TopHat: a stylish journey through modular interactive workflows

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Task Oriented Programming (TOP)

Workflows
coordinate collaboration

Interactive
driven by user input

Modular
higher order

elementary building blocks and concepts

labeled transition system

embedding in simply typed λ-calculus
(with clearly separated semantics)

FOUNDATION FOR FORMAL REASONING
AND COMPARISON TO OTHER FRAMEWORKS

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Building blocks

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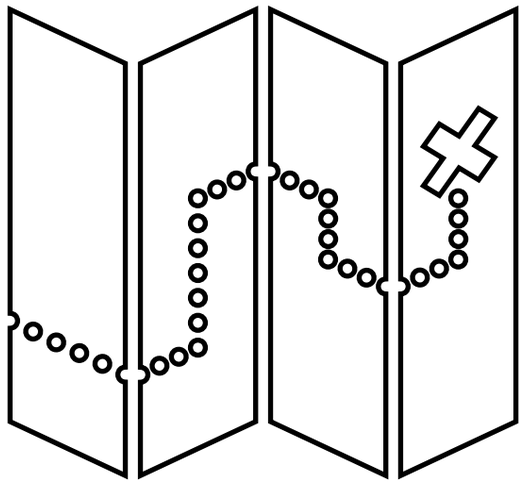
Editors

□5

Empty → ⊠Int

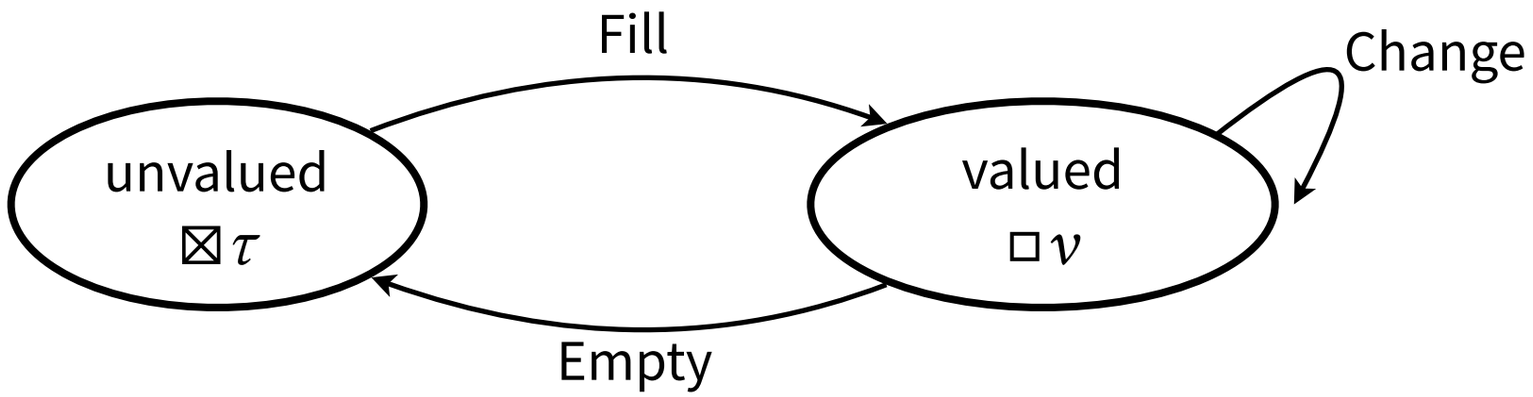


□(51°49'N, 5°52'E)

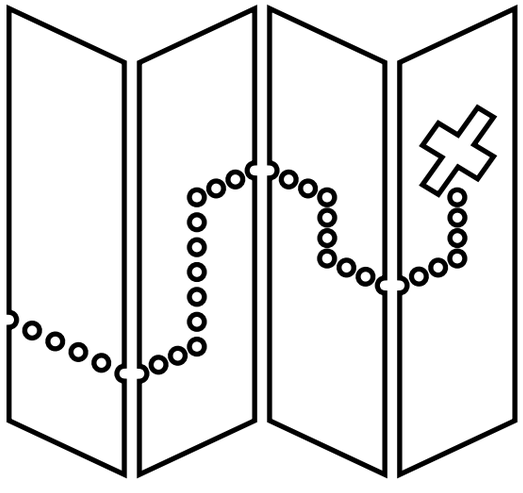
□True

False → □False

CAPTURE THE EVER CHANGING NATURE OF WIDGETS

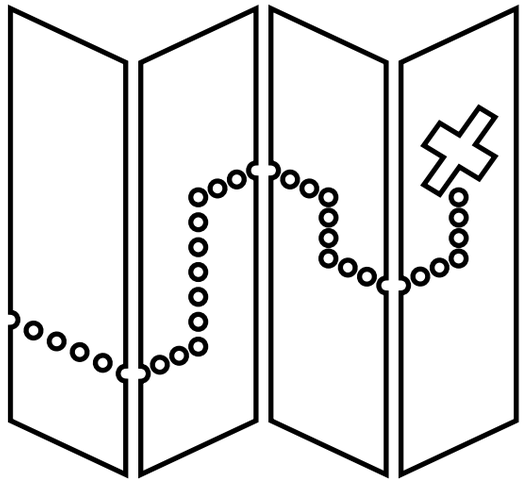


Shared editors

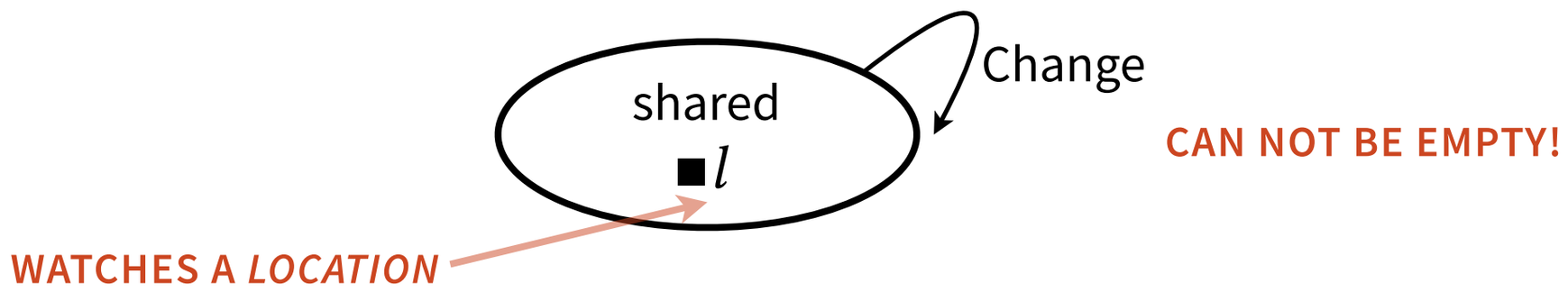


■(51°49'N, 5°52'E)

(51°49'N, 5°52'W) → ■(51°49'N, 5°52'W)

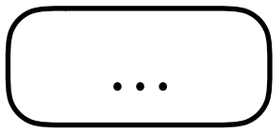


■(51°49'N, 5°52'E)

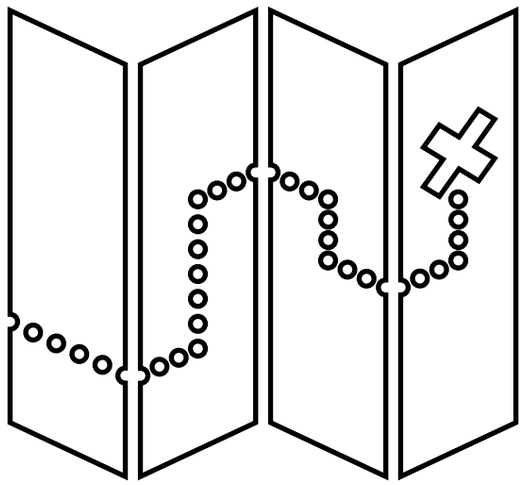


CAN NOT BE EMPTY!

Observations



$\mathcal{V}(\boxtimes \text{INT}) = \bot$



$\mathcal{V}(\square(51°49'\text{N}, 5°52'\text{E}))$
$= (51°49'\text{N}, 5°52'\text{E})$

$\mathcal{V}(\square \text{True}) = \text{True}$

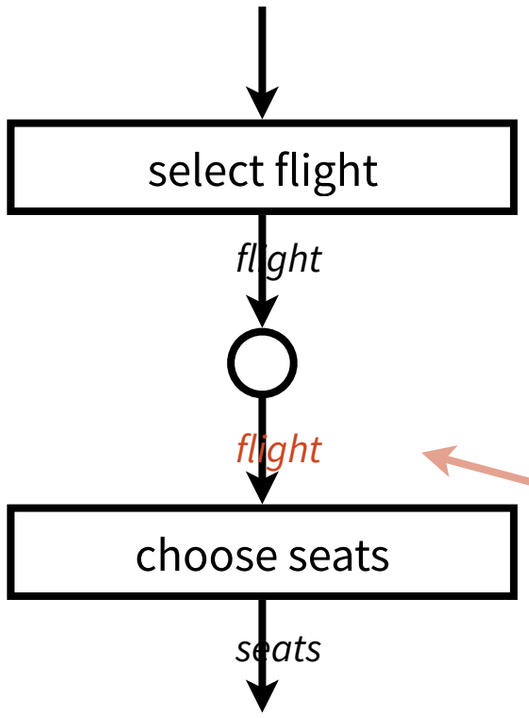
SOME TASKS DO NOT HAVE A VALUE

value $\quad \mathcal{V} : \text{TASK } \tau \longrightarrow \text{MAYBE } \tau$

user interface $\quad \mathcal{U} : \text{TASK } \tau \longrightarrow \text{HTML}$ or $\mathcal{U} : \text{TASK } \tau \longrightarrow \text{STRING}$ or $\mathcal{U} : \text{TASK } \tau \longrightarrow \ldots$

possible inputs $\quad \mathcal{J} : \text{TASK } \tau \longrightarrow \text{LIST INPUT}$

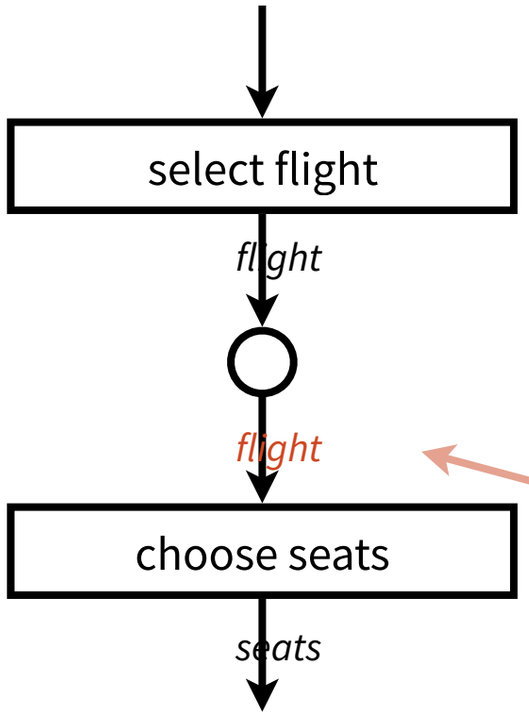
Steps



select_flight ▸ choose_seats

USE VALUE IN NEXT TASK?

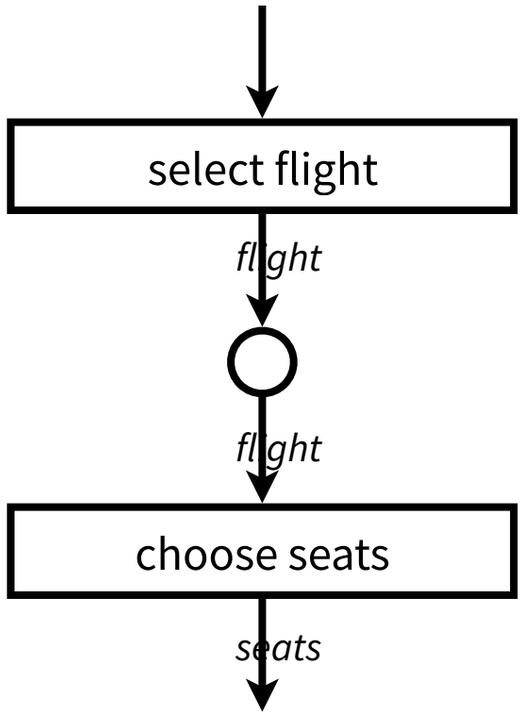
Steps



$$\text{select\_flight} \blacktriangleright \lambda \mathit{flight}.\ \text{choose\_seats}\ \mathit{flight}$$

USE VALUE IN NEXT TASK?

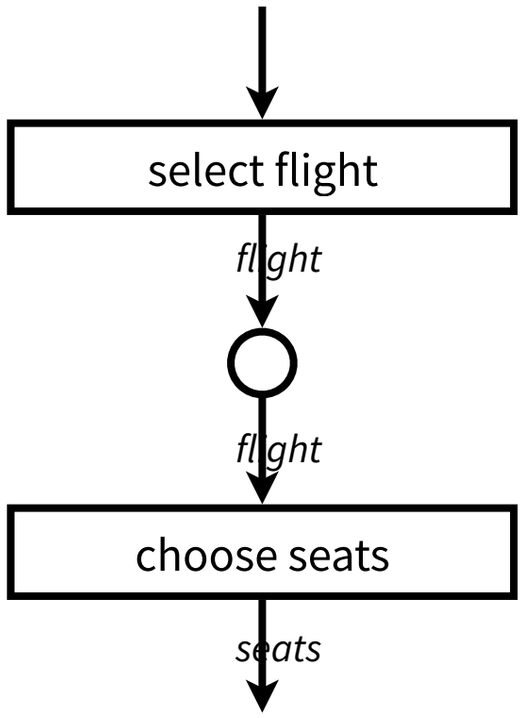
Steps



select_flight ▸ λ*flight*. choose_seats *flight*

WHEN TO PROCEED TO THE NEXT TASK?

Steps

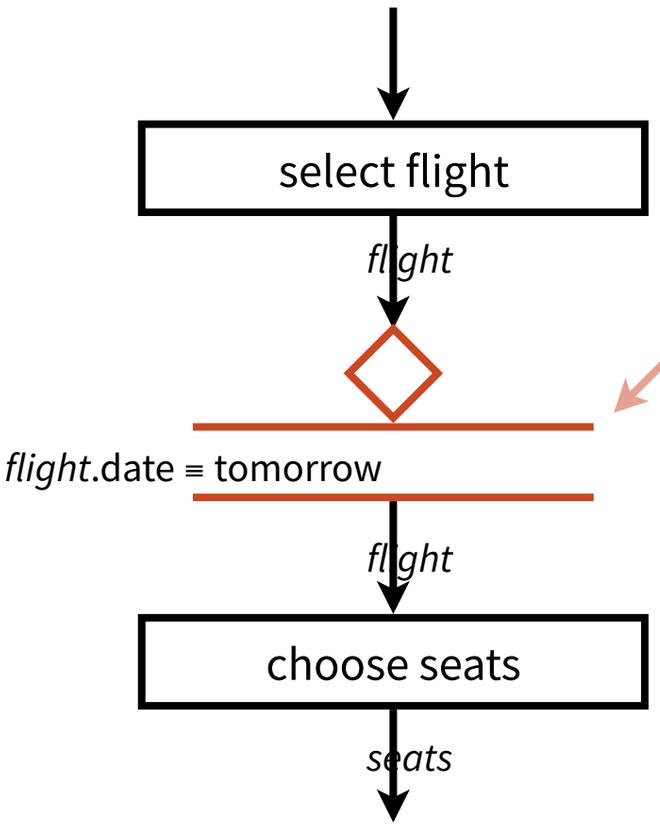


$$\text{select\_flight} \blacktriangleright \lambda \mathit{flight}.\ \text{choose\_seats}\ \mathit{flight}$$

WHEN TO PROCEED TO THE NEXT TASK?

$$\Longrightarrow \mathcal{V}(\text{select\_flight}) = v$$

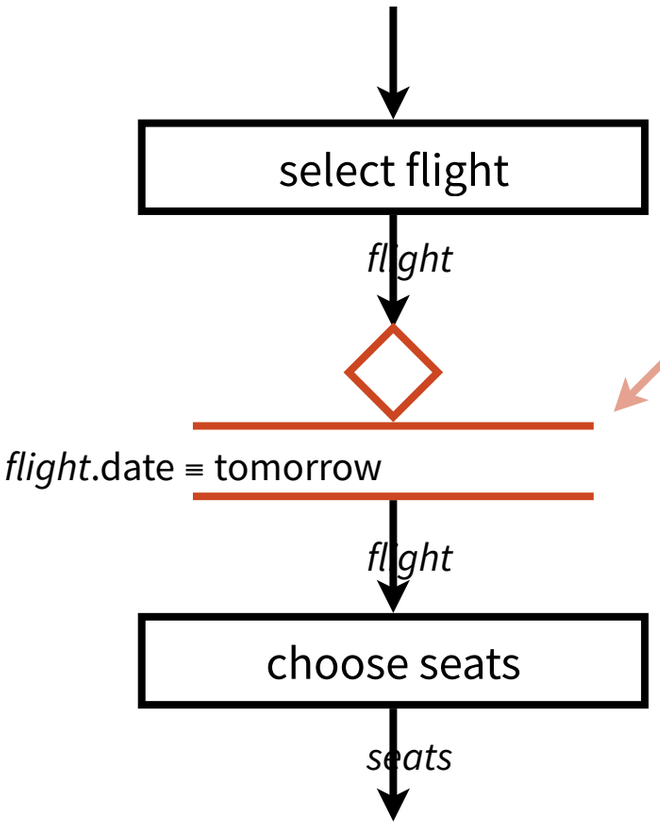
Guarded steps



ONLY WHEN GUARD IS TRUE?

select_flight ▸ λ*flight*. choose_seats *flight*

Guarded steps

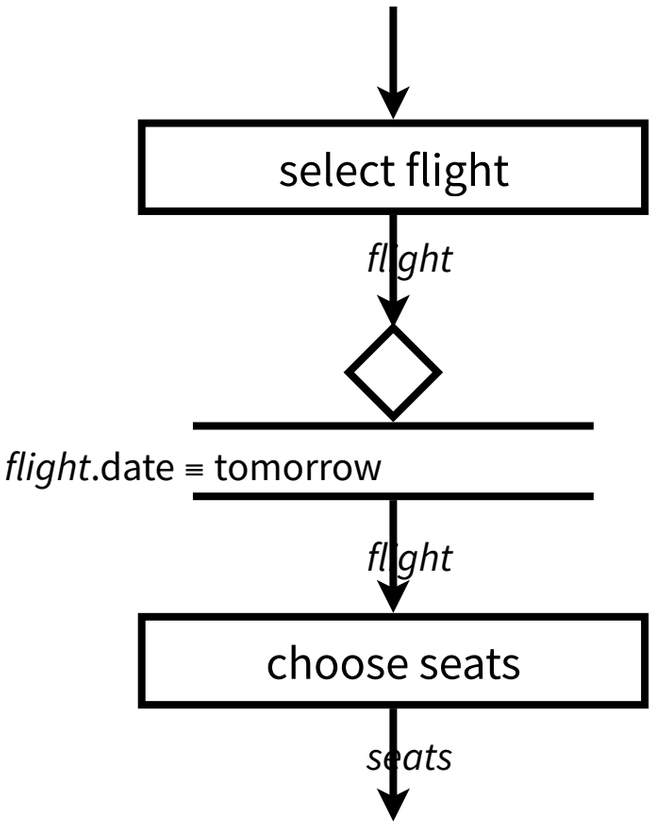


ONLY WHEN GUARD IS TRUE?

select_flight ▸ λ*flight*.
if flight.date ≡ tomorrow
then choose_seats *flight*
else ↯

FAILURE:
A TASK THAT NEVER ENDS
AND CAN NOT HANDLE USER INPUT

Guarded steps



select_flight ▸ $\lambda flight.$
if flight.date ≡ tomorrow
then choose_seats *flight*
else ↯

WHEN TO PROCEED TO THE NEXT TASK?

$\Longrightarrow \mathcal{V}(\text{select\_flight}) = v$
and … $(v) \Downarrow t$ **where** $t \neq \lightning$

USING HOST LANGUAGE SEMANTICS!

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Nitty gritty

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Grammar

Take a λ-calculus…

$$
\begin{array}{lll}
e ::= & & \text{Expressions} \\
\quad | & \lambda x : \tau.\, e \mid e_1\ e_2 & \text{– abstraction, application} \\
\quad | & x \mid c \mid e_1 \star e_2 & \text{– variable, constant, operation} \\
\quad | & \textbf{if}\ e_1\ \textbf{then}\ e_2\ \textbf{else}\ e_3 \mid \langle\rangle & \text{– branch, unit} \\
\quad | & \langle e_1, e_2\rangle \mid \mathsf{fst}\, e \mid \mathsf{snd}\, e & \text{– pair, projections} \\
\quad | & \textbf{ref}\, e \mid\, !e \mid e_1 := e_2 \mid l & \text{– references, location} \\
\quad | & p & \text{– pretask} \\
c ::= & & \text{Constants} \\
\quad | & B \mid I \mid S & \text{– boolean, integer, string}
\end{array}
\qquad \longrightarrow \qquad
\begin{array}{lll}
t ::= & & \text{Tasks} \\
\quad | & \square\, v \mid \boxtimes\, \tau \mid \blacksquare\, l & \text{– editors} \\
\quad | & t_1 \blacktriangleright e_2 \mid t_1 \triangleright e_2 & \text{– steps} \\
\quad | & \lightning \mid t_1 \bowtie t_2 & \text{– fail, combination} \\
\quad | & t_1 \blacklozenge t_2 \mid e_1 \lozenge e_2 & \text{– choices}
\end{array}
$$

…embed a workflow language

GRAMMAR IS LAYERS, SO SEMANTICS ARE TO!

COMBINATION OF TWO TASKS

RACE BETWEEN TWO TASKS

Grammar

Take a λ-calculus…

$e ::=$		Expressions
	$\lambda x : \tau.\ e \mid e_1\ e_2$	– abstraction, application
	$x \mid c \mid e_1 \star e_2$	– variable, constant, operation
	$\textbf{if}\ e_1\ \textbf{then}\ e_2\ \textbf{else}\ e_3 \mid \langle\rangle$	– branch, unit
	$\langle e_1, e_2\rangle \mid \mathsf{fst}\ e \mid \mathsf{snd}\ e$	– pair, projections
	$\textbf{ref}\ e \mid !e \mid e_1 := e_2 \mid l$	– references, location
	p	– pretask
$c ::=$		Constants
	$B \mid I \mid S$	– boolean, integer, string

…embed a workflow language

$t ::=$		Tasks
	$\square\, v \mid \boxtimes\, \tau \mid \blacksquare\, l$	– editors
	$t_1 \blacktriangleright e_2 \mid t_1 \triangleright e_2$	– steps
	$\lightning \mid t_1 \bowtie t_2$	– fail, combination
	$t_1 \blacklozenge t_2 \mid e_1 \lozenge e_2$	– choices

GRAMMAR IS LAYERS, SO SEMANTICS ARE TO!

COMBINATION OF TWO TASKS

RACE BETWEEN TWO TASKS

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Semantics

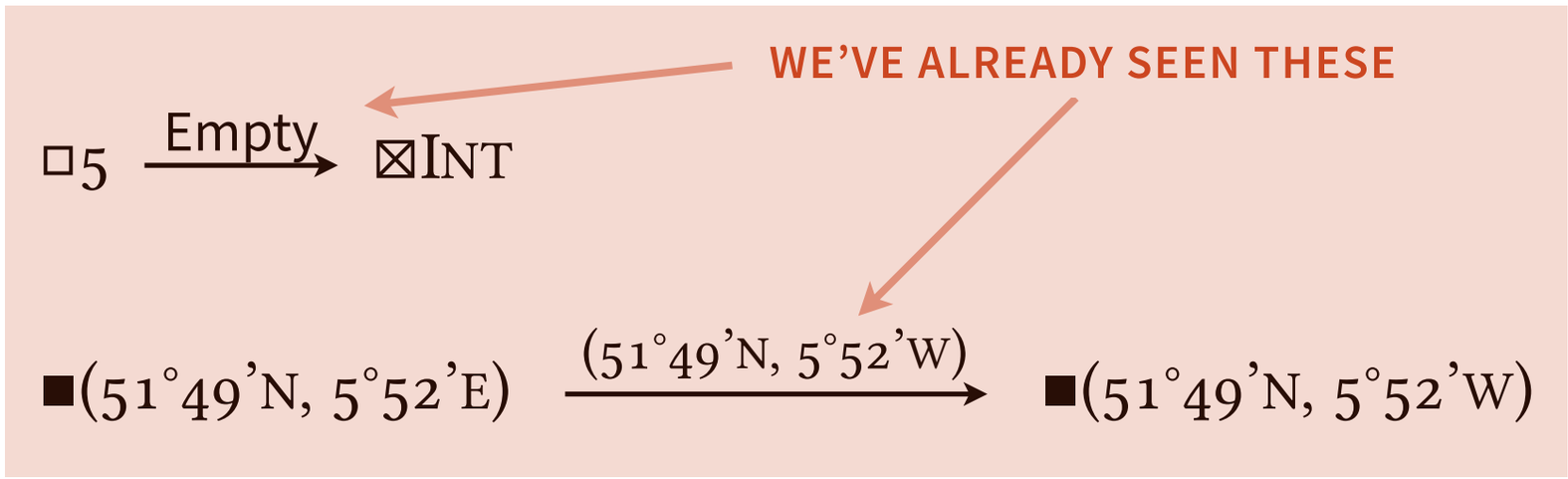
Two layers ⇒ two semantics

$e \downarrow v$ STANDARD BIG STEP SEMANTICS

$p \Downarrow t$ SPECIAL TASK SEMANTICS

But interaction… ⇒ additional layer

$t \xrightarrow{i} t'$



Comparisons

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Tasks vs Processes

TOP	CSP
“We do *A* together, then you do *B*”	“I send you *M*, you receive it and react wit *N*”
Developer models collaboration	Developer models communication
System takes care of communication	

Future work

Summary

Extras

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