



Conceptual modelling in OWL

7th tutorial

Ontologies and Semantic Web

Michal Med

michal.med@fel.cvut.cz

Crash course Protégé

- Ontology editor supporting OWL
- Download from <http://protege.stanford.edu/> and install
- Install Pellet Reasoner plug-in (info about reasoner here: <https://github.com/stardog-union/pellet>)
- Go to Preferences → Plugins and change the Plugin registry to <https://raw.githubusercontent.com/Complexible/pellet/master/protege/plugin/plugins.repository>. You will need to restart Protege before the repository change is taken into account (a Protege bug).



What is OWL?

<https://www.w3.org/TR/owl2-primer/>

Ontology language for Semantic Web. Provides **classes, properties, individuals and data values**. Can be combined with RDF information.

Supports description logics.

Description logics in OWL - terminology

DL	OWL
concept	class
role	Object property
Constant/individual	individual
theory	ontology
axiom	axiom

Description logics in OWL - Manchester syntax

description logics syntax	Manchester syntax (OWL in Protégé)
$C_1 \sqsubseteq C_2$	C_1 SubClassOf C_2
$C_1 \equiv C_2$	C_1 EquivalentTo C_2
$C_1 \sqsubseteq \neg C_2$	C_1 DisjointWith C_2
$R_1 \sqsubseteq R_2$	R_1 SubPropertyOf R_2
$\neg C$	not C
$C_1 \sqcup C_2$	C_1 or C_2
$C_1 \sqcap C_2$	C_1 and C_2
$\exists R \cdot C$	R some C
$\forall R \cdot C$	R only C
$\exists R \cdot \{i\}$	R value $\{i\}$
$(\geq 2 R C)$	R min 2 C
$(\leq 2 R C)$	R max 2 C
R^-	inverse R

- Download Pizza ontology from <https://protege.stanford.edu/ontologies/pizza/pizza.owl> (RDF/XML serialization)
- Open Protégé and open Pizza ontology in it

Tutorial in Protégé

The screenshot shows the Protégé interface with the Pizza ontology loaded. The title bar indicates the ontology is located at `http://www.co-ode.org/ontologies/pizza/2.0.0`. The main interface is divided into several panels:

- Ontology header:** Shows the **Ontology IRI** as `http://www.co-ode.org/ontologies/pizza` and the **Ontology Version IRI** as `http://www.co-ode.org/ontologies/pizza/2.0.0`.
- Annotations:** Lists three annotations:
 - `rdfs:label` [type: xsd:string] with the value `pizza`.
 - `dc:title` [language: en] with the value `pizza`.
 - `dc:description` [language: en] with the value `An ontology about pizzas and their toppings.`
- Ontology metrics:** A table showing various counts:

Metric	Count
Axiom	801
Logical axiom count	322
Declaration axioms count	120
Class count	100
Object property count	8
Data property count	0
Individual count	5
Annotation Property count	12
- Ontology prefixes:** A table showing the mapping of prefixes to their base URIs:

Prefix	Value
	<code>http://www.co-ode.org/ontologies/pizza/pizza.owl#</code>
<code>dc</code>	<code>http://purl.org/dc/elements/1.1/</code>
<code>owl</code>	<code>http://www.w3.org/2002/07/owl#</code>

Classes

The screenshot shows a web browser window displaying an ontology viewer for the 'pizza' ontology. The browser address bar shows the URL: `http://www.co-ode.org/ontologies/pizza/2.0.0`. The page title is 'pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)'. The breadcrumb navigation is: `DomainThing > Food > Pizza > CheesyPizza`. The active ontology is 'pizza'. The interface includes tabs for 'Annotation properties', 'Datatypes', 'Individuals', 'Classes', 'Object properties', and 'Data properties'. The 'Classes' tab is active, showing a class hierarchy for 'CheesyPizza'. The hierarchy starts with 'owl:Thing' and includes 'DomainThing', 'Country', 'Food', 'IceCream', 'Pizza', 'CheesyPizza', 'InterestingPizza', 'MeatyPizza', 'NamedPizza', 'NonVegetarianPizza', 'ReallItalianPizza', 'SpicyPizza', 'SpicyPizzaEquivalent', 'ThinAndCrispyPizza', 'UnclosedPizza', 'VegetarianPizza', 'VegetarianPizza1', 'VegetarianPizza2', 'PizzaBase', 'DeepPanBase', 'ThinAndCrispyBase', 'PizzaTopping', 'ValuePartition', and 'Spiciness'. The 'CheesyPizza' class is highlighted. The right panel shows the 'CheesyPizza' class details, including annotations and a description: 'Equivalent To Pizza and (hasTopping some CheeseTopping)'. The bottom of the page shows 'Git: master' and a note 'To use the reasoner click Reasoner'.

File Edit View Reasoner Tools Refactor Window Help

Search...

DomainThing > Food > Pizza > CheesyPizza

Active ontology x Entities x Individuals by class x DL Query x

Annotation properties Datatypes Individuals

Classes Object properties Data properties

Class hierarchy: CheesyPizza

Annotations Usage

Annotations: CheesyPizza

Annotations +

- `rdfs:label` [language: en] CheesyPizza
- `rdfs:label` [language: pt] PizzaComQueijo
- `skos:prefLabel` [language: en] Cheesv Pizza

Description: CheesyPizza

Equivalent To +

- `Pizza` and (hasTopping some CheeseTopping)

SubClass Of +

General class axioms +

SubClass Of (Anonymous Ancestor)

- `hasBase` some PizzaBase

Instances +

Target for Key +

Git: master

To use the reasoner click Reasoner

Object properties

File Edit View Reasoner Tools Refactor Window Help

Search...

Active ontology x Entities x Individuals by class x DL Query x

Annotation properties Datatypes Individuals
Classes Object properties Data properties

Object property hierarchy: hasBase

- owl:topObjectProperty
 - hasCountryOfOrigin
 - hasIngredient
 - hasBase
 - hasTopping
 - hasSpiciness
 - isIngredientOf

Annotations: hasBase

Annotations +

Char Description: hasBase

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

Equivalent To +

SubProperty Of +
hasIngredient

Inverse Of +
isBaseOf

Domains (intersection) +
Pizza

Ranges (intersection) +
PizzaBase

Disjoint With +

Git: master To use the reasoner click Reasoner

Data properties

The screenshot shows the Protege OWL editor interface. The browser title is "pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)". The menu bar includes File, Edit, View, Reasoner, Tools, Refactor, Window, and Help. The address bar shows the URL "pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)". The active ontology is "pizza". The main window displays the "Data properties" tab for "owl:topDataProperty". The "Data property hierarchy" shows "owl:topDataProperty" as an asserted property. The "Annotations" tab is active, showing a list of annotations. The "Description" tab is also active, showing the following characteristics for "owl:topDataProperty":

- Functional
- Equivalent To +
- SubProperty Of +
- Domains (intersection) +
- Ranges +
- Disjoint With +

At the bottom left, it says "Git: master". At the bottom right, it says "To use the reasoner click Reasoner".

Annotation properties

The screenshot shows a web browser window with the URL `http://www.co-ode.org/ontologies/pizza/2.0.0`. The browser's address bar and search bar are visible. The main content area displays the ontology editor interface, which includes a menu bar (File, Edit, View, Reasoner, Tools, Refactor, Window, Help) and a toolbar with icons for adding, deleting, and refreshing. The interface is divided into several panes: 'Active ontology', 'Entities', 'Individuals by class', and 'DL Query'. The 'Annotation property hierarchy' pane is active, showing a list of properties with checkboxes next to them. The list includes: `dc:description`, `dc:title`, `dcterms:contributor`, `dcterms:license`, `dcterms:provenance`, `owl:backwardCompatibleWith`, `owl:deprecated`, `owl:incompatibleWith`, `owl:priorVersion`, `owl:versionInfo`, `rdfs:comment`, `rdfs:isDefinedBy`, `rdfs:label`, `rdfs:seeAlso`, `skos:altLabel`, `skos:definition`, and `skos:prefLabel`. The 'Nothing Selected' message is displayed in the main content area. The bottom of the browser shows the Git status 'Git: master' and a note 'To use the reasoner click Reasoner'.

File Edit View Reasoner Tools Refactor Window Help

Search...

Active ontology x Entities x Individuals by class x DL Query x

Annotation properties Datatypes Individuals
Classes Object properties Data properties

Annotation property hierarchy:

- `dc:description`
- `dc:title`
- `dcterms:contributor`
- `dcterms:license`
- `dcterms:provenance`
- `owl:backwardCompatibleWith`
- `owl:deprecated`
- `owl:incompatibleWith`
- `owl:priorVersion`
- `owl:versionInfo`
- `rdfs:comment`
- `rdfs:isDefinedBy`
- `rdfs:label`
- `rdfs:seeAlso`
- `skos:altLabel`
- `skos:definition`
- `skos:prefLabel`

Nothing Selected

Git: master To use the reasoner click Reasoner

Datatypes

The screenshot shows a web browser window with the address bar displaying 'pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)'. The browser's menu bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. Below the menu bar is a search bar with a dropdown menu and a 'Search...' button. The main content area has several tabs: 'Active ontology', 'Entities', 'Individuals by class', and 'DL Query'. A sub-menu is open, showing 'Annotation properties', 'Datatypes', and 'Individuals'. Under 'Datatypes', there are sub-tabs for 'Classes', 'Object properties', and 'Data properties'. The 'Datatypes' sub-tab is active, displaying a list of datatypes with red circular selection indicators. The list includes: owl:rational, owl:real, rdf:PlainLiteral, rdf:XMLLiteral, rdfs:Literal, xsd:anyURI, xsd:base64Binary, xsd:boolean, xsd:byte, xsd:dateTime, xsd:dateTimeStamp, xsd:decimal, xsd:double, xsd:float, xsd:hexBinary, xsd:int, xsd:integer, xsd:language, xsd:long, xsd:Name, xsd:NCName, xsd:negativeInteger, xsd:NMTOKEN, xsd:nonNegativeInteger, xsd:nonPositiveInteger, xsd:normalizedString, and xsd:positiveInteger. A large, light gray rectangular area on the right side of the interface contains the text 'Nothing Selected'. At the bottom of the browser window, there is a status bar with 'Git: master' on the left and 'To use the reasoner click Reasoner' on the right.

File Edit View Reasoner Tools Refactor Window Help

< > pizza (http://www.co-ode.org/ontologies/pizza/2.0.0) Search...

Active ontology x Entities x Individuals by class x DL Query x

Annotation properties Datatypes Individuals
Classes Object properties Data properties

Datatypes: [] [] [] []

- owl:rational
- owl:real
- rdf:PlainLiteral
- rdf:XMLLiteral
- rdfs:Literal
- xsd:anyURI
- xsd:base64Binary
- xsd:boolean
- xsd:byte
- xsd:dateTime
- xsd:dateTimeStamp
- xsd:decimal
- xsd:double
- xsd:float
- xsd:hexBinary
- xsd:int
- xsd:integer
- xsd:language
- xsd:long
- xsd:Name
- xsd:NCName
- xsd:negativeInteger
- xsd:NMTOKEN
- xsd:nonNegativeInteger
- xsd:nonPositiveInteger
- xsd:normalizedString
- xsd:positiveInteger

Git: master

To use the reasoner click Reasoner

Individuals

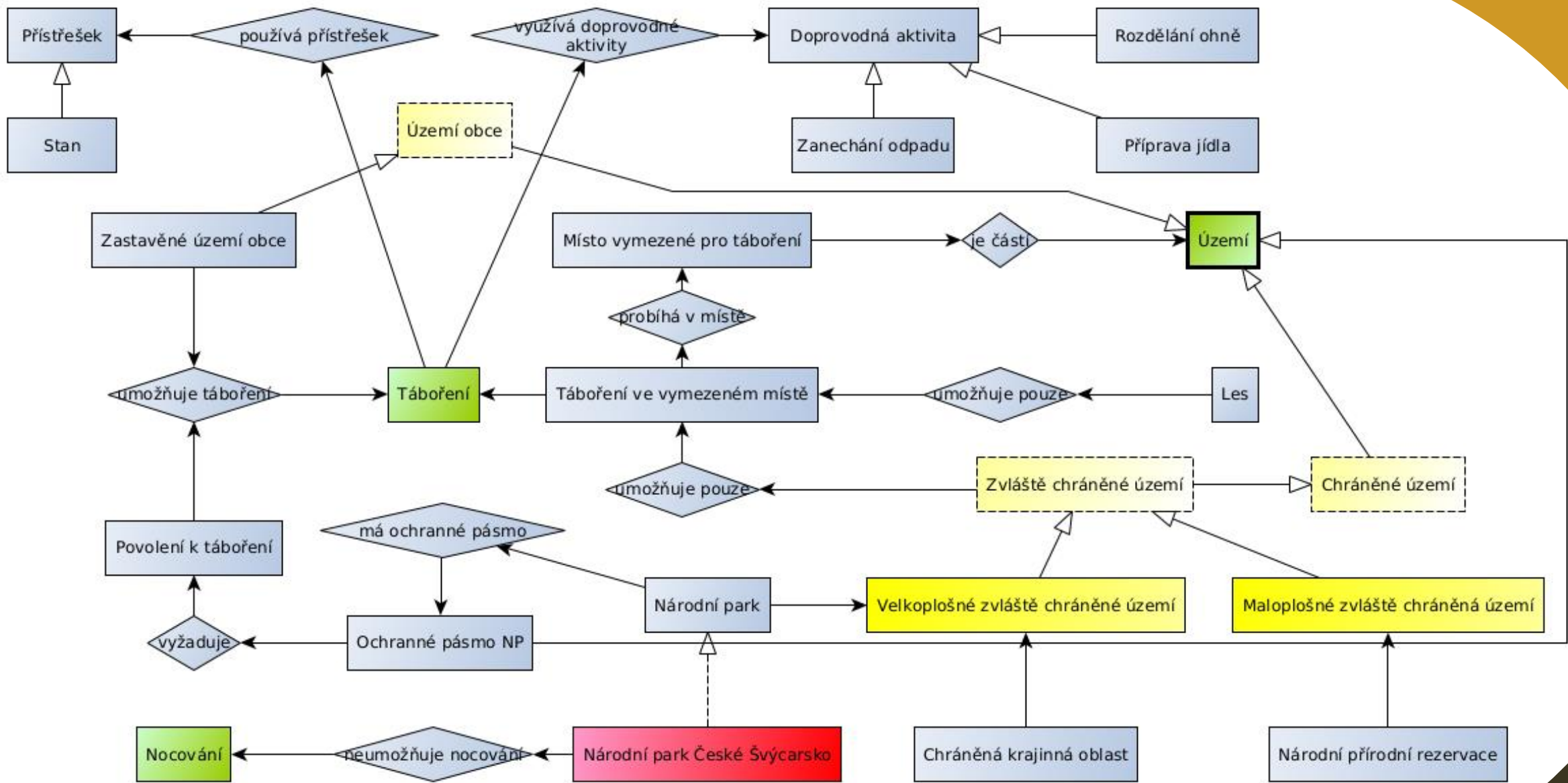
The screenshot shows a web browser window with the URL `http://www.co-ode.org/ontologies/pizza/2.0.0`. The browser's address bar and search bar are visible. The main content area is divided into several panels:

- Active ontology:** pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)
- Navigation tabs:** Active ontology, Entities, Individuals by class, DL Query
- Left Panel (Individuals):** A list of individuals: America, England, France, Germany, and Italy. The 'Italy' individual is selected and highlighted in blue.
- Right Panel (Annotations: Italy):** A section for annotations, currently empty.
- Bottom Left Panel (Description: Italy):** Shows the types of the selected individual: Country and owl:Thing. It also shows 'Same Individual As' and 'Different Individuals' sections.
- Bottom Right Panel (Property assertions: Italy):** A section for property assertions, currently empty.

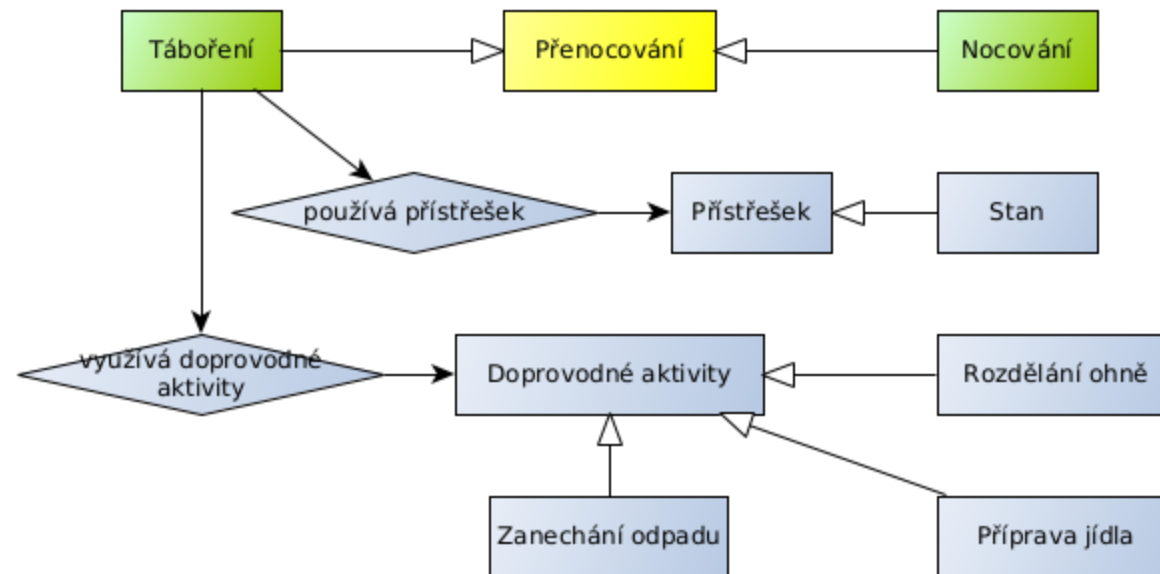
At the bottom of the browser window, there is a status bar with the text "Git: master" on the left and "To use the reasoner click Reasoner" on the right.



OWL modeling of camping and oversleeping



Model this diagram in OWL



Classes and object properties

Annotation properties | Datatypes | Individuals
Classes | Object properties | Data properties

Class hierarchy: Nocování

- owl:Thing
 - Doprovodné aktivity
 - Zanechání odpadu
 - Příprava jídla
 - Rozdělení ohně
 - Přenocování
 - Nocování**
 - Táboření
 - Přístřešek
 - Tarp
 - Stan

Annotation properties | Datatypes | Individuals
Classes | Object properties | Data properties

Object property hierarchy: využívá doprovodné aktivity

- owl:topObjectProperty
 - využívá doprovodné aktivity**
 - probíhá s použitím přístřešku

využívá doprovodné aktivity — http://osw.felk.cvut.cz/medmicha/ont

Annotations | Usage

Annotations: využívá doprovodné aktivity

Annotations +
rdfs:label [language: cs]
využívá doprovodné aktivity

Char | Description: využívá doprovodné aktivity

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

Equivalent To +

SubProperty Of +

Inverse Of +

Domains (intersection) +
● Přenocování

Ranges (intersection) +
● 'Doprovodné aktivity'

Rules

☰ Táboření — <http://osw.felk.cvut.cz/medmicha/ontologies/táboření-a-nocování/tábo>

Annotations Usage

Annotations: Táboření

Annotations +

rdfs:label [language: cs] Táboření

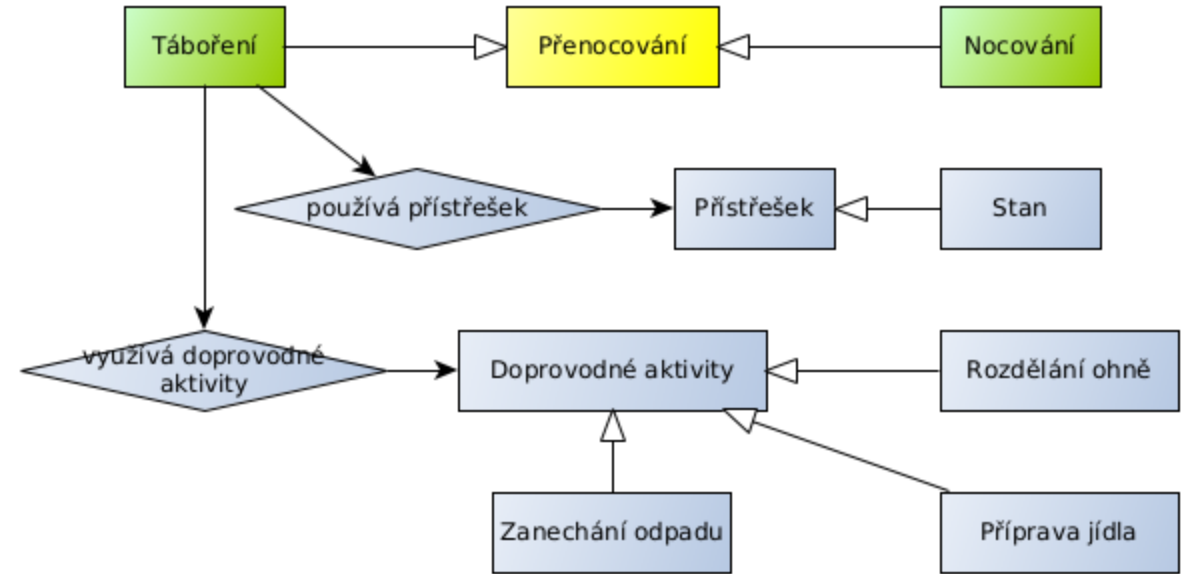
Description: Táboření

Equivalent To +

● ('probíhá s použitím přístřešku' some Přístřešek) or ('využívá doprovodné aktivity' some 'Doprovodné aktivity')

SubClass Of +

● Přenocování



Individuals

The image shows a screenshot of an ontology editor interface. The top navigation bar includes tabs for 'Annotation properties', 'Datatypes', and 'Individuals'. Below this, there are sub-tabs for 'Classes', 'Object properties', and 'Data properties'. The main content area is divided into several panels:

- Individuals: táboření_v_tisícáku**: A list of individual instances. Two are visible: 'oheň_v_tisícáku' and 'táboření_v_tisícáku', with the latter selected.
- Annotations: táboření_v_tisícáku**: A panel for viewing annotations on the selected individual, currently empty.
- Description: táboření_v_tisícáku**: A panel for the description of the selected individual.
- Property assertions: táboření_v_tisícáku**: A panel showing object property assertions. One is visible: 'využívá doprovodné aktivity' with the value 'oheň_v_tisícáku'.
- Types**: A panel showing the type 'Přenocování' associated with the individual.
- Same Individual As**: A panel for identifying other individuals that are the same as the selected one.

Reasoner

Annotation properties | Datatypes | Individuals
Classes | Object properties | Data properties

Individuals: táboření_v_tisícáku

◆ oheň_v_tisícáku
◆ **táboření_v_tisícáku**

☰ ◆ táboření_v_tisícáku — <http://osw.felk.cvut.cz/medmicha/ontologies/táboření-a->

Annotations | Usage

Annotations: táboření_v_tisícáku

Annotations +

Description: táboření_v_tisícáku

Types +

- Přenocování
- **Táboření**

Same Individual As +

Property assertions: táboření_v_tisícáku

Object property assertions +

- **'využívá doprovodné aktivity'** oheň_v_tisícáku