LAB3 REPORT

May 3, 2019

Wenchang Liu
ID: 10406141
School of Computer Science

Contents

1 Ex1 Lexical Analysis

1. POS tag the sentence

   Sentence: Steel is an alloy of iron and carbon, and sometimes other elements. Because of its high tensile strength and low cost, it is a major component used in buildings, infrastructure, tools, ships, automobiles, machines, appliances, and weapons.

   Steel(NNP) is(VBZ) an(DT) alloy(NN) of(IN) iron(NN) and(CC) carbon(NN) ,(,) and(CC) sometimes(RB) other(JJ) elements(NNS) .(.) Because(IN) of(IN) its(PRP$) high(JJ) tensile(NN) strength(NN) and(CC) low(JJ) cost(NN) ,(,) it(PRP) is(VBZ) a(DT) major(JJ) component(NN) used(VBN) in(IN) buildings(NNS) ,(,) infrastructure(NN) ,(,) tools(NNS) ,(,) ships(NNS) ,(,) automobiles(NNS) ,(,) machines(NNS) ,(,) appliances(NNS) ,(,) and(CC) weapons(NNS) .(.)

2. Identify the pronominal co-references

   Co-references are "its" and "it".

2 Ex2 C-Structures

1. Plot the constituency (phrase) structure: Sentence: ‘Steel is an alloy of iron and carbon, and sometimes other elements’.

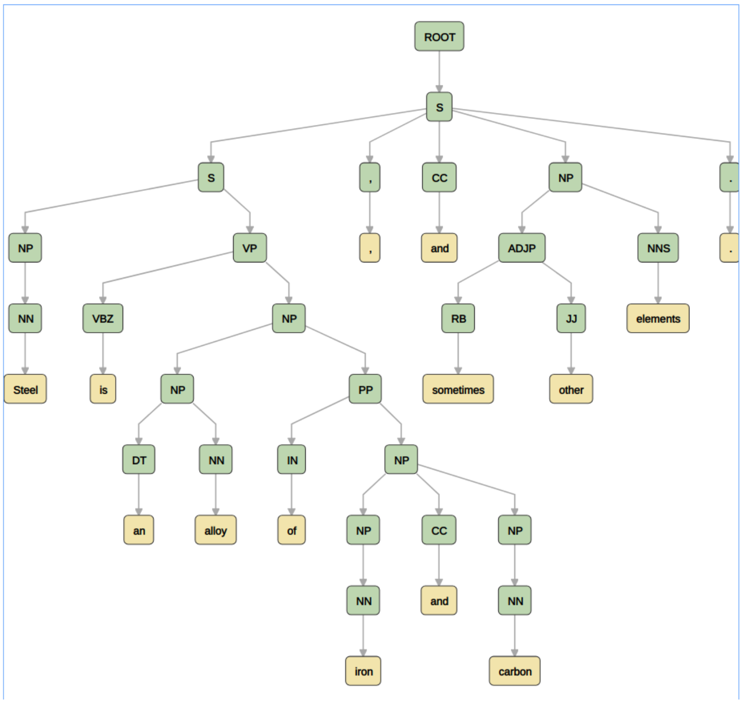


Figure 1: Constituency Parse Plot

2. List the nominal phrasal nodes (NPs) correspond to ‘molecules of meaning’ for that sentence

   NP: Steel, an alloy, iron, carbon, iron and carbon, an alloy of iron and carbon, sometimes other elements.

3. List the coordinations within that sentence.

   CC: and(iron and carbon), and(and sometimes other elements)

3 Ex3 Dependencies - Exploring new territories

1. What is the difference between dependency and constituency?

   Dependency parsing: A dependency parse connects words according to their relationships. Each vertex in the tree represents a word, child nodes are words that are dependent on the parent, and edges are labeled by the relationship.

   Constituency parsing: A constituency parse tree breaks a text into sub-phrases. Non-terminals in the tree are types of phrases, the terminals are the words in the sentence, and the edges are unlabeled.

2. What is emphasised by each representation?

   Dependency parsing: Emphasising the dependency relationships between words.

   Constituency parsing: Emphasising sub-phrases within the sentence.

3. Draw the dependency structure of the following sentence: 'Steel is analloy of iron and carbon'.

   nsubj: nominal subject

   cop: copula

   det: determiner

   nmod: nominal modifier

   case: prepositions, postpositions and other case markers

   cc: coordinating conjunction

   conj: conjunct

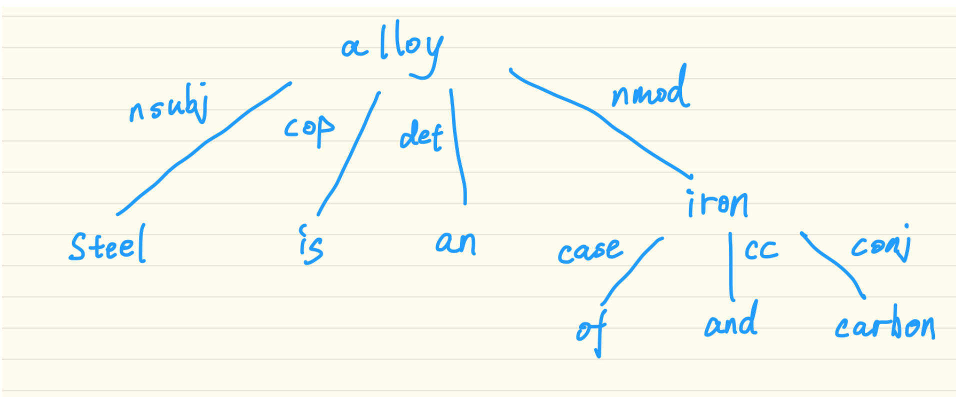


Figure 2: Dependency Parse Structure

4 Ex4 OpenIE - Semantics

1. Use openIE to extract the predicate-argument structure of:

   (1) "Steel is an alloy":

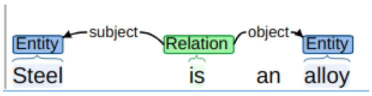


Figure 3: OpenIE result for 'Steel is an alloy'

   (2) "Steel contains carbon":

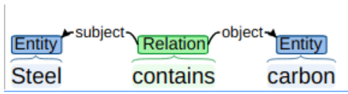


Figure 4: OpenIE result for 'Steel contains carbon'

   (3) "Steel contains iron":

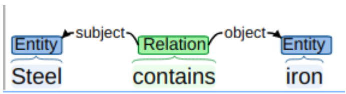


Figure 5: OpenIE result for 'Steel contains iron'

2. Represent the triples above using Prolog:

```
alloy(X) :- steel(X).
containsCarbon(X) :- steel(X).
containsIron(X) :- steel(X).
```

3. Represent the triples above using RDF:

```
<Steel> <is an> <alloy>.
<Steel> <contains> <carbon>.
<Steel> <contains> <iron>.
```

4. Formalise the axioms using Description Logics:

$$Steel \sqsubseteq Alloy$$

$$Steel \rightarrow \exists Contain.Carbon$$

$$Steel \rightarrow \exists Contain.Iron$$

5. Analyse what happens when getting "Steel is an alloy of iron and carbon.":

   There are two relations in terms of "Steel"(subject), one is relation "is" (i.e. Steel is an alloy), the other is relation "an alloy of" (i.e. Steel 'is an alloy of' iron), and the objects are "alloy" and "iron" respectively.

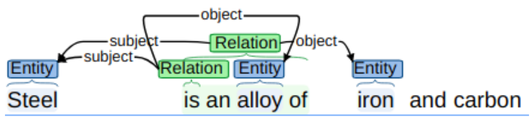


Figure 6: OpenIE result for 'Steel is an alloy of iron and carbon'

5 Ex5 Complex OpenIE, Rhetorical Structures

Sentence: 'As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating; however, it becomes less ductile.'

1. Identify the nucleus and the satellites

   nucleus: "however, it becomes less ductile."

   satellites: "As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating;"

2. Draw the diagram with the rhetorical relations

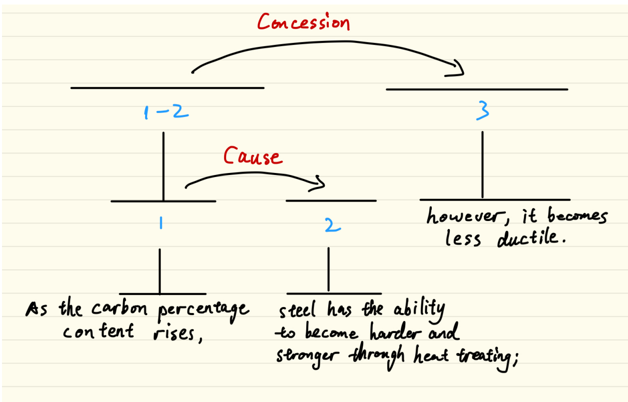


Figure 7: rhetorical relation diagram

3. Which relations are hypotactic or paratactic?

   The "concession" and "cause" are both hypotactic.

4. Write the output for that sentence using the RDF-NL notation of Graphene

```
1f497d3e35c4444b8ee59f56324c1dd2        0       Steel   has     the ability to become harder and stronger through heat
        L:IDENTIFYING_DEFINITION        5d0d33a368c14bb4b28ea91efade7107
        L:BACKGROUND    897a6ad5e7ce408bb2d64141957c3645
        L:CONTRAST      b8fe76aa010147a6ade42eb18c7e267f

6dade54fe4cf41648e4a0e1b310be9c5        1       Heat    is treating

7353d9045d81411aa00e4b3c3b069ba0        1       The carbon percentage content   rises

11fb7e370fee44488e1841b26a3cfa51        0       It      becomes less ductile
        L:CONTRAST      735d81fbb9d9408ea38f1edfb67b37fa
```

Figure 8: output from Graphene

6 Ex6 Taxonomies, Thesauri

1. List the WordNet glosses for 'martensite' and 'austenite'

   martensite: a solid solution of carbon in alpha-iron that is formed when steel is cooled so rapidly that the change from austenite to pearlite is suppressed; responsible for the hardness of quenched steel.

   austenite: a solid solution of ferric carbide or carbon in iron; cools to form pearlite or martensite.

2. List the Taxonomic/Hypernym chain up to the top for these two terms

   martensite/austenite -> solid solution, primary solid solution -> solution -> mixture -> substance ->

   (1) matter -> physical entity -> entity

   (2) part, portion, component part, component, constituent -> relation -> abstraction, abstract entity -> entity

3. List their sibling terms: ferrite, double salt

4. For the word 'temper':

   (1) how many synsets do we have? 9 synsets.

   (2) Which senses are related to steel?

   1* the elasticity and hardness of a metal object; its ability to absorb considerable energy before cracking

   2* bring to a desired consistency, texture, or hardness by a process of gradually heating and cooling

   3* harden by reheating and cooling in oil

   (3) What are its synonyms? (n)toughness; (v)anneal, normalize; (v)harden

   (4) Would you consider these perfect or near-synonyms?

   For anneal and normalize, I think they are perfect, but for toughness and harden, they are near-synonyms. Because for anneal and normalize, they are very specific and mean exactly the same thing, but for toughness, I think it is more a similar meaning not exactly the same.

7 Ex7 Frame Semantics - Exploring Further

1. Describe the frame semantics for "melt" "oxidize" as listed by VerbNet, Prop-Bank and FreameNet

   (1) VerbNet:

   $melt : KNEAD-26.5, OTHER\_COS-45.4-1$

   $oxidize : ENTITY\_SPECIFIC\_COS-45.5, OTHER\_COS-45.4$

   (2) Prop-Bank:

   $melt : MELT.v$

   $oxidize : OXIDIZE.v$

   (3) FrameNet:

   $melt : CAUSE\_CHANGE\_OF\_PHASE, CHANGE\_OF\_PHASE$

   $oxidize : CORRODING\_CAUSED$

2. How these representations compare?

   Prop-Bank is tightly connected to VerbNet lexicon, and can increase verb coverage, it is made by generalized semantic roles, defined as prototypes and has fewer thematic roles compared to FrameNet, which define roles specific to a group of predicates.

3. Using the FrameNet semantics, draw the Conceptual Graph for the following sentence: 'At 1433 degrees, the material started to progressively melt around the edges.'

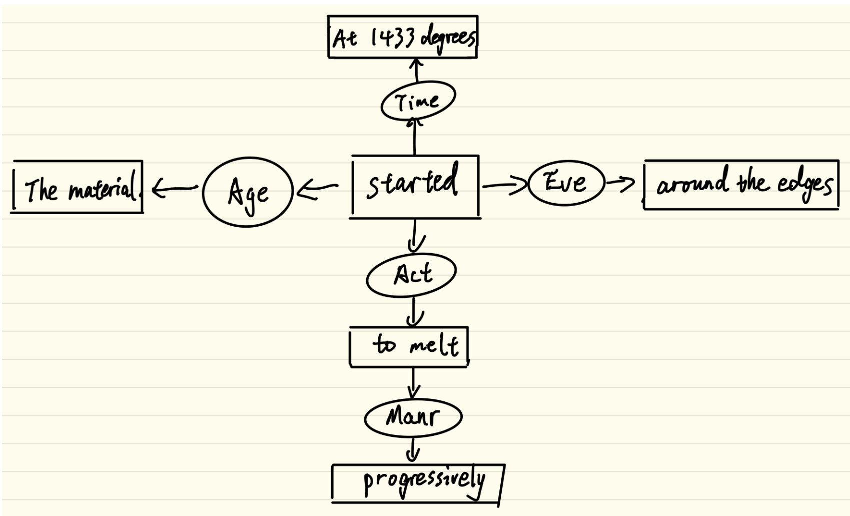


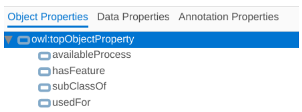
Figure 9: Conceptual graph for the sentence

8 Ex8 Ontologies - Description Logics

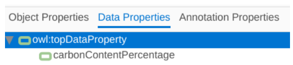
Ex8: Convert the natural language statements into an ontology.

Here are some screenshots of the work:

Figure 10: Class hierarchy of the ontology



(a) object property



(b) data property

Figure 11: Properties

See OWL file for more details in appendix A.

9 Ex9 Inductive & Deductive Reasoning

1. Using ILP to learn the definitions of each type of crystallographic structure

   FERRITE(X, Y) <- MEDIUMTEMPERATURE(X), LOWCARBON(Y).

   PEARLITE(X,Y) <- LOWTEMPERATURE(X), MEDIUMCARBON(Y).

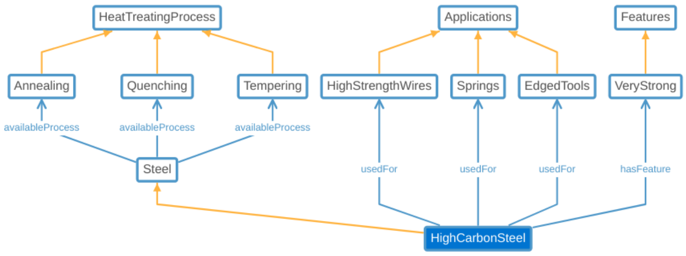


Figure 12: an example entity graph of high carbon steel

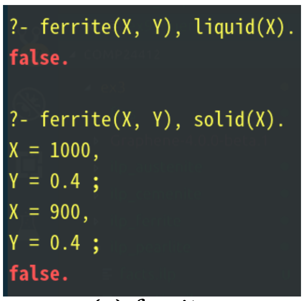
AUSTENITE(X,Y) <- MEDIUMTEMPERATURE(X), MEDIUMCARBON(Y).

CEMENTITE(X,Y) <- MEDIUMTEMPERATURE(X), HIGHCARBON(Y).

2. Perform deductive reasoning:

   Are the materials solid or liquid?

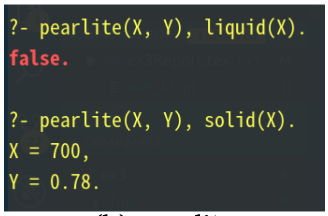
   All of theses materials are solid.



```
?- ferrite(X, Y), liquid(X).
false.

?- ferrite(X, Y), solid(X).
X = 1000,
Y = 0.4 ;
X = 900,
Y = 0.4 ;
false.
```

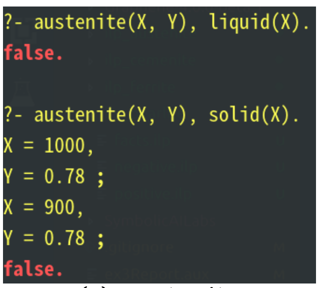
(a) ferrite



```
?- pearlite(X, Y), liquid(X).
false.

?- pearlite(X, Y), solid(X).
X = 700,
Y = 0.78.
```

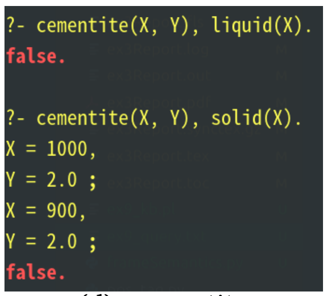
(b) pearlite



```
?- austenite(X, Y), liquid(X).
false.

?- austenite(X, Y), solid(X).
X = 1000,
Y = 0.78 ;
X = 900,
Y = 0.78 ;
false.
```

(c) austenite



```
?- cementite(X, Y), liquid(X).
false.

?- cementite(X, Y), solid(X).
X = 1000,
Y = 2.0 ;
X = 900,
Y = 2.0 ;
false.
```

(d) cementite

Figure 13: Query: are materials solid or liquid

3. Deductive again:

   Does Ferrite have high hardness? Why?

No. There is no carbon content that can fit both ferrite and high hardness.

```
?- ferrite(X, Y), highHardness(Y).
false.
```

Figure 14: Query: does ferrite have high hardness

Is Ferrite more ductile than Cementite? Why?

Yes. Ferrite is high ductility but cementite is not.

```
?- ferrite(X, Y), highDuctility(Y).
X = 1000,
Y = 0.4 ;
X = 900,
Y = 0.4.

?- cementite(X, Y), highDuctility(Y).
false.
```

Figure 15: Query: is ferrite more ductile than cementite

Which material has low tensile strength? Why?

Ferrite. Only ferrtie's carbon content can fit low tensile strength.

```
?- ferrite(X, Y), lowTensileStrength(Y).
X = 1000,
Y = 0.4 ;
X = 900,
Y = 0.4.

?- pearlite(X, Y), lowTensileStrength(Y).
false.

?- austenite(X, Y), lowTensileStrength(Y).
false.

?- cementite(X, Y), lowTensileStrength(Y).
false.
```

Figure 16: Query: which material has low tensile strength

10 Appendix A: Ontology XML


```xml
<?xml version="1.0"?>
<Ontology xmlns="http://www.w3.org/2002/07/owl#"
          xml:base="http://webprotege.stanford.edu/project/DxITv9MAicsSUu54ZOu2qG"
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:xml="http://www.w3.org/XML/1998/namespace"
          xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
          xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
          ontologyIRI="http://webprotege.stanford.edu/project/DxITv9MAicsSUu54ZOu2qG">
    <Prefix name="owl" IRI="http://www.w3.org/2002/07/owl#"/>
    <Prefix name="rdf" IRI="http://www.w3.org/1999/02/22-rdf-syntax-ns#"/>
    <Prefix name="xml" IRI="http://www.w3.org/XML/1998/namespace"/>
    <Prefix name="xsd" IRI="http://www.w3.org/2001/XMLSchema#"/>
    <Prefix name="rdfs" IRI="http://www.w3.org/2000/01/rdf-schema#"/>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R7SKPSPclcU0G2HYHr94Ysk"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R7k56fVzJcAkhFQaIEkYFSv"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R7rzlu1B3N23vhiIi73jGdI"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R8SgCQGCUPS4cPRItcYai2T"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R97OWwnTdiaAcIuIL6AKjTU"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R9H1s0evsYMcedUicerleF"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RB5l4cXsOisMbebzSFwcIS9"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RBeeFtU5HwRSVJ9WO3x4ttl"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RCtWKPeM4CphKE6VdL4d97v"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RDQQlz564YgakVQW2SiPU1N"/>
    </Declaration>
    <Declaration>
        <Class IRI="http://webprotege.stanford.edu/RDRRjjmED0zPvkyeU7TcN4G"/>
```

```
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi"/>
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RDWA3v5bJVW3VQoVRoM7zX8"/>
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RZFYpU9e4GSQcvFxNExtlR"/>
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
</Declaration>
<Declaration>
        <Class IRI="http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD"/>
</Declaration>
<Declaration>
        <ObjectProperty IRI="http://webprotege.stanford.edu/R9NHcdNpt6OdcTPXR2AuszN"/>
</Declaration>
<Declaration>
        <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
</Declaration>
<Declaration>
        <ObjectProperty IRI="http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3"/>
</Declaration>
<Declaration>
        <ObjectProperty IRI="http://webprotege.stanford.edu/RjSaLrVf3vINT3S6d3vWkn"/>
</Declaration>
<Declaration>
        <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
</Declaration>
<Declaration>
        <NamedIndividual IRI="http://webprotege.stanford.edu/R7aYMvvsLZak4GJXeegSHo8"/>
</Declaration>
<Declaration>
        <Datatype IRI="http://webprotege.stanford.edu/R8VZPAaOyVnkvotw6Wr3HOc"/>
</Declaration>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A"/>
        <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
        <DataHasValue>
                <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
                <Literal xml:lang="en">float[&gt;=&quot;0.05&quot;, &lt;=&quot;0.30&quot;]</Literal>
        </DataHasValue>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7SKPSPclcU0G2HYHr94Ysk"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
        <ObjectSomeValuesFrom>
                <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
                <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
        </ObjectSomeValuesFrom>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
```

```
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3"/>
            <Class IRI="http://webprotege.stanford.edu/RDRRjjmED0zPvkyeU7TcN4G"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
        <DataHasValue>
            <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
            <Literal>float[&gt;=&quot;1.25&quot;, &lt;=&quot;2.0&quot;]</Literal>
        </DataHasValue>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7k56fVzJcAkhFQaIEkYFSv"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R7rzlu1B3N23vhiIi73jGdI"/>
        <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
            <Class IRI="http://webprotege.stanford.edu/R7k56fVzJcAkhFQaIEkYFSv"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
            <Class IRI="http://webprotege.stanford.edu/RCtWKPeM4CphKE6VdL4d97v"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
            <Class IRI="http://webprotege.stanford.edu/RZFYpU9e4GSQcvFxNExtlR"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3"/>
            <Class IRI="http://webprotege.stanford.edu/RB5l4cXsOisMbebzSFwcIS9"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3"/>
            <Class IRI="http://webprotege.stanford.edu/RBeeFtU5HwRSVJ9WO3x4ttl"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
        <DataHasValue>
            <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
            <Literal xml:lang="en">float[&gt;=&quot;0.3&quot;, &lt;=&quot;0.6&quot;]</Literal>
        </DataHasValue>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R8SgCQGCUPS4cPRItcYai2T"/>
```

```
        <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R97OWwnTdiaAcIuIL6AKjTU"/>
        <Class IRI="http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/R9H1s0evsYMcedUicerleF"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RB5l4cXsOisMbebzSFwcIS9"/>
        <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RBeeFtU5HwRSVJ9WO3x4ttl"/>
        <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
        <ObjectSomeValuesFrom>
                <ObjectProperty IRI="http://webprotege.stanford.edu/RjSaLrVf3vINT3S6d3vWkn"/>
                <Class IRI="http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A"/>
        </ObjectSomeValuesFrom>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
        <ObjectSomeValuesFrom>
                <ObjectProperty IRI="http://webprotege.stanford.edu/RjSaLrVf3vINT3S6d3vWkn"/>
                <Class IRI="http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi"/>
        </ObjectSomeValuesFrom>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
        <ObjectSomeValuesFrom>
                <ObjectProperty IRI="http://webprotege.stanford.edu/RjSaLrVf3vINT3S6d3vWkn"/>
                <Class IRI="http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD"/>
        </ObjectSomeValuesFrom>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RCtWKPeM4CphKE6VdL4d97v"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RDQQlz564YgakVQW2SiPU1N"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RDRRjjmED0zPvkyeU7TcN4G"/>
        <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi"/>
        <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RDWA3v5bJVW3VQoVRoM7zX8"/>
        <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RZFYpU9e4GSQcvFxNExtlR"/>
        <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
</SubClassOf>
<SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <ObjectSomeValuesFrom>
                <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
                <Class IRI="http://webprotege.stanford.edu/R7SKPSPclcU0G2HYHr94Ysk"/>
```

```
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
            <Class IRI="http://webprotege.stanford.edu/R9H1s0evsYMcedUicerleF"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6"/>
            <Class IRI="http://webprotege.stanford.edu/RDQQlz564YgakVQW2SiPU1N"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <ObjectSomeValuesFrom>
            <ObjectProperty IRI="http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3"/>
            <Class IRI="http://webprotege.stanford.edu/RDWA3v5bJVW3VQoVRoM7zX8"/>
        </ObjectSomeValuesFrom>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        <DataHasValue>
            <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
            <Literal xml:lang="en">float[&gt;=&quot;0.6&quot;, &lt;=&quot;1.0&quot;]</Literal>
        </DataHasValue>
    </SubClassOf>
    <SubClassOf>
        <Class IRI="http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD"/>
        <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
    </SubClassOf>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A"/>
        <Class IRI="http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A"/>
        <Class IRI="http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC"/>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4"/>
        <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7rzlu1B3N23vhiIi73jGdI"/>
        <Class IRI="http://webprotege.stanford.edu/R8SgCQGCUPS4cPRItcYai2T"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R7rzlu1B3N23vhiIi73jGdI"/>
        <Class IRI="http://webprotege.stanford.edu/R97OWwnTdiaAcIuIL6AKjTU"/>
    </DisjointClasses>
    <DisjointClasses>
        <Class IRI="http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh"/>
```

```
            <Class IRI="http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/R8SgCQGCUPS4cPRItcYai2T"/>
            <Class IRI="http://webprotege.stanford.edu/R97OWwnTdiaAcIuIL6AKjTU"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
            <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
            <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8"/>
            <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
            <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8"/>
            <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq"/>
            <Class IRI="http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ"/>
        </DisjointClasses>
        <DisjointClasses>
            <Class IRI="http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi"/>
            <Class IRI="http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD"/>
        </DisjointClasses>
        <FunctionalDataProperty>
            <DataProperty IRI="http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ"/>
        </FunctionalDataProperty>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/R77HrYnkWf8yOdwxl3WuW1A</IRI>
            <Literal xml:lang="en">Annealing</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC</IRI>
            <Literal xml:lang="en">0.05 to 0.30% carbon content.</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/R7AO81oJArvkzcjwXCtd4FC</IRI>
            <Literal xml:lang="en">LowCarbonSteel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/R7SKPSPclcU0G2HYHr94Ysk</IRI>
            <Literal xml:lang="en">HighStrengthWires</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4</IRI>
            <Literal xml:lang="en">Approximately 1.25{2.0% carbon content.
Steels that can be tempered to great hardness. Used for special purposes
like knives, axles or punches. Most steels with more than 2.5% carbon
content are made using powder metallurgy.</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/R7Wt4ZAjowWum6jGTa6cfv4</IRI>
            <Literal xml:lang="en">UltraHighCarbonSteel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
```

```
                <IRI>http://webprotege.stanford.edu/R7aYMvvsLZak4GJXeegSHo8</IRI>
                <Literal xml:lang="en">larged</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R7k56fVzJcAkhFQaIEkYFSv</IRI>
                <Literal xml:lang="en">LargeParts</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R7rzlu1B3N23vhiIi73jGdI</IRI>
                <Literal xml:lang="en">Knives</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
                <IRI>http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh</IRI>
                <Literal xml:lang="en">Approximately 0.3{0.6% carbon content.
Balances ductility and strength and has good wear resistance;
used for large parts, forging and automotive components.</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R846GMVxIMEtXgXybWAhIyh</IRI>
                <Literal xml:lang="en">MediumCarbonSteel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R8Ej3tVsjP5Tujpp2onZ3Vj</IRI>
                <Literal xml:lang="en">SpecialPurposes</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R8SgCQGCUPS4cPRItcYai2T</IRI>
                <Literal xml:lang="en">Punches</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R8VZPAaOyVnkvotw6Wr3HOc</IRI>
                <Literal xml:lang="en">float[&gt;=&quot;0.6&quot;]</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R97OWwnTdiaAcIuIL6AKjTU</IRI>
                <Literal xml:lang="en">Axles</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R9H1s0evsYMcedUicerleF</IRI>
                <Literal xml:lang="en">Springs</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R9NHcdNpt6OdcTPXR2AuszN</IRI>
                <Literal xml:lang="en">subClassOf</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
                <IRI>http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8</IRI>
                <Literal xml:lang="en">What each type of steel can be used for</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/R9yy7Q58I36dWTaomJ0AXE8</IRI>
                <Literal xml:lang="en">Applications</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
                <IRI>http://webprotege.stanford.edu/RB5l4cXsOisMbebzSFwcIS9</IRI>
                <Literal xml:lang="en">HasGoodWearResistance</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
                <AnnotationProperty abbreviatedIRI="rdfs:label"/>
```

```
            <IRI>http://webprotege.stanford.edu/RBeeFtU5HwRSVJ9WO3x4ttl</IRI>
            <Literal xml:lang="en">BalanceDuctilityAndStrength</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RBxTDEpGv7sSa7xJNtZ18C6</IRI>
            <Literal xml:lang="en">usedFor</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8</IRI>
            <Literal xml:lang="en">There are many types of heat treating processes available to steel.
The most common are annealing, quenching, and tempering.</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RCMNXtsT7lXkcYrxO6nbnf8</IRI>
            <Literal xml:lang="en">Steel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq</IRI>
            <Literal xml:lang="en">Features that each type of steel holds</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RCp1BzKb6cmUuQCt9gBiIsq</IRI>
            <Literal xml:lang="en">Features</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RCtWKPeM4CphKE6VdL4d97v</IRI>
            <Literal xml:lang="en">AutomotiveComponents</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RDQQlz564YgakVQW2SiPU1N</IRI>
            <Literal xml:lang="en">EdgedTools</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RDRRjjmED0zPvkyeU7TcN4G</IRI>
            <Literal xml:lang="en">CanTemperedToGreatHardness</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RDRaSF2IL8pbEI59iTgzNsi</IRI>
            <Literal xml:lang="en">Quenching</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RDWA3v5bJVW3VQoVRoM7zX8</IRI>
            <Literal xml:lang="en">VeryStrong</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ</IRI>
            <Literal xml:lang="en">Heat TreatingProcess that are available to steel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RDe1Cs54n6wUTMYYNavFMuQ</IRI>
            <Literal xml:lang="en">HeatTreatingProcess</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RG8xtrhT3IRlly1RC1A2I3</IRI>
            <Literal xml:lang="en">hasFeature</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RZFYpU9e4GSQcvFxNExtlR</IRI>
```

```
            <Literal xml:lang="en">Forging</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RjSaLrVf3vINT3S6d3vWkn</IRI>
            <Literal xml:lang="en">availableProcess</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RmF9qJDswdWG6qQ4xfUPyQ</IRI>
            <Literal xml:lang="en">carbonContentPercentage</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:comment"/>
            <IRI>http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy</IRI>
            <Literal xml:lang="en">Approximately 0.60 to 1.00% carbon content.
Very strong, used for springs, edged tools, and high-strength wires.</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RnpAm5YZIAcl4mr9ZbfPJy</IRI>
            <Literal xml:lang="en">HighCarbonSteel</Literal>
        </AnnotationAssertion>
        <AnnotationAssertion>
            <AnnotationProperty abbreviatedIRI="rdfs:label"/>
            <IRI>http://webprotege.stanford.edu/RzLMMM8OeWX5JtMmZdpFwD</IRI>
            <Literal xml:lang="en">Tempering</Literal>
        </AnnotationAssertion>
</Ontology>



<!-- Generated by the OWL API (version 4.5.10) https://github.com/owlcs/owlapi -->
```

11 Appendix B: Prolog knowledge base

```
% exercise 9 prolog knowledge base
highTemperature(1535).
mediumTemperature(1000).
mediumTemperature(900).
lowTemperature(700).
highCarbon(2.0).
mediumCarbon(0.78).
lowCarbon(0.4).

liquid(X) :- highTemperature(X).
solid(X) :- mediumTemperature(X).
solid(X) :- lowTemperature(X).

ferrite(X, Y) :- mediumTemperature(X), lowCarbon(Y).
pearlite(X, Y) :- lowTemperature(X), mediumCarbon(Y).
austenite(X, Y) :- mediumTemperature(X), mediumCarbon(Y).
cementite(X, Y) :- mediumTemperature(X), highCarbon(Y).

highHardness(X) :- highCarbon(X).
mediumHardness(X) :- mediumCarbon(X).
lowHardness(X) :- lowCarbon(X).
highDuctility(X) :- lowCarbon(X).
mediumDuctility(X) :- mediumCarbon(X).
lowDuctility(X) :- highCarbon(X).
highTensileStrength(X) :- mediumCarbon(X).
mediumTensileStrength(X) :- highCarbon(X).
lowTensileStrength(X) :- lowCarbon(X).
```