Interaction meanings and intermeaning actions
Chung-chieh Shan, 2005-12-08

Classic Montagovian semantics deals with aboutness as primary, whereas dynamic semantics deals with information update as primary. What might a semantics look like that deals with interaction -- that is, agents seeking and providing information -- as primary?

I describe a model of interaction that I am working on for simple information exchanges. The model depicts interaction by graph rewrites and denotes interaction by message relations. It promises to formalize aboutness and information update on a new foundation, while remaining compatible with existing semantic tools like the lambda-calculus.

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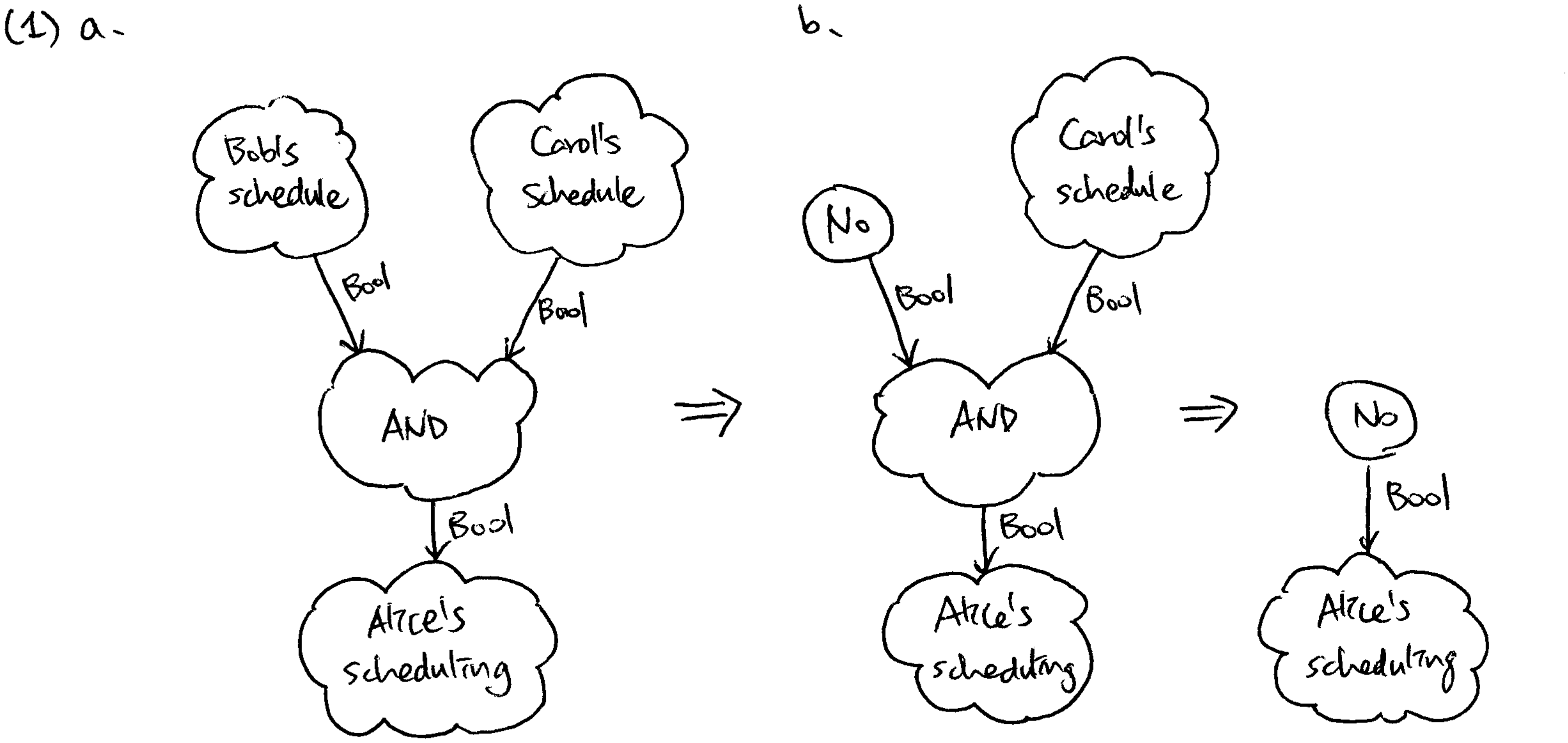
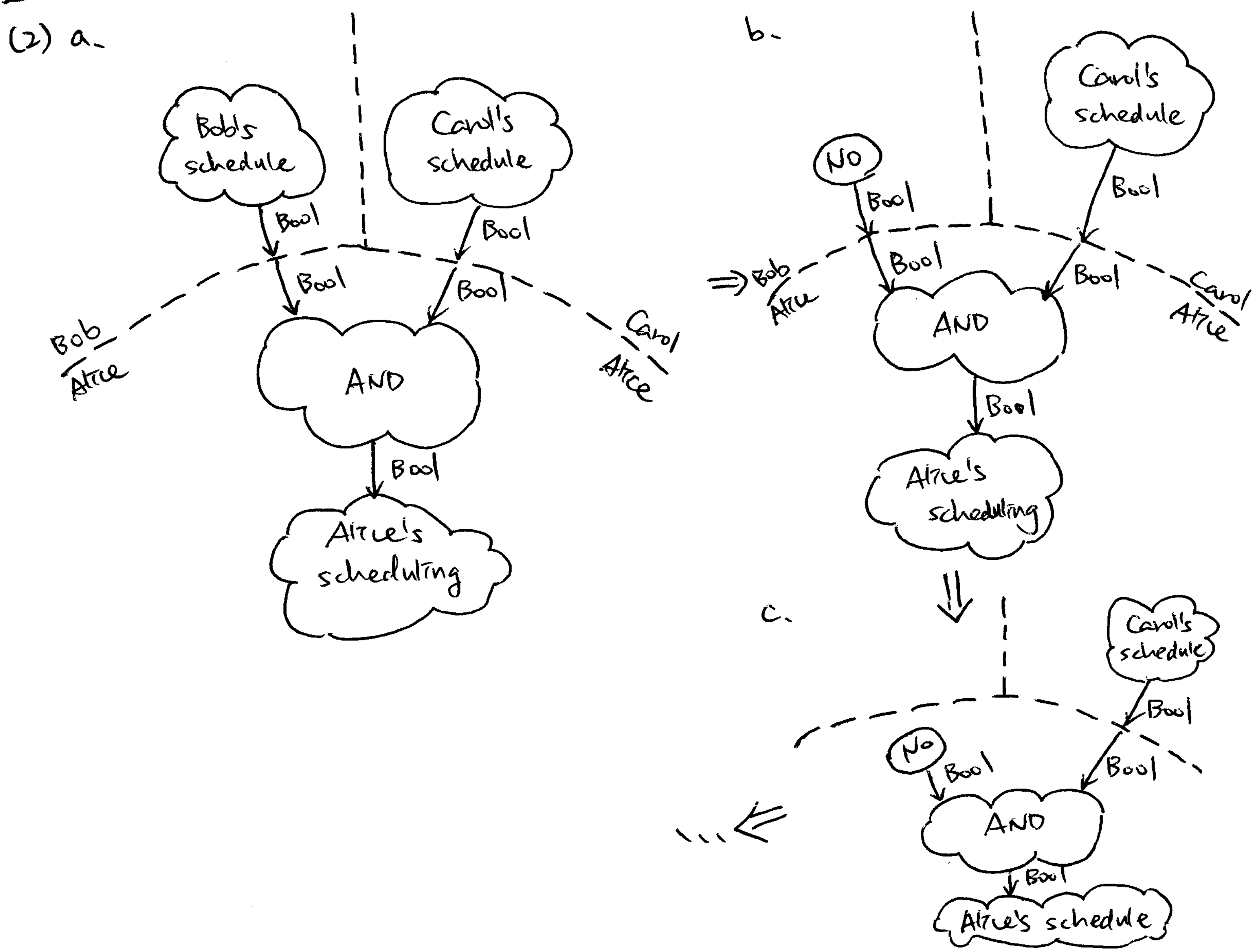
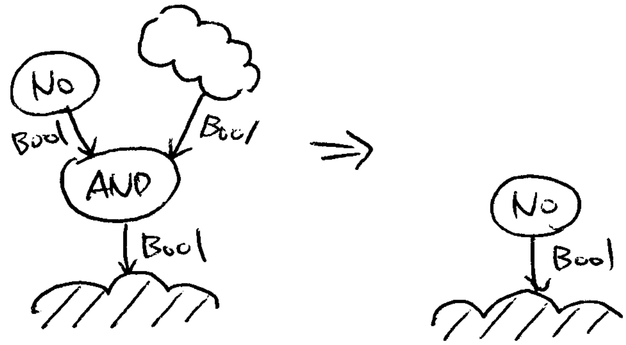
Interaction among
- people (information updates)
- things (aboutness)
- modules (interface)
- constituents (syntax)
- ...


(1) a.
Bob's schedule
Carol's schedule
Bool
Bool
AND
Bool
Alice's scheduling
b.
No
Carol's schedule
Bool
Bool
AND
Bool
Alice's scheduling
No
Bool
Alice's scheduling

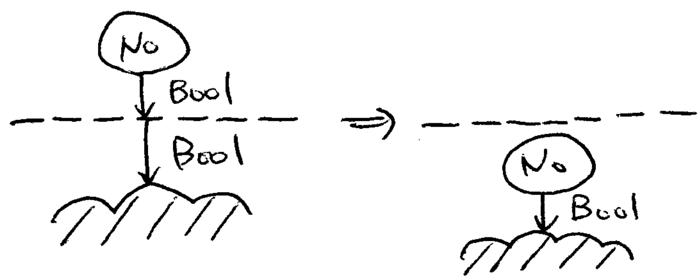

(2) a.
Bob's schedule
Carol's schedule
Bool
Bool
Bool
Bool
Bob
Alice
Carol
Alice
AND
Bool
Alice's scheduling
b.
No
Carol's schedule
Bool
Bool
Bool
Bool
Bob
Alice
Carol
Alice
AND
Bool
Alice's scheduling
c.
Carol's schedule
No
Bool
Bool
Bool
AND
Bool
Alice's schedule
...

(3) Rewriting rules capture the dynamics of

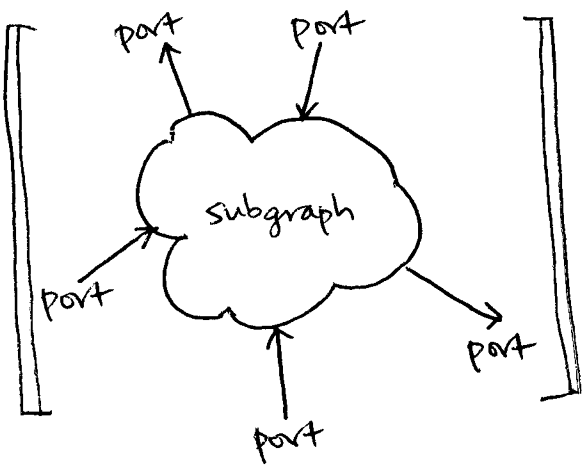
(a) computation




(b) communication




(4) Denotations = "context semantics" ; "game strategies"

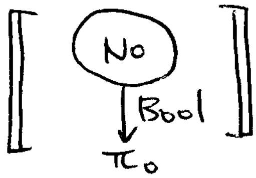



$= \{ \langle \text{input}, \text{port}, \text{output}, \text{port} \rangle, \ldots \}$

(Actually, easier to use a <u>symmetric</u> relation between message-port pairs.)

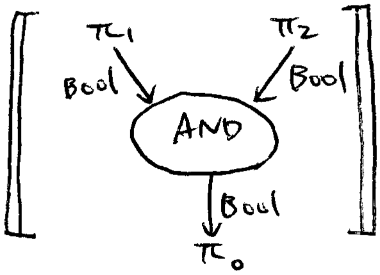
port names are arbitrary

(5) (a)



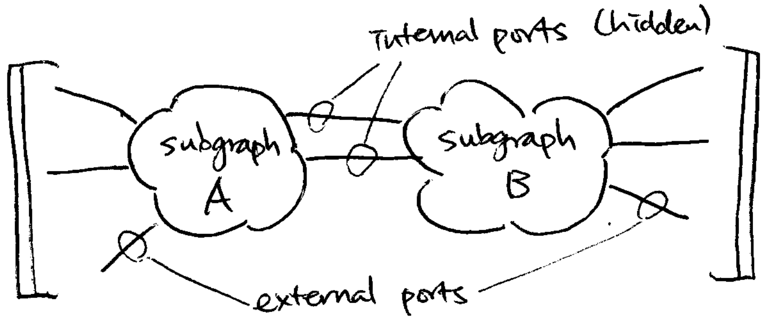

$$= \{ \langle ?, \pi_0, \mathrm{NO}, \pi_0 \rangle \}$$

(b)



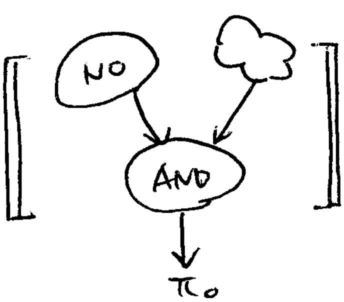

$$= \{ \langle ?, \pi_0, ?, \pi_1 \rangle, \langle \mathrm{NO}, \pi_1, \mathrm{NO}, \pi_0 \rangle, \langle \mathrm{YES}, \pi_1, ?, \pi_2 \rangle, \langle \mathrm{NO}, \pi_2, \mathrm{NO}, \pi_0 \rangle, \langle \mathrm{YES}, \pi_2, \mathrm{YES}, \pi_0 \rangle \}$$

(c) Composition

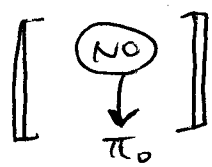



$$= \{ \langle \mu_0, \pi_0, \mu_n, \pi_n \rangle \mid \pi_0, \pi_n \text{ are external ports, } \pi_1, \ldots, \pi_{n-1} \text{ are internal ports, } \langle \mu_i, \pi_i, \mu_{i+1}, \pi_{i+1} \rangle \text{ (or its reverse) } \in [\![A]\!] \cup [\![B]\!] \text{ for } i = 0, \ldots, n-1 \}$$

(d) graph rewrites preserve denotation



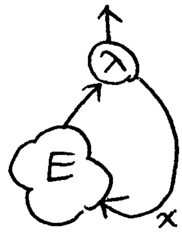

$$= \{ \langle ?, \pi_0, \mathrm{NO}, \pi_0 \rangle \} =$$



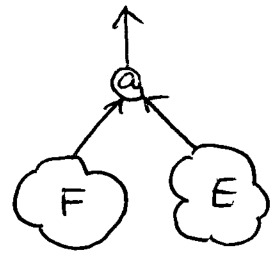

(e) $[\![ \pi' \longleftarrow \pi ]\!] = \{ \langle \mu, \pi, \mu, \pi' \rangle \mid \mu \text{ is a message} \}$

(6) a. $x$


b. $\lambda x. E$

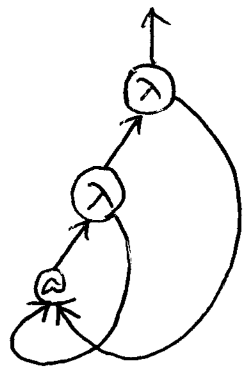



c. $F(E)$



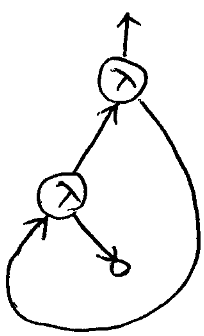

(7) a. $\lambda x. x$

b. $\lambda x. \lambda c. c(x)$

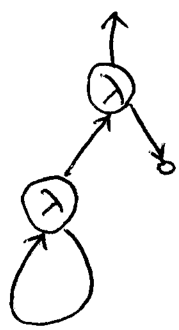


Consider only "affine" $\lambda$-terms for now — no variable appears multiple times. ("sharing" complicates the picture.)

c. $\lambda x. \lambda y. x$

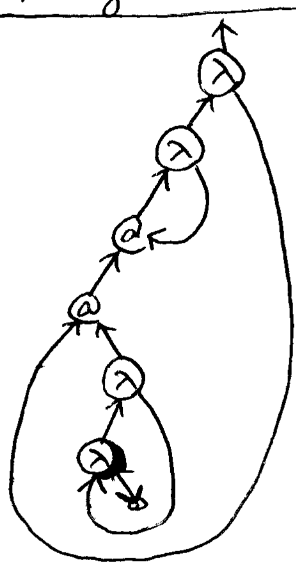


d. $\lambda x. \lambda y. y$

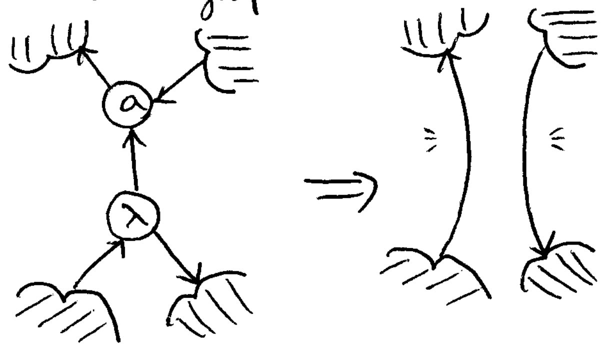


(7c) is like NO
(7d) is like YES
(7e) is like AND.

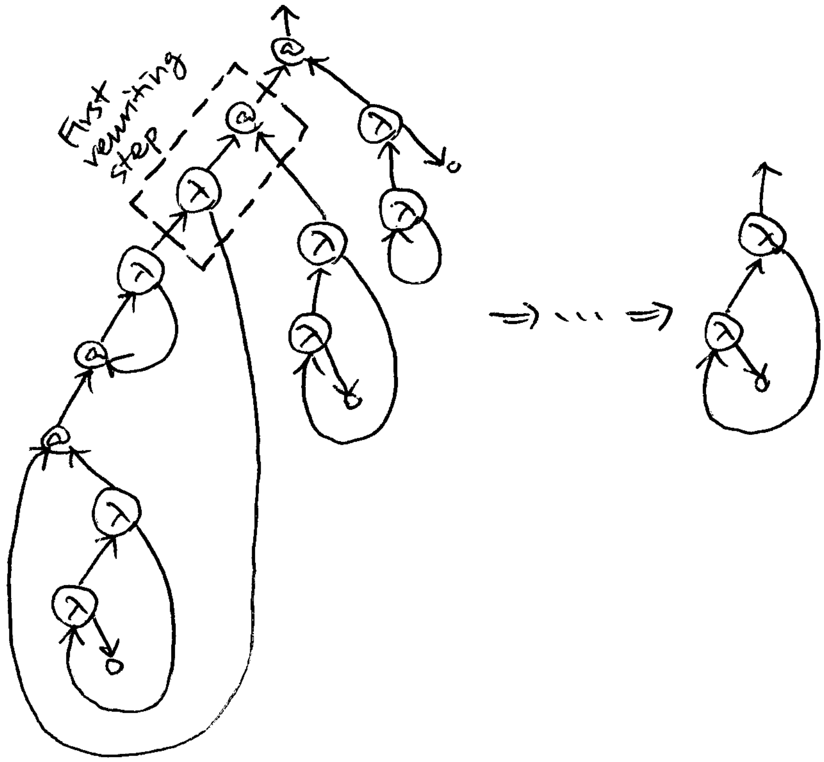
e. $\lambda f. \lambda g. f(\lambda x. \lambda y. x)(g)$



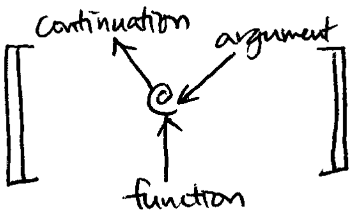
(8) $\lambda$-conversion as a graph rewrite



(9) Example: AND (NO) (YES) $\Longrightarrow$ NO

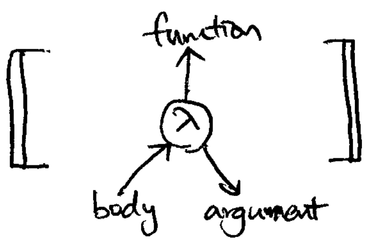



(10) a.




$= \{ \langle \mu, \text{continuation}, \langle 0, \mu \rangle, \text{function} \rangle, \langle \mu, \text{argument}, \langle 1, \mu \rangle, \text{function} \rangle$ for $\mu$ a message $\}$

b.




$= \{ \langle \langle 0, \mu \rangle, \text{function}, \mu, \text{body} \rangle, \langle \langle 1, \mu \rangle, \text{function}, \mu, \text{argument} \rangle$ for $\mu$ a message $\}$