hyper numbers

Project Marie Curie-Sklodowska

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Why hypernumbers?

Unicorns
And
Rainbows

<----------------->
^  "Help Ma! my eyes are bleeding..."

HN
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

(hndev@jakub.dev) 2> A1 = 3.3
(hndev@jakub.dev) 3> A2 = A1 - 32. -29
(hndev@jakub.dev) 4> A3 = A2 * 5/9. -16.11111111111111
Abstraction

As a collection of:

Value = formula

spreadsheets remain flat.

There is a need to provide re-usable abstractions.
User centred approach

Attention:

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

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

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fn: user.stone2kg</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Description:</td>
<td>Convert kg to stone - Conversion of Measurement</td>
</tr>
<tr>
<td>3</td>
<td>Units</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Param_1:</td>
<td>Weight</td>
</tr>
<tr>
<td>5</td>
<td>Weight in stone</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Param_2:</td>
<td>Factor</td>
</tr>
<tr>
<td>7</td>
<td>A constant numerical conversion factor</td>
<td>6.35029318</td>
</tr>
<tr>
<td>8</td>
<td>Return value:</td>
<td>34.9266124</td>
</tr>
</tbody>
</table>
User view – create new function

When finished Function Wizard is called
User view –
create new function
New function is ready to use
User view –
create new function

=user.stone2kilo(10)
User view – create new function

Average mpg of 3 cars. Need to provide with the data in the individual cells of each car.

<table>
<thead>
<tr>
<th>s (car1)</th>
<th>r1</th>
</tr>
</thead>
<tbody>
<tr>
<td>s (car2)</td>
<td>r2</td>
</tr>
<tr>
<td>s (car3)</td>
<td>r3</td>
</tr>
</tbody>
</table>

Function Wizard – inserting into cell: A1

DGET
(help and examples)

Extracts a single record from a list or database that meets the criteria. *(Identical to Excel)*

**Database:**

**Database Field:**

**Search Criteria:**

= DGET(,,,)
Developer's task - create new function

function name

corresponding workbook

wizard template

Abstract Syntax Tree
Developer's task - create new function

Wizard template

```json
[
  {
    "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

```javascript
[{{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", 34.926612490000004},
  {"__recompile", false},
  {"formula", "=F5*F6"},
  {"overwrite-color", "auto"},
  {"style", 1306406057572107},
  {"value", "34.926612490000004"}]}
]
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

\[
\begin{align*}
&= F5*F6 \\
&[\text{'*'}, \\
&\text{cellref,}\{\text{offset,4}\},\{\text{offset,-3}\},"./","F5"}, \\
&\text{cellref,}\{\text{offset,4}\},\{\text{offset,-2}\},"./","F6"}] \\
&= F5* /page1/F6 \\
&[\text{'*'}, \\
&\text{cellref,}\{\text{offset,4}\},\{\text{offset,-3}\},"./","F5"}, \\
&\text{cellref,}\{\text{offset,6}\},\{\text{offset,-6}\},"/page1/","/page1/H2"}] \\
\end{align*}
\]
Developer's task - create new function

Abstract Syntax Tree II

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

http POST

hn_mochi::ipost() -> hn_web_admin::rpc()

Pattern matching

new_db_api::write_attributes1() -> new_db_wu::write_formula1()

Extract values from KV struct received

curie::create_user_fn()

Prepare DB entry

remoting_reg::notify()

Notify the browser of changes

page_refresh

DB
The Event Cycle

**Function application**

The Browser

```
= user.mpg_of_3()
```

http POST

```
hn_mochi:ipost()
```

Formula transformed to AST:
```
"=user.fn(A1)"

<=>

```
['user.fn',
{cellref, ...}]
```

Notify the browser of changes

```
new_db_api:write_attributes1()
```

```
new_db_wu.write_attributes1()
```

Match on: "user." ++ R

Get AST from DB
(use function name)

```
muin:transform()
```

```
muin:funcall()
```

Apply arguments to AST

```
remoting_reg:notify()
```

page_refresh

```
curie:read_user_fn()
```

```
new_db_api:write_attributes1()
```

Match on: "user." ++ R

Get AST from DB
(use function name)

```
curie:read_user_fn()
```

Read DB (new_db_ap and new_db_wu)
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
User centred approach II

Attention Investment

Cognitive Dimensions

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User centred approach II

Attention Investment

Cognitive Dimensions

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Future work

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