Inductive Program Synthesis for Bidirectional Transformations

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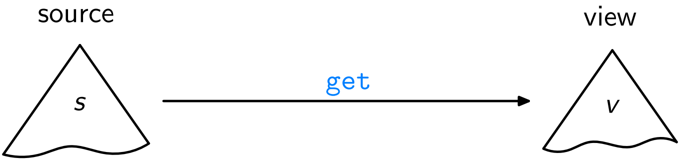
Dagstuhl Seminar 15442

Bidirectional Transformation



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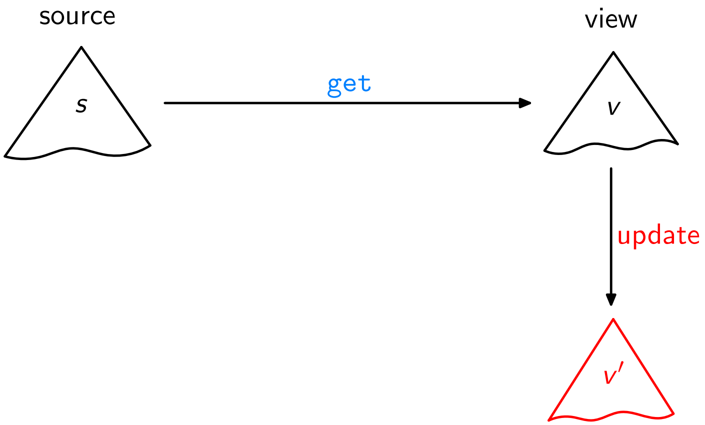

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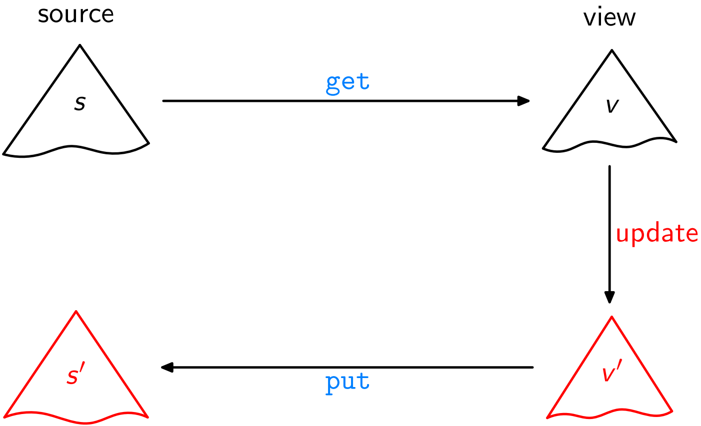

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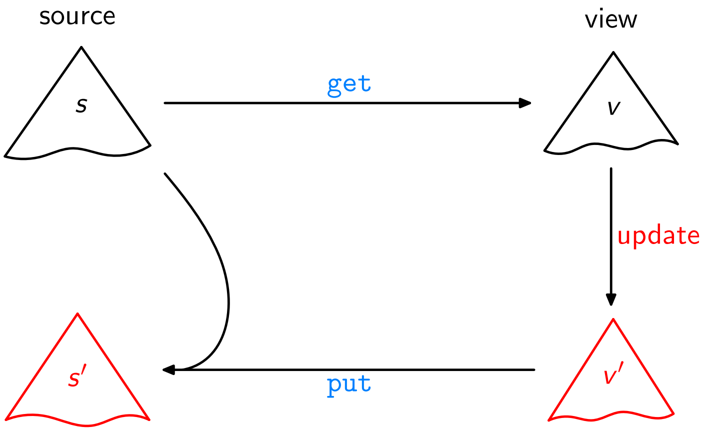


Bidirectional Transformation

Examples:

$$\text{“abc”} \xrightarrow{\texttt{tail}} \text{“bc”}$$

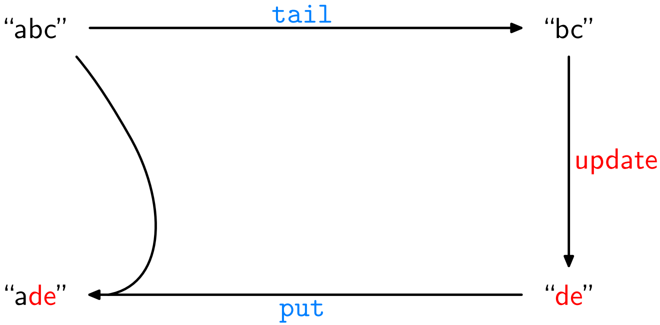
Bidirectional Transformation

Examples:

$$
\begin{tikzcd}
\text{“abc”} \arrow[r, "\texttt{tail}"] & \text{“bc”} \arrow[d, "\text{update}"] \\
 & \text{“de”}
\end{tikzcd}
$$

Bidirectional Transformation

Examples:



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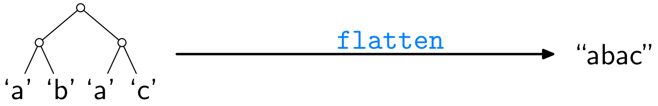

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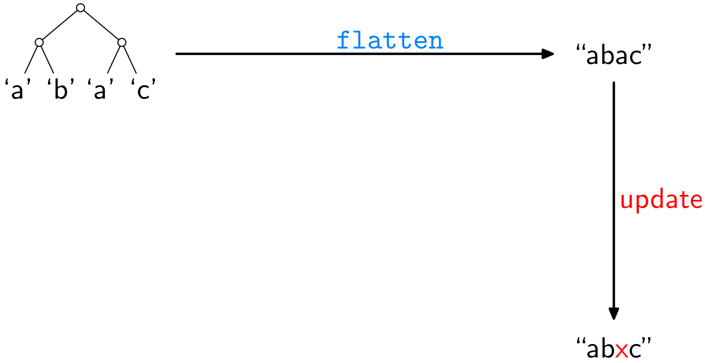

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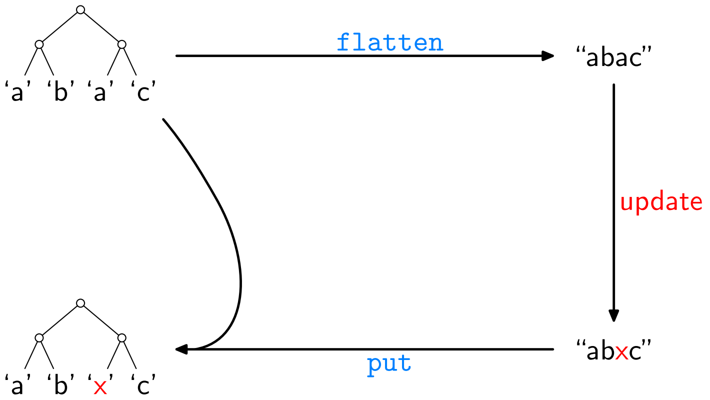

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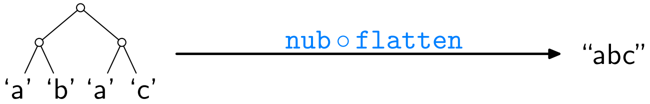

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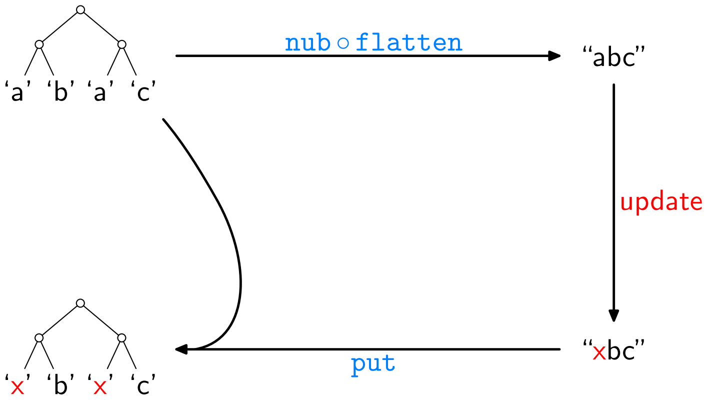

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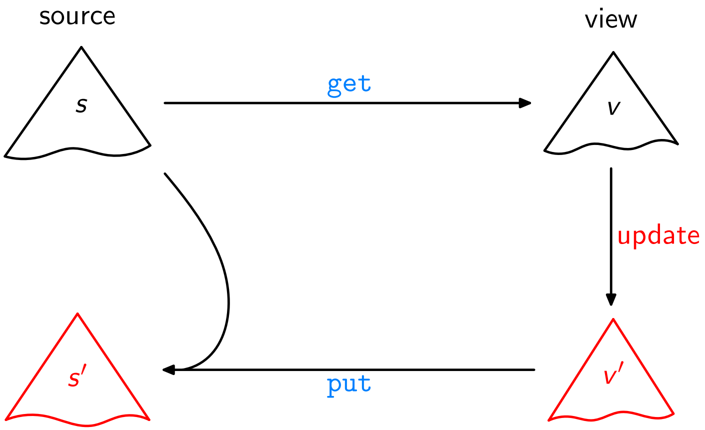
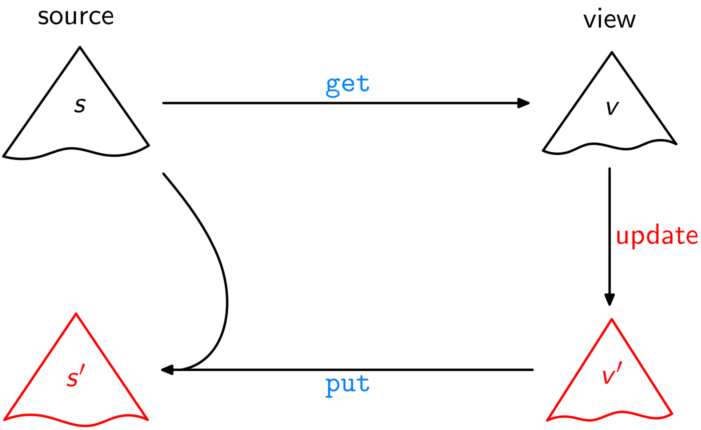


Bidirectional Transformation – Laws



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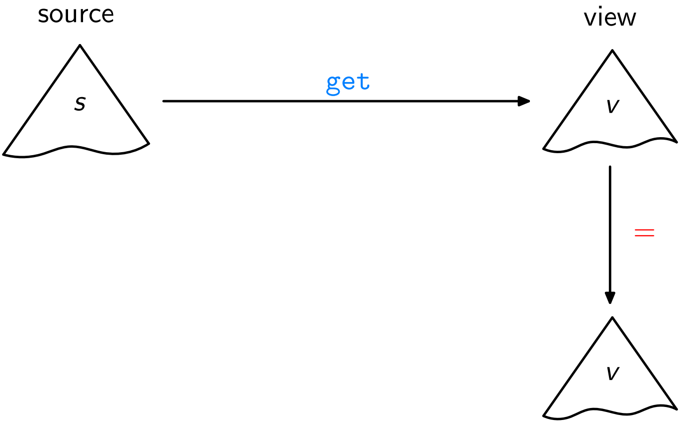
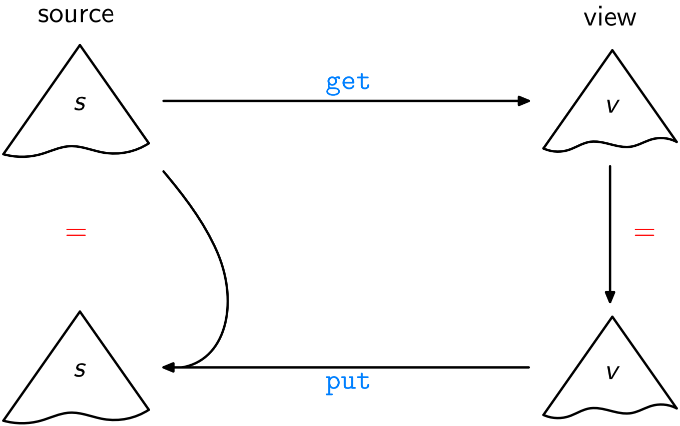


Acceptability / GetPut

Bidirectional Transformation – Laws



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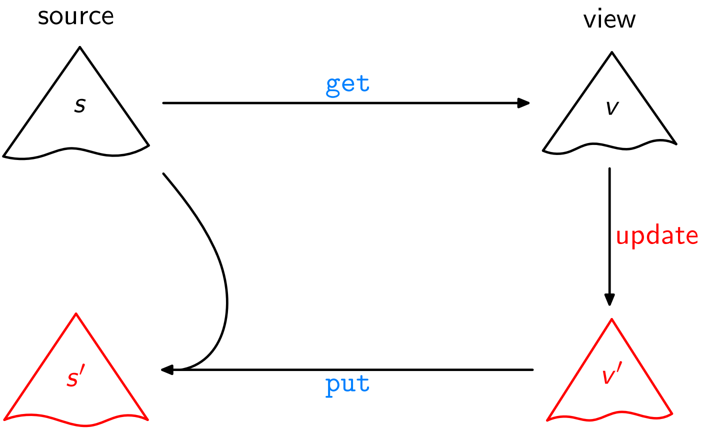

Consistency / PutGet

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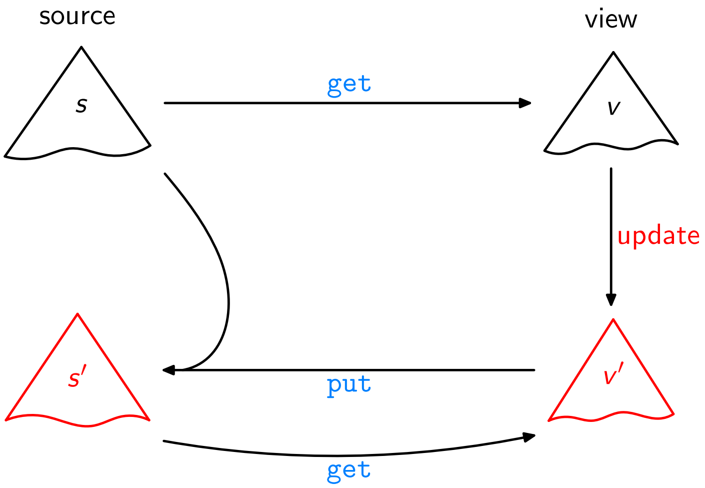

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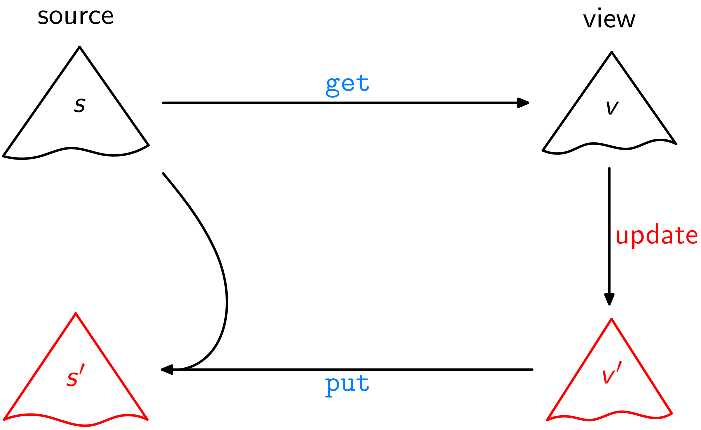
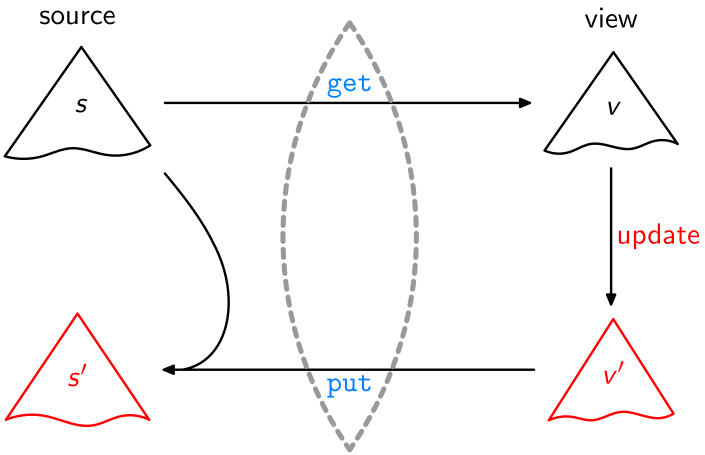


Bidirectional Transformation – PL Approaches



Lenses, DSLs

[Foster et al., ACM TOPLAS'07, ...]

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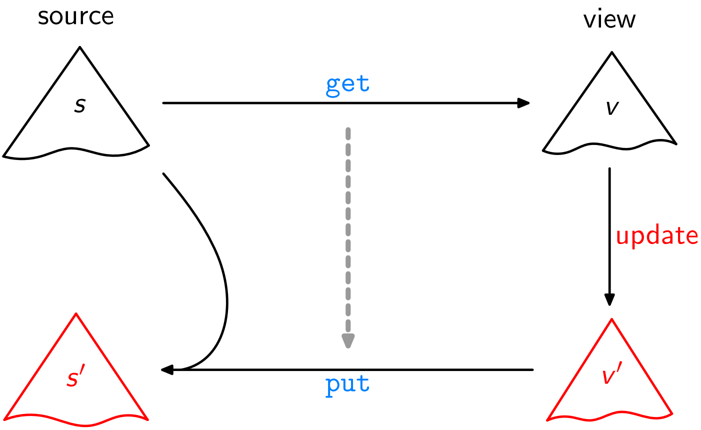

Bidirectionalization

[Matsuda et al., ICFP'07], [V., POPL'09], ...

Nondeterminism / Choices to make

Let `get` = `sieve` with:

s	""	"a"	"ab"	"abc"	"abcd"	"abcde"
`sieve` s	""	""	"b"	"b"	"bd"	"bd"

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Then, for example:

`put "abcd" "xy"` $=$ `"axcy"`

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put "abcde" "xy"  = "axcye"
put "abcde" "xyz" = "axcyez"          or "axcyez  "?
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put "abcd"  "x"   = "axc"        or "ax"?,   or "cx"?
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But "really intended":

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A slightly more complex case, with recursion

Let $\texttt{get} = \texttt{init}$ with:

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Possible, and correct:

$$\begin{aligned} \texttt{put}\; xs\; ys \mid \texttt{length}\; ys == (\texttt{length}\; xs) - 1 &= ys +\!\!+ [\texttt{last}\; xs] \\ \mid \texttt{otherwise} &= ys +\!\!+ \texttt{" "} \end{aligned}$$

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Problem: How to produce the "intuitive" solution?

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$$\texttt{put}\ s\ (\texttt{get}\ s) = s$$

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Like, for $\texttt{get} = \texttt{init}$:

$$\begin{aligned}
&\texttt{put}\ [a] && [\,] && = [a]\\
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&\texttt{put}\ [a,b,c] && [a,b] && = [a,b,c]\\
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But then one would synthesize:

$$\texttt{put}\ xs\ ys = xs$$

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Instead of:

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use:

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\end{aligned}$$

Then, Igor II synthesizes:

$$\begin{aligned}
&\texttt{put}\ [a] && [\,] && = [a]\\
&\texttt{put}\ (_ : (x : ys)) && (a : bs) && = (a : (\texttt{put}\ (x : ys)\ bs))
\end{aligned}$$

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Also works for $\texttt{get} = \texttt{sieve}$. Gives:

$$
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But this $\texttt{put}$ is not defined when $(\texttt{length}\ s)\ /\ 2 < \texttt{length}\ v'$.

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Idea: Introduce extra examples covering such cases:

$$\texttt{put}\ [\,]\ [b] = [\_, b]$$

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But actually then, in general, also need to express inequality constraints . . .

Conclusion / Outlook

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  - either naively as a black box, or deeper integration
  - further ideas: I/O pairs per parametricity of `get`;
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    ...
- Extensions to Igor II:
  - dealing with wildcards on rhs of I/O pairs
  - a new operator for introducing accumulating parameters
  - some reduction of search space

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J. Voigtländer.
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