

EGG intro semantics week 2

The algebra of events

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So far

- ▶ A richly structured domain of individuals from Link
 - ▶ A set A of atomic individuals.
 - ▶ A larger set E of individuals, structured as a join atomic semilattice. $E \setminus A$ is the set of plural individuals derived by summing atomic individuals.
 - ▶ D , a subset of A , the set of masses, with its own (non-atomic) lattice structure.
 - ▶ A mapping m from E to D , and part-of relations \sqsubseteq_i and \sqsubseteq_m .
- ▶ Davidsonian arguments for verbs as event descriptions, and formal similarities between events and individuals.
- ▶ Aspectual classes, the progressive, and measuring out all hinting at further similarities.
 - ▶ Accomplishment *climb* has activity *climb* and achievement *reach the summit* as proper parts.
 - ▶ Progressives relate actual subevents to inertial whole events.
 - ▶ Measuring out relates the structure of events and of their arguments.

Today

- ▶ We're going to repeat the Link exercise, with events.
- ▶ This is initially Emmon Bach's idea, and we'll be guided by his relation:

events : processes :: things : stuff

- ▶ By the end, we should have a better vocabulary for talking about the puzzles from yesterday.

Atomic events and plural events

- (1)
 - a. Mary stumble: atomic event
 - b. John run a mile: atomic event
 - c. People stumble: plural event
 - d. Mary stumble and Mary run a mile: plural event
- ▶ Atomic events and a sum operation \oplus generate a lattice structure just like atomic individuals, with part-of relation \sqsubseteq_e .
 - ▶ The event of John running a mile is composed of processes of John running. Every subpart of running is running, and there are possible no minimal parts (though see Dowty).
 - ▶ This means that our set of atomic events will contain a set of processes, analogous to the set of masses, without atoms, and ordered by their own relation \sqsubseteq_p .

Packaging and grinding

- ▶ David Lewis is credited with inventing a Universal Grinder, which converts any atomic or plural individual into a mass.
 - ▶ There was dog splattered all over the road.
 - ▶ Much missionary was eaten at the festival.
- ▶ There's also a Universal Packager (which isn't quite the converse).
 - ▶ Muds: kinds of mud
 - ▶ Ice-creams: portions of ice-cream
 - ▶ Furnitures: ???
- ▶ Same thing with relationships between events and processes.
 - ▶ John is always painting the Forth Bridge.
 - ▶ I looked for a unicorn in just 5 minutes!

Packing and grinding

- ▶ Grinding and packaging share an asymmetry in the two domains: grinding just returns undifferentiated stuff/process; packaging requires a more or less conventional package.
 - ▶ I have executed a predefined unicorn-search routine in just 5 minutes!
- ▶ Difficult to grind minimal units in both cases.
 - ▶ #There was dot all over the paper (as a result of a malfunctioning dot-matrix printer).
 - ▶ #John is always blinking (iteration only)

Bach's Partitive Puzzle

- ▶ A nominal equivalent of the imperfective paradox.
 - (2) a. This is part of a paper on natural language metaphysics.
 - b. We found part of a Roman aqueduct.
 - c. There is apple in the salad.
- ▶ $\exists x.^mP(x)$ doesn't entail $\exists x.P(x)$, any more than $\exists e.^pP(e)$ entails $\exists e.P(e)$.
- ▶ This is quite a deep parallel, because no-one (to my knowledge) has proposed “object inertia” in which part of an aqueduct projects to a whole aqueduct in some inertia world.
- ▶ It suggests an alternative treatment (initially quite unsatisfactory) of the imperfective paradox:
 - ▶ John is writing a paper
 - ▶ $\exists e, e', t. AT(e, t) \wedge e \sqsubset_p e' \wedge \exists x.(paper(x) \wedge write(j, x, e'))$

Cumulativity and atelicity

- ▶ In our discussion of Link, we mentioned the notion of cumulativity.
 - ▶ P is cumulative iff $P(x) \wedge P(y) \wedge x \neq y \rightarrow P(x \oplus y)$
- ▶ The opposite (in some senses) of cumulativity is often called quantization, following Manfred Krifka.
 - ▶ P is quantized iff $P(x) \wedge P(y) \rightarrow \neg y \sqsubseteq x$
- ▶ Krifka recast telicity as quantization and atelicity as cumulativity.
 - ▶ Running is cumulative because running + running = running.
 - ▶ Running a mile is quantized because one event of running a mile can't be part of another (this also applies to vaguer measures like running a race).

Cumulative arguments, cumulative events

- ▶ Krifka also investigated measuring-out relations from this algebraic perspective.
- ▶ He proved that in certain circumstances, properties of an argument determine properties of the event. For example:
 - ▶ If an event predicate is cumulative (reading + reading = reading)
 - ▶ and the theme is cumulative (letters + letters = letters)
 - ▶ and the relation between event and theme is *summative* ($R(e_1, x) \wedge R(e_2, y) \rightarrow R(e_1 \oplus e_2, x \oplus y)$, read this letter + read that letter \in [read])
 - ▶ then the combination of event predicate and theme is cumulative (read letters + read letters = read letters).

Gradual events

- ▶ The other question is when a quantized object induces a quantized event.
- ▶ One major case of this is *gradual events*. These satisfy three properties:
 1. Mapping to objects:
$$R(e, x) \wedge e' \sqsubseteq_p e \rightarrow \exists x'(x' \sqsubseteq_m x \wedge R(e', x'))$$
 2. Mapping to events:
$$R(e, x) \wedge x' \sqsubseteq_m x \rightarrow \exists e'(e' \sqsubseteq_p e \wedge R(e', x'))$$
 3. Uniqueness of objects: $R(e, x) \wedge R(e, x') \rightarrow x = x'$
- ▶ Krifka's claim: gradual events with quantized arguments of R give either quantized events or iterated events.
- ▶ If an event can't be iterated (e.g. you can only write a given novel once), you must have quantization.

Key cases

- (3)
- a. Read a letter
 - (i) Reading: cumulative (reading + reading = reading), gradual w.r.t. theme
 - (ii) A letter: quantized (a letter + a letter \neq a letter)
 - (iii) Gradual relation + quantized argument = quantized event.
 - b. Read letters
 - (i) Letters: cumulative (letters + letters = letters)
 - (ii) Cumulative event predicate + cumulative argument = cumulative event
- (4) Touch a horse
- a. Touching: cumulative (touching + touching = touching), but not gradual w.r.t. theme (touching part of a horse is not part of touching a horse).
 - b. So a quantized theme doesn't give a quantized event.

Key cases

- (5)
 - a. Push a cart into a wall
 - b. Push a cart into walls
 - (i) Like *Read (a) letter(s)* except gradual w.r.t. goal rather than theme.
 - c. Push carts into a wall
 - (i) Still cumulative + summative event predicate + cumulative theme
 - (ii) This is cumulative w.r.t. theme and quantized w.r.t. goal, and still behaves as cumulative overall. Should we be surprised?

Summary I

- ▶ Several individually challenging puzzles can be related if we follow Emmon Bach and postulate that events and individuals have a similar algebraic structure.
 - ▶ Telicity
 - ▶ Measuring out
 - ▶ Imperfective paradox
- ▶ Central analogy: events : processes :: things : stuff
- ▶ Events form a join atomic semilattice, with part-of relation $sqsubseteq_e$.
- ▶ Processes form a join semilattice (without minimal parts?).
- ▶ There is a many–many relation between processes and events, just as between masses and individuals.

Summary II

- ▶ The same properties of cumulativity and quantization which we saw in the individual domain capture the notion of telicity.
- ▶ The imperfective paradox at least has a nominal analogue in the partitive puzzle.
- ▶ Transfer of properties of cumulativity and quantization between events and objects relies on quite complex interactions. Krifka presented this as determined by three factors.
 1. Properties of the event: $P(e)$
 2. Properties of the object: $Q(x)$
 3. Properties of the thematic relation: $R(e, x)$

$P(e)$	$Q(x)$	$R(e, x)$	$\lambda e \exists x. (P(e) \wedge Q(x) \wedge R(e, x))$
cumulative	cumulative	summative	cumulative
	quantized	gradual	quantized

Unanswered questions

- ▶ We'd already been explaining that stuff using operators like CAUSE and BECOME, inertia worlds, etc.
- ▶ Could we have done without that?
- ▶ Answer: Maybe. . .
- ▶ We'll have a try tomorrow.