hierarchy: Game
Asserted
Annotations | Usage
Usage: Game

```
owl:Thing
  Game
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
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  Genre
    MultiPlayer
    Online
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    DifficultyValuePartition
      Easy
      Hard
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Show: ✓ this ✓ disjoints ✓ named sub/superclasses

Found 10 uses of Game

```
Game
  Game SubClassOf owl:Thing
  Class: Game
  DisjointClasses: Game, Genre, Platform, ValuePartition
Genre
  DisjointClasses: Game, Genre, Platform, ValuePartition
hasDifficulty
```

Description: Game

Description of the class “Game”

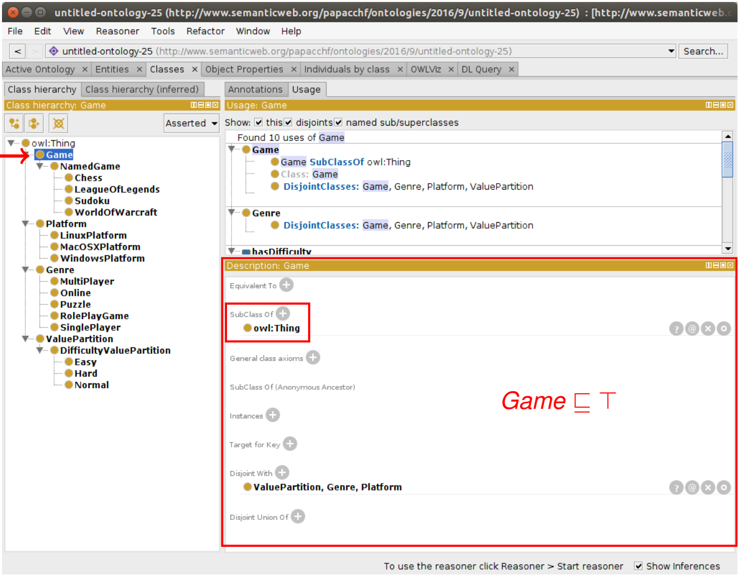
- Equivalent To
- SubClass Of
  - owl:Thing
- General class axioms
- SubClass Of (Anonymous Ancestor)
- Instances
- Target for Key
- Disjoint With
  - ValuePartition, Genre, Platform
- Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy. . .



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Active Ontology | Entities | Classes | Object Properties | Individuals by class | OWLViz | DL Query

Class hierarchy | Class hierarchy (inferred)

Class hierarchy: Game — Asserted

- owl:Thing
  - Game
    - NamedGame
      - Chess
      - LeagueOfLegends
      - Sudoku
      - WorldOfWarcraft
  - Platform
    - LinuxPlatform
    - MacOSXPlatform
    - WindowsPlatform
  - Genre
    - MultiPlayer
    - Online
    - Puzzle
    - RolePlayGame
    - SinglePlayer
  - ValuePartition
    - DifficultyValuePartition
      - Easy
      - Hard
      - Normal

Annotations | Usage

Usage: Game

Show: ✓ this ✓ disjoints ✓ named sub/superclasses

Found 10 uses of Game

- Game
  - Game SubClassOf owl:Thing
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Description: Game

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Instances

Target for Key

Disjoint With
- ValuePartition, Genre, Platform

Disjoint Union Of

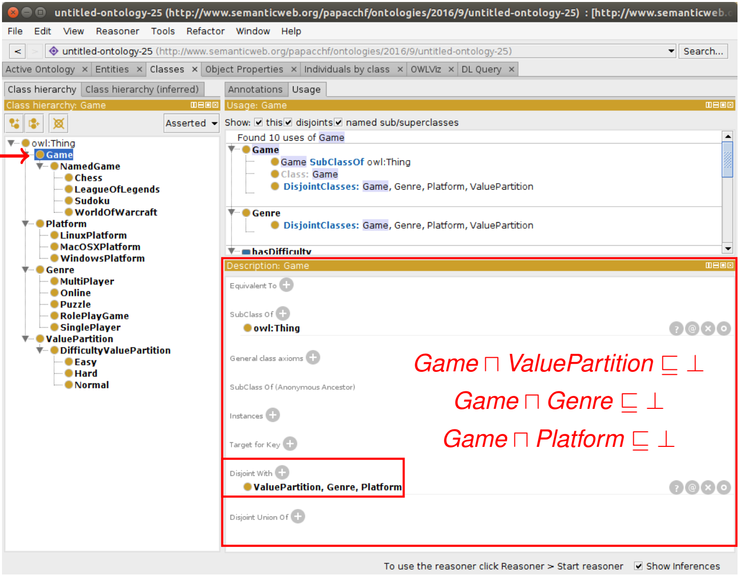
$Game \sqsubseteq \top$

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy…



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Show: ✓ this ✓ disjoints ✓ named sub/superclasses

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Instances

Target for Key

Disjoint With
- ValuePartition, Genre, Platform

Disjoint Union Of

$$Game \sqcap ValuePartition \sqsubseteq \bot$$

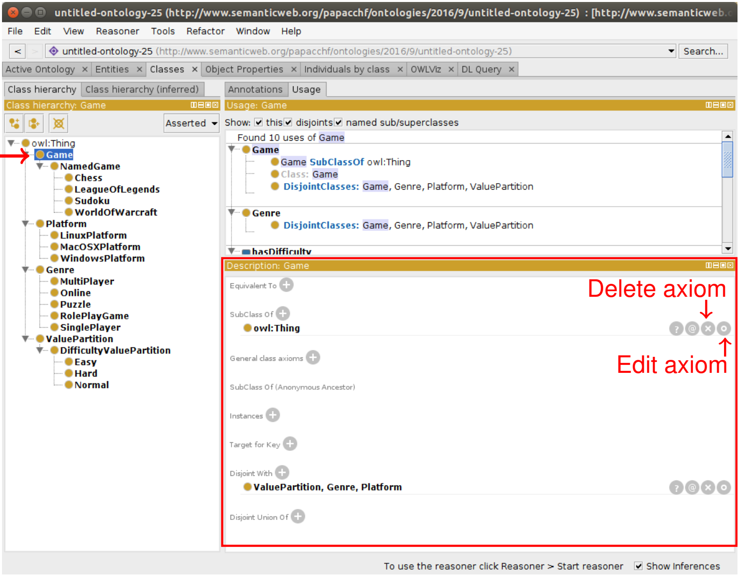
$$Game \sqcap Genre \sqsubseteq \bot$$

$$Game \sqcap Platform \sqsubseteq \bot$$

Adding Class Hierarchies

It allows us to speed up the process of adding classes.

Tools → Create class hierarchy. . .



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Target for Key

Disjoint With
- ValuePartition, Genre, Platform

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

What Now?

What we have…

- all non-definable classes
- an initial class hierarchy
- basic (among siblings) disjoint axioms

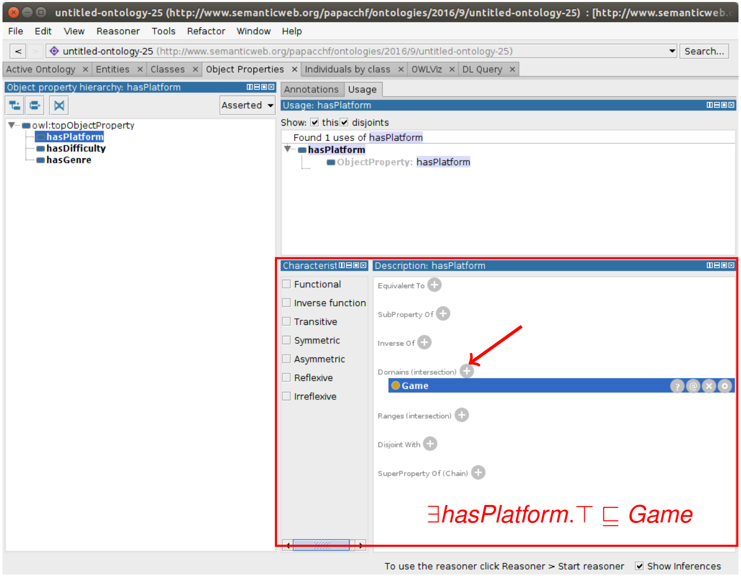
What we need to add…

- object properties
- relations between classes
- definable classes

Object Properties (Domain and Range)

Make sure to have the "Object Properties" tab open

Window $\rightarrow$ Tabs $\rightarrow$ Object Properties



$\exists hasPlatform.\top \sqsubseteq Game$

Object Properties (Domain and Range)

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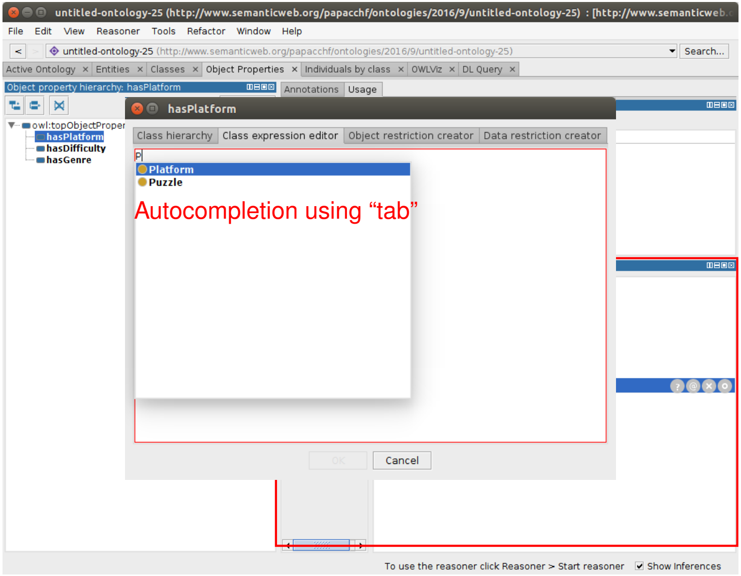
Window → Tabs → Object Properties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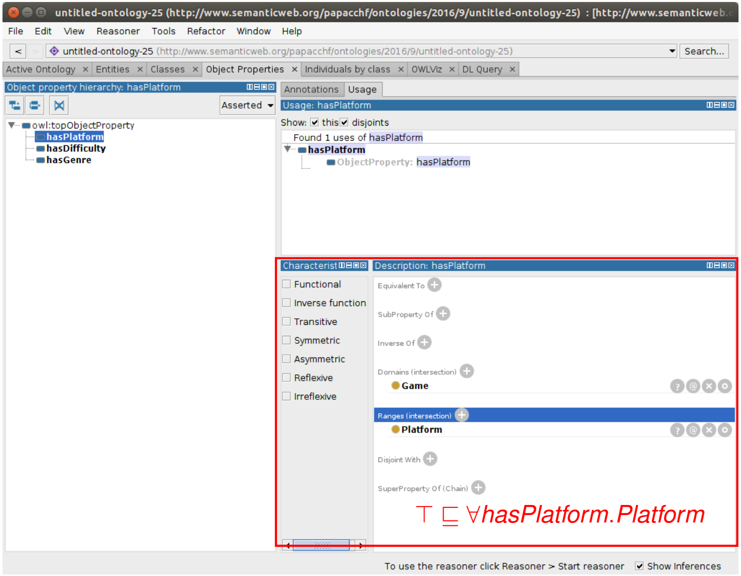
Search...
Active Ontology Entities Classes Object Properties Individuals by class OWLViz DL Query
Object property hierarchy: hasPlatform
Annotations Usage
owl:topObjectProper
hasPlatform
hasDifficulty
hasGenre
hasPlatform
Class hierarchy Class expression editor Object restriction creator Data restriction creator
P
Platform
Puzzle
Autocompletion using “tab”
OK Cancel
To use the reasoner click Reasoner > Start reasoner
Show Inferences

Object Properties (Domain and Range)

Make sure to have the "Object Properties" tab open

Window $\rightarrow$ Tabs $\rightarrow$ Object Properties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Search...
Active Ontology
Entities
Classes
Object Properties
Individuals by class
OWLViz
DL Query

Object property hierarchy: hasPlatform

Asserted

- owl:topObjectProperty
  - **hasPlatform**
  - **hasDifficulty**
  - **hasGenre**

Annotations | Usage

Usage: hasPlatform

Show: ☑ this ☑ disjoints

Found 1 uses of hasPlatform

- **hasPlatform**
  - ObjectProperty: hasPlatform

Characteristics

- ☐ Functional
- ☐ Inverse function
- ☐ Transitive
- ☐ Symmetric
- ☐ Asymmetric
- ☐ Reflexive
- ☐ Irreflexive

Description: hasPlatform

Equivalent To

SubProperty Of

Inverse Of

Domains (intersection)

- **Game**

Ranges (intersection)

- **Platform**

Disjoint With

SuperProperty Of (Chain)

$\top \sqsubseteq \forall hasPlatform.Platform$

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Adding Axioms

Which axioms?

- only axioms of the following forms
  - $A \sqsubseteq C$ (necessary condition for A)
  - $A \equiv C$ (sufficient and necessary condition for A – definition)
- for each subclass of NamedGame we need to insert axioms expressing something like
  - Chess can be installed on any platform
  - League of Legends is an online game
- DifficultyValuePartition need to be properly defined

  (i.e., its values can only be Hard, Normal, or Easy)
- adding definable classes

$A \sqsubseteq C$ – Example

- Natural language specification

  Chess can be installed on any platform

- Rephrase the specification using the ontology vocabulary

  Chess has platform Windows, has platform MacOSX, and has platform Linux

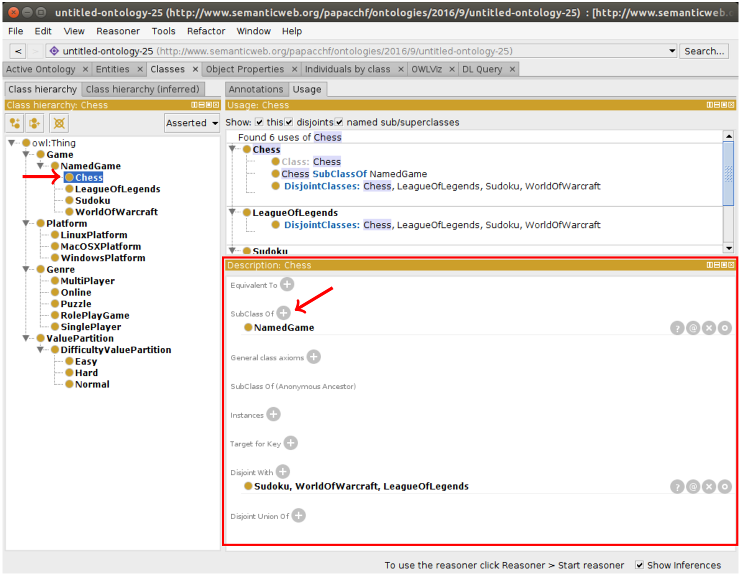
- Write it in description logic syntax (optional)

  $Chess \sqsubseteq \exists hasPlatform.WindowsPlatform$
  $Chess \sqsubseteq \exists hasPlatform.MacOSXPlatform$
  $Chess \sqsubseteq \exists hasPlatform.LinuxPlatform$

- Write it in Manchester syntax (the right-hand side is enough)

  hasPlatform some WindowsPlatform
  hasPlatform some MacOSXPlatform
  hasPlatform some LinuxPlatform

Adding Axioms to the Class “Chess”



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Class hierarchy
Class hierarchy (inferred)
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Usage
Class hierarchy: Chess
Asserted
Usage: Chess
Show: ✓ this ✓ disjoints ✓ named sub/superclasses

owl:Thing
- Game
  - NamedGame
    - Chess
    - LeagueOfLegends
    - Sudoku
    - WorldOfWarcraft
- Platform
  - LinuxPlatform
  - MacOSXPlatform
  - WindowsPlatform
- Genre
  - MultiPlayer
  - Online
  - Puzzle
  - RolePlayGame
  - SinglePlayer
- ValuePartition
  - DifficultyValuePartition
    - Easy
    - Hard
    - Normal

Found 6 uses of Chess

- Chess
  - Class: Chess
  - Chess SubClassOf NamedGame
  - DisjointClasses: Chess, LeagueOfLegends, Sudoku, WorldOfWarcraft
- LeagueOfLegends
  - DisjointClasses: Chess, LeagueOfLegends, Sudoku, WorldOfWarcraft
- Sudoku

Description: Chess

Equivalent To

SubClass Of
- NamedGame

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

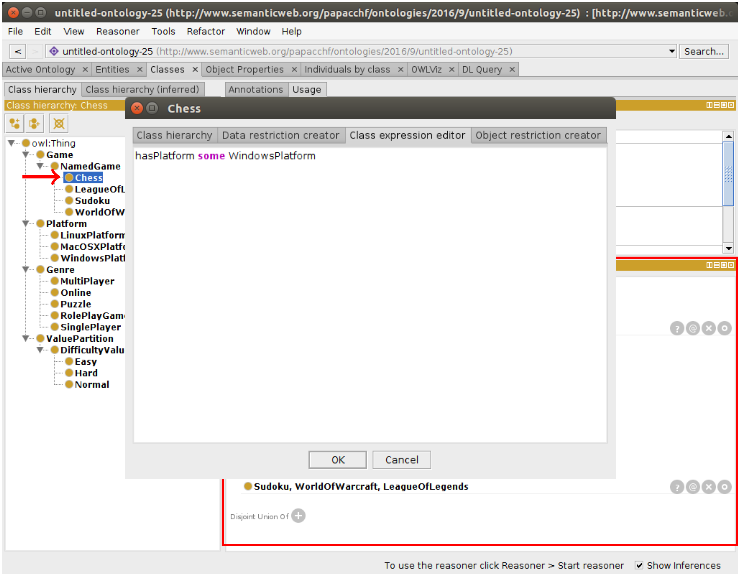
Target for Key

Disjoint With
- Sudoku, WorldOfWarcraft, LeagueOfLegends

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

Adding Axioms to the Class "Chess"



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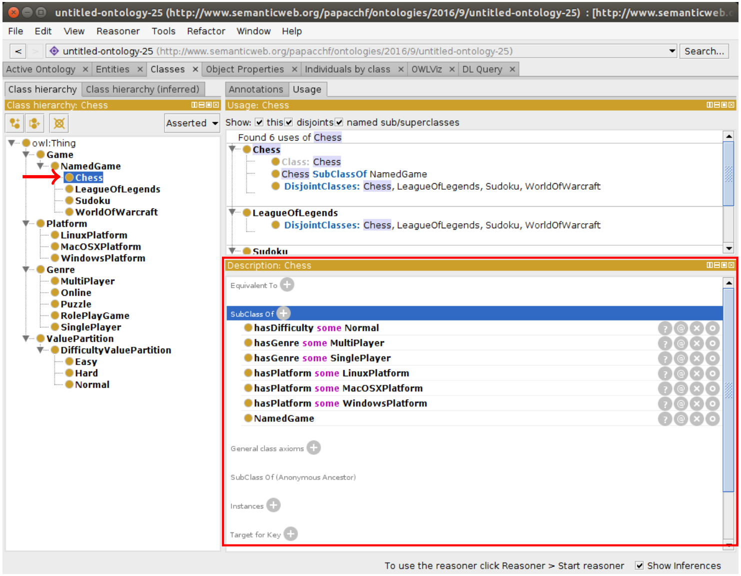
Search...
Active Ontology × Entities × Classes × Object Properties × Individuals by class × OWLViz × DL Query ×
Class hierarchy | Class hierarchy (inferred)
Annotations | Usage
Class hierarchy: Chess
owl:Thing
Game
NamedGame
Chess
LeagueOfL
Sudoku
WorldOfW
Platform
LinuxPlatforn
MacOSXPlatf
WindowsPlat
Genre
MultiPlayer
Online
Puzzle
RolePlayGam
SinglePlayer
ValuePartition
DifficultyValu
Easy
Hard
Normal
Chess
Class hierarchy | Data restriction creator | Class expression editor | Object restriction creator
OK
Cancel
Sudoku, WorldOfWarcraft, LeagueOfLegends
Disjoint Union Of
To use the reasoner click Reasoner > Start reasoner
Show Inferences

```
hasPlatform some WindowsPlatform
```

Adding Axioms to the Class “Chess”



untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25) : [http://www.semanticweb.

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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)
Search...
Active Ontology
Entities
Classes
Object Properties
Individuals by class
OWLViz
DL Query
Class hierarchy
Class hierarchy (inferred)
Annotations
Usage
Class hierarchy: Chess
Asserted
Usage: Chess
Show: ✓ this ✓ disjoints ✓ named sub/superclasses

```
owl:Thing
  Game
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

Found 6 uses of Chess

```
Chess
    Class: Chess
    Chess SubClassOf NamedGame
    DisjointClasses: Chess, LeagueOfLegends, Sudoku, WorldOfWarcraft
LeagueOfLegends
    DisjointClasses: Chess, LeagueOfLegends, Sudoku, WorldOfWarcraft
Sudoku
```

Description: Chess

Equivalent To

SubClass Of

```
hasDifficulty some Normal
hasGenre some MultiPlayer
hasGenre some SinglePlayer
hasPlatform some LinuxPlatform
hasPlatform some MacOSXPlatform
hasPlatform some WindowsPlatform
NamedGame
```

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

Target for Key

To use the reasoner click Reasoner > Start reasoner ✓ Show Inferences

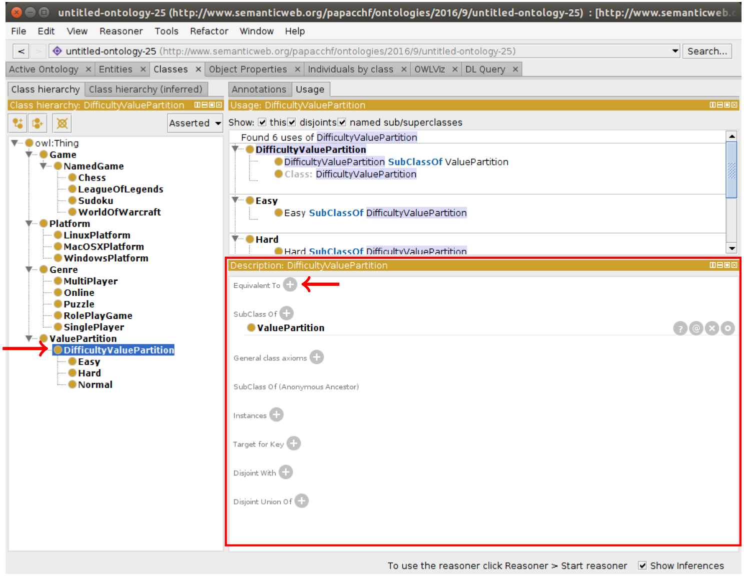
Improving DifficultyValuePartition Definition

What needs to be done?

- add $\mathit{DifficultyValuePartition} \equiv \mathit{Hard} \sqcup \mathit{Normal} \sqcup \mathit{Easy}$

  Note that Hard, Normal and Easy are already disjoint
- add domain and range of hasDifficulty
- make hasDifficulty functional

Improving DifficultyValuePartition Definition (cont'd)



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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)

Active Ontology | Entities | Classes | Object Properties | Individuals by class | OWLViz | DL Query

Class hierarchy | Class hierarchy (inferred)

Class hierarchy: DifficultyValuePartition

Asserted

- owl:Thing
  - Game
    - NamedGame
      - Chess
      - LeagueOfLegends
      - Sudoku
      - WorldOfWarcraft
  - Platform
    - LinuxPlatform
    - MacOSXPlatform
    - WindowsPlatform
  - Genre
    - MultiPlayer
    - Online
    - Puzzle
    - RolePlayGame
    - SinglePlayer
  - ValuePartition
    - DifficultyValuePartition
      - Easy
      - Hard
      - Normal

Annotations | Usage

Usage: DifficultyValuePartition

Show: ☑ this ☑ disjoints ☑ named sub/superclasses

Found 6 uses of DifficultyValuePartition

- DifficultyValuePartition
  - DifficultyValuePartition SubClassOf ValuePartition
  - Class: DifficultyValuePartition
- Easy
  - Easy SubClassOf DifficultyValuePartition
- Hard
  - Hard SubClassOf DifficultyValuePartition

Description: DifficultyValuePartition

Equivalent To

SubClass Of
- ValuePartition

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

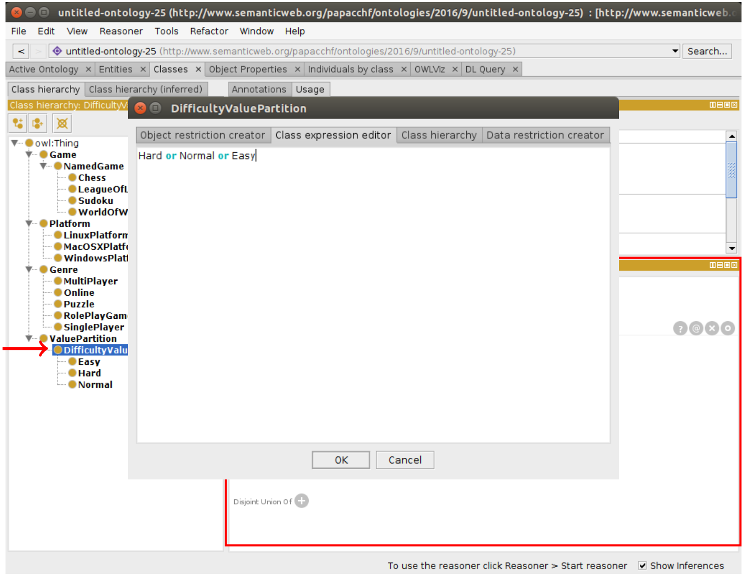
Target for Key

Disjoint With

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Improving DifficultyValuePartition Definition (cont'd)



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Active Ontology | Entities | Classes | Object Properties | Individuals by class | OWLViz | DL Query

Class hierarchy | Class hierarchy (inferred) | Annotations | Usage

Class hierarchy: DifficultyV

- owl:Thing
  - Game
    - NamedGame
      - Chess
      - LeagueOfL
      - Sudoku
      - WorldOfW
  - Platform
    - LinuxPlatform
    - MacOSXPlatf
    - WindowsPlat
  - Genre
    - MultiPlayer
    - Online
    - Puzzle
    - RolePlayGam
    - SinglePlayer
  - ValuePartition
    - DifficultyValu
      - Easy
      - Hard
      - Normal

DifficultyValuePartition

Object restriction creator | Class expression editor | Class hierarchy | Data restriction creator

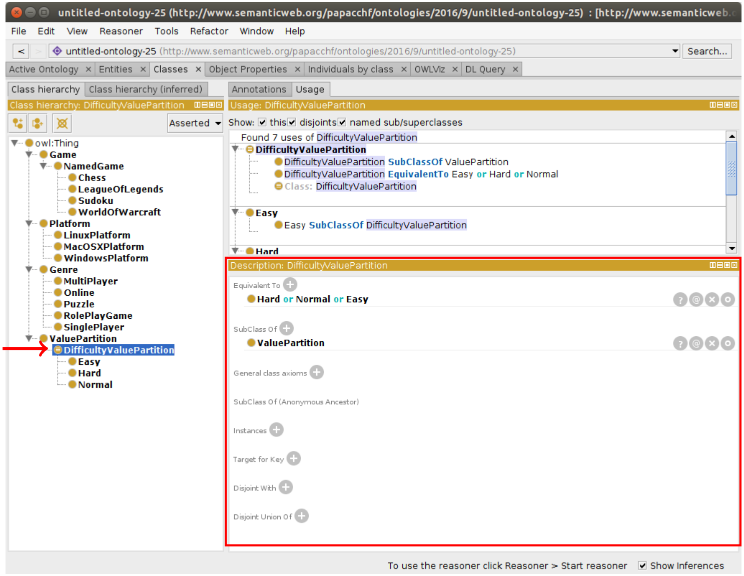
```
Hard or Normal or Easy
```

OK | Cancel

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Improving DifficultyValuePartition Definition (cont'd)



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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)

Active Ontology | Entities | Classes | Object Properties | Individuals by class | OWLViz | DL Query

Class hierarchy | Class hierarchy (inferred)

Class hierarchy: DifficultyValuePartition

Asserted

```
owl:Thing
  Game
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

Annotations | Usage

Usage: DifficultyValuePartition

Show: ☑ this ☑ disjoints ☑ named sub/superclasses

Found 7 uses of DifficultyValuePartition

```
DifficultyValuePartition
  DifficultyValuePartition SubClassOf ValuePartition
  DifficultyValuePartition EquivalentTo Easy or Hard or Normal
  Class: DifficultyValuePartition
Easy
  Easy SubClassOf DifficultyValuePartition
Hard
```

Description: DifficultyValuePartition

Equivalent To
Hard or Normal or Easy

SubClass Of
ValuePartition

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

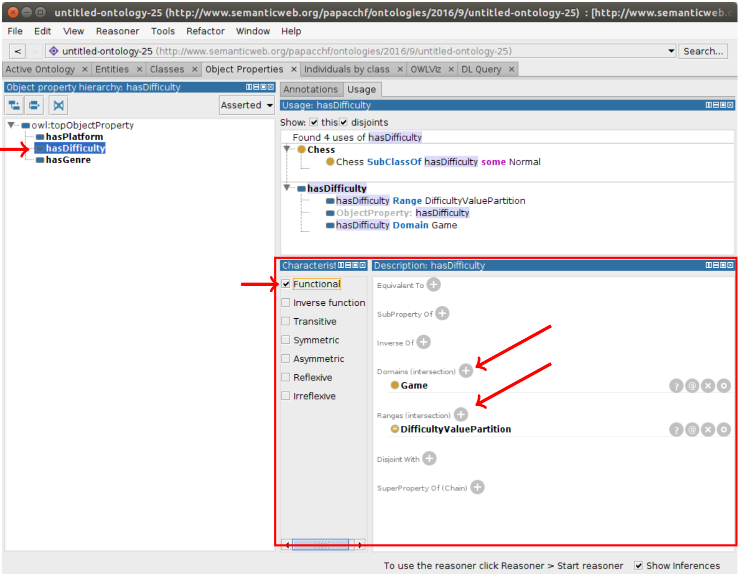
Target for Key

Disjoint With

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Improving DifficultyValuePartition Definition (cont'd)



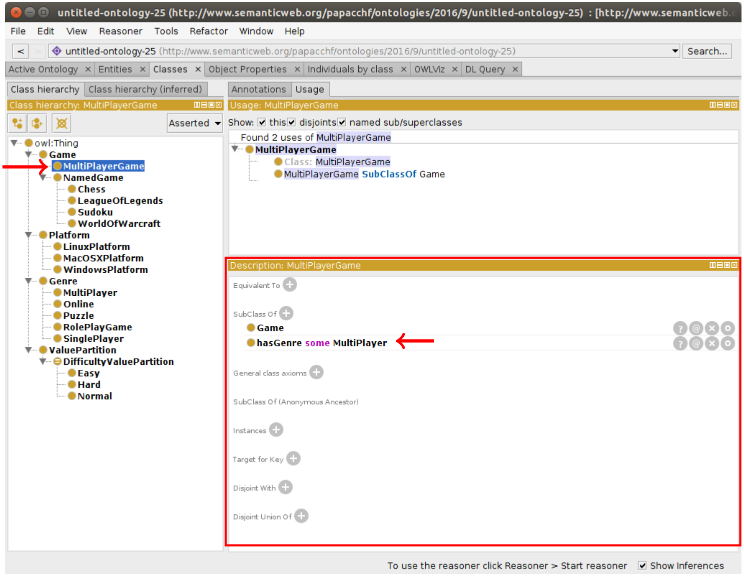
Found 4 uses of hasDifficulty

- Chess
  - Chess SubClassOf hasDifficulty some Normal
- hasDifficulty
  - hasDifficulty Range DifficultyValuePartition
  - ObjectProperty: hasDifficulty
  - hasDifficulty Domain Game

- [✓] Functional
- [ ] Inverse function
- [ ] Transitive
- [ ] Symmetric
- [ ] Asymmetric
- [ ] Reflexive
- [ ] Irreflexive

To use the reasoner click Reasoner > Start reasoner   [✓] Show Inferences

Adding Definable Class “MultiPlayerGame”



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Active Ontology | Entities | Classes | Object Properties | Individuals by class | OWLViz | DL Query

Class hierarchy | Class hierarchy (inferred)

Class hierarchy: MultiPlayerGame

Asserted

```
owl:Thing
  Game
    MultiPlayerGame
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

Annotations | Usage

Usage: MultiPlayerGame

Show: ☑ this ☑ disjoints ☑ named sub/superclasses

Found 2 uses of MultiPlayerGame

```
MultiPlayerGame
  Class: MultiPlayerGame
  MultiPlayerGame SubClassOf Game
```

Description: MultiPlayerGame

Equivalent To

SubClass Of
- Game
- hasGenre some MultiPlayer

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

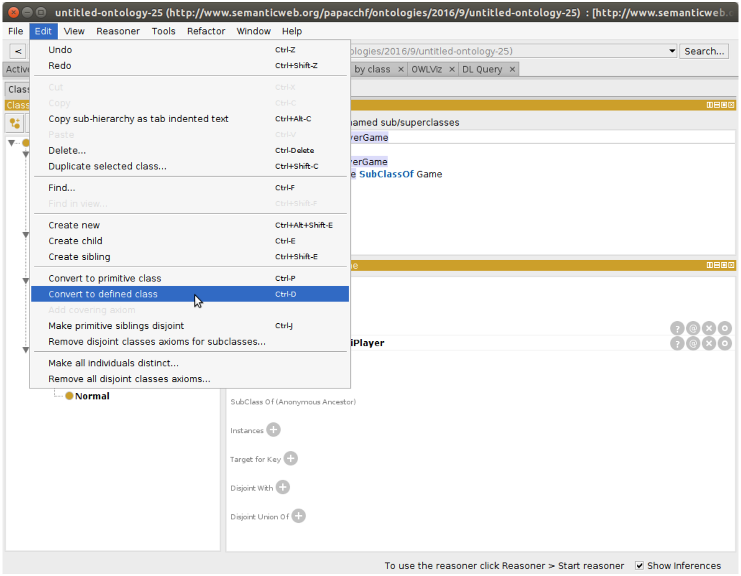
Target for Key

Disjoint With

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Adding Definable Class “MultiPlayerGame”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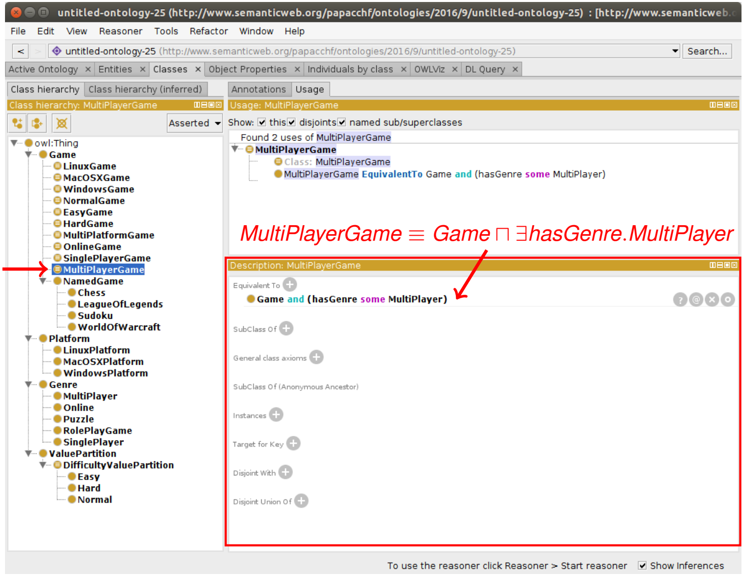
File
Edit
View
Reasoner
Tools
Refactor
Window
Help
Undo Ctrl-Z
Redo Ctrl+Shift-Z
Cut Ctrl-X
Copy Ctrl-C
Copy sub-hierarchy as tab indented text Ctrl+Alt-C
Paste Ctrl-V
Delete... Ctrl-Delete
Duplicate selected class... Ctrl+Shift-C
Find... Ctrl-F
Find in view... Ctrl+Shift-F
Create new Ctrl+Alt+Shift-E
Create child Ctrl-E
Create sibling Ctrl+Shift-E
Convert to primitive class Ctrl-P
Convert to defined class Ctrl-D
Add covering axiom
Make primitive siblings disjoint Ctrl-J
Remove disjoint classes axioms for subclasses...
Make all individuals distinct...
Remove all disjoint classes axioms...
ologies/2016/9/untitled-ontology-25)
Search...
by class
OWLViz
DL Query
amed sub/superclasses
erGame
erGame
e SubClassOf Game
iPlayer
Normal
SubClass Of (Anonymous Ancestor)
Instances
Target for Key
Disjoint With
Disjoint Union Of
To use the reasoner click Reasoner > Start reasoner
Show Inferences

Adding Definable Class “MultiPlayerGame”



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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25)
Search...
Active Ontology
Entities
Classes
Object Properties
Individuals by class
OWLViz
DL Query
Class hierarchy
Class hierarchy (inferred)
Annotations
Usage
Class hierarchy: MultiPlayerGame
Asserted
Usage: MultiPlayerGame
Show: this disjoints named sub/superclasses

```
owl:Thing
  Game
    LinuxGame
    MacOSXGame
    WindowsGame
    NormalGame
    EasyGame
    HardGame
    MultiPlatformGame
    OnlineGame
    SinglePlayerGame
    MultiPlayerGame
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

```
Found 2 uses of MultiPlayerGame
MultiPlayerGame
    Class: MultiPlayerGame
    MultiPlayerGame EquivalentTo Game and (hasGenre some MultiPlayer)
```

$$MultiPlayerGame \equiv Game \sqcap \exists hasGenre.MultiPlayer$$

Description: MultiPlayerGame

Equivalent To
Game and (hasGenre some MultiPlayer)

SubClass Of

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

Target for Key

Disjoint With

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner

Show Inferences

Reasoning

Protégé can be used for reasoning tasks such as classification

- configure the reasoner

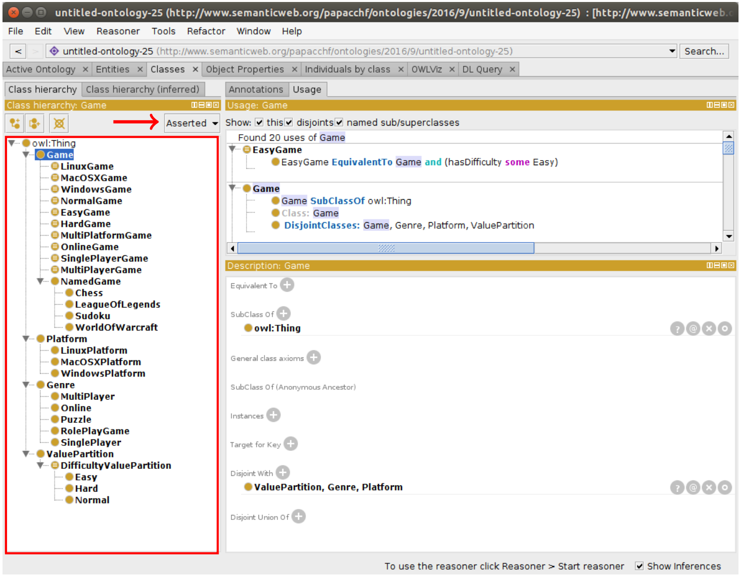
  Reasoner → Configure... (for this tutorial, check everything under Class inferences and Object property inferences)

- select a reasoner

  for example, Reasoner → HermiT (other reasoners can be added, which one to use depends on several factors such as the expressivity of the ontology)

- finally, Reasoner → Start reasoner

Reasoning Example



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untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25) Search...

Active Ontology × Entities × Classes × Object Properties × Individuals by class × OWLViz × DL Query ×

Class hierarchy | Class hierarchy (inferred)

Class hierarchy: Game

Asserted

```
owl:Thing
  Game
    LinuxGame
    MacOSXGame
    WindowsGame
    NormalGame
    EasyGame
    HardGame
    MultiPlatformGame
    OnlineGame
    SinglePlayerGame
    MultiPlayerGame
    NamedGame
      Chess
      LeagueOfLegends
      Sudoku
      WorldOfWarcraft
  Platform
    LinuxPlatform
    MacOSXPlatform
    WindowsPlatform
  Genre
    MultiPlayer
    Online
    Puzzle
    RolePlayGame
    SinglePlayer
  ValuePartition
    DifficultyValuePartition
      Easy
      Hard
      Normal
```

Annotations | Usage

Usage: Game

Show: ☑ this ☑ disjoints ☑ named sub/superclasses

Found 20 uses of Game

- EasyGame
  - EasyGame EquivalentTo Game and (hasDifficulty some Easy)
- Game
  - Game SubClassOf owl:Thing
  - Class: Game
  - DisjointClasses: Game, Genre, Platform, ValuePartition

Description: Game

Equivalent To

SubClass Of
- owl:Thing

General class axioms

SubClass Of (Anonymous Ancestor)

Instances

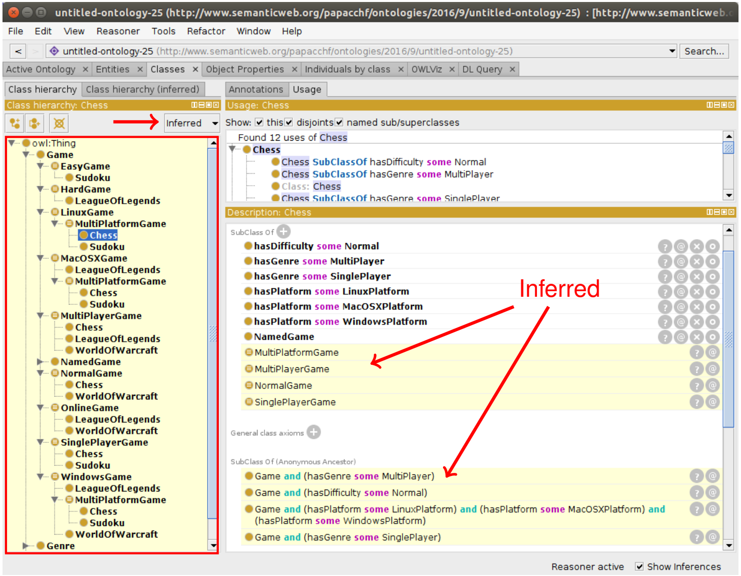
Target for Key

Disjoint With
- ValuePartition, Genre, Platform

Disjoint Union Of

To use the reasoner click Reasoner > Start reasoner ☑ Show Inferences

Reasoning Example


untitled-ontology-25 (http://www.semanticweb.org/papacchf/ontologies/2016/9/untitled-ontology-25) : [http://www.semanticweb.

Show: ☑ this ☑ disjoints ☑ named sub/superclasses

Found 12 uses of Chess

- Chess
  - Chess SubClassOf hasDifficulty some Normal
  - Chess SubClassOf hasGenre some MultiPlayer
  - Class: Chess
  - Chess SubClassOf hasGenre some SinglePlayer

```
owl:Thing
  Game
    EasyGame
      Sudoku
    HardGame
      LeagueOfLegends
    LinuxGame
      MultiPlatformGame
        Chess
        Sudoku
    MacOSXGame
      LeagueOfLegends
      MultiPlatformGame
        Chess
        Sudoku
    MultiPlayerGame
      Chess
      LeagueOfLegends
      WorldOfWarcraft
    NamedGame
    NormalGame
      Chess
      WorldOfWarcraft
    OnlineGame
      LeagueOfLegends
      WorldOfWarcraft
    SinglePlayerGame
      Chess
      Sudoku
    WindowsGame
      LeagueOfLegends
      MultiPlatformGame
        Chess
        Sudoku
      WorldOfWarcraft
  Genre
```

Description: Chess

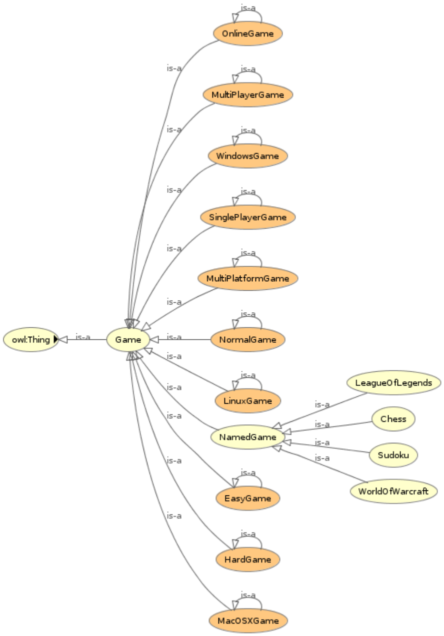
SubClass Of
- hasDifficulty some Normal
- hasGenre some MultiPlayer
- hasGenre some SinglePlayer
- hasPlatform some LinuxPlatform
- hasPlatform some MacOSXPlatform
- hasPlatform some WindowsPlatform
- NamedGame
- MultiPlatformGame
- MultiPlayerGame
- NormalGame
- SinglePlayerGame

General class axioms

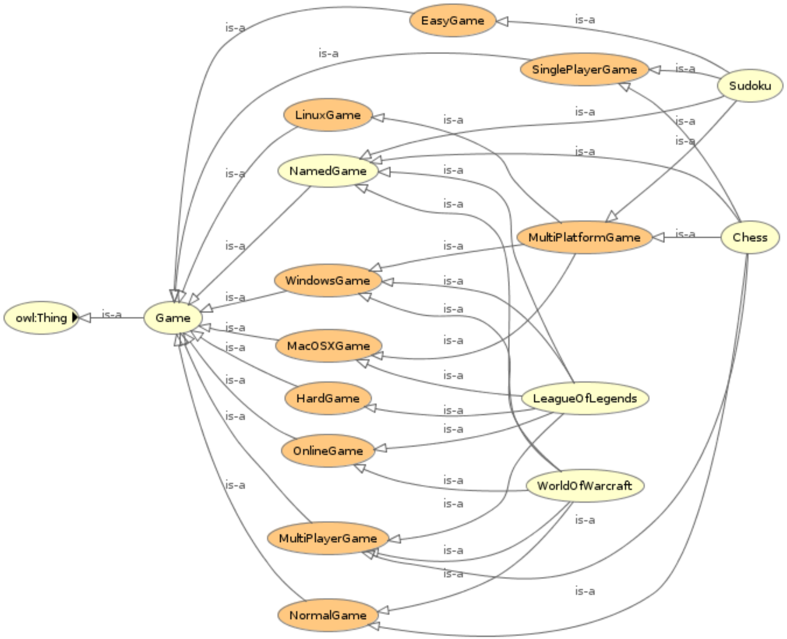
SubClass Of (Anonymous Ancestor)
- Game and (hasGenre some MultiPlayer)
- Game and (hasDifficulty some Normal)
- Game and (hasPlatform some LinuxPlatform) and (hasPlatform some MacOSXPlatform) and (hasPlatform some WindowsPlatform)
- Game and (hasGenre some SinglePlayer)

Reasoner active ☑ Show Inferences

Reasoning – Visually (Asserted)



Reasoning – Visually (Inferred)


EasyGame
SinglePlayerGame
Sudoku
LinuxGame
NamedGame
MultiPlatformGame
Chess
WindowsGame
owl:Thing
Game
MacOSXGame
HardGame
LeagueOfLegends
OnlineGame
WorldOfWarcraft
MultiPlayerGame
NormalGame
is-a