DAS
Semantics

Quantification, Truth and Sentiment

Francis Bond
Department of Asian Studies
Palacký University
https://fcbond.github.io/
bond@ieee.org

Lecture 4

Overview

- Truth and Logic
- Quantification and Negation
- Sentiment and Connotation
- Presupposition

Motivation

- Logic is expressed in sometimes unexpected ways in natural language, we will look at some of these examples (Quantification and Negation)

- We use language to reason, as we can see in the Holmes's stories
  - Sherlock looks at the evidence
  - and forms conclusions

  We will look at how we can do this (Truth and Logic)

- Finally, language is expressive because of the color: the way Doyle paints different characters as good or evil (Sentiment and Connotation)

Reasoning

SHERLOCK: *"You will not apply my precept," he said, shaking his head. "How often have I said to you that when you have eliminated the impossible, whatever remains, however improbable, must be the truth? We know that he did not come through the door, the window, or the chimney. We also know that he could not have been concealed in the room, as there is no concealment possible. When, then, did he come?"*

The Sign of the Four (SIGN)

Three Kinds of Reasoning

- **Deductive Reasoning** allows you to start from general premises or categories, then to prove a specific conclusion (100%).

- **Inductive Reasoning** is reasoning in which the premises give evidence for the degree of truth of the conclusion (probably).
  We balance probabilities and choose the most likely. It is the scientific use of the imagination. (HOUN)

- **Abductive Reasoning** goes from observation to hypothesis. The goal is to find the theory which best accounts for the observation, ideally seeking to find the simplest and most likely explanation.

Holmesian deduction is abductive reasoning:

- come up with explanations
- eliminate wrong ones (using deductive reasoning)
- the remaining one is the best explanation

Logic (Deductive Reasoning)

- Classical logic is an attempt to find valid principles of argument and inference.

a	Humans are mortal	**premise**
b	Socrates is human	**premise**
c	Socrates is mortal	**conclusion**

- Can we go from a and b to c? Yes

- Truth is **empirical**: The premises need to correspond with the facts of the world
  - Sentences have **truth values** (true, false or unknown)
  - The state of the world that makes a sentence true or false are its **truth conditions**

Logical Connectives

- **and** ($p \wedge q$: conjunction) *a*
  —both must be true
- **or** ($p \vee q$: disjunction, inclusive or) *nebo*
  —at least one must be true
- **xor** ($p \oplus q$: exclusive or, either or) *exkluzivní nebo/buď anebo*
  —exactly one must be true
- **if** ($p \rightarrow q$: implication) *jestliže*
  —if p is true, then q must be true
- **iff** ($p \equiv q$: if and only if) ($(p \rightarrow q) \wedge (q \rightarrow p)$) *právě tehdy, když*
  —both must be true or both false
- **not** ($\neg p$: negation) *ne*
  —not p is true when p is false (and false when p is true)

Truth Tables

p	q	$p \rightarrow q$	$p \wedge q$	$p \vee q$	$p \oplus q$	$p \equiv q$	$\neg p$
		if	and	or	XOR	iff	not
T	T	T	T	T	F	T	F
T	F	F	F	T	T	F	F
F	T	T	F	T	T	F	T
F	F	T	F	F	F	T	T

- Words themselves often carry more implications
  I did A and B often implies *I did A first*

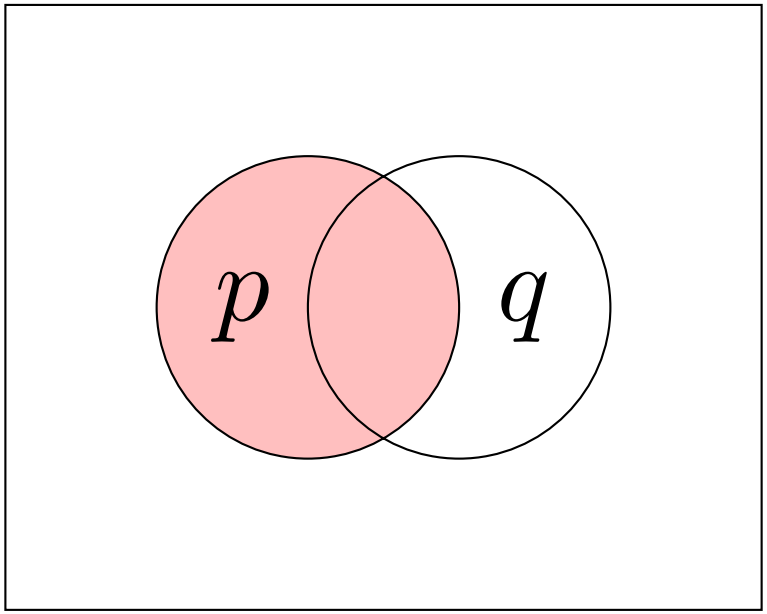
- There are many ways of saying the operations

- **entailment** ($\vdash$: logical consequence, $\therefore$) something logically follows from the preceding statements

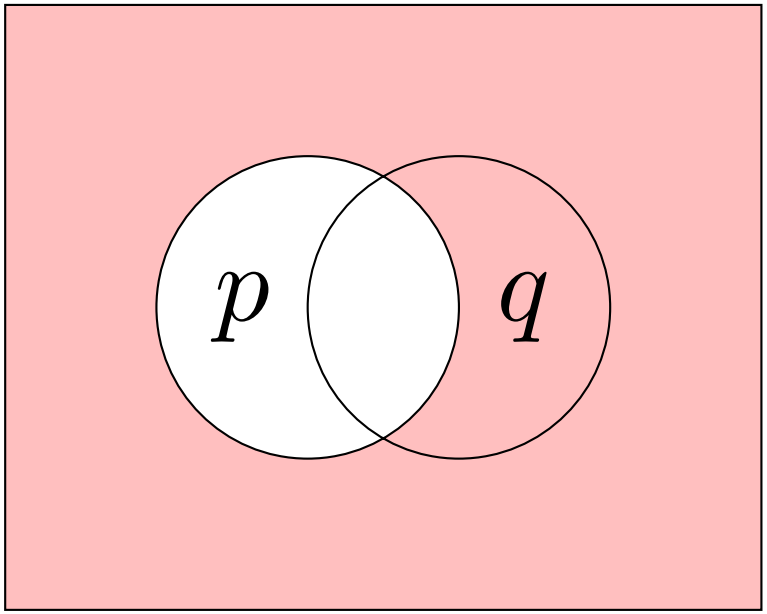
  An **argument** is a connected series of statements attempting to establish a proposition.

Logical Connectives as Graphs (p and $\neg p$)

p

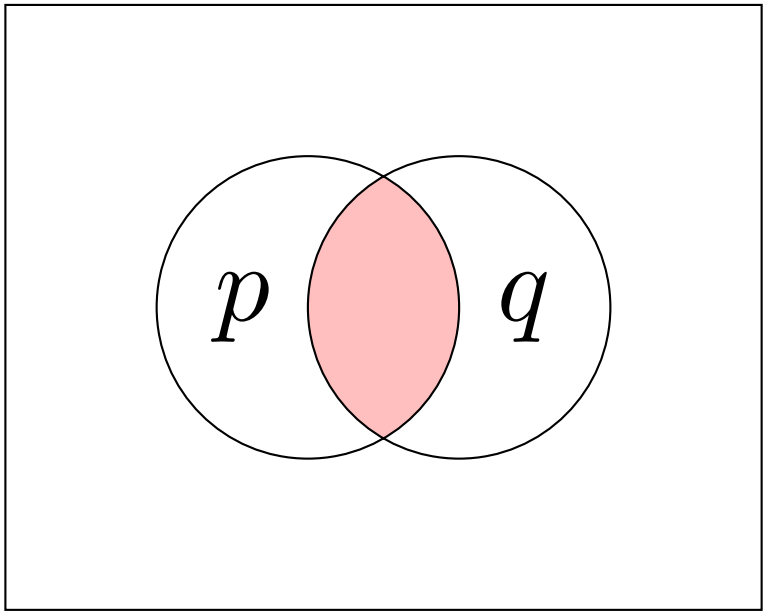


$\neg p$ “not”

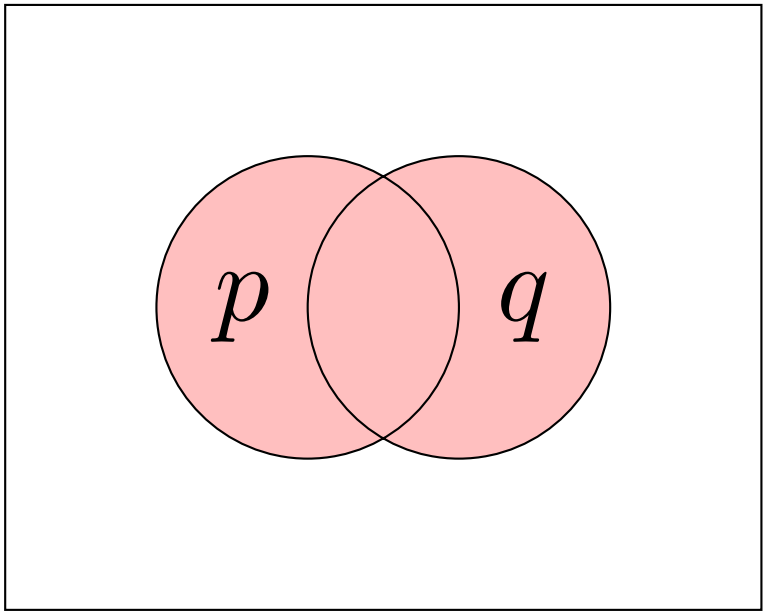


Logical Connectives as Graphs ($p \wedge q$ and $p \vee q$)

$p \wedge q$ "and"

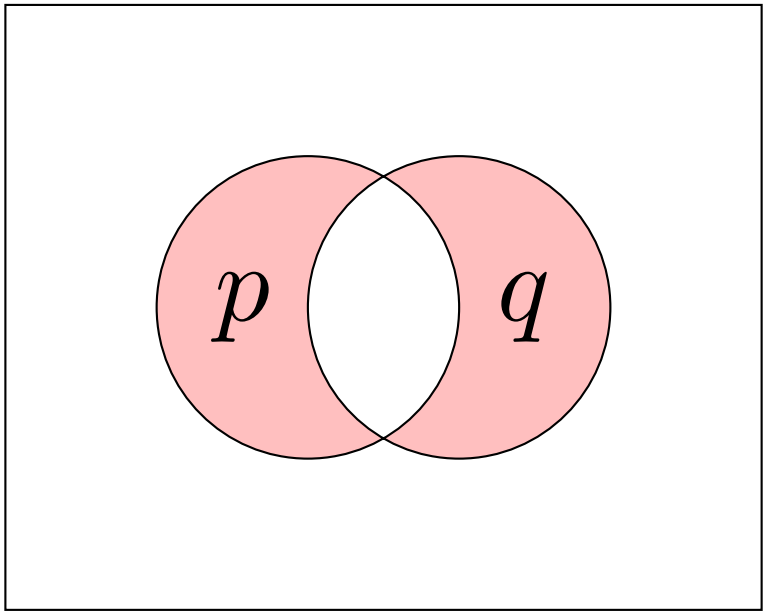


$p \vee q$ "or"

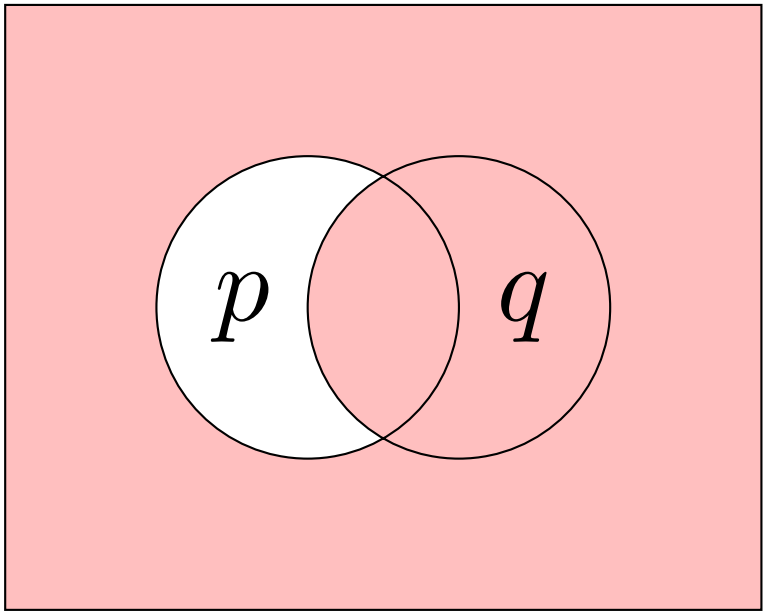


Logical Connectives as Graphs ($p \oplus q$ and $p \rightarrow q$)

$p \oplus q$ "exclusive or"

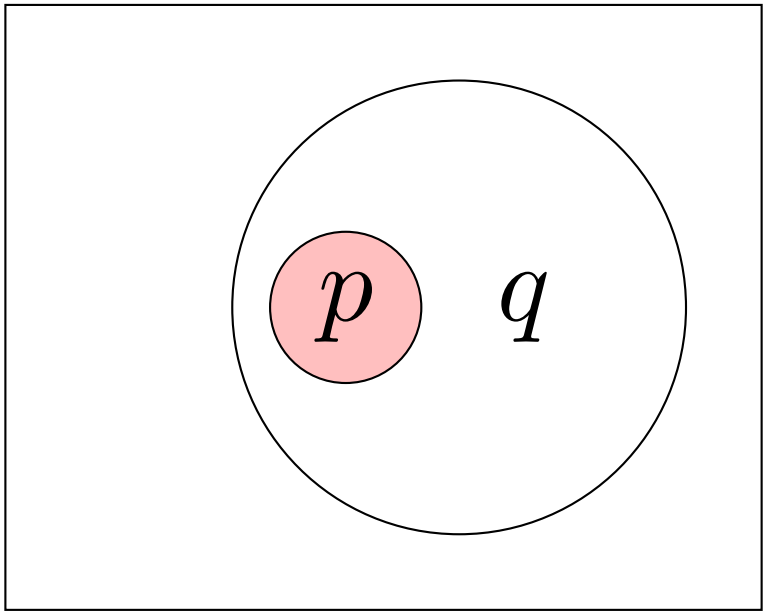


$p \rightarrow q$ "if"

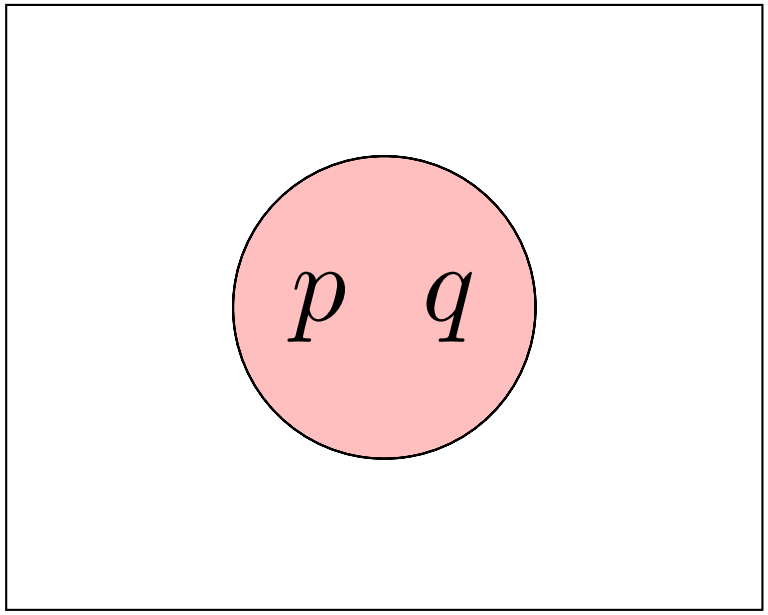


Semantic Relations as Graphs ($p \subset q$ and $p \sim q$)

$p \subset q$ `hypernym`



$p \sim q$ `synonym`



Modus ponens

a	All humans are mortal	$p \rightarrow q$	if someone is human then they are mortal
b	Socrates is human	p	
c	Therefore, Socrates is mortal	q	

p	q	$p \rightarrow q$
T	T	**T**
T	F	F
F	T	**T**
F	F	**T**

- The way that affirms by affirming (Latin)
- $p \rightarrow q, p \vdash q$ (if p then q, and p implies q)
- **material implication** (Not quite the same as English ***if***)

Modus tollens

a	If something is human then it is mortal	$p \rightarrow q$
b	Zeus is not mortal	$\neg q$
c	Zeus is not human	$\neg p$

p	q	$p \rightarrow q$
T	T	**T**
T	**F**	F
F	T	**T**
F	**F**	**T**

- The way that negates by negating (Latin)
- $p \rightarrow q, \neg q \vdash \neg p$ (if p then q, and not q implies not p)

Other types of syllogisms

➢ Hypothetical syllogism

a If something is human then it is mortal
b If something is mortal then it dies

---

c If something is human then it dies

$p \rightarrow q, q \rightarrow r \vdash p \rightarrow r$

➢ Disjunctive syllogism

(modus tollendo ponens: affirm by denying)

p Either a human is mortal or a human is immortal
q A human is not immortal

---

r A human is mortal

$p \oplus q, \neg p \vdash q$

These are all ways of proving something is true.

Bad Arguments

- Formal (can be disproved with truth tables)
  - **Affirming the consequent**: $p \to q, q \vdash p$
    professors talk too much, *you talk too much* $\vdash$ *you are a professor*

- Informal
  - **Equivocation**: The sign said *fine for parking here*, and since it was fine, I parked there.
  - **No True Scotsman**: X doesn't do Y; a is an X and does Y; a is not a true X
  - **Slippery Slope**: We mustn't allow text abbreviations or students will not be able to write normal text.
  - **False Dilemma**: You are with us or against us [or possibly don't care]
  - **Guilt by Association**: Hitler was a vegetarian $\vdash$ vegetarianism is bad

⚠ – a bad argument doesn't mean the conclusion is wrong
just that the argument doesn't prove it, …

Arguments in Sherlock Holmes

- Most of the deduction in Sherlock Holmes depends on having a very restricted set of possibilities
  - partly a literary trick: the author controls the world they write about
    - Holmes is very lucky in his choice of theories
  - partly a reflection of the stratification of Victorian society
    - there are many hypotheses based on stereotypes
    - SHERLOCK: *There is no vehicle save a dog-cart which throws up mud in that way, and then only when you sit on the left-hand side of the driver.*

Arguments in Sherlock Holmes: Jabez

- *Beyond the obvious facts that* (conclusions)
  - *he has at some time done manual labour*,
    his right hand is stronger than his left
  - *he is a Freemason*,
    an arc and compass breastpin
  - *he has been in China*
    pink tattoo and coin
  - *he has done a considerable amount of writing lately*
    smooth patch on right cuff and left elbow

? Can you come up with alternative explanations?

Quantification and Negation

Shades of meaning

- We can restrict the scope of statements with quantifiers
- We can change the polarity of statements using negation
- These interact with each other in interesting ways
- These interact with language in interesting ways

Simple Statements in Predicate Logic

- Consider simple sentences
  - Represent the **predicates** by a capital letter
    these can be n-ary
  - Represent the **individual constants** by lower case letters
  - Represent **variables** by lower case letters (x,y,z)

(1) *Bobbie is asleep*: A(b)

(2) *Freddie drinks*: D(f)

(3) *Freddie drinks beer*: D(f,b)

(4) *Freddie prefers beer to whiskey*: P(f,b,w)

(5) *Someone is asleep*: A(x) $(A(x) \wedge P(x))$

Complex Statements in Predicate Logic

- Join simple sentences with logical connectives
  treat relative clauses as **and**

  (6) *Bobbie who is asleep writhes*: $A(b) \wedge W(b)$
  (7) *Bobbie is asleep and Freddie drinks*: $A(b) \wedge D(f)$
  (8) *Freddie drinks and sleeps*: $D(f) \wedge S(f)$
  (9) *Freddie doesn't drink beer*: $\neg D(f,b)$
  (10) *If Freddie drinks whiskey Bobbie sleeps*: $D(f,w) \rightarrow S(b)$

- If you run out of letters, use two, keep them unique in the world you are modeling

  (11) *Bobbie who is asleep snores*: $A(b) \wedge Sn(b)$

Quantifiers in Predicate Logic

- Quantifiers bind variables and scope over predications
  - **Universal Quantifier** (∀: *each, every, all*) *univerzální kvantifikátor*
    — true for every element *for all/pro všechna*
  - **Existential Quantifier** (∃: *some, a*) *existenciální kvantifikátor*
    — true for at least one element *exists/existuje*

    (12) *All students learn logic*: ∀x (S(x) → L(x,l))

    (13) *A student learns logic*: ∃x (S(x) ∧ L(x,l))

    (14) *Some students learn logic*: ∃x (S(x) ∧ L(x,l))

    (15) *No students learn logic*: ¬∃x (S(x) ∧ L(x,l))

    (16) *All students don't learn logic*: ∀x (S(x) → ¬L(x,l))
    logically equivalent to (15)
  - ∀ must check each one (so →)
  - ∃ is falsified by one counter example (so ∧)
- All variables must be bound
  If there is an x, y, z it must have a ∀ or ∃

Why Translate to Predicate Logic

- Explicit representation of scope ambiguity

  (17) *Everyone loves someone*

  a. *Everyone has someone they love*:
  $\forall x\ (P(x) \rightarrow \exists y\ (P(y) \wedge L(x,y))$
  $\forall x \exists y\ (L(x,y))$

  b. *There is some person who is loved by everyone*:
  $\exists y\ (P(y) \wedge \forall x\ (P(x) \rightarrow L(x,y))$
  $\exists y \forall x\ (L(x,y))$

  (18) *Everyone didn't pass the exam*

  a. *Every person failed the exam*: $\forall x\ (P(x) \rightarrow \neg F(x,e))$

  b. *Not all people passed the exam*: $\neg \forall x\ (P(x) \rightarrow F(x,e))$

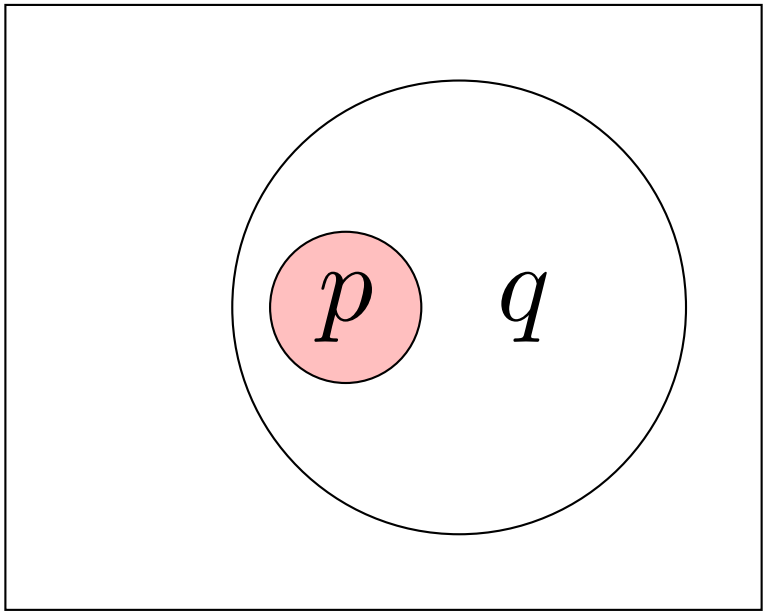
- You can also use logic to try to reason with the real world
  denotational semantic analysis
  it turns out that this is hard

Generalized Quantifiers

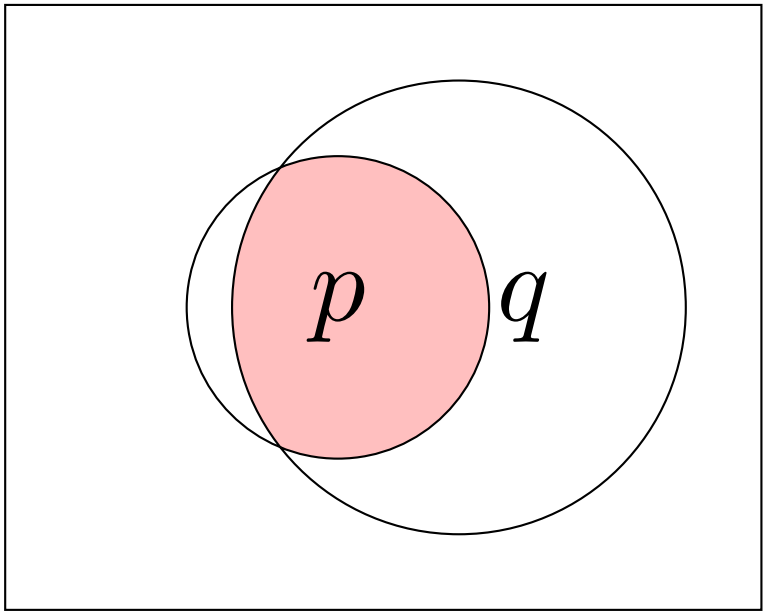
- Q(A,B): *Q A are B*
- `most(A,B)` = true iff $|A \cap B| > |A - B|$
- `all(A,B)` = true iff $A \subseteq B$
- `some(A,B)` = true iff $A \cap B \neq \emptyset$
- `no(A,B)` = true iff $A \cap B = \emptyset$
- `fewer than x(A,B,X)` = true iff $|A \cap B| < |X|$

Generalized Quantifiers: `all`, `most`

all p are q

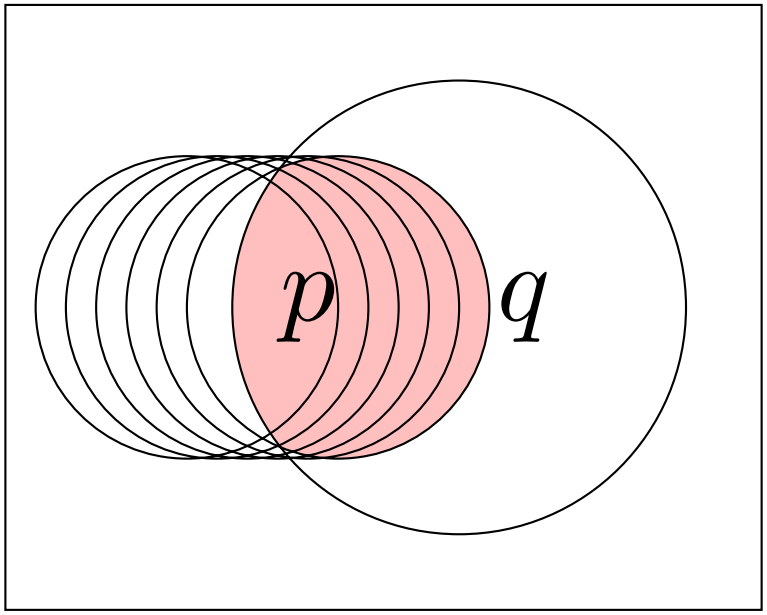


most p are q

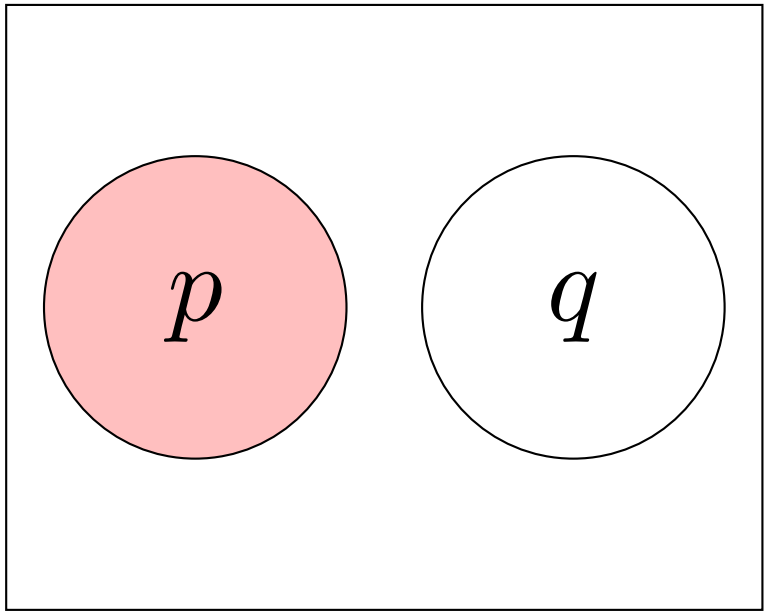


Generalized Quantifiers: `some`, `no`

some p are q



no p are q



Strong/Weak Quantifiers

(19) only **weak** quantifiers can occur in existential *there* sentences

a. *There is a fox in the henhouse*

b. *There are two foxes in the henhouse*

c. **There is every fox in the henhouse*

d. **There are both foxes in the henhouse*

➢ **symmetrical** (cardinal) quantifiers are **weak**
det(A,B) = det(B,A)

(20) *three lecturers are Australian* = *three Australians are lecturers*

➢ **asymmetrical** (proportional) quantifiers are **strong**
det(A,B) $\neq$ det(B,A)

(21) *most lecturers are Australian* $\neq$ *most Australians are lecturers*

? Come up with some more strong and weak quantifiers

Negative Polarity Items (NPI)

- Some words in English mainly appear in negative environments

(22) a. *Kim doesn't ever eat dessert*
b. **Kim does ever eat dessert*

(23) a. *Kim hasn't eaten dessert yet*
b. **Kim has eaten dessert yet*

(24) a. *Few people have eaten dessert yet*
b. **Many people have eaten dessert yet*

(25) a. *Rarely does Kim ever eat dessert*
b. **Often does Kim ever eat dessert*

- Not just negation, but also some quantifiers

? Come up with some NPIs and environments

Monotonicity

- Some quantifiers control entailment between sets and subsets
  - **Upward entailment** goes from a subset to a set
  - **Downward entailment** goes from a set to a subset

(26) a. *Kim doesn't eat dessert* $\Rightarrow$ *Kim doesn't eat hot dessert*

b. *Kim doesn't eat hot dessert* $\not\Rightarrow$ *Kim doesn't eat dessert*

Downward entailment

(27) a. *Kim eats some desserts* $\not\Rightarrow$ *Kim eats hot desserts*

b. *Kim eats some hot desserts* $\Rightarrow$ *Kim eats some desserts*

Upward entailment

- Negative Polarity Items are licensed by downward entailing expressions

- Formal models of quantification can be used to make predictions about seemingly unrelated phenomena

In other languages too!

(28) 我 没有 任何 朋友
wo mei-you renhe pengyou
I NEG-have any friend
"I don't have any friends."

(29) * 我 有 任何 朋友
wo you renhe pengyou
I have any friend
*"I have any friends."

(30) *Nemám žádné přátele.*
NEG.HAVE.1SG any friends
"I don't have any friends."

(31) * *Mám žádné přátele.*
HAVE.1SG any friends
*"I have any friends."

Negation Scope

Negation can be triggered by many things, and the elements can be far away.

(32) *The German was sent for but professed to know nothing of the matter …* (HOUN)

(33) *I trust that there is nothing of consequence which I have overlooked?*”

(34) “*A dabbler in science, Mr. Holmes, a picker up of shells on the shores of the great unknown ocean.*

(35) *Our client looked down with a rueful face at his own unconventional appearance.*

Sentiment and Connotation

Connotation

Many words carry more meaning than just identifying their referent.

(36) a. *Kim is slender*
b. *Kim is thin*
c. *Kim is haggard*

(37) a. *The young lout is here.*
b. *The young boy is here.*
c. *The young gentleman is here.*

(38) a. *The young lout is arrogant.*
b. *The young boy is proud.*
c. *The young gentleman is confident.*

(39) a. *That bitch is cheap.*
b. *That woman is economical.*
c. *That lady is frugal.*

Sentiment in the Holmes corpus

- Doyle often gives us not-so subtle cues as to whether characters are good or bad.

- Some of them are very nationalist (and borderline racist, but not always)

(40) *A large face, seared with a thousand wrinkles, burned yellow with the sun, and marked with every evil passion, was turned from one to the other of us, while his deep-set, bile-shot eyes, and the high thin fleshless nose, gave him somewhat the resemblance to a fierce old bird of prey.* (SPEC)

(41) *He was a fine creature, this man of the old English soil, simple, straight and gentle, with his great, earnest, blue eyes and broad, comely face.* (DANC)

(42) *"The aborigines of the Andaman Islands may perhaps claim the distinction of being the smallest race upon this earth, …They are naturally hideous, having large, misshapen heads, small, fierce eyes, and distorted features."* (SIGN)

(43) *There was a portrait within of a man, strikingly handsome and intelligent, but bearing unmistakable signs upon his features of his African descent.* (YELL)

? Can you find some examples of clearly positive or negative descriptions?

Sentiment and Composition

- Sentiment can be built up.

  (44) *good* $\uparrow$

  (45) *very good* $\uparrow\uparrow$

  (46) *less than very good* $\downarrow$

  (47) *I have never found it to be less than very good* $u\uparrow\uparrow\uparrow$

- It can be complex

  (48) *The new story is good, especially the characterization, although the dialogue is a little stiff.*

- Polarity can depend on the target

  (49) *The screen is very wide.*

  (50) *Their nostrils are very wide.*

- It can come from other things than lexical cues: $\star\star\star\star\star$

Annotating Sentiment

Score	*Example*	*Example*	*Example*	*Corpus Examples*
95	*fantastic*	*very good*		*perfect, splendidly*
64	*good*	*good*		*soothing, pleasure*
34	*ok*	*sort of good*	*not bad*	*easy, interesting*
0	*beige*	*neutral*		*puff*
-34	*poorly*	*a bit bad*		*rumour, cripple*
-64	*bad*	*bad*	*not good*	*hideous, death*
-95	*awful*	*very bad*		*deadly, horror-stricken*

We annotate **senses**: words given their meaning, before they are transformed by the syntax. So ***good*** in *That is very very good* and ***good*** in *That is no good* get the same score.

➢ Note that most words carry no sentiment.

High and Low Examples in multiple languages

Concept	freq	score	*English*	score	Chinese	score	Japanese	Score
i40833	24	50	*marriage*	39	婚事	34	結婚	58
			wedding	34				
i11080	5	40	*rich*	33	有钱	34	裕福	66
i72643	4	33	*smile*	32	微笑	34	笑み	34
i23529	40	−68	*die*	−80	去世	−60	亡くなる	−63
					死亡	−64	死ぬ	−62
i36562	5	−83	*murder*	−95	谋杀	−95	殺し	−64
							殺害	−63

By generalizing to the concept, we can share sentiment values across languages (Bond et al., 2016, 2019).

Presupposition

Presuppositions

- Many statements assume the truth of something else

  (51) a. *Mary's sister bakes the best pies.*
  b. *Mary has a sister.*

- Negating the presupposing sentence a doesn't affect the presupposition b

- Names presuppose that their referents exist

- Triggers
  - Clefts (*it was X that Y*); Time adverbial; Comparative
  - Factive verbs: *realize*; some judgement verbs: *blame*; some change of state: *stop*

Semantic approach

- p *Mary's sister bakes the best pies* presupposing sentence
  q *Mary has a sister* presupposition

p		q
T	$\rightarrow$	T
F	$\rightarrow$	T
F, T	$\leftarrow$	T

- Also true of: $\neg p$ *Mary's sister doesn't bake the best pies*

- Is that different from this?

  a *I gave my dog a bath today.*
  b *I gave an animal a bath today.*

Presupposition versus entailment

- Negating the presupposing sentence does not affect the presupposition whereas negating an entailing sentence destroys the entailment.

- Can you think of other examples that show this difference?

Interactional approach

- Presupposition is one aspect of a speaker's strategy of organizing information for maximum clarity for the listener.

(52) *Mary's sister bakes the best pies.*

a. Assertion 1: *Mary has a sister X.*

b. Assertion 2: *X bakes the best pies.*

- Assertion 1 is in the **background** (old information)

- Assertion 2 is in the **foreground** (new information)

Presupposition failure

- (53) *The King of France is bald.*
  (54) *There is a King of France.* presupposition

- The problem with names and definite description is that they presuppose the existence of the named or described entities.

- Solution: A speaker's use of a name or definite description to refer usually carries a guarantee that the listener can identify the referent.

Presupposition triggers

➢ Cleft construction

(55) *It was his nonsense that irritated me.*

(56) *What irritated me was his nonsense.* (pseudo)

(57) *Something irritated me.* presupposition

➢ Time adverbial

(58) *I was working five jobs before you went to school*

(59) *You went to school.* presupposition

➢ Comparative

(60) *You are even more silly than he is.*

(61) *He is silly.* presupposition

Presupposition triggers: Lexical triggers

- **Factive verbs** presuppose the truth of their complement clauses.

(62) a. *The students realized that Alex was hungry.*

b. *The students thought that Alex was hungry.* no presupposition

(63) a. *Alex regretted not eating lunch.*

b. *Alex considered not eating lunch.* no presupposition

- **Verbs of judgement**

(64) *Kim blamed me for making a mistake*

- **Change of state** (sometimes)

(65) *Alex stopped talking to their imaginary friend.*

(66) *Have you stopped beating your dog?*

Presupposition and context

- Presuppositions are context dependent.

(67)	a.	*John ate before going to the movies.*	
	b.	*John went to the movies.*	presupposition
(68)	a.	$^{??}$*John died before going to the movies*	
	b.	*John went to the movies.*	presupposition

- Presuppositions are **defeasible**: they can be canceled given the right context.

Conclusions

- Language can be used to reason
- We reason unconsciously when we decide which words to use
- Language can be used to convey impressions and opinions
  - You will try to measure this as part of projects 1 and 2
- Saeed (2015) talks about Logic and Truth in Chapter 4
- Kroeger (2022) talks about Truth and Inference in Chapter 3 (meaning relations, presupposition), and the Logic of Truth in Chaper 4 (propositional logic, quantifiers). He goes into more detail in Chapters 13, Modeling Compositionality, and 14 Quantifiers

*

References

Francis Bond, Arkadiusz Janz, and Maciej Piasecki. 2019. A comparison of sense-level sentiment scores. In *Proceedings of the 11th Global Wordnet Conference (GWC 2019)*.

Francis Bond, Tomoko Ohkuma, Luís Morgado da Costa, Yasuhide Miura, Rachel Chen, Takayuki Kuribayashi, and Wenjie Wang. 2016. A multilingual sentiment corpus for Chinese, English and Japanese. In *6th Emotion and Sentiment Analysis Workshop (at LREC 2016)*. Portorož.

Paul Kroeger. 2022. *Analyzing meaning*. Number 5 in Textbooks in Language Sciences. Language Science Press, Berlin.

John I. Saeed. 2015. *Semantics*. Wiley-Blackwell, fourth edition.

Glossary of Key Terms (English–Czech)

English	Česky
argument	argument
asymmetrical	asymetrický
background	pozadí
change of state	změna stavu
cleft construction	klivní konstrukce
comparative	komparativ
compositional Semantics	kompoziční sémantika
conclusion	závěr
deductive reasoning	deduktivní usuzování
defeasible	porazitelný / zvratitelný
denotational semantic analysis	denotační sémantická analýza
disjunctive syllogism	disjunktivní sylogismus
downward entailment	dolní implikace
empirical	empirický
entailment	implikace / logický závěr
equivocation	dvojsmysl / záměna významů
existential quantifier	existenciální kvantifikátor
factive verbs	faktivní slovesa
false dilemma	falešné dilema

English	Česky
foreground	popředí
guilt by association	vina sdružením / vina z asociace
hypothetical syllogism	hypotetický sylogismus
if	jestliže
iff	právě tehdy, když
individual constants	individuální konstanty
inductive Reasoning	induktivní usuzování
interpretation	interpretace
material implication	materiální implikace
not	ne
no true Scotsman	žádný pravý Skot (klam)
or	nebo
predicates	predikáty
premise	premisa
senses	významy
slippery slope	kluzký svah (klam)
strong	silný
symmetrical	symetrický
time adverbial	příslovečné určení času

English	Česky
truth conditions	pravdivostní podmínky
truth values	pravdivostní hodnoty
universal quantifier	univerzální kvantifikátor
upward entailment	horní implikace
variables	proměnné
verbs of judgement	slovesa úsudku
weak	slabý
xor	exkluzivní nebo / buď anebo