

Arrows in Commercial Web Applications

Eric Fritz Jose Antony Tian Zhao

University of Wisconsin - Milwaukee

Research History

Directing JavaScript with Arrows

Khoo Yit Phang, Michael Hicks, Jeffrey S. Foster, and Vibha Sazawal.
5th Symposium on Dynamic Languages, 2009.

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Arrows in Commercial Web Applications

Eric Fritz, Jose Antony, and Tian Zhao.

HotWeb, 2016.

Example Application - Inventory Search

[Prev](#) · Displaying 21-24 of 24 · [Next](#)

ID	Name	Category	Subcategory	Price / Unit	Margin
223	Rush Hierlooms Collection 1" Thick Stackable Bookcases	Furniture	Bookcases	170.98	0.66
224	Rush Hierlooms Collection Rich Wood Bookcases	Furniture	Bookcases	160.98	0.72
230	Safco Value Mate Steel Bookcase, Baked Enamel Finish on Steel, Black	Furniture	Bookcases	70.98	0
231	Sauder Camden County Barrister Bookcase, Planked Cherry Finish	Furniture	Bookcases	120.98	0.71

Example Application - Inventory Search

<input type="text" value="bookcase"/>		Prev · Displaying 21-24 of 24 · Next			
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Requirements:

Filter displayed results by name and category

Paginate results when filtered set is > 50 items

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Performance Optimizations:

Cache server results for same query/page

Attempt to pre-fetch the next page of results

Don't make a remote request while the user is typing

Sequencing Filtering + Paging (Using Callbacks)

```
function call(query, page, handler) {
  $.ajax({ 'url': makeURL(query, page), 'success': handler });
}

function showPage(resp) {
  const pageTo = (page) => () => {
    $('#prev, #next').unbind('click');
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main

Call Stack



Event Queue

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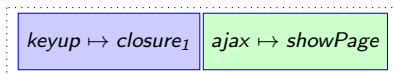


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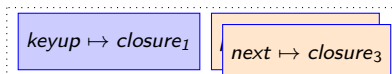
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closure₃



keyup \mapsto *closure₁*

prev \mapsto *closure₂*

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Event registration/de-registration is ad-hoc
Lose imperative exception semantics

```
try {  
  User.findOne({name: 'Eric'}, (err, obj) => {  
    if (err != null) { throw err; }  
    else if (obj == null) { throw new Error('Not Found'); }  
    else { /* ... */ }  
  });  
} catch (err) {  
  /* ... */  
}
```

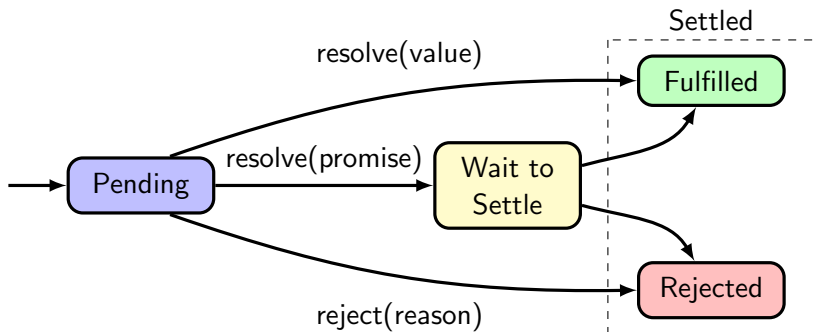
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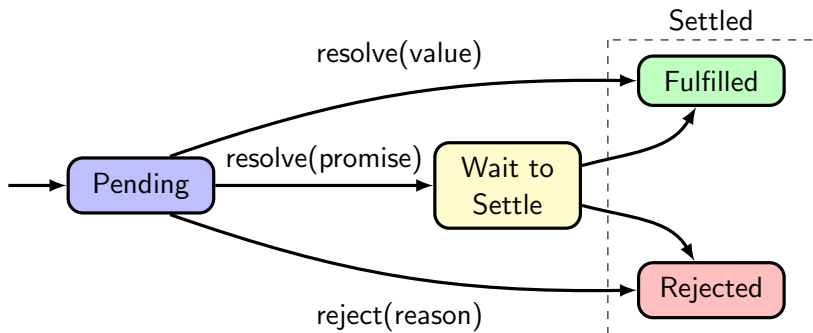
20% of function calls provide a callback
72% of callbacks are asynchronous
48% of callbacks are anonymous
(Gallaba et al.)

Promises – A Better Abstraction



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promise.then(onSuccess);  
promise.then(onSuccess, onError);  
promise.then(onSuccess).catch(onError);
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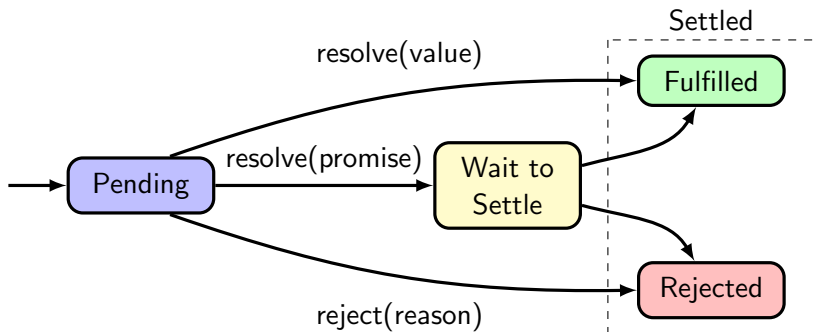
Promises – A Better Abstraction



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var promise = new Promise((resolve, reject) => {  
  conn.query('SELECT * from items', (err, row) => {  
    if (!!err) reject(err);  
    else      resolve(row);  
  });  
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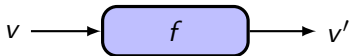
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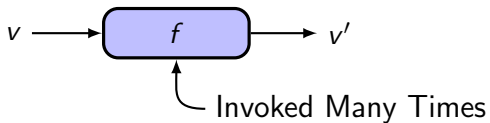
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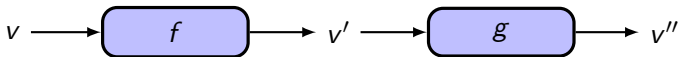
Arrows – Attacking the Abstraction Differently



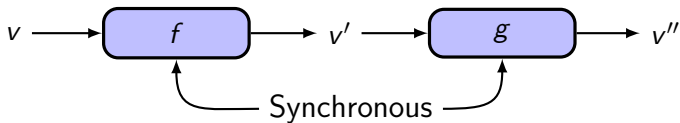
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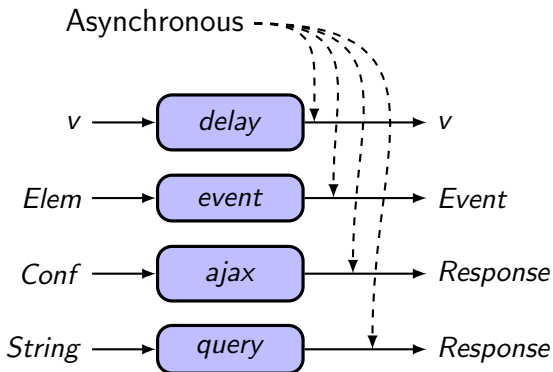
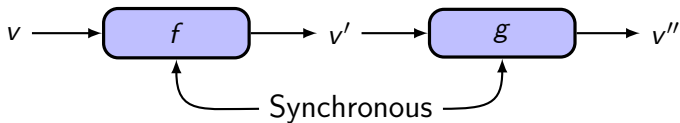
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Arrows - Async Machine Composition

```
let page = Arrow.fix(a => Arrow.seq([
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  explode,
  Arrow.seq([
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    handle
  ]).remember(),
  Arrow.any([
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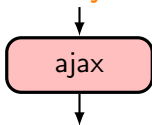
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filter.run();
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Composition Time {

Execution Time {

Arrows - Async Machine Composition

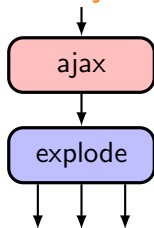


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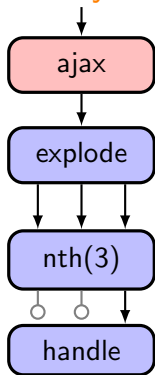


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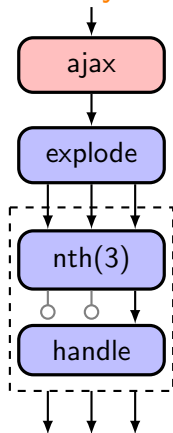


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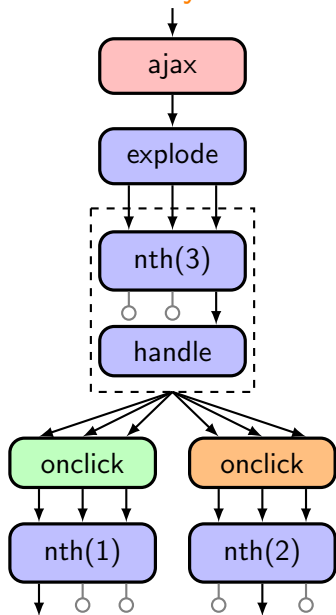


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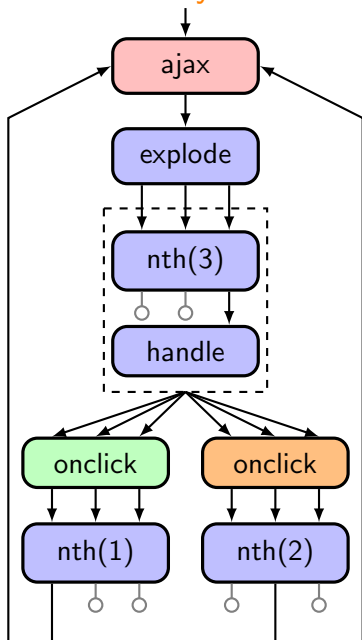


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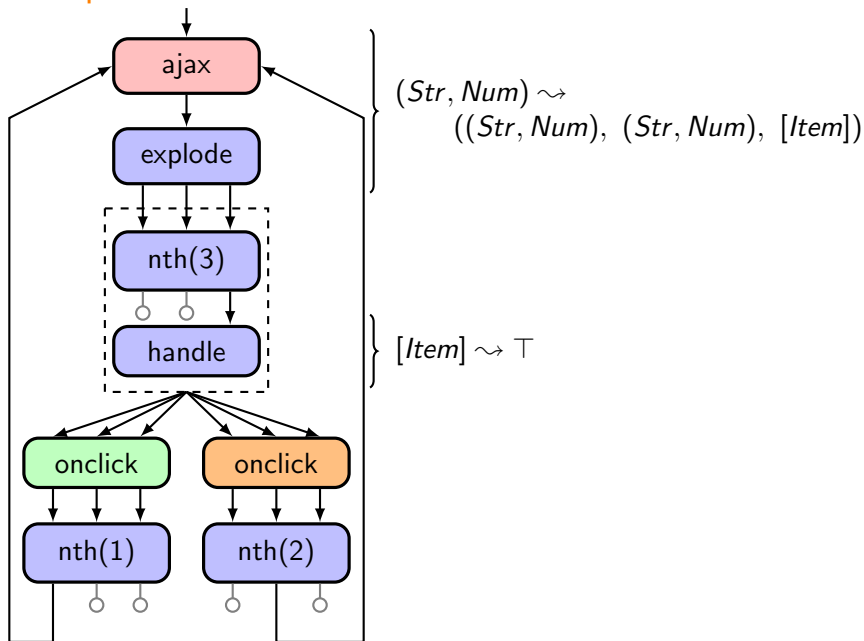


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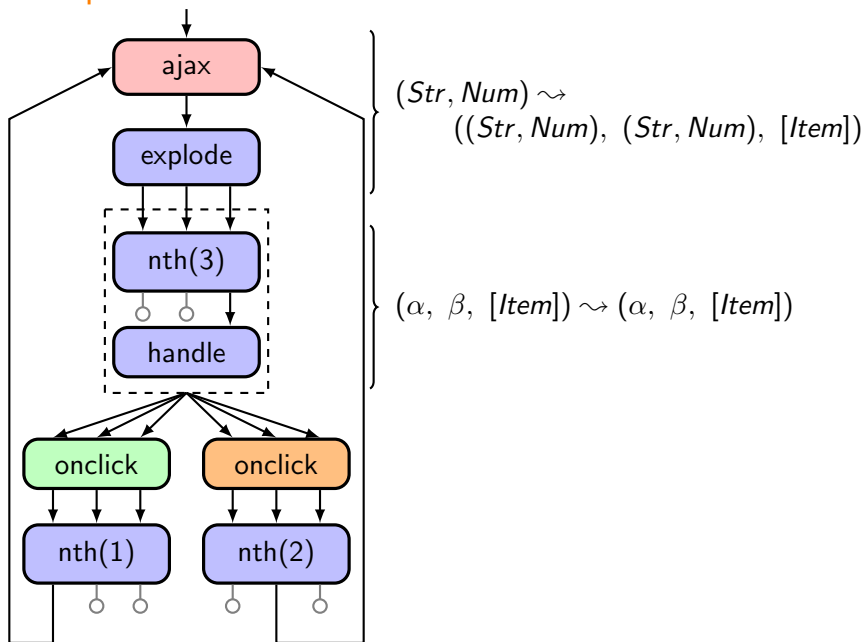
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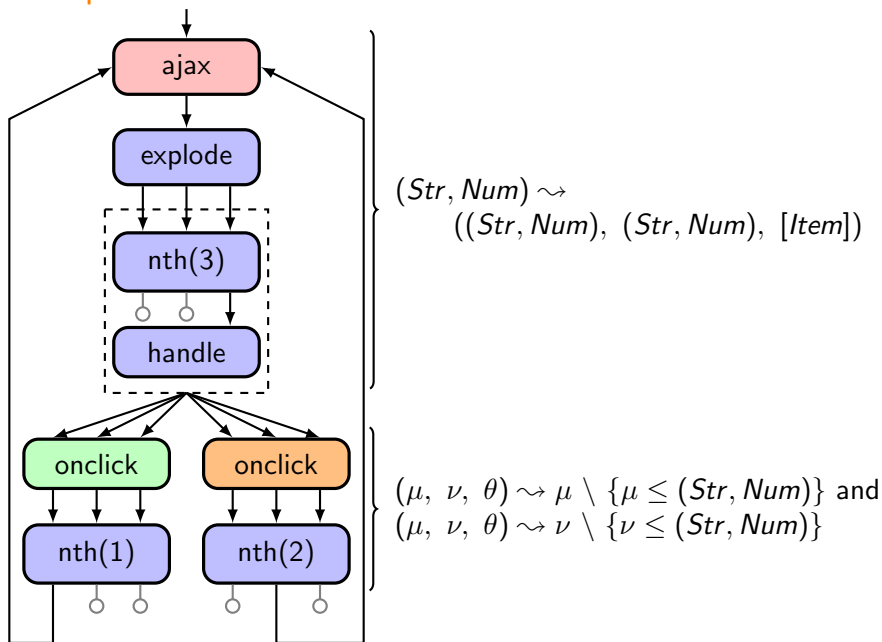
Composition-Time Inference



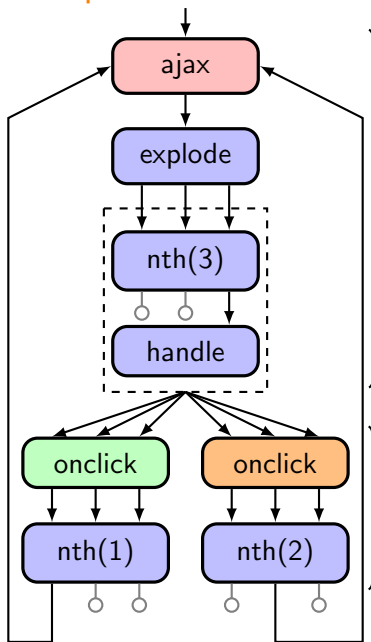
Composition-Time Inference



Composition-Time Inference



Composition-Time Inference



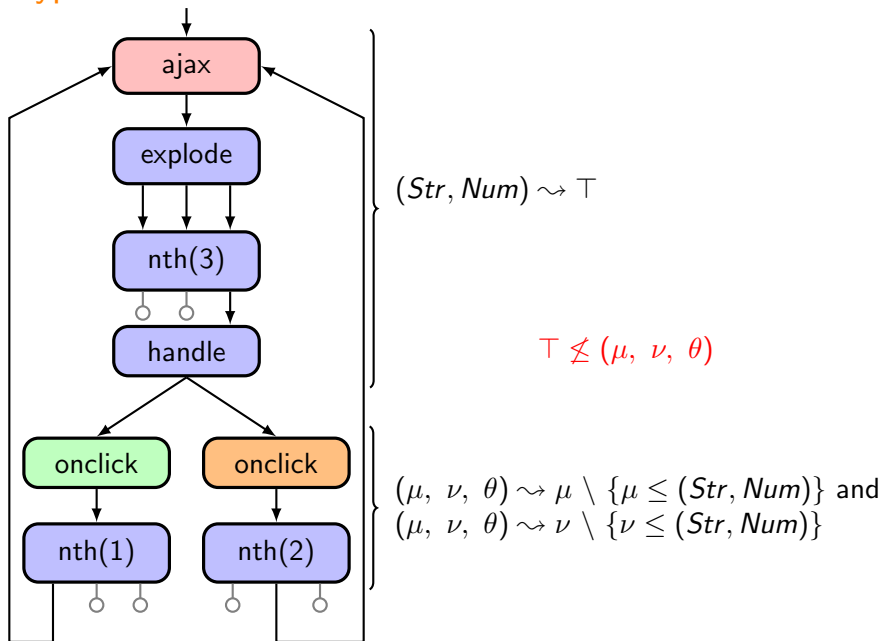
$$(Str, Num) \leadsto ((Str, Num), (Str, Num), [Item])$$

$$(Str, Num) \leq \nu \leq (Str, Num)$$

$$(Str, Num) \leq \mu \leq (Str, Num)$$

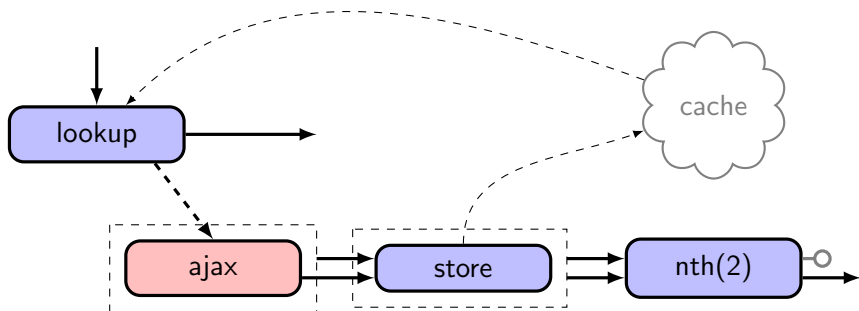
$$(\mu, \nu, \theta) \leadsto \mu \setminus \{\mu \leq (Str, Num)\} \text{ and } (\mu, \nu, \theta) \leadsto \nu \setminus \{\nu \leq (Str, Num)\}$$

Type Clash Detection



Adding Optimizations

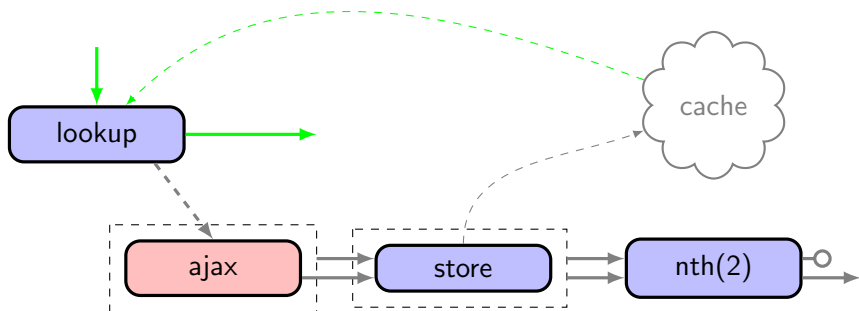
Cached Ajax Responses



```
const cachedAjax = Arrow.catch(lookup, Arrow.seq([
  ajax.carry(),
  store.remember(),
  new NthArrow(2)
]));
```

```
function lookup(key) {
  if (key in cache) return cache[key];
  else               throw key;
}
```

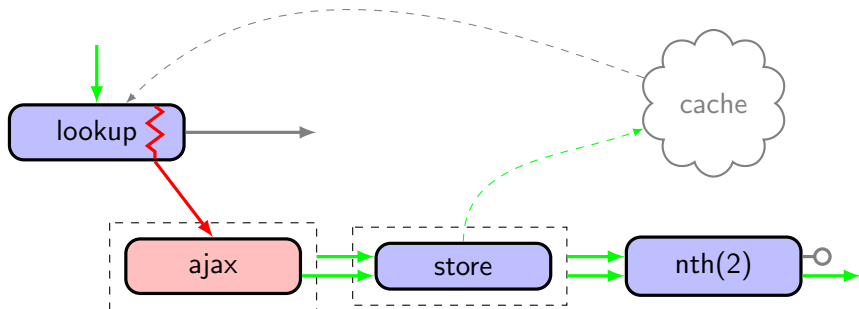
Cached Ajax Responses



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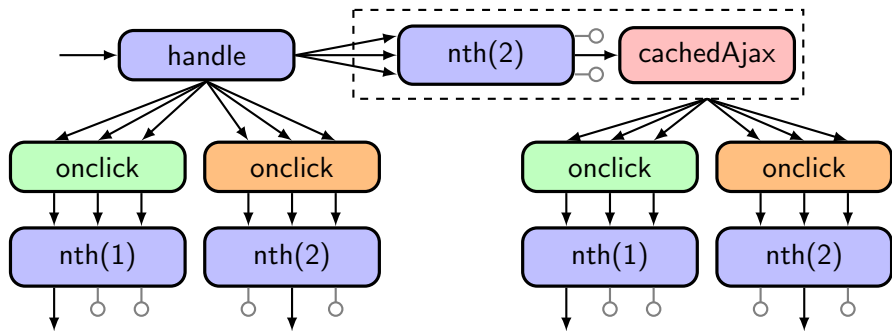
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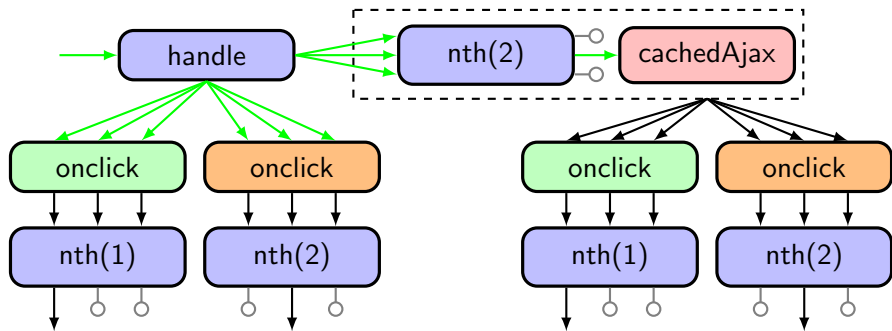
Pre-Fetching Next Page



```
const progress = Arrows.any([
  new NthArrow(1).onclick('#prev'),
  new NthArrow(1).onclick('#next')
]);

Arrow.any([progress, Arrow.seq([
  Arrow.seq([new NthArrow(2), cachedAjax]).remember(),
  progress
])]);
```

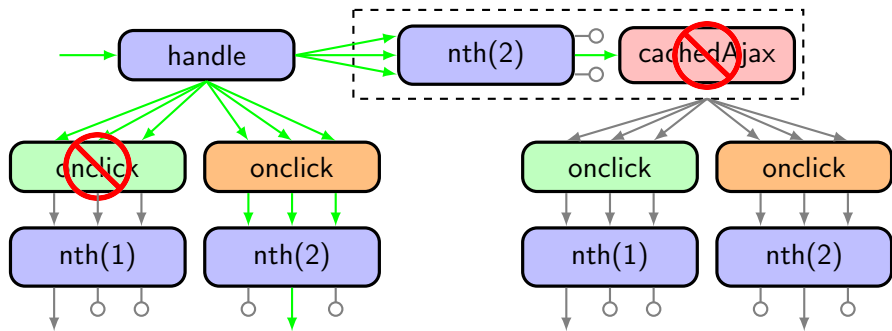
Pre-Fetching Next Page



```
const progress = Arrows.any([
  new NthArrow(1).onclick('#prev'),
  new NthArrow(1).onclick('#next')
]);

Arrow.any([progress, Arrow.seq([
  Arrow.seq([new NthArrow(2), cachedAjax]).remember(),
  progress
])]);
```

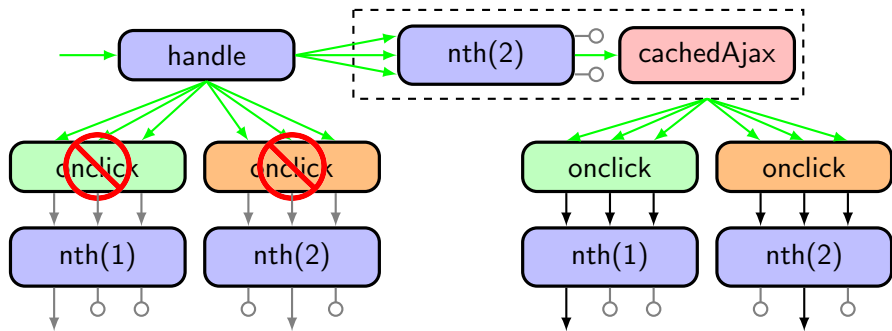
Pre-Fetching Next Page



```
const progress = Arrows.any([
  new NthArrow(1).onclick('#prev'),
  new NthArrow(1).onclick('#next')
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  Arrow.seq([new NthArrow(2), cachedAjax]).remember(),
  progress
])]);
```

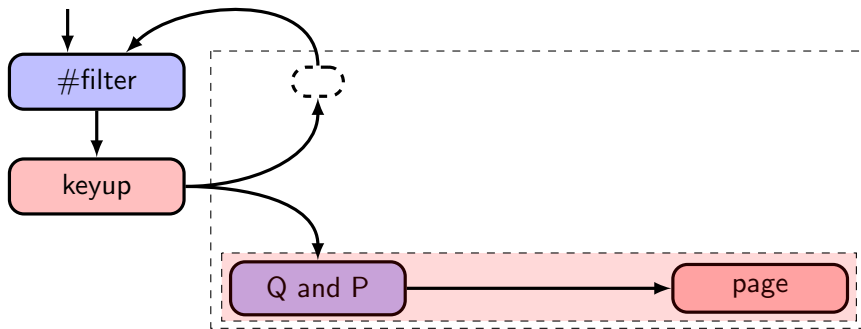
Pre-Fetching Next Page



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  new NthArrow(1).onclick('#prev'),
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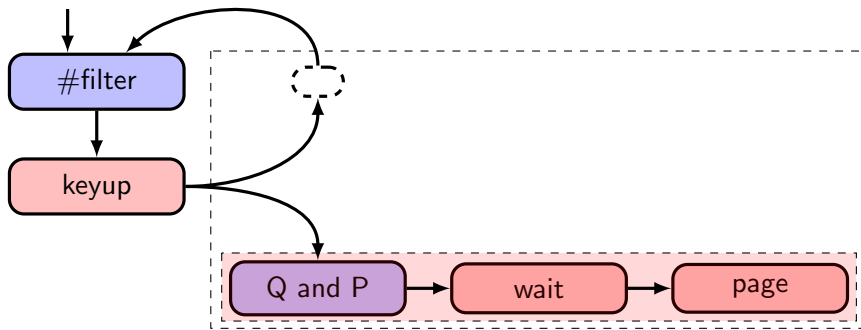
No In-Flight Requests as User Types



```
let filter = Arrow.fix(a => Arrow.any([
  a,
  Arrow.seq([
    getQueryAndPage,

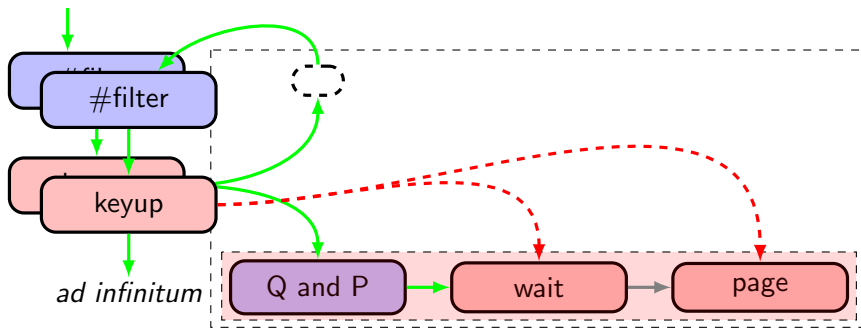
    page
  ]).noemit(),
]).onkeyup('#filter'));
```


No In-Flight Requests as User Types



```
let filter = Arrow.fix(a => Arrow.any([
  a,
  Arrow.seq([
    getQueryAndPage,
    new DelayArrow(400),
    page
  ]).noemit(),
]).onkeyup('#filter'));
```

No In-Flight Requests as User Types



```
let filter = Arrow.fix(a => Arrow.any([
  a,
  Arrow.seq([
    getQueryAndPage,
    new DelayArrow(400),
    page
  ]).noemit(),
]).onkeyup('#filter'));
```

Conclusion

Composing an *interaction machine* is a powerful shift in abstraction
Opens up opportunity for 'static' benefits

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Questions?