



# Conceptual modelling in OWL

7th tutorial

Ontologies and Semantic Web

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# 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)
$C_1 \sqsubseteq C_2$	$C_1$ <b>SubClassOf</b> $C_2$
$C_1 \equiv C_2$	$C_1$ <b>EquivalentTo</b> $C_2$
$C_1 \sqsubseteq \neg C_2$	$C_1$ <b>DisjointWith</b> $C_2$
$R_1 \sqsubseteq R_2$	$R_1$ <b>SubPropertyOf</b> $R_2$
$\neg C$	<b>not</b> $C$
$C_1 \sqcup C_2$	$C_1$ <b>or</b> $C_2$
$C_1 \sqcap C_2$	$C_1$ <b>and</b> $C_2$
$\exists R \cdot C$	$R$ <b>some</b> $C$
$\forall R \cdot C$	$R$ <b>only</b> $C$
$\exists R \cdot \{i\}$	$R$ <b>value</b> $\{i\}$
$(\geq 2 R C)$	$R$ <b>min 2</b> $C$
$(\leq 2 R C)$	$R$ <b>max 2</b> $C$
$R^-$	<b>inverse</b> $R$

- 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 prefix mappings:

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 the Protege web interface for the 'pizza' ontology. The browser address bar displays the URL: `http://www.co-ode.org/ontologies/pizza/2.0.0`. The interface includes a menu bar (File, Edit, View, Reasoner, Tools, Refactor, Window, Help) and a breadcrumb trail: `DomainThing > Food > Pizza > CheesyPizza`.

The main interface is divided into several panes:

- Class hierarchy: CheesyPizza**: A tree view showing the ontology structure. The 'CheesyPizza' class is highlighted in blue. The hierarchy includes `owl:Thing`, `DomainThing`, `Country`, `Food`, `IceCream`, `Pizza`, and various subclasses like `CheesyPizza`, `InterestingPizza`, `MeatyPizza`, `NamedPizza`, `NonVegetarianPizza`, `ReallItalianPizza`, `SpicyPizza`, `SpicyPizzaEquivalent`, `ThinAndCrispyPizza`, `UnclosedPizza`, `VegetarianPizza`, `VegetarianPizza1`, `VegetarianPizza2`, `PizzaBase`, `DeepPanBase`, `ThinAndCrispyBase`, `PizzaTopping`, `ValuePartition`, and `Spiciness` (with subclasses `Hot`, `Medium`, `Mild`).
- Annotations: CheesyPizza**: A list of annotations for the selected class. Visible annotations include:
  - `rdfs:label` [language: en] CheesyPizza
  - `rdfs:label` [language: pt] PizzaComQueijo
  - `skos:prefLabel` [language: en] Cheesv Pizza
- Description: CheesyPizza**: Shows the logical description of the class:
  - Equivalent To: `Pizza and (hasTopping some CheeseTopping)`
  - SubClass Of: (empty)
  - General class axioms: (empty)
  - SubClass Of (Anonymous Ancestor): `hasBase some PizzaBase`
  - Instances: (empty)
  - Target for Key: (empty)

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

# Object properties

The screenshot displays the Protege web interface for editing the 'pizza' ontology. The browser address bar shows the URL: `http://www.co-ode.org/ontologies/pizza/2.0.0`. The interface includes a menu bar (File, Edit, View, Reasoner, Tools, Refactor, Window, Help) and a search bar. The main area is divided into several panels:

- Object property hierarchy: hasBase**: A tree view showing the hierarchy of object properties. The selected path is `owl:topObjectProperty` > `hasIngredient` > `hasBase`. Other properties shown include `hasCountryOfOrigin`, `hasTopping`, `hasSpiciness`, and `isIngredientOf`.
- Annotations: hasBase**: A panel for adding annotations to the selected property.
- Description: hasBase**: A panel showing the logical description of the property. It includes a list of checkboxes for property characteristics (Functional, Inverse function, Transitive, Symmetric, Asymmetric, Reflexive, Irreflexive) and a list of logical relationships:
  - Equivalent To: `hasIngredient`
  - SubProperty Of: `isBaseOf`
  - Inverse Of: `isBaseOf`
  - Domains (intersection): `Pizza`
  - Ranges (intersection): `PizzaBase`
  - Disjoint With: (empty)

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



# 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 main workspace is divided into several panes:

- Left Pane:** Shows the "Data property hierarchy" for `owl:topDataProperty`. It includes a toolbar with icons for adding, deleting, and refreshing, and a dropdown menu set to "Asserted". The property `owl:topDataProperty` is listed.
- Top Right Pane:** Shows the "Annotations" for `owl:topDataProperty`. It has tabs for "Annotations" and "Usage".
- Bottom Right Pane:** Shows the "Description" for `owl:topDataProperty`. It includes a "Characteristics" section with a checkbox for "Functional" (which is currently unchecked). Below this, there are several expandable sections, each with a plus sign (+):
  - Equivalent To
  - SubProperty Of
  - Domains (intersection)
  - Ranges
  - Disjoint With

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

# 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. The interface is divided into several panes:

- Active ontology:** pizza (http://www.co-ode.org/ontologies/pizza/2.0.0)
- Annotation properties:** A list of properties including `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`.
- Classes:** A list of classes.
- Object properties:** A list of object properties.
- Data properties:** A list of data properties.

The **Annotation property hierarchy** pane is currently selected, showing a list of properties. A large, semi-transparent box with the text "Nothing Selected" is overlaid on the right side of the interface. At the bottom of the browser window, there is a status bar with the text "Git: master" and "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' 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 box with rounded corners is overlaid on the right side of the interface, containing the text 'Nothing Selected' in a large, gray font. 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

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

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

Individuals: Italy

- America
- England
- France
- Germany
- Italy**

Annotations: Italy

Annotations +

Description: Italy

Types +

- Country
- owl:Thing

Same Individual As +

Different Individuals +

- America, England, France, Germany

Property assertions: Italy

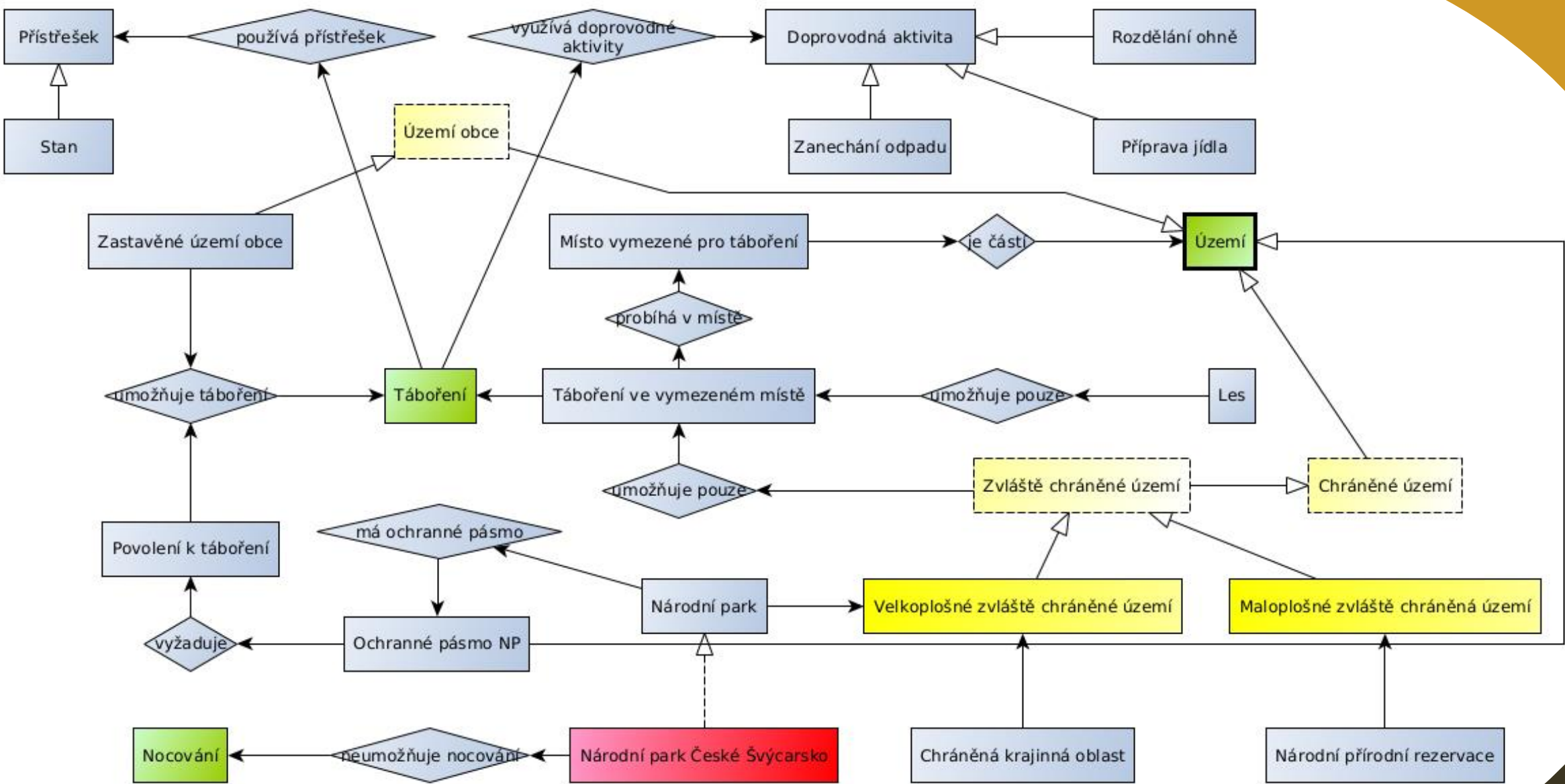
- Object property assertions +
- Data property assertions +
- Negative object property assertions +
- Negative data property assertions +

Git: master

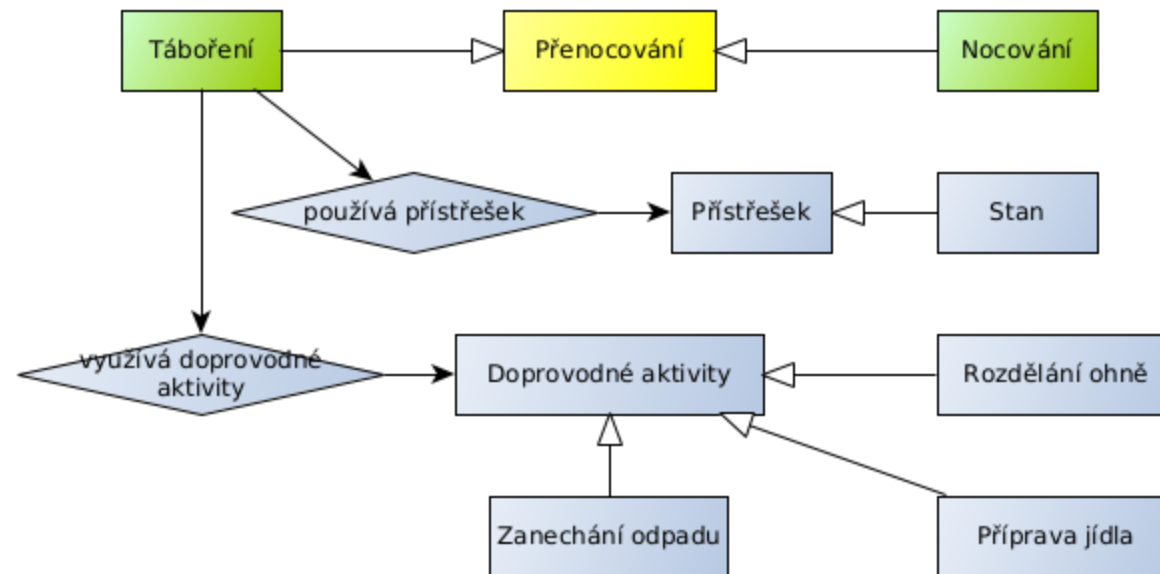
To use the reasoner click Reasoner



# **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

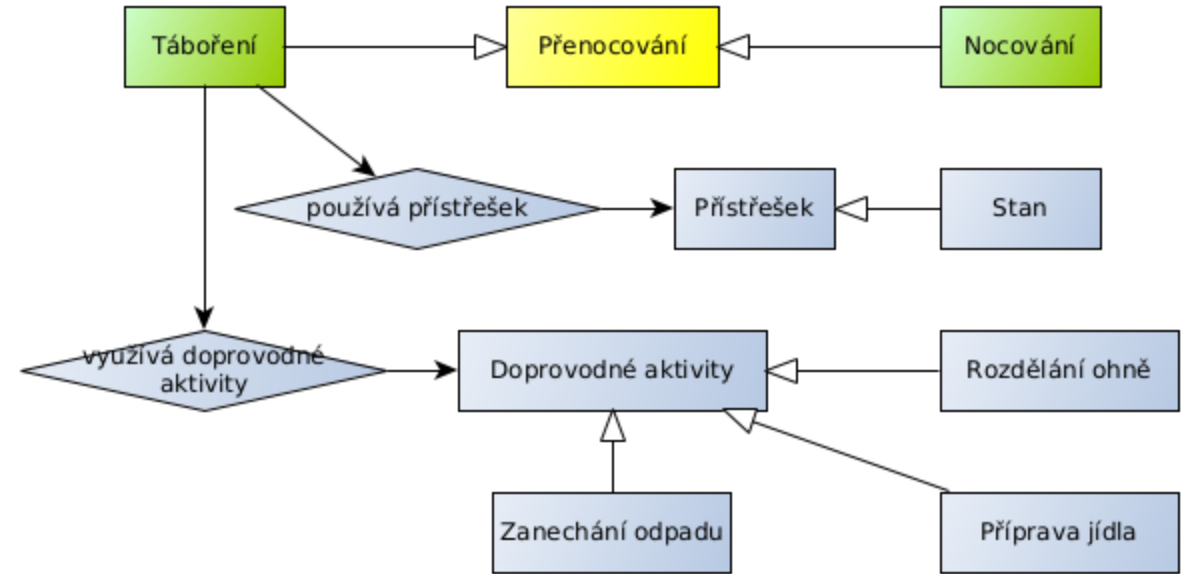
Description: Táboření

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-left pane displays a list of individuals under the heading "Individuals: táboření\_v\_tisícáku". Two individuals are listed: "oheň\_v\_tisícáku" and "táboření\_v\_tisícáku", with the latter selected. The top-right pane shows the details for the selected individual "táboření\_v\_tisícáku". It includes a title bar with the URI "http://osw.felk.cvut.cz/medmicha/ontologies/táboření-a-r...", tabs for "Annotations" and "Usage", and a main content area with an "Annotations" section. Below this, there are sections for "Description: táboření\_v\_tisícáku", "Types" (showing "Přenocování"), "Same Individual As", and "Property assertions: táboření\_v\_tisícáku" (showing "'využívá doprovodné aktivity' oheň\_v\_tisícáku").

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

Individuals: táboření\_v\_tisícáku

Annotations | Usage

Annotations: táboření\_v\_tisícáku

Annotations +

oheň\_v\_tisícáku  
táboření\_v\_tisícáku

Description: táboření\_v\_tisícáku

Property assertions: táboření\_v\_tisícáku

Types +  
● Přenocování

Same Individual As +

Object property assertions +  
■ 'využívá doprovodné aktivity' oheň\_v\_tisícáku

# 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

Property assertions: táboření\_v\_tisícáku

Types +

- Přenocování
- Táboření

Same Individual As +

Object property assertions +

- 'využívá doprovodné aktivity' oheň\_v\_tisícáku