COMP24412 Lab 3 - The Riddle of Steel Report

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0.1 Lexical Analysis

Steel is 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.

1. POS tagging the above sentence:
    - NN: Noun, singular or mass
        - steel
        - alloy
        - iron
        - carbon
        - strength
        - cost
        - component
        - infrastructure
    - NNS: Noun, plural
        - elements
        - buildings
        - tools
        - ships
        - automobiles
        - machines
        - appliances
        - weapons
    - JJ: Adjectives
        - other
        - high
        - tensile
        - low
        - major
    - RB: Adverb

  - sometimes
- CC: Coordinating conjunction
  - Because
  - and
- DT: Determiner
  - an
  - a
  - its
- IN: Preposition/subordinating conjunction
  - in
  - of
- VBD: Verb, past tense
  - Used
- VZD: Verb, 3rd person singular present
  - is
- PP$: Possessive pronoun
  - it

2. Pronominal co-references: steel, it

0.2 C-Structures

Sentence is 'Steel is an alloy of iron and carbon, and sometimes other elements.'.

1. Constituency structure: see Figure 1.
2. Nominal phrasal nodes:
3. Co-ordinations:
   - Coordinating conjunction: '...iron AND carbon, AND...'
   - Gapped coordination: '...sometimes other elements.'

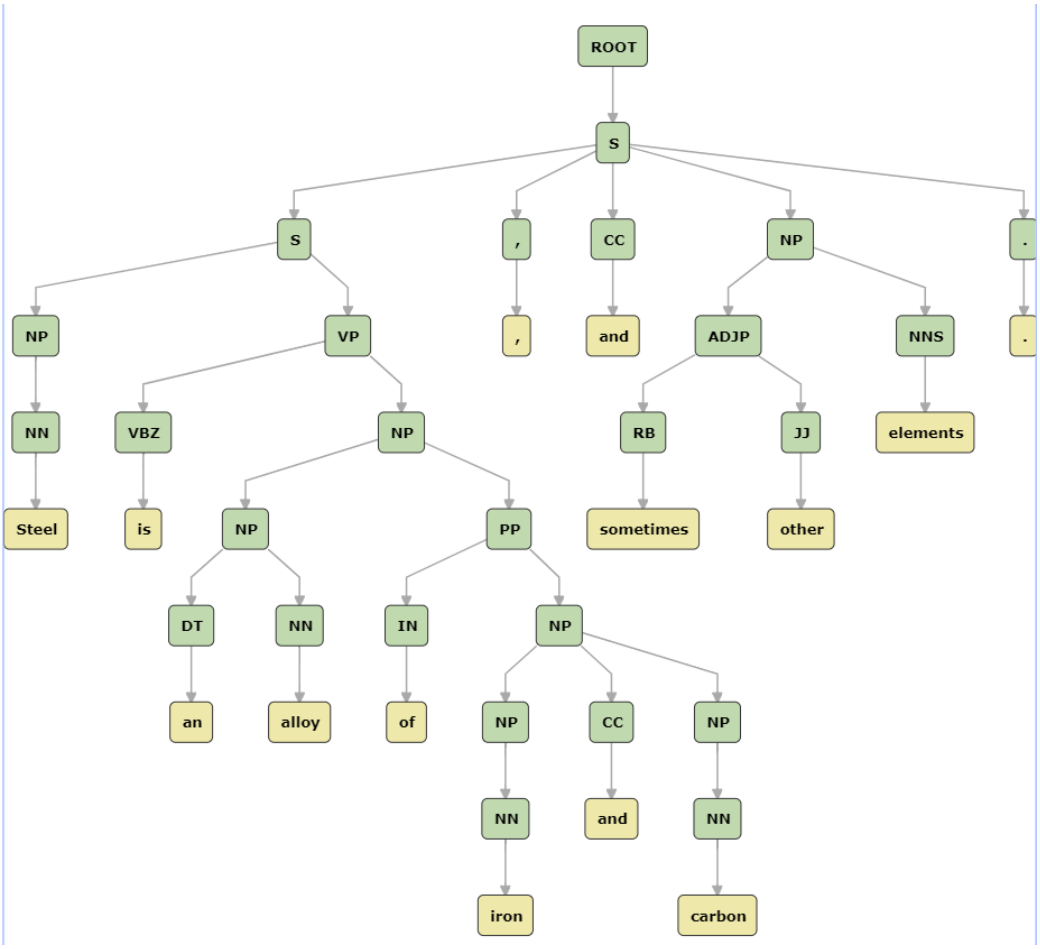

Figure 1: C-strcuture for the sentence

0.3 Dependencies - Exploring new territories

1. Constituency parsing divides text into sub-phrases. Using a tree structure, the types of phrases belong on branches, the individual words in the sentence are leaves, and the designation 'Sentence' is the root.

   Dependency parsing connects words according to their relationships. Again using a tree structure, each node in the tree represents a word, with the leaf nodes being 'dependent' on the internal nodes, which are most often verbs.

2. Dependency structure: see Figure 2.

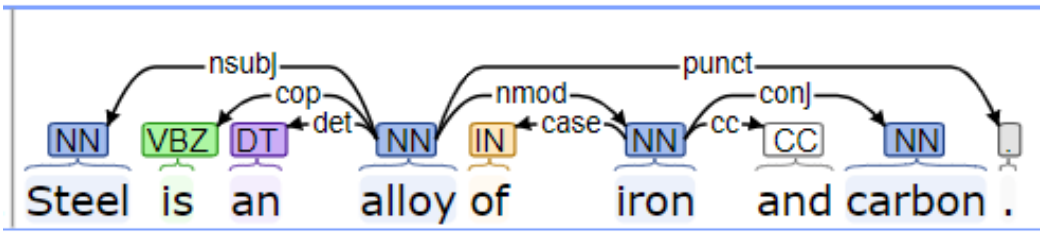

Figure 2: Dependency structure for sentence: 'Steel is an alloy of iron and carbon'

0.4 Open IE - Semantics

1. Here are the predicate-argument structures for the following sentences:
   (a) 'Steel is an alloy.': Entity(Steel) ← Subject – relation(is) – Object → (an alloy) Entity(alloy).
   (b) 'Steel contains carbon.': Entity(Steel) ← Subject – relation(contains) – Object → (carbon) Entity(carbon).
   (c) 'Steel contains iron.': Entity(Steel) ← Subject – relation(contains) – Object → (iron) Entity(iron).
2. Prolog translation of triples:
   steel(X) :- alloy(X), contains(X, carbon), contains(X, iron).
3. RDF translation of triples:
   (a) $\langle Steel \rangle$ $\langle isan \rangle$ $\langle alloy \rangle$.
   (b) $\langle Steel \rangle$ $\langle contains \rangle$ $\langle carbon \rangle$.
   (c) $\langle Steel \rangle$ $\langle contains \rangle$ $\langle iron \rangle$.
4. Axiom formalisation using Description Logics:
   Steel$\equiv$ alloy $\sqcap$ hasCarbon $\sqcap$ hasIron

5. 'Steel is an alloy of iron and carbon.' - as per the next figure, the predicate-argument structure is more complex, and the Prolog itself might differ like so:

   steel(X) :- alloy(X, [carbon, iron]).

   Previously, the three separate statements simply translated to three relational statements. However, an 'alloy of' some elements means there might be a predicate named alloy taking two arguments, testing if the first contains the second (which is in list form since an alloy can have more than two elements in it).

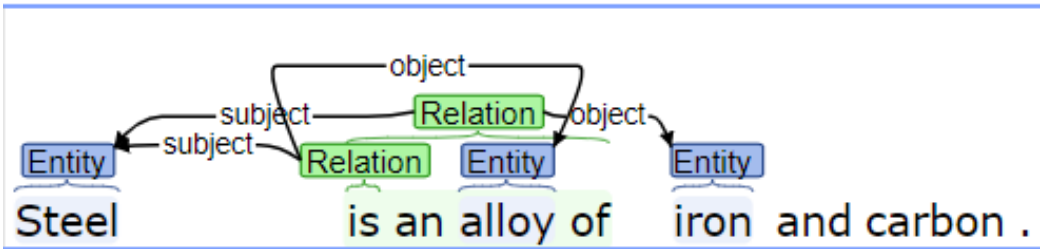

Figure 3: Predicate-argument structure for: 'Steel is an alloy of iron and carbon.'

0.5 Complex Open IE, Rhetorical Strcutures

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

1. Nucleus: 'As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating;'

   Satellite: 'however, it becomes less ductile.'

2. Diagram: see fig. 5

3. Hypotactic relations:

   -

   Paratactic relations:

   -

4. RDF-NL notation of above sentence:

   - 0 the carbon percentage content rises
   - 0 steel has the ability to become harder through heat treating (L:LIST)
   - 0 steel has the ability to become stronger through heat treating (L:LIST)

0.6 Taxonomies, Thesauri

1. 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. Hypernym hierarchies for martensite and austenite:

   They are the same from the initial definitions of both words:

   - Start with either one:
     - 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)
   - solid solution, primary solid solution: (a homogeneous solid that can exist over a range of component chemicals; a constituent of alloys that is formed when atoms of an element are incorporated into the crystals of a metal)
   - solution: (a homogeneous mixture of two or more substances; frequently (but not necessarily) a liquid solution) "he used a solution of peroxide and water"

- mixture: ((chemistry) a substance consisting of two or more substances mixed together (not in fixed proportions and not with chemical bonding))
- substance: (the real physical matter of which a person or thing consists) "DNA is the substance of our genes"
  - matter: (that which has mass and occupies space) "physicists study both the nature of matter and the forces which govern it"
  - physical entity: (an entity that has physical existence)
  - OR, instead of the above two, these three:
  - part, portion, component, constituent: (something determined in relation to something that includes it) "he wanted to feel a part of something bigger than himself"; "I read a portion of the manuscript"; "the smaller component is hard to reach"; "the animal constituent of plankton"
  - relation: (an abstraction belonging to or characteristic of two entities or parts together)
  - abstraction, abstract entity: (a general concept formed by extracting common features from specific examples)
- entity: (that which is perceived or known or inferred to have its own distinct existence)

3. Sibling terms for martensite: (primary solid solution, solid solution), austenite, ferrite, double salt

   Sibling terms for austenite: (primary solid solution, solid solution), austenite, ferrite, double salt

4. There are 9 synsets (4 noun based, 5 verb based). The steel-related synsets are:

   - toughness: (the elasticity and hardness of a metal object; its ability to absorb considerable energy before cracking), a near-synonym
   - harden: (harden by reheating and cooling in oil) "temper steel", a near-synonym
   - anneal, normalise: (bring to a desired consistency, texture, or hardness by a process of gradually heating and cooling) "temper glass"

0.7 Frame Semantics - Exploring Further

Verbs: melt, oxidise

1. Frame semantics for these verbs using VerbNet, PropBank and FrameNet
    - PropBank
        - Roleset id, melt: to change from a solid to a liquid state, melted, in a (hot) liquid state
        - Roleset id, oxidize: to (cause to) convert into an oxide, combine with oxygen
        - Aliases, melt: melt, motlen
        - Aliases, oxidize: oxidize, oxidation
        - Roles, melt: agent, thing melted
        - Roles, oxidize: Cause of oxidizing, Scientist causing conversion
    - FrameNet: both verbs return no frame results when searched for, but here are the differences between the lexical unit search results
        - Melt:
            * melt (verb), cause change of phase, finished initial
            * melt (verb), change of phase, finished initial
            * melt (verb), apply heat, created
            * melt (verb), substance, finished initial
            * melt (verb), apply heat, created
        - Oxidise:
            * oxidise (verb), corroding caused, insufficient attestations
            * oxidise (verb), corroding, created
    - VerbNet:
2. Awaiting answers from Andre
3. Awaiting answers from Andre