

hypernumbers

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Why hypernumbers?

Unicorns
And
Rainbows

<----->
^
HN

"Help Ma!
my eyes are
bleeding..."

A User-Centred Approach to Functions in Excel

Simon Peyton Jones

Alan Blackwell

Margaret Burnett

- To bring the benefits of additional programming language features to a system that is often not recognised as a programming language.
- Maintain high usability of the original product.
- Maintain backwards compatibility.

Success of Spreadsheets

- Used by millions of people.
- Suited for various different tasks (with its specific formulas, models, functions).
- Easy to use.

Spreadsheet as a Programming language

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[functions](#)

	A	B
1	3	
2	=A1-32	
3	=A2 * 5/9	
4		



```
(hndev@jakub.dev)2> A1 = 3.  
3  
(hndev@jakub.dev)3> A2 = A1 -32.  
-29  
(hndev@jakub.dev)4> A3 = A2 * 5/9.  
-16.111111111111111
```

Abstraction

As a collection of:

Value = formula

spreadsheets remain flat.

There is a need to provide re-usable abstractions.

User centred approach

Attention:

- $(\text{Pay-off} * (1 - \text{Risk}) - \text{Cost}) \geq 0$

Cognitive Dimensions:

- consistency
- progressive evaluation
- viscosity

Main use cases

- creating user-defined functions
- deleting existing user-defined functions
- displaying/editing user-defined functions
- function invocation(application)

How was it done?








User view

Developer's task

User view – create new function

User specifies the function in a new tab

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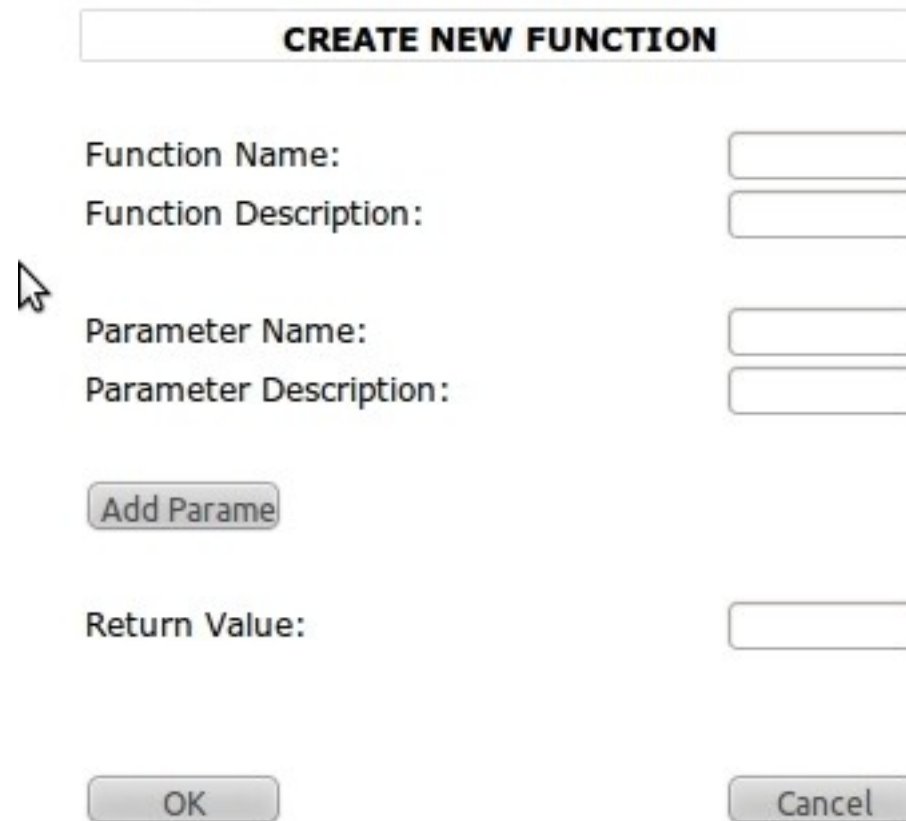
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[functions](#)

	A	B	C	D	E	F	G
1	Fn:	user.stone2kg					
2	Description:	Convert kg to stone - Conversion of Measurement					
3		Units					
4							
5	Param_1:	Weight	Weight in stone			5.5	
6	Param_2:	Factor	A constant numerical conversion factor			6.35029318	
7							
8	Return value:	34.92661249					
9							

User view – create new function

When finished Function Wizard is called



CREATE NEW FUNCTION

Function Name:

Function Description:

Parameter Name:

Parameter Description:

Add Parame

Return Value:

OK Cancel

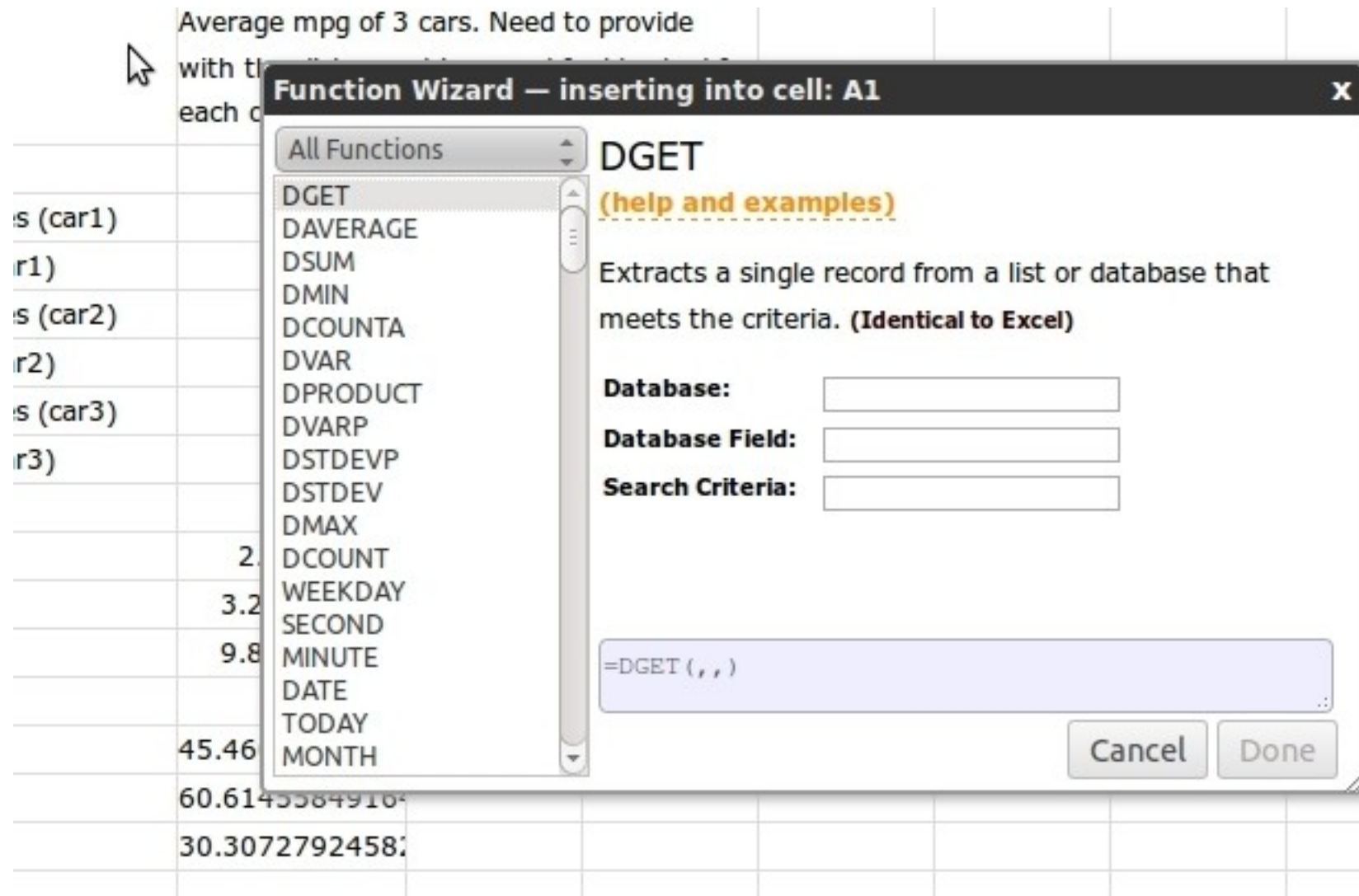
User view –
create new function

New function is ready to use

User view –
create new function

```
=user.stone2kilo(10)
```

User view – create new function



Developer's task -
create new function

function name

corresponding workbook

wizard template

Abstract Syntax Tree

Developer's task - create new function

Wizard template

```
[{ "fn": "user.stone2kg",
  "category": "User Defined",
  "desc": "Convert kg to stone - Conversion of Measurement Units",
  "experimental": false,
  "includable": true,
  "inexcel": true,
  "resize": false,
  "wizardready": true,
  "link": "/user_defined/stone2kg",
  "args":
  [{ "name": "Weight",
    "desc": "Weight in stone",
    "type": "finite"},
  { "name": "Factor",
    "desc": "A constant numerical conversion factor",
    "type": "finite"}]
}]
```

Developer's task - create new function

Abstract Syntax Tree

Cell's attributes

```
[{{xrefX,1314095422346971,"http://hypernumbers.dev:9000",  
  ["stone2kg"],{cell,{2,8}}}},  
  [ {"__ast",  
    [ '*',  
      {cellref,{offset,4},{offset,-3},"./","F5"},  
      {cellref,{offset,4},{offset,-2},"./","F6"}}]],  
    {"__default-align","right"},  
    {"__rawvalue",34.9266124900000004},  
    {"__recompile",false},  
    {"formula","=F5*F6"},  
    {"overwrite-color","auto"},  
    {"style",1306406057572107},  
    {"value","34.9266124900000004"}]  
}]
```

Developer's task - create new function

Abstract Syntax Tree II

AST constrains:

Developer's task - create new function

Abstract Syntax Tree II

- elements of the AST have to be either arguments of the function or numeric factors

Developer's task - create new function

Abstract Syntax Tree II

- rangeref has to be translated to the list of cellrefs

```
= average(E1:E3)
```

```
[average,  
 {rangeref,finite,"./",  
  {{offset,0},{offset,-3}},  
  {{offset,0},{offset,-1}},  
  1,3,"E1:E3"}]
```

```
[average,  
 {cellref,{offset,0},{offset,-3},"./","E1"},  
 {cellref,{offset,0},{offset,-2},"./","E2"},  
 {cellref,{offset,0},{offset,-1},"./","E3"}]
```

Developer's task - create new function

Abstract Syntax Tree II

- no off-page references

```
= F5*F6
['*',
 {cellref,{offset,4},{offset,-3},"./","F5"},
 {cellref,{offset,4},{offset,-2},"./","F6"}]
```

```
= F5* /page1/F6
['*',
 {cellref,{offset,4},{offset,-3},"./","F5"},
 {cellref,{offset,6},{offset,-6},"/page1/","/page1/H2"}]
```

Developer's task - create new function

Abstract Syntax Tree II

	A	B	C
1			
2			
3	input 1	2	
4	input 2	4	
5	input 3	6	
6			
7	step1_sum	12	$=b3+b4+b5$
8	step2_coun	3	$=count(b3:b5)$
9	step3	4.0	$=b7/b8$
10			
11	final_result	2.0	$=b9/2$
12			

```
['/',{cellref,{offset,0},{offset,-2},"./","B9"},2]
```

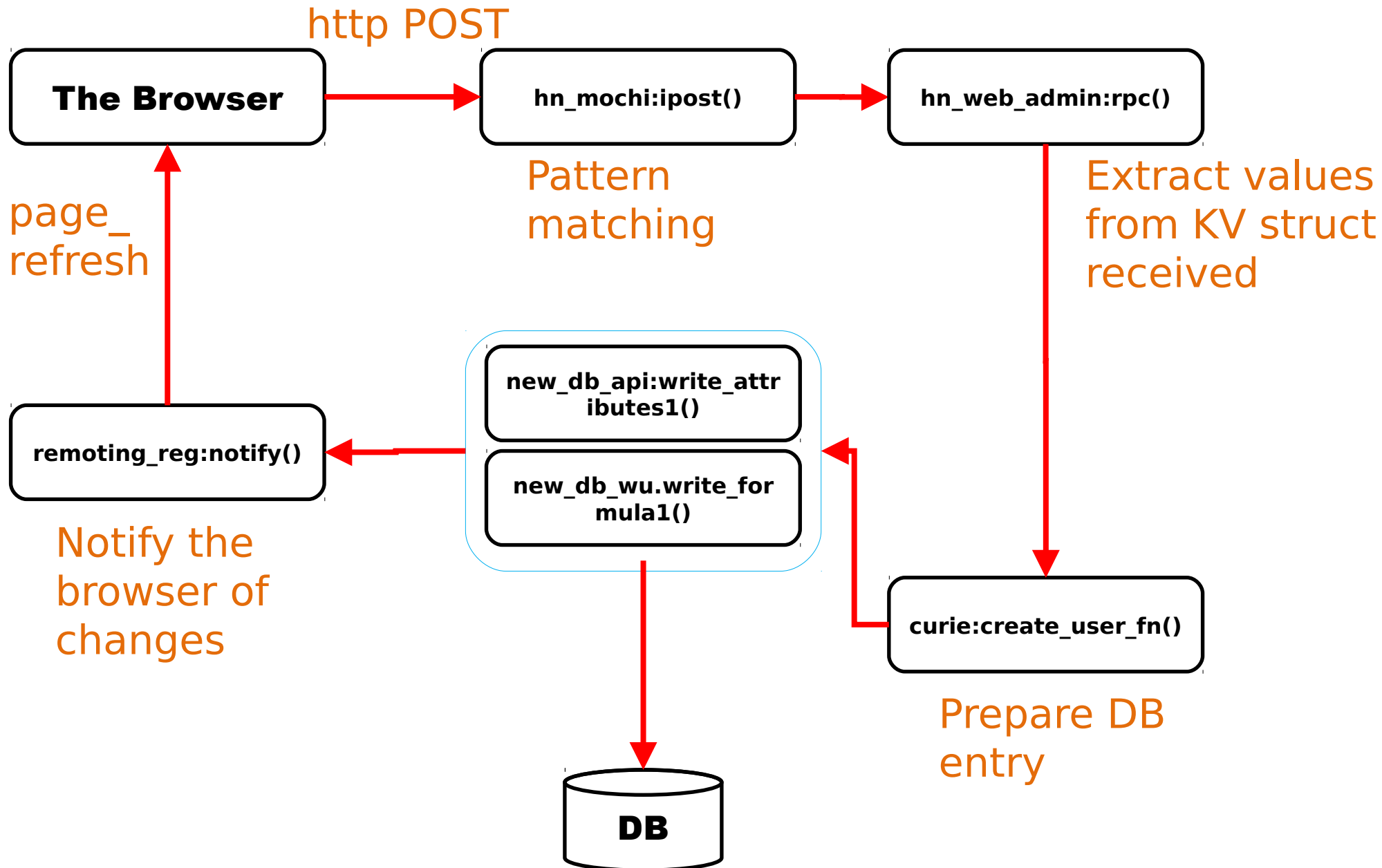
Developer's task - create new function

Abstract Syntax Tree II

```
[ '/',  
  ['/',  
    ['+',  
      ['+',  
        {cellref,{offset,0},{offset,-8},"./","B3"},  
        {cellref,{offset,0},{offset,-7},"./","B4"}],  
        {cellref,{offset,0},{offset,-6},"./","B5"}],  
      [count,  
        {cellref,{offset,0},{offset,-8},"./","B3"},  
        {cellref,{offset,0},{offset,-7},"./","B4"},  
        {cellref,{offset,0},{offset,-6},"./","B5"}]],  
    2]
```

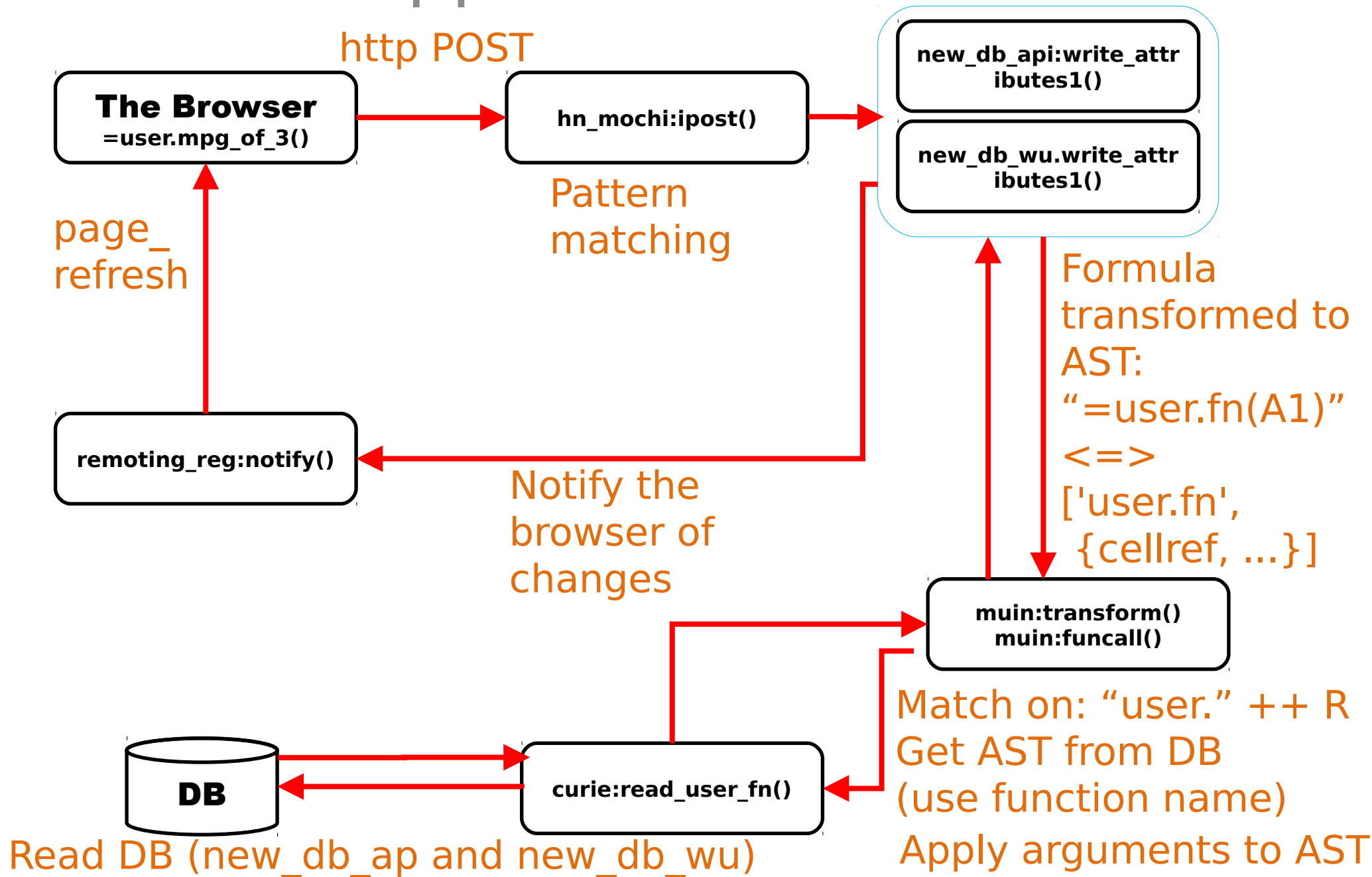

The Event Cycle

Create user function



The Event Cycle

Function application



User centred approach II

Attention Investment

User centred approach II

Attention Investment

Cognitive Dimensions




- consistency

User centred approach II

Attention Investment Cognitive Dimensions

- consistency
- progressive evaluation

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[functions](#)

	A	B	C
1	#NAME?	_ =user.mpg_of_33(100,10,200,12,300,22)	
2	#VALUE!	_ =user.mpg_of_3(100,10,200,12)	
3			

User centred approach II

Attention Investment

Cognitive Dimensions

- consistency
- progressive evaluation
- viscosity

User centred approach II

Attention Investment Cognitive Dimensions

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Future work

- Updating GUI
- Testing, testing, testing...