



Conceptual modelling in OWL

9th 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 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

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

Ontology header: **Ontology IRI** **Ontology Version IRI**

Annotations +

- rdfs:label** [type: xsd:string] pizza
- dc:title** [language: en] pizza
- dc:description** [language: en] An ontology about pizzas and their toppings.
This is an example ontology that contains all constructs required for the various versions of the Pizza Tutorial run by Manchester University (see...

Ontology metrics:

Metrics	
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

Class axioms

SubClassOf	259
EquivalentClasses	15

Ontology imports | **Ontology Prefixes** | General class axioms

Ontology prefixes:

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

Git: master To use the reasoner, click...

Classes

The screenshot shows a web browser window displaying an ontology editor for the 'pizza' ontology. The browser's 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 browser's menu bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. The page content is organized into several panels:

- Active ontology:** Shows the current ontology and navigation options: 'Entities', 'Individuals by class', and 'DL Query'.
- Annotation properties:** Includes 'Classes', 'Object properties', and 'Data properties'.
- Class hierarchy:** A tree view showing the hierarchy of classes. The root is 'owl:Thing', which branches into 'DomainThing', 'Country', 'Food', 'IceCream', and 'Pizza'. The 'Pizza' class is expanded, showing its subclasses: 'CheesyPizza', 'InterestingPizza', 'MeatyPizza', 'NamedPizza', 'NonVegetarianPizza', 'ReallItalianPizza', 'SpicyPizza', 'SpicyPizzaEquivalent', 'ThinAndCrispyPizza', 'UnclosedPizza', 'VegetarianPizza', 'VegetarianPizza1', and 'VegetarianPizza2'. Below these are 'PizzaBase', 'DeepPanBase', and 'ThinAndCrispyBase'. The 'PizzaTopping' class is also visible. The 'ValuePartition' class is expanded to show 'Spiciness', which has subclasses 'Hot', 'Medium', and 'Mild'.
- CheesyPizza details:** The right-hand side of the page shows the details for the 'CheesyPizza' class. It includes:
 - Annotations:** A list of annotations for 'CheesyPizza', including 'rdfs:label [language: en] CheesyPizza', 'rdfs:label [language: pt] PizzaComQueijo', and 'skos:prefLabel [language: en] Cheesv Pizza'.
 - Description:** The description for 'CheesyPizza' is 'Equivalent To Pizza and (hasTopping some CheeseTopping)'. Below this, it shows 'SubClass Of' relationships: 'SubClass Of Pizza' and 'SubClass Of (Anonymous Ancestor) hasBase some PizzaBase'.
 - Instances:** A section for 'Instances'.
 - Target for Key:** A section for 'Target for Key'.

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.

Object properties

The screenshot displays the Protege web interface for 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 panes:

- Object property hierarchy: hasBase**: A tree view showing the hierarchy of object properties. The selected path is `owl:topObjectProperty` > `hasIngredient` > `hasBase`. Other visible properties include `hasCountryOfOrigin`, `hasTopping`, `hasSpiciness`, and `isIngredientOf`.
- Annotations: hasBase**: A pane for viewing annotations, currently empty.
- Description: hasBase**: A pane showing the logical description of the property. It includes a list of characteristics on the left and a list of logical relationships on the right.
 - Characteristics:** Functional, Inverse function, Transitive, Symmetric, Asymmetric, Reflexive, Irreflexive.
 - Logical Relationships:**
 - Equivalent To: (empty)
 - SubProperty Of: `hasIngredient`
 - 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:

- Top Left:** A tabbed interface with "Active ontology", "Entities", "Individuals by class", and "DL Query". Below these are tabs for "Annotation properties", "Datatypes", and "Individuals". Under "Annotation properties", there are sub-tabs for "Classes", "Object properties", and "Data properties". The "Data properties" tab is active, showing a "Data property hierarchy: owl:topDataProperty" with a tree view containing "owl:topDataProperty".
- Top Right:** A pane titled "owl:topDataProperty — http://www.w3.org/2002/07/owl#topDataProperty" with sub-tabs for "Annotations" and "Usage". The "Annotations" tab is active, showing an empty list of annotations.
- Bottom Right:** A pane titled "Description: owl:topDataProperty" with a "Characteristics" section containing a checked "Functional" checkbox. Below this are several expandable sections, each with a plus sign: "Equivalent To", "SubProperty Of", "Domains (intersection)", "Ranges", and "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 a large, light gray box on the right side of the interface. At the bottom of the browser window, the text 'Git: master' is visible on the left, and 'To use the reasoner click Reasoner' is visible on the right.

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 URL `http://www.co-ode.org/ontologies/pizza/2.0.0`. The browser's address bar and search bar both contain the same URL. The page title is `owl:topDataProperty — http://www.w3.org/2002/07/owl#topDataProperty`. The interface includes a menu bar with `File`, `Edit`, `View`, `Reasoner`, `Tools`, `Refactor`, `Window`, and `Help`. Below the menu bar are tabs for `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 selected, displaying a list of datatypes with red circular selection indicators next to each. 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 grey box with the text `Nothing Selected` is overlaid on the right side of the interface. At the bottom left, it says `Git: master`. At the bottom right, it says `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 both contain the text "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".

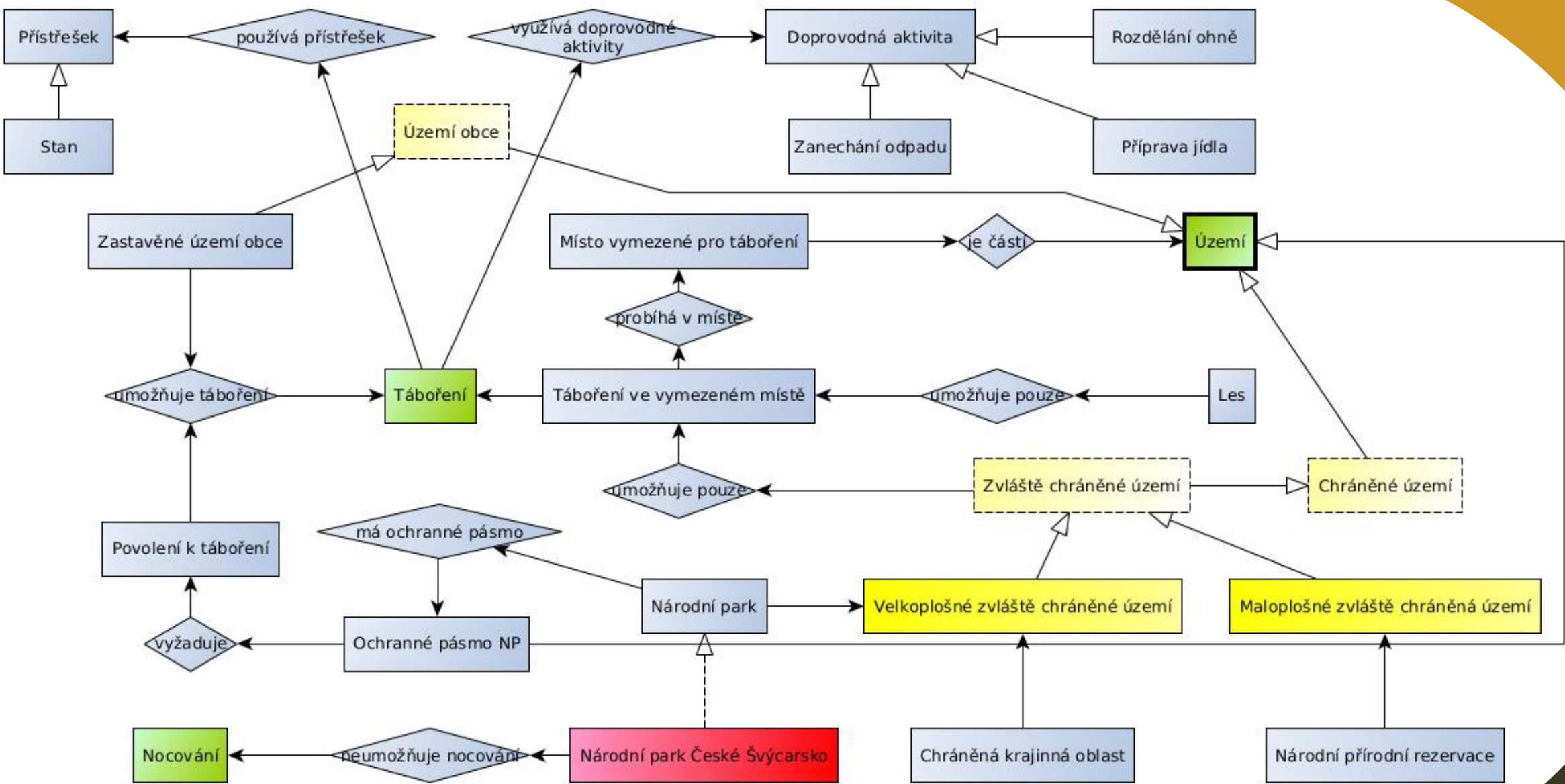
The main interface is divided into several panes:

- Active ontology:** A tabbed interface with "Entities", "Individuals by class", and "DL Query".
- Navigation:** A set of tabs for "Annotation properties", "Datatypes", "Individuals", "Classes", "Object properties", and "Data properties".
- Individuals: Italy:** A list of individuals: "America", "England", "France", "Germany", and "Italy". "Italy" is selected and highlighted in blue.
- Annotations: Italy:** A pane for viewing annotations, currently empty.
- Description: Italy:** A pane showing the class hierarchy for "Italy":
 - Types: "Country" and "owl:Thing".
 - Same Individual As: (empty)
 - Different Individuals: "America, England, France, Germany".
- Property assertions: Italy:** A pane for viewing property assertions, currently empty.

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.



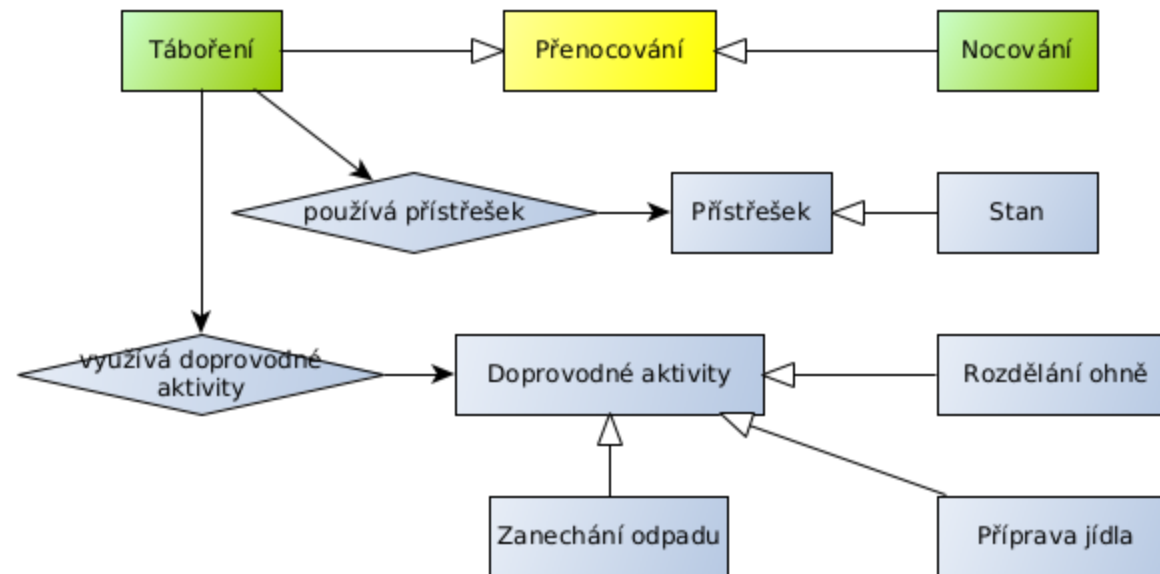
OWL modeling of camping and oversleeping



The diagram illustrates the regulatory framework for camping in the Czech Republic. It shows how various entities and conditions influence the possibility of camping. Key elements include:

- Entities and Locations:** Stan (tent), Přístřešek (shelter), Území obce (municipal territory), Zastavěné území obce (built-up municipal territory), Území (territory), Místo vymezené pro táboření (designated camping site), Táboření ve vymezeném místě (camping in a designated site), Les (forest), Zvláště chráněné území (special protected areas), Chráněné území (protected areas), Velkoplošné zvláště chráněné území (large special protected areas), Maloplošné zvláště chráněná území (small special protected areas), Narodni park (national park), Narodni park České Švýcarsko (national park of the Bohemian Paradise), Chranena krajinná oblast (landscape protected area), Narodni prírodní rezervace (national natural reserve).
- Activities and Conditions:** Rozdělání ohně (fire splitting), Zanechání odpadu (waste disposal), Příprava jídla (food preparation), Doprovodná aktivita (accompanying activity), Táboření (camping), Nocování (overnight stay), má ochranné pásmo (has a protection zone), vyžaduje (requires), umožňuje pouze (allows only), probíhá v místě (takes place in the location), umožňuje (allows), je částí (is a part of), používá (uses), využívá (uses).
- Flow and Logic:** The flow starts from the location (Území obce) and moves through various conditions and permissions (Zastavěné území obce, Umoznuje táboření, Povolení k táboření) to the actual camping (Táboření). It also branches into specific activities (Doprovodná aktivita) and protected areas (Zvláště chráněné území). The National Park of the Bohemian Paradise is highlighted as a specific case with its own set of rules, including a protection zone and restrictions on overnight stays.

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

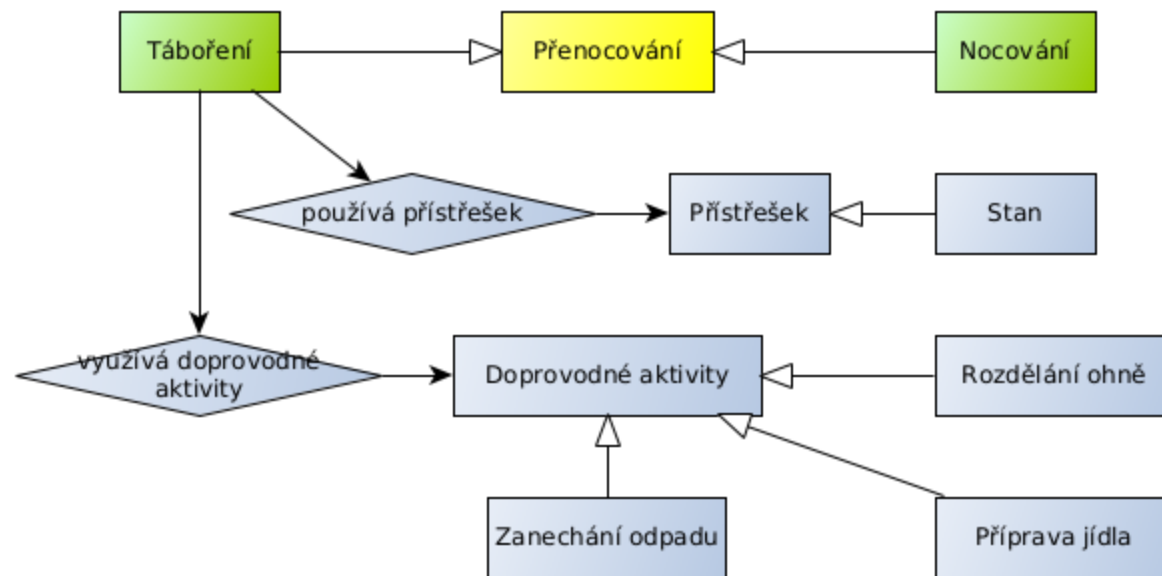
Description: Táboření

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, currently empty.
- 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

Property assertions: táboření_v_tisícáku

Types +

- Přenocování
- Táboření

Same Individual As +

Object property assertions +

- 'využívá doprovodné aktivity' oheň_v_tisícáku