

Adding Syntax Parameter to Sweet.js macro library for JavaScript

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ABSTRACT

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Macros have a long history in computing, Mozilla Sweet.js provides a way for developer to enrich the JavaScript by adding new syntax to the language through the use of macro. Sweet.js provide the possibility to define the hygienic macros inspired by Scheme. In this paper I present the implementation of the Syntax-Parameter feature to SweetJS library. Syntax parameter is a mechanism for rebinding a macro definition within the dynamic extent of a macro expansion. In implementation I defined the “syntaxparam” which define and bind the syntax parameter part of the compiler, “syntaxLocalValue” which pull the syntax parameter definition in the defined scope and “replaceSyntaxParamTransform” which transform to the identifier within the macro body using syntaxLocalValue.

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CHAPTER 1

Introduction

1.1 What is macro?

Macro is a rule or pattern that specifies how certain input sequence, should be mapped to output sequence according to some defined procedure. Using macro system, programmer can introduce new syntactic elements to the programming language. Macro found in a program are expanded by a macro expander. Macros allow a programmer to enable code reuse.

There are two type of macro system

1. **Lexical macro systems** , called lexical macro system, such as C preprocessor, "Preprocessor" generally means a tool that transform the codes before the main compiler get hold of it. Lexical macros are ignorant of the grammar of core programming language and this sometime result in ill-formed program and result in accidental capture of the identifier. Example

```
#define INCI(i) {int a=0; ++i;}

int main(void)
{
    int a = 0, b = 0;
    INCI(a);
    INCI(b);
    printf("a is now %d, b is now %d\n", a, b);
    return 0;
}
```


Running through C preprocessor result in

```
int main(void)
{
    int a = 0, b = 0;
    {int a=0; ++a;};
    {int a=0; ++b;};
    printf("a is now %d, b is now %d\n", a, b);
    return 0;
}
```

2. **Syntatic macro systems** , like Lisp and Scheme programming language. these macro system are aware of the grammar of core programming language they transform the syntax tree according to a number of user-defined rules. Rule can be written in the same programming language as the program, or in other language that rely on fully external language to define the transformation, such as the XSLT preprocessor for XML. Example

```
(define-syntax swap!
  (syntax-rules ()
    ((_ a b)
      (let ((value a))
        (set! a b)
        (set! b value))))))
```

1.2 What Sweet.JS bring for us?

Sweet.js is a hygienic macro compiler for JavaScript that take JavaScript macros and produces normal JavaScript one can run in browser or using Node.js. The idea is that you define a macro with a name and a list of patterns. Whenever macro is invoked, at compile time the code is matched and expanded.

Sweet.js provide the two way to define a macro: simple pattern based rule macros work by matching a syntax pattern generating the new pattern based on the template and the more powerful procedural case macros allow you to manipulate syntax. Example

```
macro define {  
  rule { $x } => {  
    var $x  
  }  
  
  rule { $x = $expr } => {  
    var $x = $expr  
  }  
}  
  
define y;  
define y = 5;
```

Above code will expand to

```
var y;  
var y = 5;
```

1.3 Syntax-Parameter

Hygienic macro are macros whose expansion is result not to cause the accidental capture of identifier introduced by the macro expander. Hygiene prevents variables name inside the macros from clashing with the variables in the surrounding code. They are the feature of programming language such as Scheme and Dylan.

There are occasions when traditional hygienic binding are insufficient example, "anaphoric if condition" where while expanding the macro definition at compile time may introduce new variable binding, these new binding can end up capturing variables in your own code. That is new binding might shadow a variable which you have already created. Example

```
(define-syntax or
  (syntax-rules ()
    ((_ e1 e2)
      (let ((t e1))
        (if t t e2))))))
```

Calling above macro

```
(let ((t 5))
  (or #f t))
```

expand to

```
(let ((t 5))
  (let ((t #f))
    (if t t t)))
```

This program evaluate to `#f`, which is not the desired output, on expanding the

macro the binding `t` is shadowed to `#f`. This issue is being resolved in Scheme using `syntax-parameter`. Syntax parameter are a mechanism for rebinding a macro definition with in the dynamic extent of a macro expansion.

The same problem i observed with Sweet.JS library, in this paper i present the example of macro where it break Sweet.JS hygienic macro and proposed the solution taking inspiration from the Scheme's `syntax parameter`. Problem and solution discussed in up-coming chapter.

CHAPTER 2

Basics of Sweet.JS

Sweet.js implements macros for JavaScript, which takes source code written with sweet.js macros and produces the expanded source that can be run in any JavaScript environment.

2.1 Type of macros

1. **Rule macros** Rule macros work by matching a syntax pattern and generating new syntax based on the template. To define rule base macro

```
macro <name> {  
  rule { <pattern> } => { <template> }  
}
```

Lets write the macro that define swapping of two number

```
macro swap {  
  rule { ($x, $y) } => {  
    var tmp = $x;  
    $x = $y;  
    $y = tmp;  
  }  
}
```

```
var foo = 5;  
var tmp = 6;
```

```
swap( foo , tmp );
```

When the compiler hits "swap", it invokes the macro and runs each rule against the code after it. When a pattern is matched, it returns the code within the rule. You can bind identifiers & expressions within the matching pattern and use them within the code.

it might expand to

```
var foo = 5;
var tmp = 6;
var tmp = foo;
foo = tmp;
tmp = tmp;
```

The tmp created from the macro collides with my local tmp. This is a serious problem, but macros solve this by implementing hygiene. Basically they track the scope of variables during expansion and rename them to maintain the correct scope. Sweet.js fully implements hygiene so it never generates the code you see above. It would actually generate this

```
var foo = 5;
var tmp$1 = 6;
var tmp$2 = foo;
foo = tmp$1;
tmp$1 = tmp$2;
```

It looks a little ugly, but notice how two different "tmp" variables are created. This makes it extremely powerful to create complex macros elegantly.

2. **Case macros** Case macro are analogous to syntax-case in Scheme, case macro allow macro author to use javascript code to procedurally create and manipulate the syntax. To define case base macro

```
macro <name> {  
    case { <pattern> } => { <body> }  
}
```

Example

```
macro rand {  
    case { _ $x } => {  
        var r = Math.random();  
        letstx $r = [makeValue(r)];  
        return #{ var $x = $r }  
    }  
}
```

```
rand x;
```

Expand To

```
var x$123 = 0.8367501533161177;
```

case is run at expand-time and you use `#{ }` to create "templates" that construct code just like the rule in the other macros.

2.2 High level design

JavaScript macro system, `sweet.js`, include a separate reader that converts a sequence of tokens into a sequence of token trees, analogous to s-expression in

scheme, without feedback from the parser.



Figure 1: Sweet.JS anatomy.

Here reader records sufficiently history information in the form of token tree in order to decide how to parse the token.

Example

```

macro id {
    case { _ $x } => {
        return #{ $x }
    }
}

id 42

```

Reader convert string of token to token tree,

```

[
  { type:3,value:"macro"},
  {type:3,value:"id"},
  {type:11,value:{},inner:
    [{type:4,value:"case"},
    {type:11,value:{},inner:[{type:3,value:"_"},{type:3,value:"$x"}]},
    {type:7,value:"=>"},
    {type:11,value:{},inner:[{type:4,value:"return"},{type:7,value:"#"},
    {type:11,value:{},inner:[{type:3,value:"$x"}]}]}]}]}
]

```

Figure 2: Token tree.


```
[{  
  type:"Program",  
  body:[{type:"ExpressionStatement",expression:{type:"literal",value:42}  
    }],  
  error:[{..}]  
}]
```

Figure 3: Final AST from parser.

2.3 Problem statement

Will discuss the issue faced / breaking hygiene and anaphoric if

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