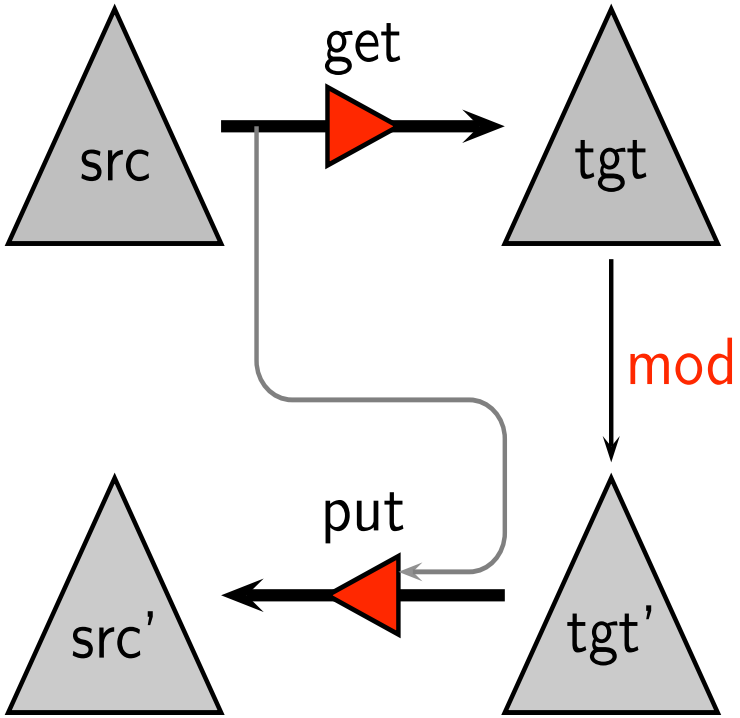
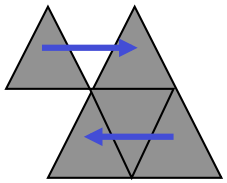
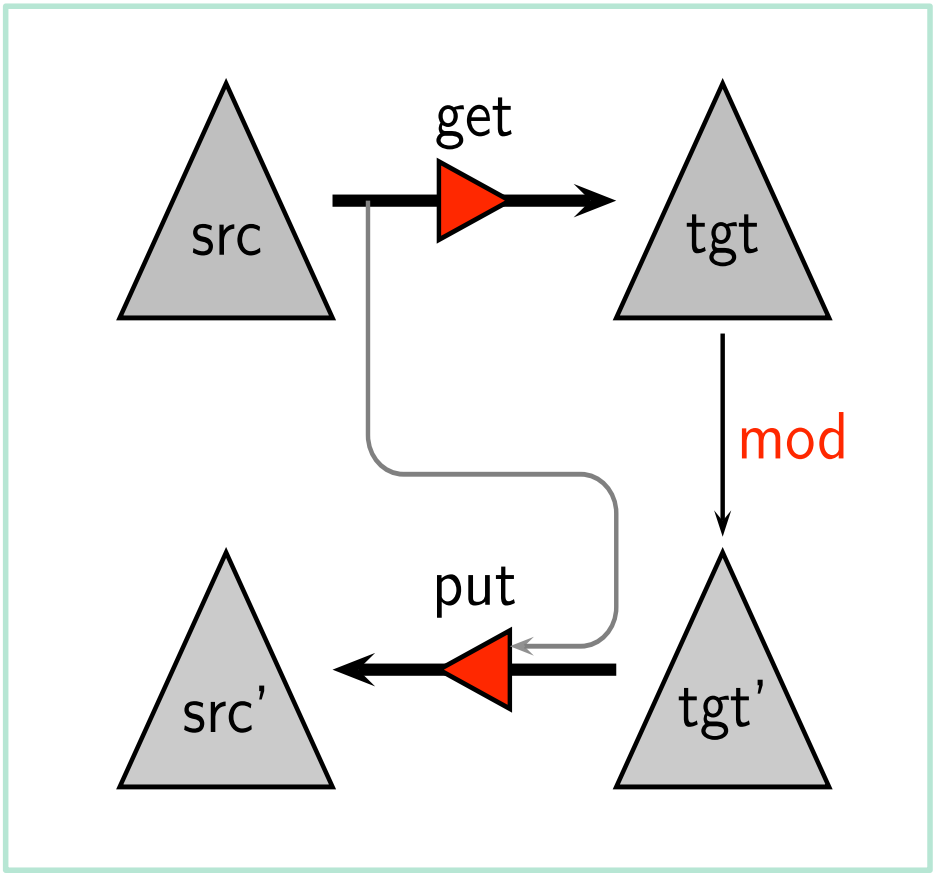
Bidirectional Transformation (BX)

[Nate Foster, et al: POPL 2005]





Roundtrip Properties

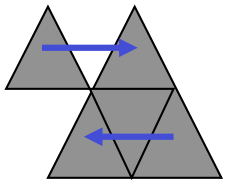


Get-Put:

put s (get s) = s

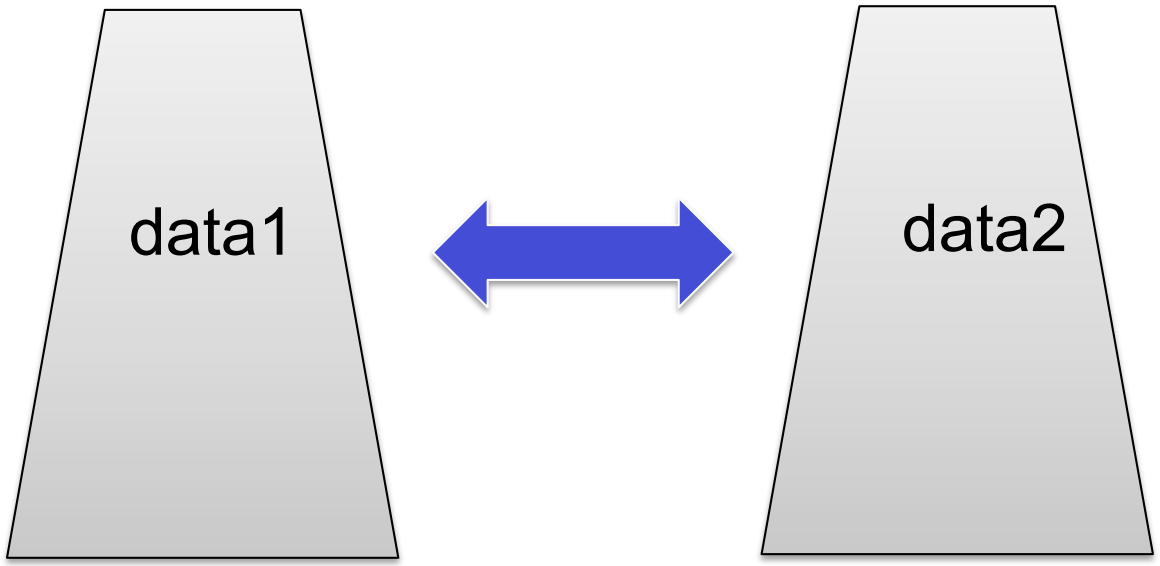
Put-Get:

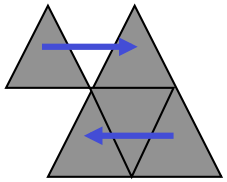
get (put s t) = t



What is BX Programming?

Define a pair of functions get/put such that the two kinds of data can be synchronized.



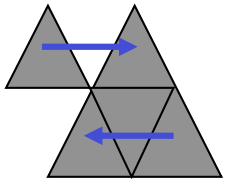


Bidirectional Transformation Languages

- We need languages to support development of software with bidirectional computation

  - Lens (for data sync) Univ. of Pennsylvania, …
    [POPL'05, PODS'06, ICFP'08, ICFP'10, POPL'11,'12]

  - X/Inv/BiX/UnQL+ Univ. of Tokyo / NII
    [PEPM'04, ICFP'07, ASE'07, FSE'09, ESOP'10, ICFP'10, MODELS'10, PPDP'11, ICSE'12, PPDP'13, ICFP'13]



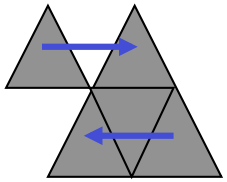
Existing Approaches to Bidirectional Programming

"get" (forward transformation)

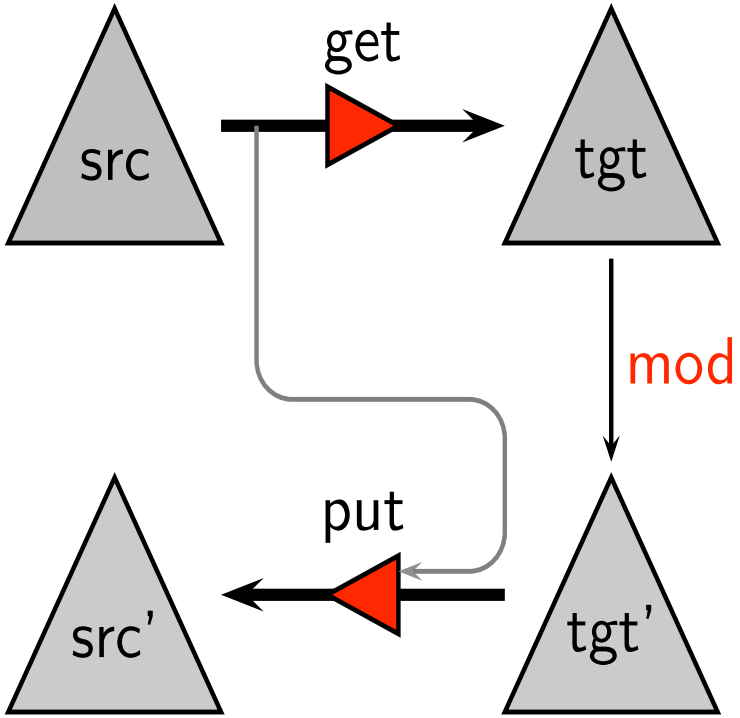
"put" (backward transformation)

- Domain Specific Bidirectional Languages
- Automatic Bidirectionization of ATL, XQuery, UnQL

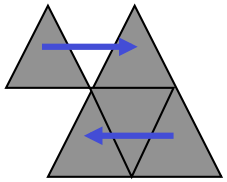
Assumption:
Each get has one corresponding put.



Not Practical!

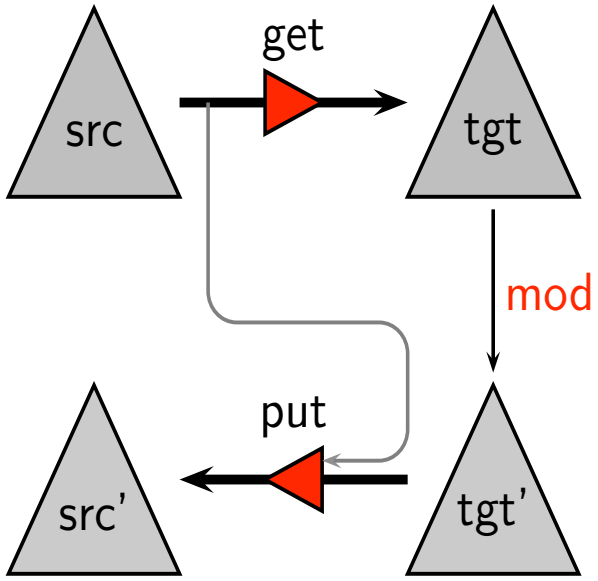


Since get is generally non-injective, many suitable puts correspond to one get, each being useful in different context.



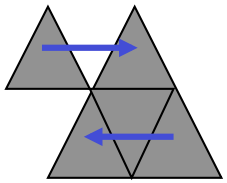
Put is the essence of BX!

- An important but little-known fact:



put uniquely determines get.

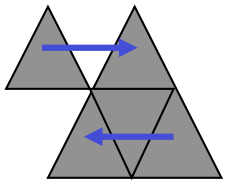
Sebastian Fischer, Zhenjiang Hu, Hugo Pacheco, A Clear Picture of Lenses, submitted to JFP, 2013 (available upon request)



Put-based BX Programming

Define a pair of functions get/put such that the two kinds of data can be synchronized.

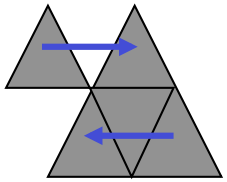
Define a well-behaved put such that the two kinds of data can be synchronized.



This talk

Can we provide a language for programming "put"?

- Easy to use
- Powerful to specify various "put"
- Static check of well-behavedness of "put"
- Automatic derivation of "get"



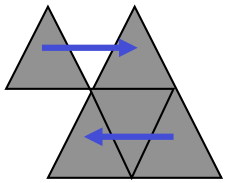
What is the essence of "put"?

put : Old Source → View → New Source

put' : View → Old Source → New Source

put' : View → (Old Source → New Source)

"put" uses a view to update the source.

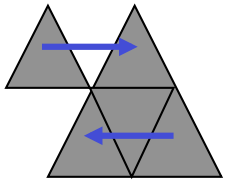


“put” is nothing but an update language!

- Languages for updating XML trees
  - XQuery!
  - Flux [ICFP 2008]: a functional update language

- There are huge number of update languages, general and specific

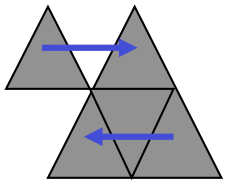
BiFlux: A View-Embedding Update Language



Flux

- Flux (Functional Lightweight Updates for XML) [Cheney, ICFP 2008]:
  - functional language
  - clear semantics
  - straightforward type-checking

```
UPDATE $x AS books/book BY
     REPLACE IN year WITH "1859"
     INSERT …
     DELETE …
     UPDATE …. BY …
      …
WHERE $x/title/text() = "A Tale of Two Cities"
```

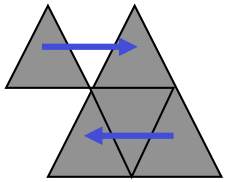


BiFlux

- Use an XML view to update an XML source
  - All the view must be embedded in the updated source

```
UPDATE source BY
   Update Stmt1
     …
FOR VIEW view
matching-clause
```

MATCH → Stmt
UNMATCHS → Stmt
UNMATCHV → Stmt



A Bookstore Example

Source:

```
<bookstore>
 <book category='Food'>
   <title >Everyday Italian</title>
   <author>Giada De Laurentiis</author>
   <year>2005</year>
   <price>30.00</price>
 </book>
 <book>
   <title >Harry Potter</title>
   <author>J K. Rowling</author>
   <year>2005</year>
   <price>29.99</price>
 </book>
</bookstore>
```

View:

```
<books>
 <book>
  <title>Everyday Italian</title>
  <price>30.00</price>
 </book>
 <book>
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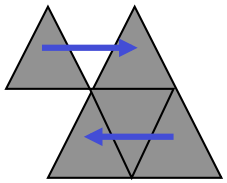
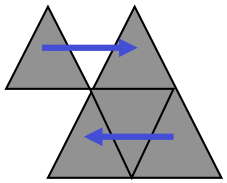
```


Davi M. J. Barbosa et al. Matching Lenses: Alignment and View Update,ICFP 2010



Update Bookmark with View

```
PROCEDURE updateBookStore(source $source AS s:bookstore, view $view AS v:books) =
UPDATE $book IN $source/bookstore/book BY
{
      MATCH     -> REPLACE price WITH $price
      UNMATCHV -> CREATE VALUE <book category='undefined'>
                                  <title/>
                                  <author>??</author>
                                  <year>??</year>
                                  <price/>
                            </book>
     UNMATCHS -> DELETE .
}
FOR VIEW book[$title  AS v:title, $price AS v:price] IN $view/books/*
MATCHING SOURCE BY $book/title VIEW BY $title
```

Update Books when Titles Match

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```

View':

```
<books>
 <book>
  <title>Harry Potter</title>
  <price>19.99</price>
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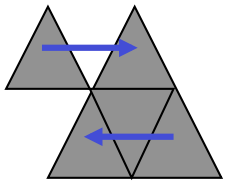
  <title>XQuery Kick Start</title>
  <price>29.99</price>
 </book>
 </books>
```



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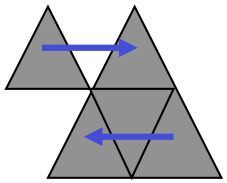

Update Books with no Corresponding Books in the View

Source:

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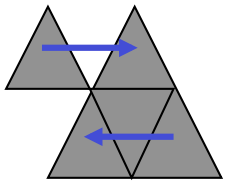

Update Books with no Corresponding Books in the View

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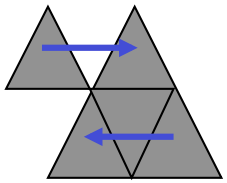

Update Books with Books only in the View

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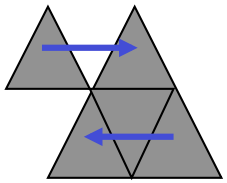

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   <year>2005</year>
   <price>19.99</price>
 </book>
 <book category='undefined'>
   <title />
   <author>??</author>
   <year>??</year>
   <price/>
 </book>
</bookstore>
```

View':

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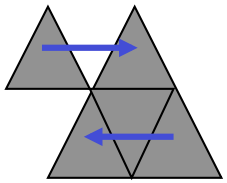

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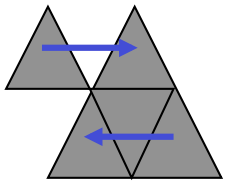

Forward Update Propagation for Free

Source:

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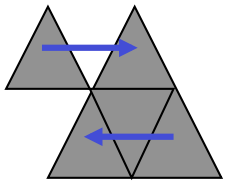

Forward Update Propagation for Free

Source:

```
<bookstore>
<book>
   <title >Harry Potter</title>
   <author>J K. Rowling</author>
   <year>2005</year>
   <price>100.00</price>
 </book>
 <book category='Computer Science'>
   <title>XQuery Kick Start</title>
   <author>Taro Tanaka</author>
   <year>2010</year>
   <price>29.99</price>
 </book>
</bookstore>
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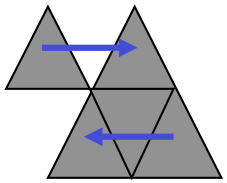

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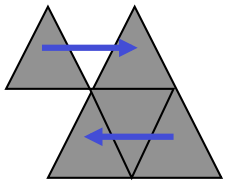
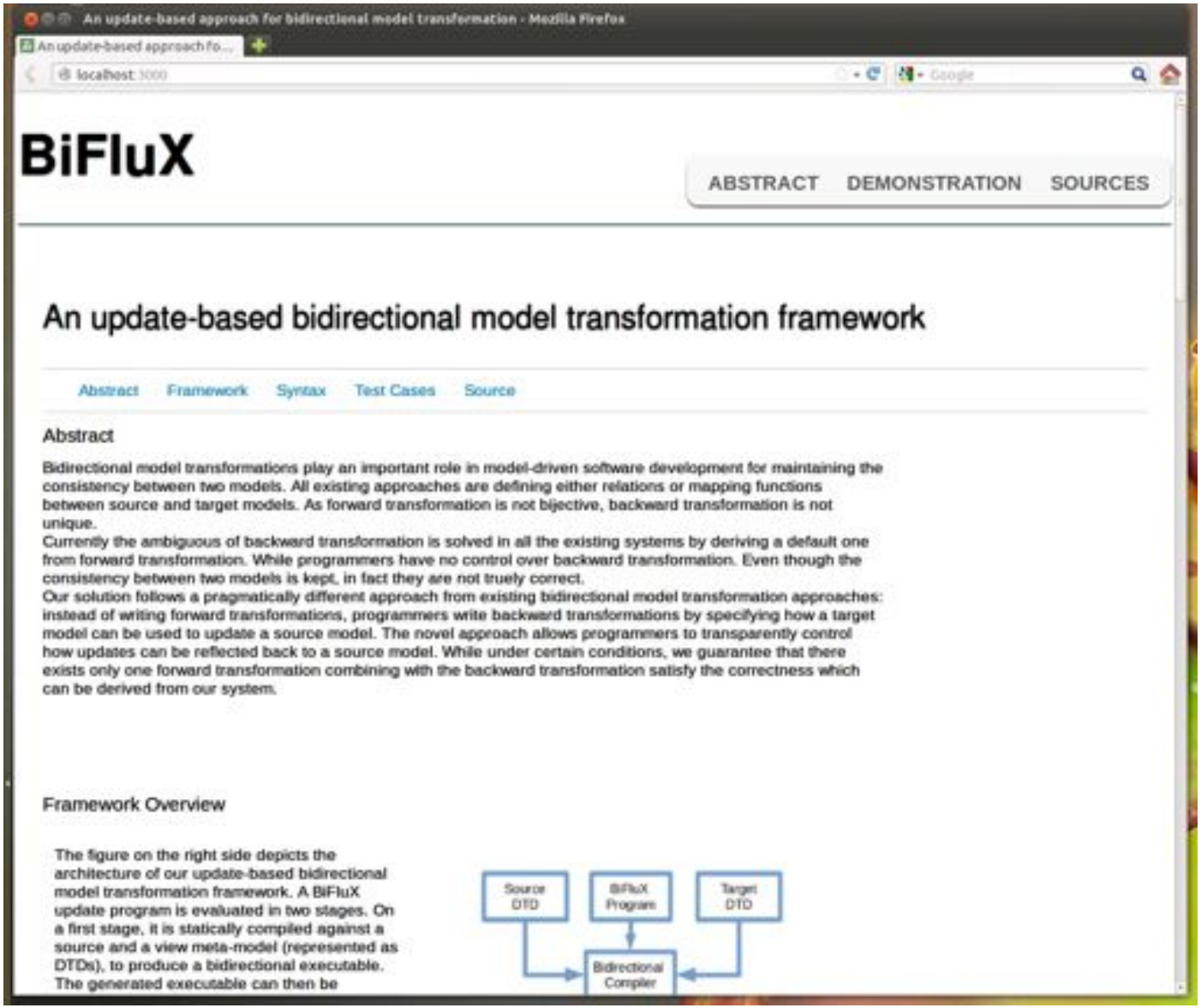
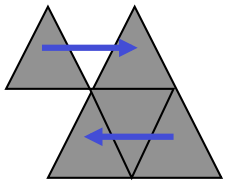


BiFlux Demo (by Tao Zan)



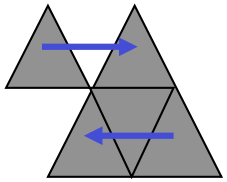


Conclusion

We design and implement BiFlux, an update language for programming "put":

- Easy to use
- Powerful to specify various "put"
- Static check of well-behavedness of "put"
- Automatic derivation of "get"

A post-doc position is open.



BiG Project Web Site

For more information, please visit the project page which contains all published papers as well as the source codes.