NICF -TEXT ANALYTICS

MODULE 7: LINGUISTIC RESOURCES

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Objectives

At the end of this module, you can

- Identify common text analytics artifacts or resources
- Develop such artifacts/resources based on domain knowledge

Outline

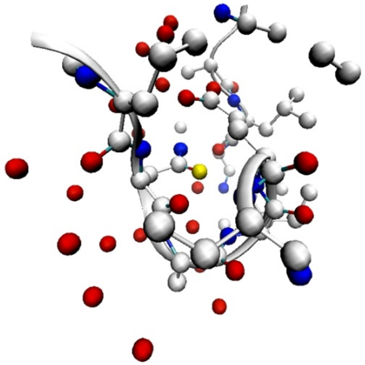
- Linguistic/knowledge resources and their roles in text analytics
- Corpora
- Dictionaries
- Defining patterns using regular expressions

Linguistic Resources

- Sets of language data and descriptions in machine readable form
- Used for building text analytics systems
  - **Corpora** - to provide examples for statistical methods and machine learning algorithms to work
- Or for improving text analytics systems, needed by various processing steps
  - **Dictionaries** - valid terms, POS information, list of stop words, or words to be filtered
  - **Terminologies** – special domain words and phrases
  - **Patterns/rules** – for information extraction

Knowledge Resources

- Taxonomy and ontology – a hierarchical conceptual model to map terms to concepts
- Prerequisite for advance text mining, together with terminology lexicon
  - E.g. to derive complex information such as temporal, causal, conditional and other types of semantic relations between biomedical entities instead of simple associations



Corpora

- Often labelled or annotated, to provide examples for statistical methods and machine learning algorithms to work
- Quality of corpora is critical for the resulting models
  - Validity – correct (need “ground truth” to measure)
  - Reliability – consistent (measured by coefficients of agreement)

Corpus Annotation

- Objective tasks - easier, subjective tasks - much harder
- Define task and guidelines
  - The source text? What to annotate? What are the labels for them?
  - Criteria, decision rules and examples
- Train the annotators (humans)
  - Each annotator tries annotating the same set of articles.
  - Check self-agreement rate
    - Individual annotator annotates some randomly selected samples again
    - To eliminate poor performers, or improve their work
  - Check inter-annotator agreement (IAA) rate
    - To resolve conflicts, refine guidelines with example of boundary cases
    - To improve IAA rate before large scale annotation
- In actual annotation, still assign a portion of items to be annotated by two or more annotators for monitoring quality

Inter-Annotator Agreement

- Agreement between multiple annotators (assumption: *consistency implies validity*.)
- Used to evaluate and monitor the annotation quality
- Common measures:
  - Cohen’s Kappa
  - Fleiss’s Kappa
  - Scott’s Pi
  - Krippendorff’s Alpha
  - Etc.

Cohen's Kappa

- The agreement rate for qualitative items taking into account the possibility of chance agreement

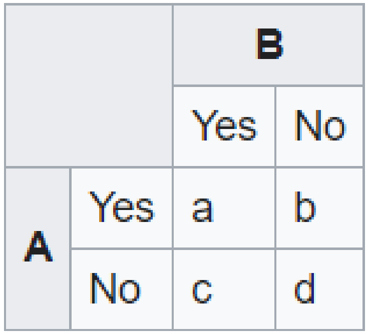
$$k = \frac{p_o - p_e}{1 - p_e}$$

  - p_o : observed agreement
  - p_e : expected agreement

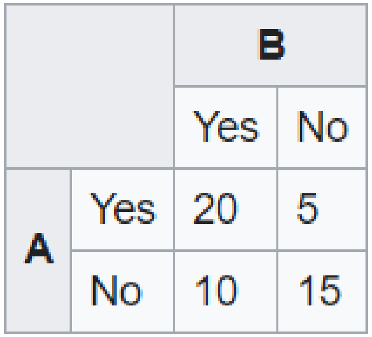
$$p_e = \frac{1}{N^2} \sum_k n_{k1} \, n_{k2}$$

  - k : number of categories
  - N : number of observations
  - n_{ki}: number of times annotator *i* predicted category *k*

Example of Kappa



		B	
		Yes	No
A	Yes	a	b
	No	c	d



		B	
		Yes	No
A	Yes	20	5
	No	10	15

$$p_o = \frac{a+d}{a+b+c+d} = \frac{20+15}{50} = 0.7$$

$$p_{\text{Yes}} = \frac{a+b}{a+b+c+d} \cdot \frac{a+c}{a+b+c+d} = 0.5 \times 0.6 = 0.3$$

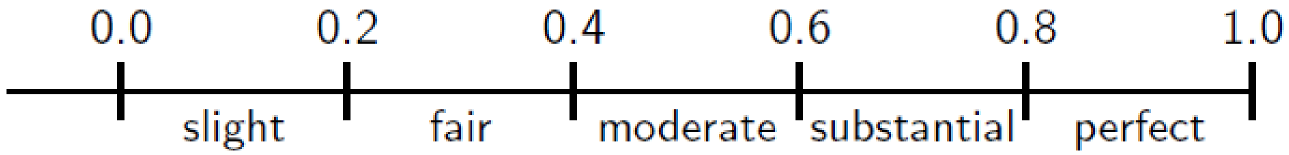
$$p_{\text{No}} = \frac{c+d}{a+b+c+d} \cdot \frac{b+d}{a+b+c+d} = 0.5 \times 0.4 = 0.2$$

$$p_e = p_{\text{Yes}} + p_{\text{No}} = 0.3 + 0.2 = 0.5$$

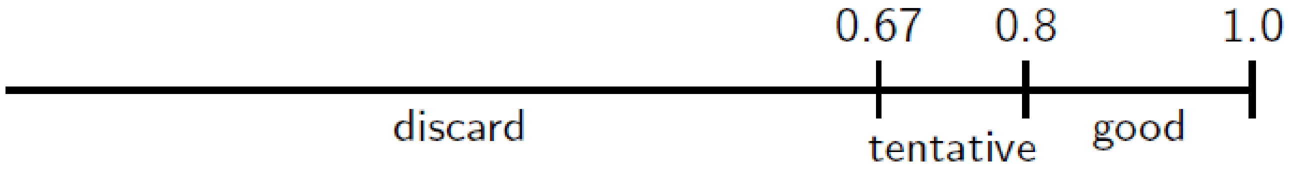
$$\kappa = \frac{p_o - p_e}{1 - p_e} = \frac{0.7 - 0.5}{1 - 0.5} = 0.4$$

Interpretation of Kappa

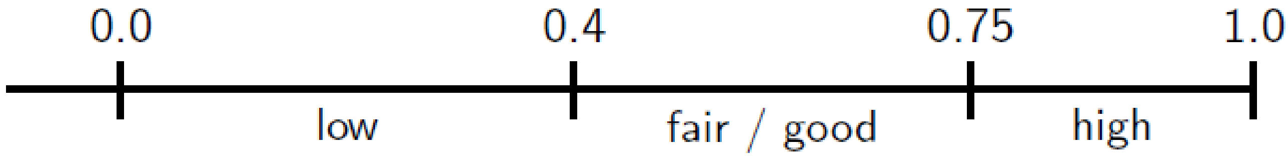
- Landis and Koch, 1977



- Krippendorff, 1980



- Green, 1997



- Artstein and Poesio, 2008: "*If a threshold needs to be set, 0.8 is a good value*."

Dictionaries

- Text analytics systems may be equipped with dictionaries in different languages for various purposes.
  - General domain dictionaries for more accurate tokenization, stemming, and POS tagging.
  - Terminology dictionaries for special domains or tasks
    - e.g. Biomedical domain
    - Customer Relation Management
    - IT
    - Market Intelligence
    - Opinions Mining, etc.

Valid Term Dictionary

- A list of valid terms in the language in concern
- Or as dictionary for terms to be used in the term vector (e.g. R Text Mining package)
  - Only terms in the dictionary appear in the document term vector or matrix.
  - It helps to restrict the dimension of the matrix a priori and to focus on specific terms for distinct text mining contexts.
- It may include useful information such as POS

Filter Dictionary

- Also known as *Stopword List* / *exclusion dictionary*
- To support the stopword removal step in preprocessing
- A list of very common words
  - usually functional words like *preposition*, *conjunction*, etc.
  - or words that are unimportant for the mining task
- Example stopword list (not complete):

a
about
above
after
again
against
all
am
an
and
any
are
aren't
as
at
be
because
been
before
being
below
between
both
been
before
being
below
between
both
but
by
…

From http://www.ranks.nl/resources/stopwords.html

Synonym Dictionaries

- Also known as *substitution* dictionary, to group similar words under one term
- Typically for known synonyms, user-defined synonyms

dislike, *detest*

- Also a direct way to deal with common misspellings with the correct spelling

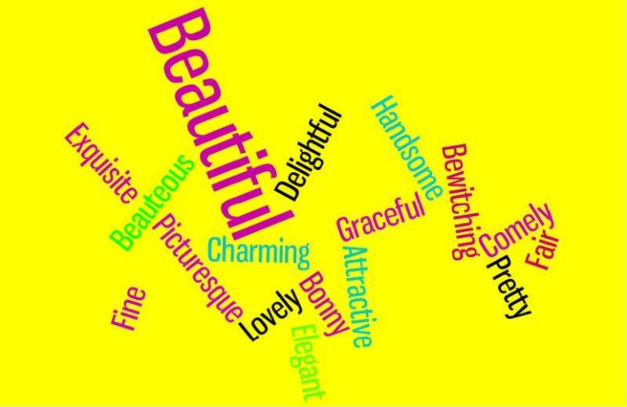
dislike, *dilike*

- Can be used as a hard way to deal with inflections if no stemmer is used

like, *likes, liked*

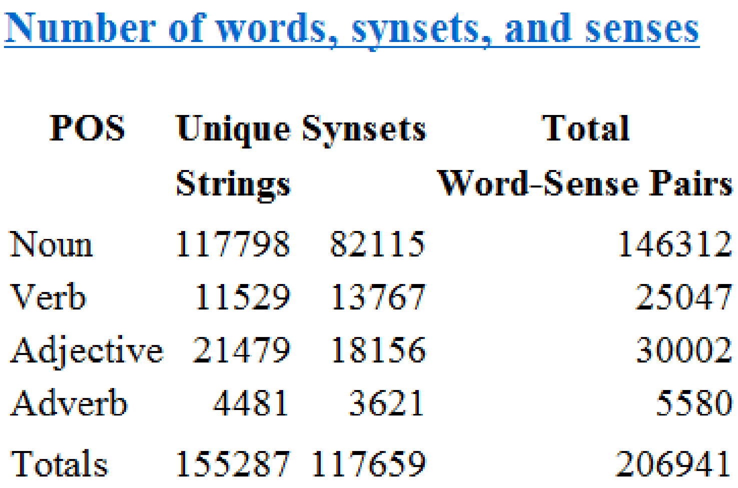
Synonym Dictionaries

- Typically synonym words are listed in a file for string match
- Some tools allow certain flexibility in stating how the synonyms should be matched
  - Strictly as it appears in the definition, disallowing inflected forms
  - With any word starting with the term
  - With any word ending with the term



WordNet

- A large lexical database of English
- Created and maintained by the Cognitive Science Laboratory of Princeton University
- *Nouns*, *verbs*, *adjectives* and *adverbs* are grouped into sets of cognitive synonyms (*synsets*), each expressing a distinct concept



Number of words, synsets, and senses

POS	Unique Strings	Synsets	Total Word-Sense Pairs
Noun	117798	82115	146312
Verb	11529	13767	25047
Adjective	21479	18156	30002
Adverb	4481	3621	5580
Totals	155287	117659	206941

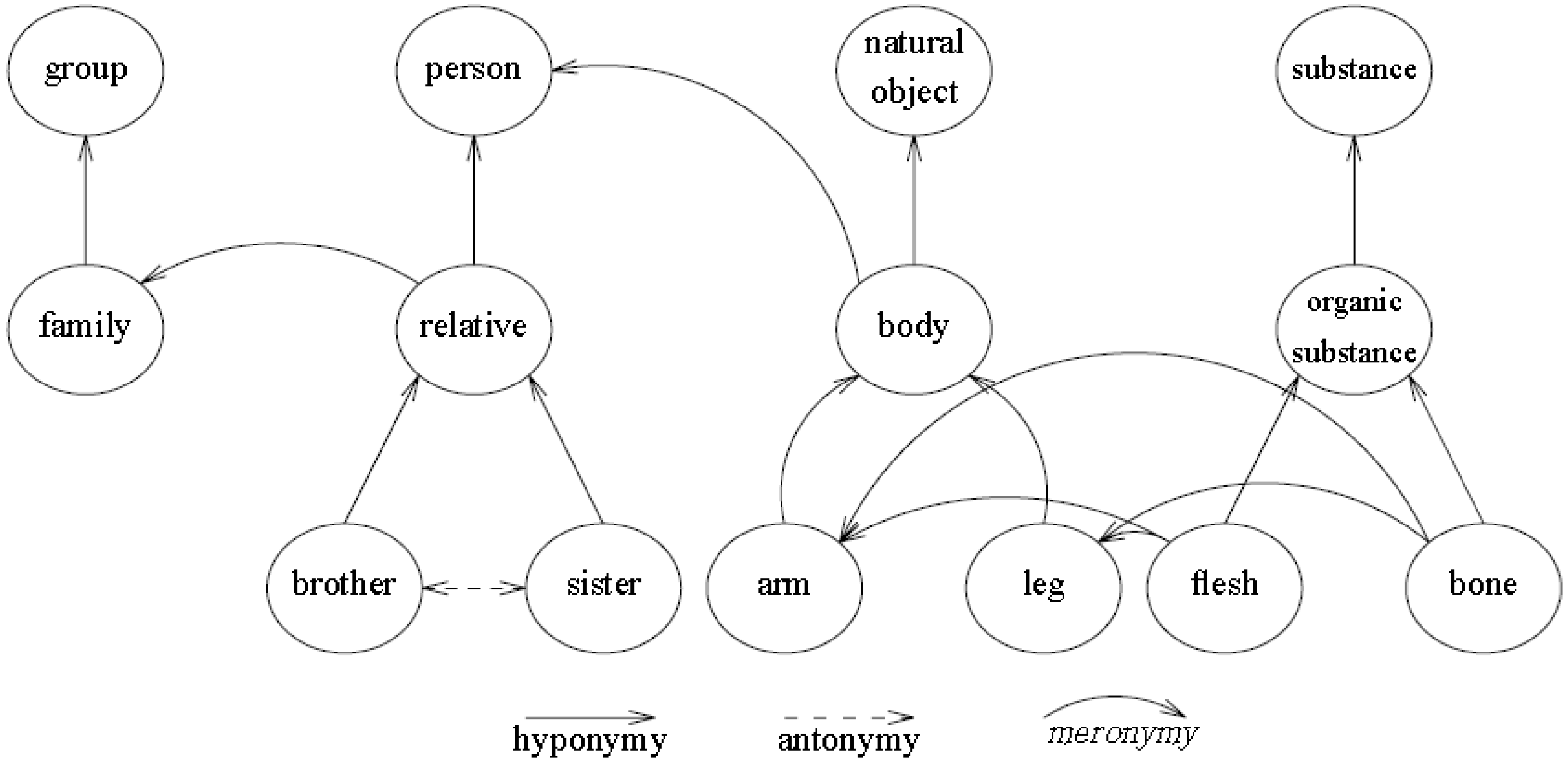
Statistics from WordNet website
http://wordnet.princeton.edu/wordnet/man/wnstats.7WN.html

WordNet

- Synsets are linked by conceptual-semantic and lexical relations
  - Lexical relations
    - Synonymy – e.g. *shut* and *close*, *happy* and *joyful*
    - Antonymy – e.g. *wet* and *dry*, *young* and *old*, *happy* and *sad*
    - Morphological relations
  - Semantic relations
    - Hyponymy (or ISA relation, super-subordinate relation) – e.g. *apple* and *fruit*, *bed* and *furniture*, *communicate* and *talk* and *whisper*
    - Meronymy (part-whole relation) – e.g. *leg* and *chair*
  - And more…

WordNet

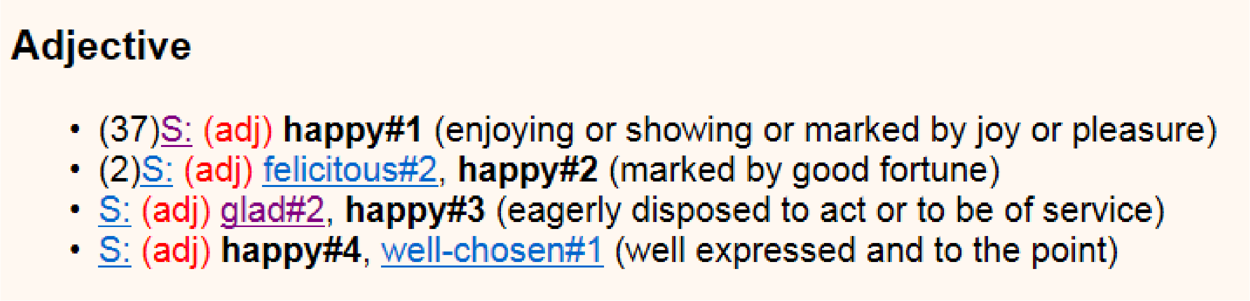
Figure 2. Network representation of three semantic relations among an illustrative variety of lexical concepts



From *Nouns in WordNet: A Lexical Inheritance System*

WordNet

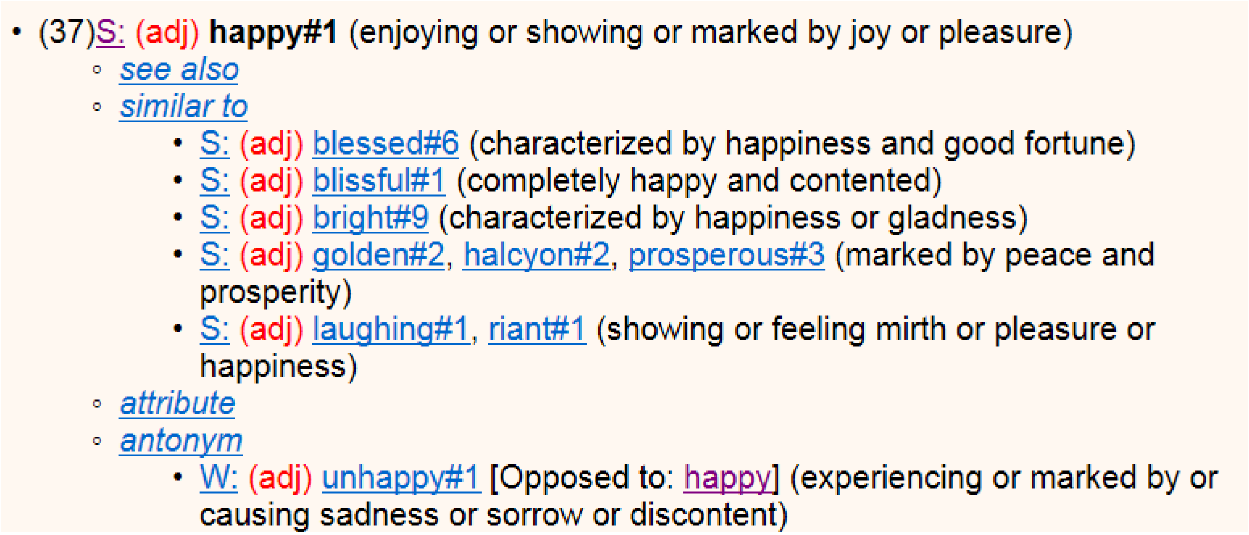
- Example information in Wordnet for “happy”:



Adjective

- (37)S: (adj) **happy#1** (enjoying or showing or marked by joy or pleasure)
- (2)S: (adj) felicitous#2, **happy#2** (marked by good fortune)
- S: (adj) glad#2, **happy#3** (eagerly disposed to act or to be of service)
- S: (adj) **happy#4**, well-chosen#1 (well expressed and to the point)

- Expanded view:



- (37)S: (adj) **happy#1** (enjoying or showing or marked by joy or pleasure)
  - *see also*
  - *similar to*
    - S: (adj) blessed#6 (characterized by happiness and good fortune)
    - S: (adj) blissful#1 (completely happy and contented)
    - S: (adj) bright#9 (characterized by happiness or gladness)
    - S: (adj) golden#2, halcyon#2, prosperous#3 (marked by peace and prosperity)
    - S: (adj) laughing#1, riant#1 (showing or feeling mirth or pleasure or happiness)
  - *attribute*
  - *antonym*
    - W: (adj) unhappy#1 [Opposed to: happy] (experiencing or marked by or causing sadness or sorrow or discontent)

WordNet

- Free and open source
- Proved useful for a wide range of Natural Language Processing applications
  - Word sense disambiguation
  - Word semantic distance measuring
  - Mono- and cross-lingual Information retrieval,
  - Question-answering systems
  - Machine translation
  - Document structuring and categorisation

Sentiment/Opinion Lexicon

- Essential resources required for Opinion Mining to detect sentences containing subjective opinions.
- also known as *sentiment words, opinion words, polar words,* or *opinion-bearing words*.
- Lexicons or dictionaries of words or phrases that convey *positive* or *negative* sentiments, for example:

beautiful, wonderful, amazing…
bad, poor, awful…

- Such sentiment/opinion lexicon can be manually compiled (labor intensive and time consuming!), or ‘learned’ from dictionaries or corpora (not so easy too)

Challenges in Using Opinion Lexicon

- An opinion word’s opinion orientation can be sensitive to its context.
  - E.g. *long* – positive or negative?
    - “The battery life is very ***long***”
    - “The queue at the counter is very ***long*** “

- Sarcasm, in which the speakers say the opposite of what they mean
  - E.g. “What a ***great*** phone! It stopped working in two days.”

Defining Patterns using Regular Expressions

Defining patterns/rules

- With regular expression, we can extract strings containing certain characters, or not containing certain characters, or strings with pre-specified patterns of letters or numbers.
- Such patterns can be defined in a very compact way
  - E.g. regular expression for email addresses

    [a-zA-Z0-9._-]+@([a-zA-Z0-9.-]+\.)+[a-zA-Z]{2,4}
  - Strings matching this expression can then be extracted
    - E.g. *zhenzhen@nus.edu.sg*

Regular expressions are very useful in extracting concepts expressed in a certain way, e.g. *currency*, *dates*, *e-mail addresses*, *phone numbers*, etc.

Common Operators

- Special characters (operators) are used to define character patterns

Operator	Purpose
. (period)	Match any single character E.g. .in matches both ***Win**dows*, and ***Lin**ux*
^	Match the empty string that occurs at the beginning of a line or string E.g. ^tre will not match *s**tre**tch*
$	Match the empty string that occurs at the end of a line
\d	Match any single digit
\D	Match any single non-digit character
\w	Match any single alphanumeric character

Common Operators

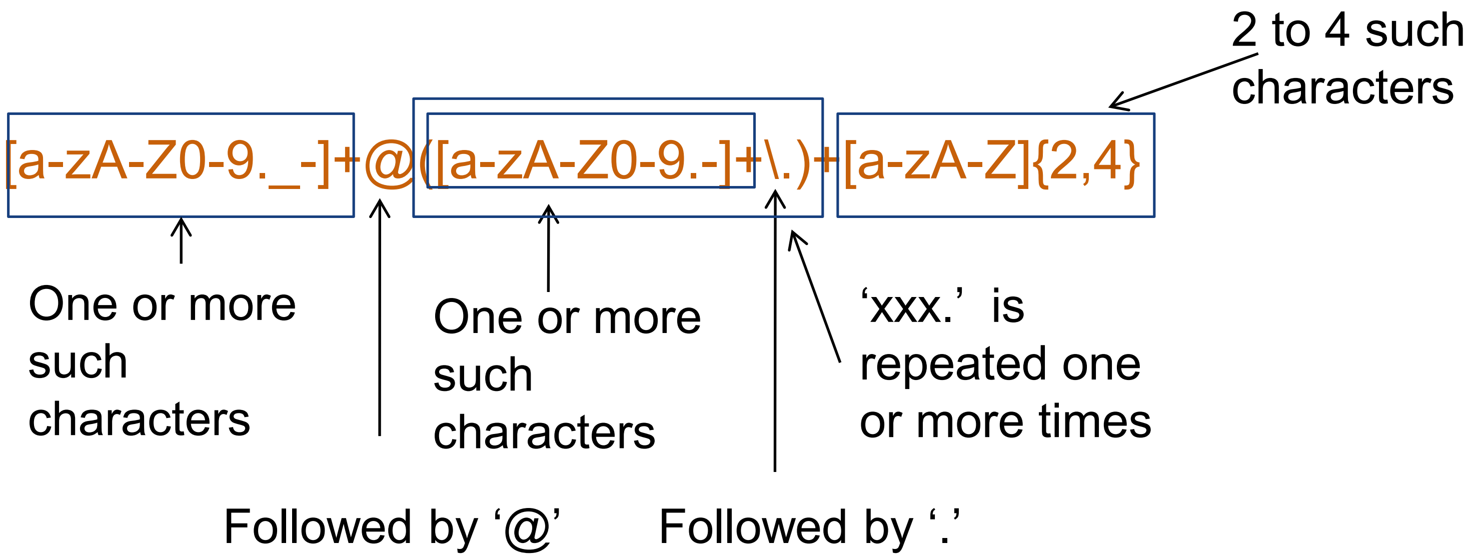
Operator	Purpose
?	Match the preceding character 0 or 1 time E.g. colou?r matches ***color*** *(0)* and ***colour*** *(1)*
*	Zero or more of the preceding character E.g. tre* matches ***tree*** *(2)*, ***tre**ad* *(1)*, and ***tr**ough* *(0)*
+	Match the preceding character 1 or more times E.g. tre+ matches ***tree***, and ***tre**ad*
[…]	Match anything inside the square brackets for one character position once E.g. [0-9] matches any character in the range 0-9 [abc] matches ***a***, ***b***, or ***c***
[^…]	Match any character excluding those in the square brackets E.g. [^A-M]in matches ***Win**dows*, but not ***Lin**ux*

Common Operators

Operator	Purpose
{n}	Match the preceding character, or character range, n times E.g. [0-9]{3}-[0-9]{4} matches local phone number like *123-4567*
{n,m}	Match the preceding character at least n times but not more than m times E.g. [A-Z]{2,4} matches *com*, *sg*, but not *abcde*
()	Group parts of search expression together
|	Separate two alternative values E.g. gr(a|e)y matches both *gray* and *grey*
\b	Match empty string, frequently used to indicate a word boundary E.g. \bhis\b matches *his* only, not *this* or *history*

Regular Expression

- Take a look at our email pattern regex again:



[a-zA-Z0-9._-]+@([a-zA-Z0-9.-]+\.)+[a-zA-Z]{2,4}

One or more such characters

Followed by '@'

One or more such characters

Followed by '.'

'xxx.' is repeated one or more times

2 to 4 such characters

Reference and Resources

- GA Miller. WordNet: A Lexical Database for English, *Communications of the ACM*, 1995
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