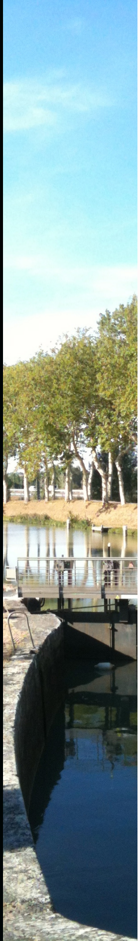

TYTLES
TYpes Theory and LExical Semantics: Introduction to the Workshop

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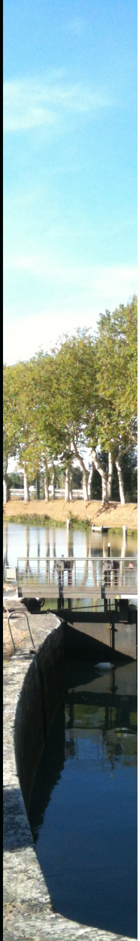
ESSLLI 2015 Barcelona



1. Lexical semantics

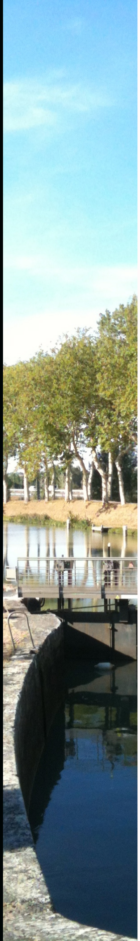
Usually lexical semantics refers to:

- Word meaning in context (various forms of polysemy)
- Relation between meanings
- Lexical networks

Remark: relation between meanings $\rightarrow$ higher order logic is needed

Usual techniques:

- description with features (human / non human)
- sometimes arguments structures specifying the nature of the arguments
- in NLP: word vectors



2. Polysemy

(1) Simple

a. The river passed the bank.

b. The bank is nearby the river.

c. The bank phoned me.

(2) Institutions and such

a. The journal is printed on pink paper.

b. The journal hired a new commentator.

c. The journal is nearby the port.

(3) Events

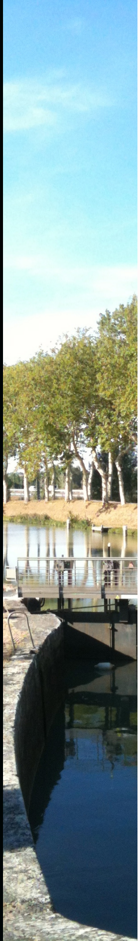
a. The signature took three months.

b. The signature is unreadable.

(4) Dot objects

a. The book is red.

b. The book is quite interesting.

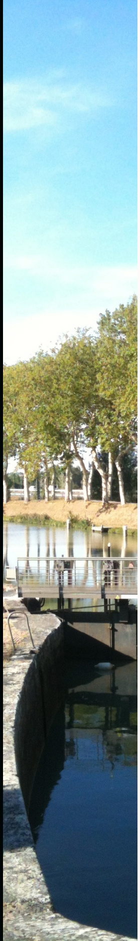


3. Borderline examples

(5) a. I am parked behind a blue BMW.

b. The ham sandwich asked for a coffee.

Rather supports contextualism in the radical minimalism / contextualism debate.



4. Copredication

(6) Dinner was delicious but took ages. (event / food)

(7) * The salmon we had for lunch was lightning fast. (animal / food)

(8) I forgot on the table my preferred book on logic. (physical / info)

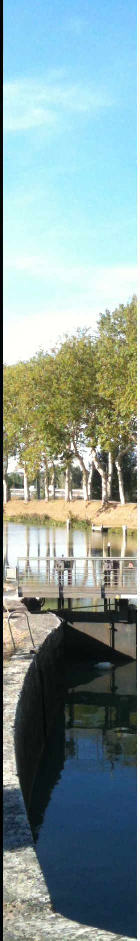
(9) I carried the books from the shelf to the attic since i already read them. (phys. / info)

(10) Liverpool is a poor town and an important harbour. (people / geographic)

(11) * Liverpool defeated Chelsea and is an important harbour. (football / geographic)

(12) (context: ok) Barcelona won four champions leagues and organised the olympiads.

(13) (contrast: ok) Libourne, a small south-west town, defeated Lille.



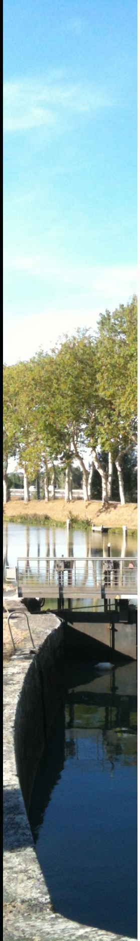
5. Integrating lexical semantics into a compositional and computational framework

Standard lexical semantics, distributional semantics (in NLP big data, machine learning):

what a text speaks about

Formal semantics:

what a (few) sentence(s) assert(s)



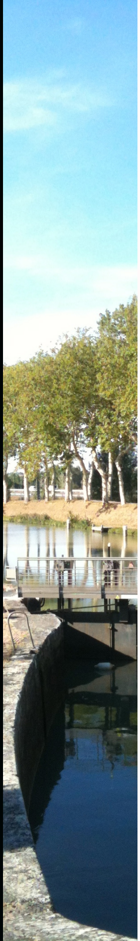
6. Complementary approaches

(14) (was geach a student of Wittgenstein) In 1941, he married Elisabeth Anscombe, by whom he got in contact with Wittgenstein. Although he never attended his lectures, he was strongly influenced by him.

(15) The children will have a pizza.

Both word meaning and sentence/discourse structure are needed to understand.

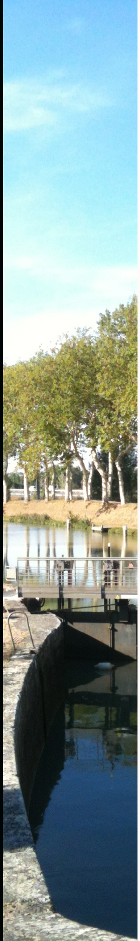
In Man Machine Interaction no large data but proper understanding is mandatory.



7. Pustejovsky's generative lexicon 1/4

Pioneering work:

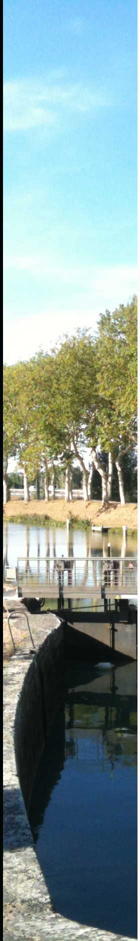
- compositional (generative) view of word meaning
- formal framework : word meaning as complex feature structures the way they combine is less specified
- can be implemented for computing semantics
- qualia structure can be learnt (at least partly)



8. Pustejovsky's generative lexicon 2/4

The four levels of an entry:

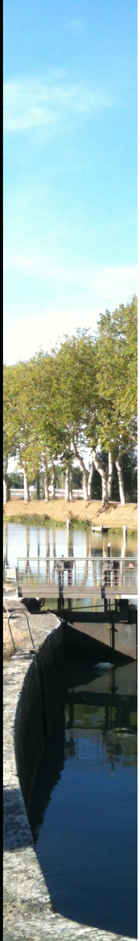
- lexical typing structure: giving an explicit type for a word positioned within a type system for the language;
- argument structure: specifying the number and nature of the arguments to a predicate;
- event structure: defining the event type of the expression and any subeventual structure it may have; with subevents;
- qualia structure: a structural differentiation of the predicative force for a lexical item.



9. Pustejovsky's generative lexicon 3/4

Qualia Structure:

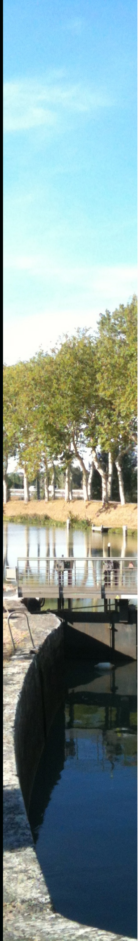
- formal: the basic category of which distinguishes the meaning of a word within a larger domain;
- constitutive: the relation between an object and its constituent parts;
- telic: the purpose or function of the object, if there is one;
- agentive: the factors involved in the object's origins or "coming into being.



10. Pustejovsky's generative lexicon 4/4

Types in Pustejovsky:

- base types organised as an ontology
- there also are functional types
- in the argument structure the types are specified



11. Pustejovsky's GL: conclusion

Compositional semantics that integrates lexical aspects.

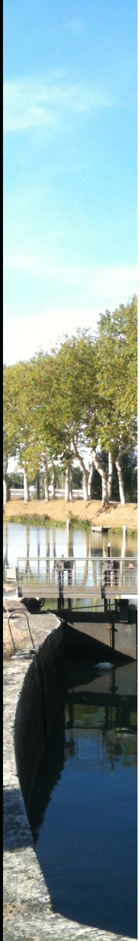
Entries are well defined.

The base types ans their ontology remain obscure.

The composition modes are described on examples there is no general procedure that could be implemented, and the relation to syntax is no explicited.

Is this framework able to compute the semantics of a whole complex sentence, or of a small discourse?

Can one learn other levels than qualia structure?



12. Restrictions of selection

A common way to start addressing lexical issues in compositional semantics:

(16) The chair barked.

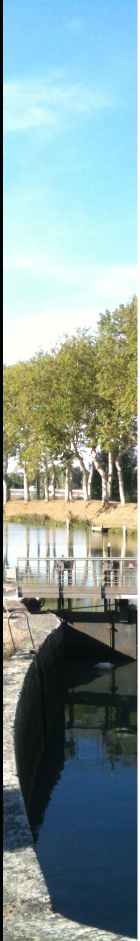
(17) Dictionary: "barks" is said from an animal, usually a dog.

Simple and good idea: infelicitous semantic composition is type mismatch.

A function/predicate is expecting an argument of type A and receives an argument of type B.

Such constraint needs to be relaxed because of the context.

(18) I was so late for registration that the secretary barked at me.

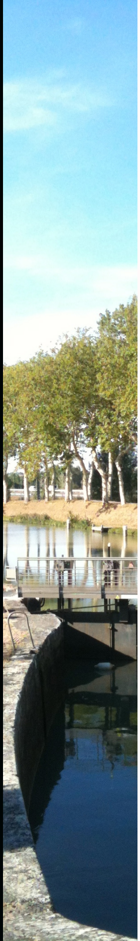


13. Lexical issues are idiosyncratic

Observe that meaning transfers are idiosyncratic:

(19) a. Ma voiture est crevée.
b. My can has a pinhole?
c. My car is flat?

(20) a. My brother in law is trivial.
b. He always makes trivial jokes.
c. A trivial vector space.
d. Apart from the trivial solution $x^2 + x$ has no real solution.



14. Four frameworks: 1/3 TCL

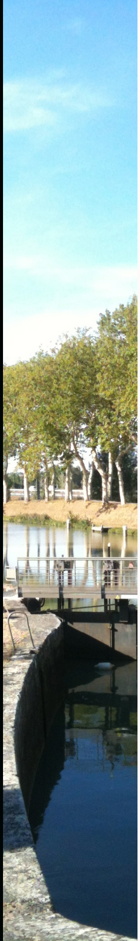
TCL: type composition logic (Asher)

Simply typed lambda calculus with many types.

Meaning : formulae of higher order logic

Enriched with composition rules that import constructions from category theory (e.g. pullbacks for dot object).

Question: do the terms obtain from lexical entries by those enriched rules always reduce to a meaningful term/formula?



15. Four Frameworks: 2/4 MTTc+ DTS

Asher & Luo, Bekki, Chatzikyriakidis, Mineshima, Meaning logic and composition logic: type theory (Subtyping)

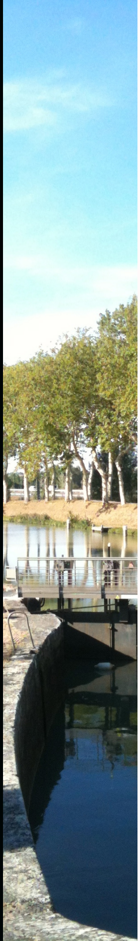
Dependent types: family of types $B(a)$ with x in a type A (dependent types may depend on terms).

Type $\Pi a : A.B(a)$ types for functions that maps a proof of A into a proof of $B(a)$ such functions may also be viewed as a term/proof of $\forall a : AB(a)$.

Type $\Sigma a : AB(a)$ types of couples (a, b) with a proof/term of type A and a proof/term of type $B(a)$ such couples may also be viewed as a term/proof of $\exists a : AB(a)$.

Coercice subtyping: $\dfrac{f : A \to B \quad a : A' \quad A' <_c A}{f(a) : B}$

Here: Seohyun Im and Chungmin Lee — Daisuke Bekki and Miho Satoh — Ribeka Tanaka, Koji Mineshima and Daisuke Bekki.



16. Four frameworks: 3/4 TTR

Type theory with records Cooper

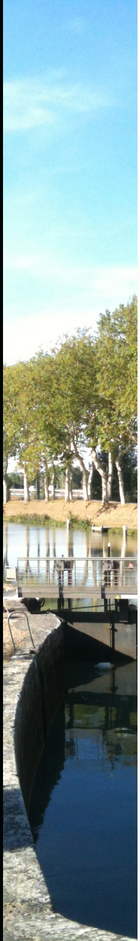
Meaning logic and composition logic: type theory

Record types are sequences of types terms $t_i : T_i$ where T_{i+1} may depend (dependent type) on the typed terms t_k with $1 \leq k \leq i$.

$$\left[\begin{array}{lll} \text{x} & : & \textit{Real} \\ \text{loc} & : & \textit{Loc} \\ \text{e} & : & \text{temp(loc, x)} \end{array}\right]$$

$$\left[\begin{array}{lll} \text{scale} & : & (\textit{AmbTempFrame} \rightarrow \textit{Real}) \\ \text{e} & : & \textit{AmbTempFrame}^2 \\ \text{c}_{\text{rise}} & : & \text{scale(e[0])} < \text{scale(e[1])} \end{array}\right]$$

Here papers by : Staffan Larsson — Simon Dobnik — Peter Sutton and Hana Filip — Ellen Breitholz — Pepijn Kokke



17. Four frameworks: 4/4 MGL

Montagovian Generative Lexicon (Retoré, Mery, Bassac, Moot, Real ...)
As Montague or TCL: typed lambda calculus for composing minings expressed in a different language (higher order predicate logic).

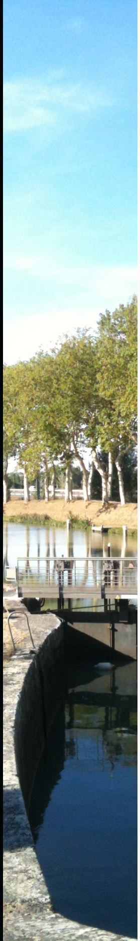
Montague with several base types (like Musken's Ty_n)

Quantification over types to factor uniform combinations.

Coercions are word specific (and not ontological)

For copredication some coercions block others.

Here: Bruno Mery

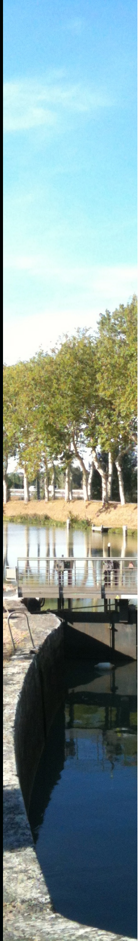


18. Common question 1) "base types"

What should be the base types?

- a dozen of ontological types (Asher, TCL)
- classifiers (like in Japanese, Mandarin, Sign Languages ...)
- common nouns (Luo)

A hint can be provided by dictionaries: how do they express the restriction of selection? which classes/sorts/types do they use?



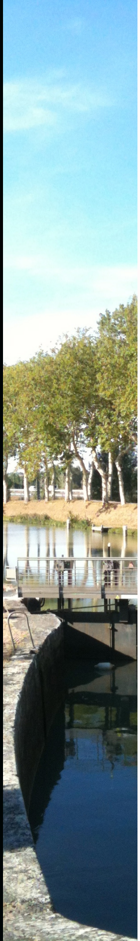
19. Common question 2) subtyping

Related to base types: if many of them subtyping is needed for natural coercions (=? ontological inclusions)

Subtyping with quantification over types: complicated! The $\forall\alpha$ should preserve subtyping for positive occurrences of the type variable α and reverse subtyping for negative occurrences of α.

As said above for MTT a good solution by Luo & Soloviev: coercive subtyping Technical requirement that makes it work: at most one coercion between any two types. Adaptation to System F by Lang & Retoré

A question does linguistic generalisation correspond to ontological generalisation ?



20. Common question 3) learning

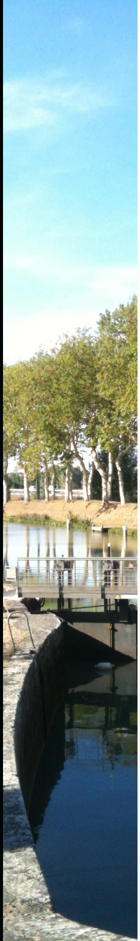
Machine learning techniques cannot learn sophisticated structures like types and terms. An exception without sequel: Luke S. Zettlemoyer and Michael Collins. Learning to Map Sentences to Logical Form: Structured Classification with Probabilistic Categorial Grammars. (2005)

An alternative exploiting existing lexical resources (Here: Stergios Chatzikyriakidis, Mathieu Lafourcade, Lionel Ramadier and Manel Zarrouk. — Livy Real and Alexandre Rademaker)

- Turning existing data (e.g. lexical networks like WordNet, or JeuxDeMots crowdsourced by an Internet game) into the terms and types we need.

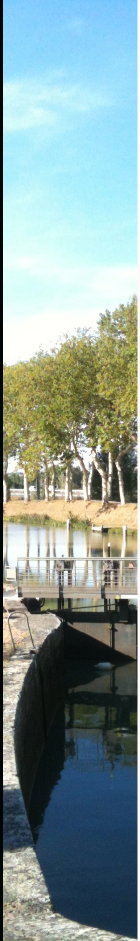
- Groups of words that are similar in some aspect and the aspect which makes them similar as well can be observed.

- Privileged relation can be extracted as well (e.g. is an agent, an object a location for).



Another alternative (Cooper, Here: Ellen Breitholtz):

- Mimicking the interactive process by which we do learn meanings.
- Allow every one to have his one lexicon,
- Lexicons may evolve.
- Quite interesting *per se* about human cognition.



21. Common question 4) revisiting compositional semantics

Having a complicated type system allow to revisit standard issue in formal semantics:

- quantification (in situ quantification with Hilbert's epsilon works much better in the typed case) Here: Justyna Grudzinska and Marek Zawadowski — Laura Kallmeyer, Timm Lichte, Rainer Osswald, Sylvain Pogodalla and Christian Wurm
- plurals (Mery, Moot, Retoré)
- count/mass nouns (Mery, Moot, Retoré Here: Peter Sutton and Hana Filip)
- predicates/type judgements (Luo, Retoré) $a : A$ vs. $\tilde{A}(a)$.