The Programming Language Egison

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Profile of my language Egison

Paradigm	**Pattern-matching-oriented**, Pure functional
Author	Satoshi Egi
License	MIT
Version	3.2.21 (2014/02/18)
First Released	2011/5/24
Filename Extension	.egi
Implemented in	Haskell (about 2,500 lines)

Two aspects of programming languages

- **Human-centric aspect**
  - Represent human's intuition directly
- **Computer-centric aspect**
  - Represent how computers run directly

Two aspects of programming languages

- **Human-centric aspect**
  - Represent human's intuition directly
- **Computer-centric aspect**
  - Represent how computers run directly

Evolution of languages from human-centric aspect

* : World first

- **Fortran(1957)**
  - Modular programming*
- **Lisp(1958)**
  - First class functions*
  - Garbage collector*
- **Scheme(1975)**
  - Lexical scope with first class functions*
- **Haskell(1990)**
  - Purely functional programming
  - Strong static typing
- **Egison(2011)**
  - Pattern-matching against unfree data types*
    e.g. list, multiset, set, graph, tree, …

The first sample code of Egison

```
(define $poker-hands
  (lambda [$cs]
    (match cs (multiset card)
      {[<cons <card $s $n>
         <cons <card ,s ,(- n 1)>
          <cons <card ,s ,(- n 2)>
           <cons <card ,s ,(- n 3)>
            <cons <card ,s ,(- n 4)>
             <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons <card _ ,n>
           <cons <card _ ,n>
            <cons _
             <nil>>>>>>
        <Four-of-Kind>]
       [<cons <card _ $m>
         <cons <card _ ,m>
          <cons <card _ ,m>
           <cons <card _ $n>
            <cons <card _ ,n>
             <nil>>>>>>
        <Full-House>]
       [<cons <card $s _>
         <cons <card ,s _>
          <cons <card ,s _>
           <cons <card ,s _>
            <cons <card ,s _>
             <nil>>>>>>
        <Flush>]
       [<cons <card _ $n>
         <cons <card _ ,(- n 1)>
          <cons <card _ ,(- n 2)>
           <cons <card _ ,(- n 3)>
            <cons <card _ ,(- n 4)>
             <nil>>>>>>
        <Straight>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons <card _ ,n>
           <cons _
            <cons _
             <nil>>>>>>
        <Three-of-Kind>]
       [<cons <card _ $m>
         <cons <card _ ,m>
          <cons <card _ $n>
           <cons <card _ ,n>
            <cons _
             <nil>>>>>>
        <Two-Pair>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <One-Pair>]
       [<cons _
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          <cons _
           <cons _
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        <Nothing>]})))
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         <cons <card _ ,n>
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           <cons _
            <cons _
             <nil>>>>>>
        <One-Pair>]
       [<cons _
         <cons _
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <Nothing>]}))))
```

Match as a set of cards

The first sample code of Egison

```
(define $poker-hands
  (lambda [$cs]
    (match cs (multiset card)
      {[<cons <card $s $n>
        <cons <card ,s ,(- n 1)>
         <cons <card ,s ,(- n 2)>
          <cons <card ,s ,(- n 3)>
           <cons <card ,s ,(- n 4)>
            <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons <card _ ,n>
           <cons <card _ ,n>
            <cons <card _ ,n>
             <cons _
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        <Four-of-Kind>]
       [<cons <card _ $m>
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        <Flush>]
       [<cons <card _ $n>
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            <cons <card _ ,(- n 4)>
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        <Straight>]
       [<cons <card _ $n>
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             <nil>>>>>>
        <Two-Pair>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <One-Pair>]
       [<cons _
         <cons _
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <Nothing>]})))
```

Pattern for straight flash

The pattern for straight flush

```
(define $poker-hands
  (lambda [$cs]
    (match cs (multiset card)
      {[<cons <card $s $n>
        <cons <card ,s ,(- n 1)>
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           <cons <card ,s ,(- n 4)>
            <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
         <cons <card _ ,n>
```

The pattern for straight flush

```
(define $poker-hands
  (lambda [$cs]
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        <cons <card ,s ,(- n 1)>
         <cons <card ,s ,(- n 2)>
          <cons <card ,s ,(- n 3)>
           <cons <card ,s ,(- n 4)>
            <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
        <cons <card _ ,n>
```

Same suit with $s

The pattern for straight flush

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(define $poker-hands
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        <Straight-Flush>]
       [<cons <card _ $n>
        <cons <card _ ,n>
```

Numbers are serial from $n

Same suit with $s

The pattern for straight flush

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(define $poker-hands
  (lambda [$cs]
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         <cons <card ,s ,(- n 2)>
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           <cons <card ,s ,(- n 4)>
            <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
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```

Numbers are serial from $n

Same suit with $s

We can use non-linear patterns

The first sample code of Egison

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(define $poker-hands
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           <cons <card ,s ,(- n 3)>
            <cons <card ,s ,(- n 4)>
             <nil>>>>>>
        <Straight-Flush>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons <card _ ,n>
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            <cons _
             <nil>>>>>>
        <Four-of-Kind>]
       [<cons <card _ $m>
         <cons <card _ ,m>
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        <Full-House>]
       [<cons <card $s _>
         <cons <card ,s _>
          <cons <card ,s _>
           <cons <card ,s _>
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        <Flush>]
       [<cons <card _ $n>
         <cons <card _ ,(- n 1)>
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       [<cons <card _ $n>
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            <cons _
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        <Three-of-Kind>]
       [<cons <card _ $m>
         <cons <card _ ,m>
          <cons <card _ $n>
           <cons <card _ ,n>
            <cons _
             <nil>>>>>>
        <Two-Pair>]
       [<cons <card _ $n>
         <cons <card _ ,n>
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <One-Pair>]
       [<cons _
         <cons _
          <cons _
           <cons _
            <cons _
             <nil>>>>>>
        <Nothing>]})))
```

Pattern for two pair

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The pattern for two pair

```
 <Three-of-Kind>]
[<cons <card _ $m>
  <cons <card _ ,m>
   <cons <card _ $n>
    <cons <card _ ,n>
     <cons _
      <nil>>>>>>
 <Two-Pair>]
[<cons <card _ $n>
```

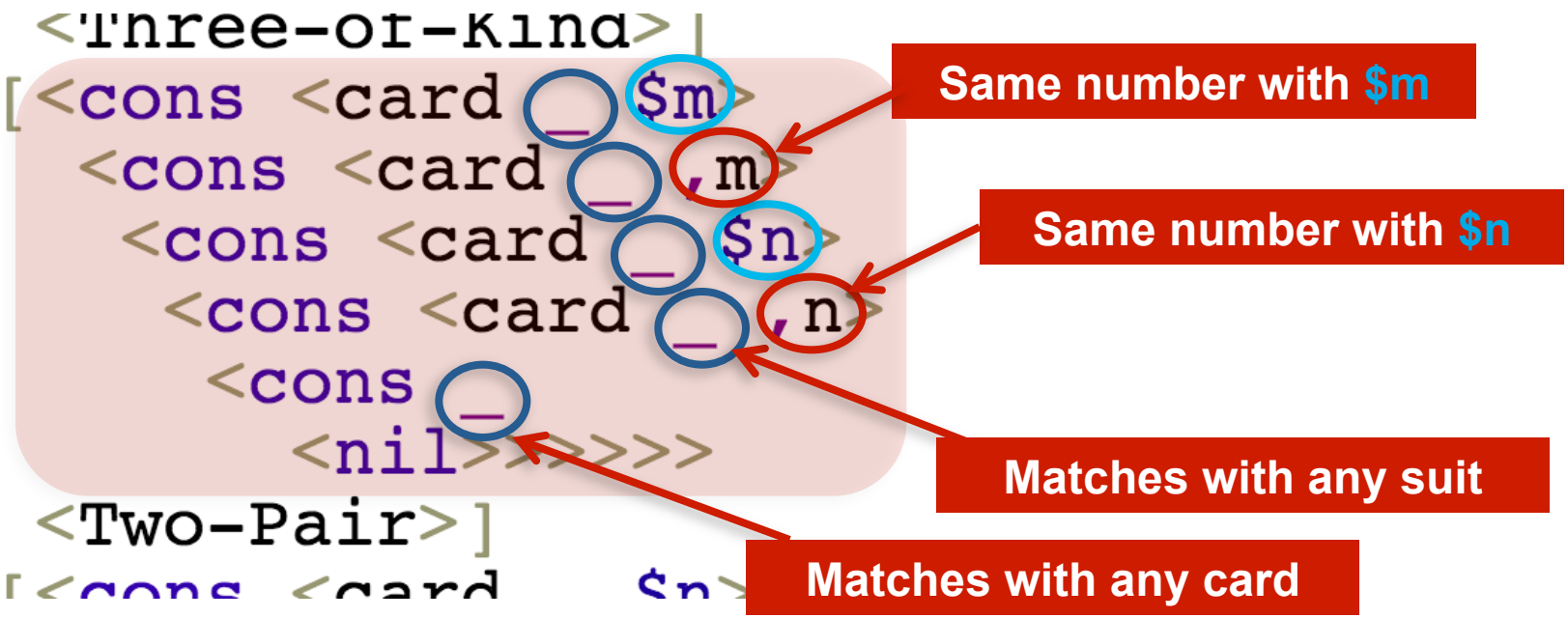
The pattern for two pair

```
 <Three-of-Kind>]
[<cons <card _ $m>
  <cons <card _ ,m>
    <cons <card _ $n>
      <cons <card _ ,n>
        <cons _
          <nil>>>>>>
 <Two-Pair>]
[<cons <card    $n>
```

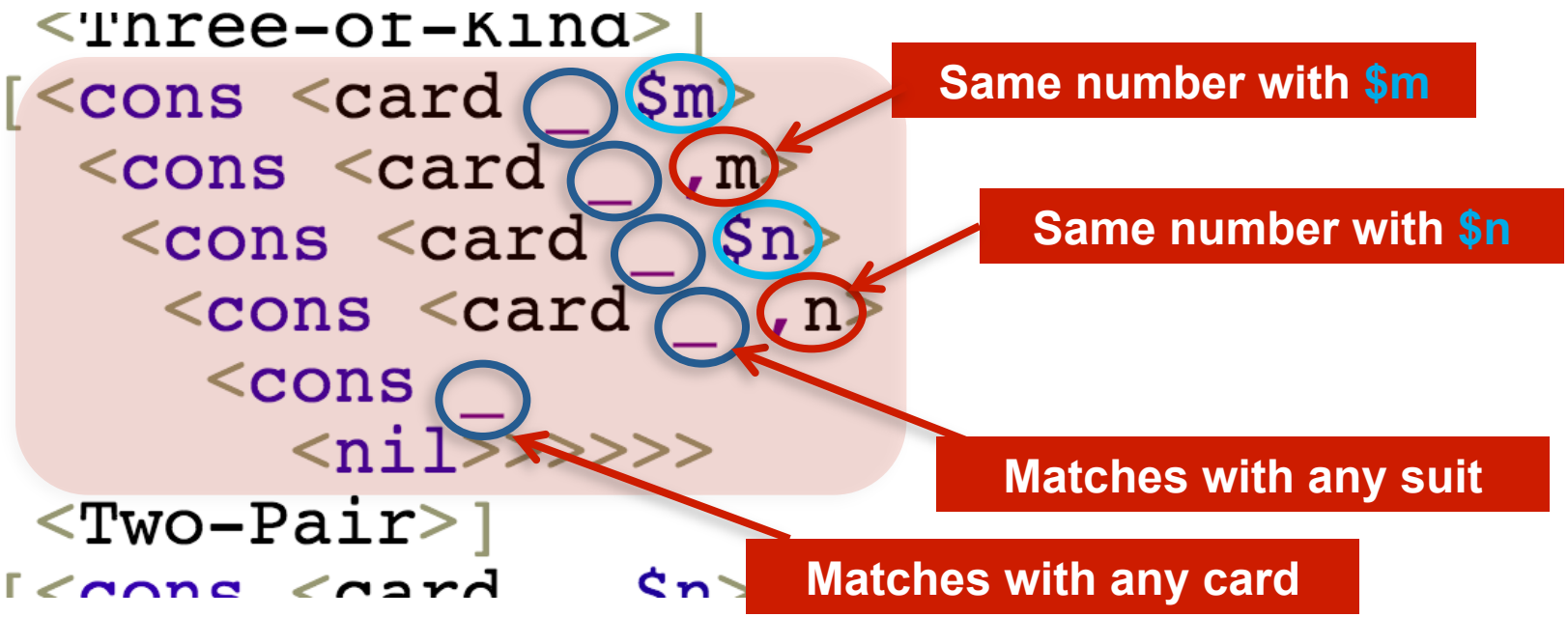
Matches with any suit

Matches with any card

The pattern for two pair



The pattern for two pair



Non-linear patterns have very strong power

The first sample code

```
(define $poker-hands
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        <Four-of-Kind>]
       [<cons <card _ $m>
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        <Full-House>]
       [<cons <card $s _>
        <cons <card ,s _>
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       [<cons <card _ $n>
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       [<cons <card _ $n>
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       [<cons _
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        <Nothing>]}))))
```

Non-linear patterns enables to represent all hands in a single pattern

The first sample code

```
(define $poker-hands
  (lambda [$cs]
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        <Nothing>]})))
```

Isn't it great?

Non-linear patterns enables to represent all hands in a single pattern

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Our next plans

- **Provide new elegant ways to access data**
  - Create the most elegant query language
  - Able to access lists, sets, graphs, trees or any other data in a unified way
- **Provide new elegant ways for data analysis**
  - Provide a way to access various algorithm and data structures in a unified way
- **Implementing new interesting applications**

  e.g.
  - Natural language processing, New programming languages, Mathematical expression handling
  - **…(I'd like various new challenges)**

Our next plans

Stage1

- **Provide new elegant ways to access data**
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Stage2

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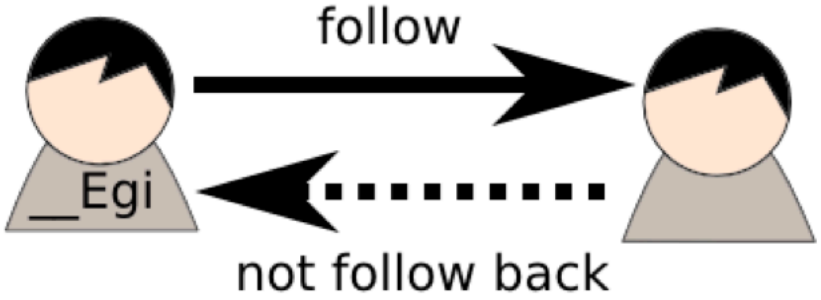
Query example

- Query that returns twitter users who are followed by “__Egi” but not follow back “__Egi”.



SQL version

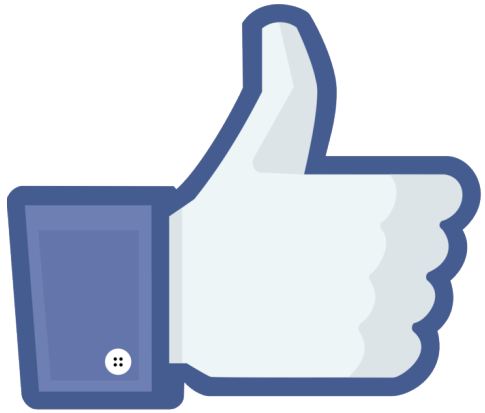
- Complex and difficult to understand
  - Complex where clause contains “NOT EXIST”
  - Subquery

```
SELECT DISTINCT ON (twitter_user4.screen_name) twitter_user4.screen_name
  FROM twitter_user AS twitter_user1,
       follow AS follow2,
       twitter_user AS twitter_user4
  WHERE twitter_user1.screen_name = '__Egi'
    AND follow2.from_uid = twitter_user1.uid
    AND twitter_user4.uid = follow2.to_uid
    AND NOT EXISTS
      (SELECT ''
         FROM follow AS follow3
         WHERE follow3.from_uid = follow2.to_uid
           AND follow3.to_uid = twitter_user1.uid)
  ORDER BY twitter_user4.screen_name;
```

Egison version

- Very Simple
  - No where clauses
  - No subquery

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
   <cons <follow ,uid $fid> _>
   ^<cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
  return <user fid fname>
```



Egison version

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Joining 4 tables

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
   <cons <follow ,uid $fid> _>
   ^<cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
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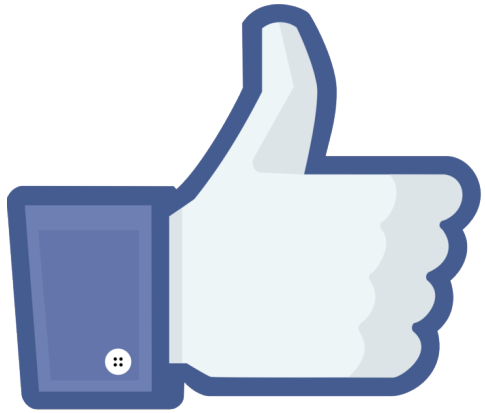
```



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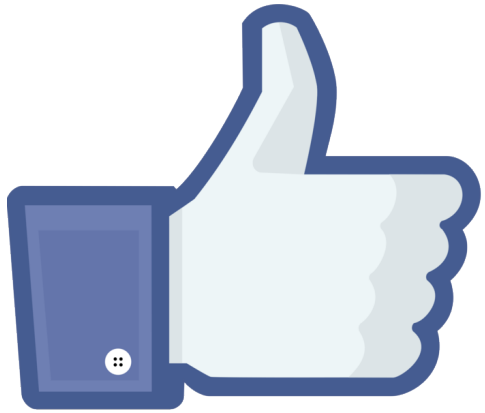
```

1. Get id of "__Egi"



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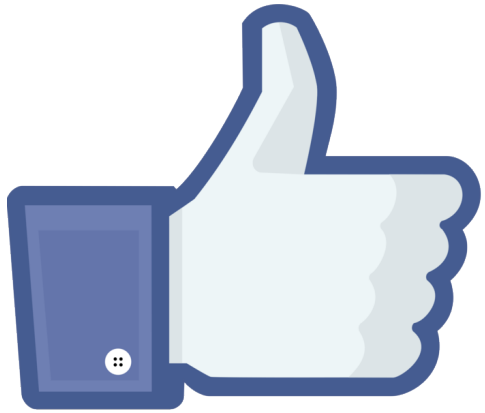
  return <user fid fname>
```

1. Get id of "__Egi"
2. Followed by 'uid'



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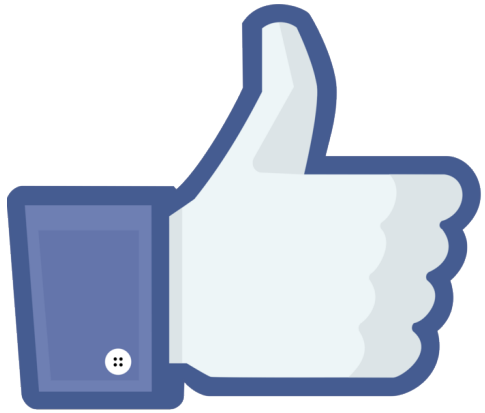
Joining 4 tables

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
   <cons <follow ,uid $fid> _>
   <cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
  return <user fid fname>
```

not

1. Get id of "__Egi"
2. Followed by 'uid'
3. But not follow back



Egison version

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Joining 4 tables

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
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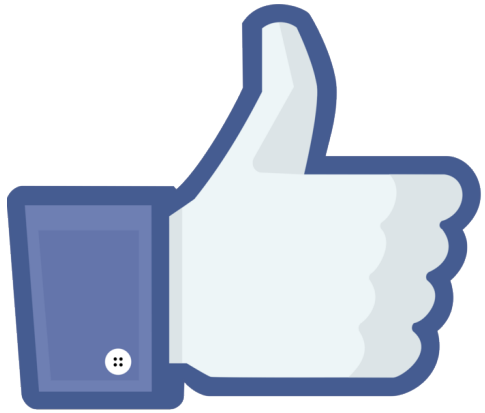
   ^<cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
  return <user fid fname>
```

not

1. Get id of "__Egi"
2. Followed by 'uid'
3. But not follow back
4. Get name of 'fid'



Egison version

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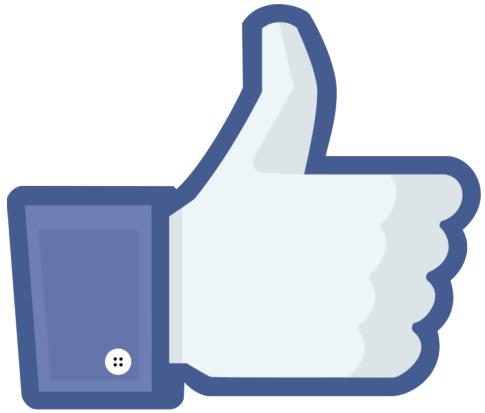
Joining 4 tables

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
   <cons <follow ,uid $fid> _>
   ^<cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
  return <user fid fname>
```

not

1. Get id of "__Egi"
2. Followed by 'uid'
3. But not follow back
4. Get name of 'fid'

Return the results



Egison version

- Very Simple
  - No where clauses
  - No subquery

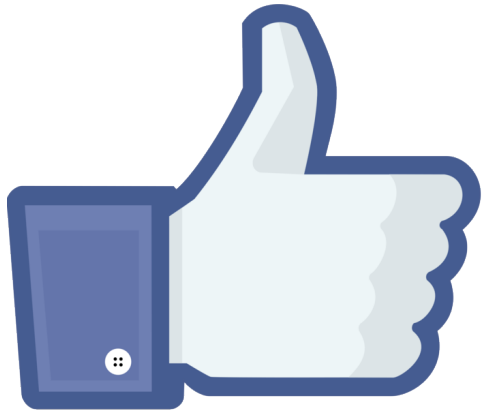
Joining 4 tables

```
match-all [user follow follow user]
  [<cons <user $uid ,"__Egi"> _>
   <cons <follow ,uid $fid> _>
not ^<cons <follow ,fid ,uid> _>
   <cons <user ,fid $fname> _>]
  return <user fid fname>
```

1. Get id of "__Egi"
2. Followed by 'uid'
3. But not follow back
4. Get name of 'fid'

Return the results

We can run this query against data in SQLite!



However...

- **Difficult to use for many, yet**
  - Our syntax is simple but unusual.

GUI frontend

- **We'll provide GUI for intuitive data access**
  - Data access for even **non-engineers**

Very Easy!

The plan after the next

- **Provide new elegant ways to access data**
  - Create the most elegant query language
  - Able to access lists, sets, graphs, trees or any other data in a unified way

Stage1

- **Provide new elegant ways for data analysis**
  - Provide a way to access various algorithm and data structures in a unified way

Stage2

- **Implementing new interesting applications**

e.g.

- Natural language processing, New programming languages, Mathematical expression handling
- **…(I'd like various new challenges)**

For that…

- **Human-centric aspect**
  - Represent human's intuition directly
- **Computer-centric aspect**
  - Represent how computers run directly

The plans always in the mind

Stage1

- **Provide new elegant ways to access data**
  - Create the most elegant query language
  - Able to access lists, sets, graphs, trees or any other data in a unified way

Stage2

- **Provide new elegant ways for data analysis**
  - Provide a way to access various algorithm and data structures in a unified way

- **Implementing new interesting applications**

  e.g.
  - Natural language processing, New programming languages, Mathematical expression handling
  - **…(I'd like various new challenges)**

Ultimate goal

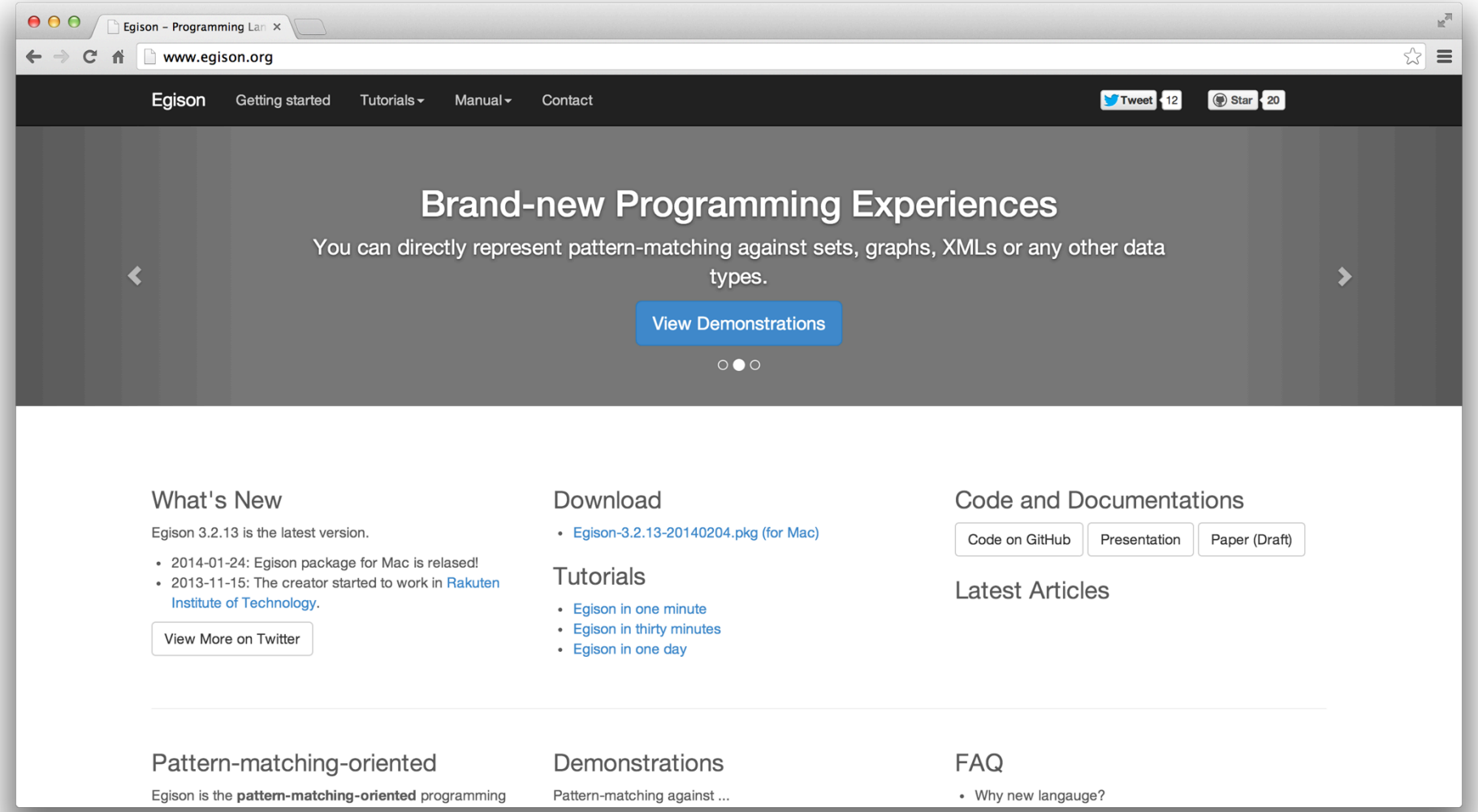
- The ultimate goal is to create auto theory constructor

Automatically extract beautiful rules from messy world

Effort for propagation

Egison web site

Please visit the web site. http://www.egison.org



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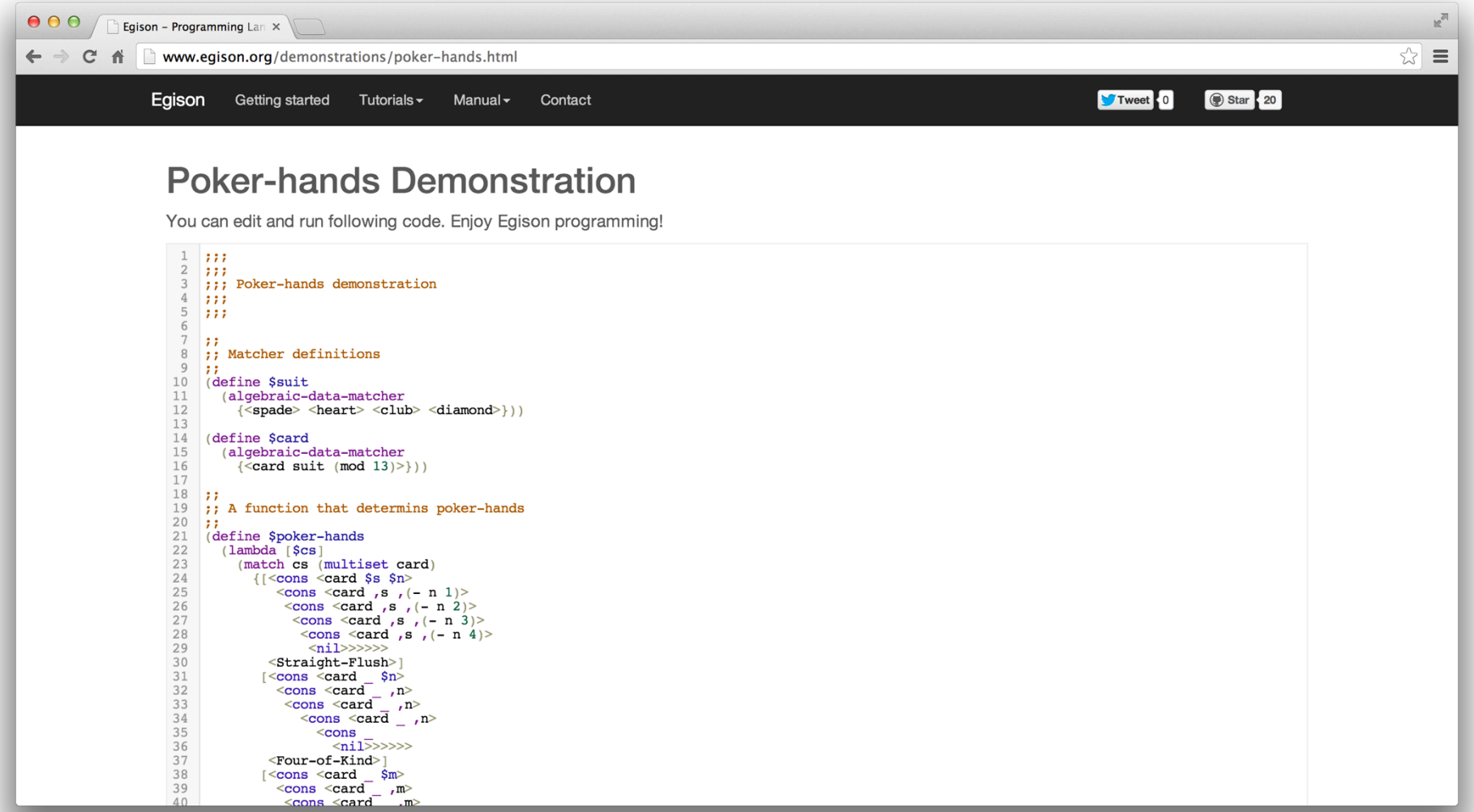
Online interpreter

We can try Egison online right now!



Installer of Egison and ‘egison-tutorial’

- We’ve prepared a package for Mac users
  - http://www.egison.org/getting-started.html

Install me Egison and please try ‘egison-tutorial’!

Get following commands!

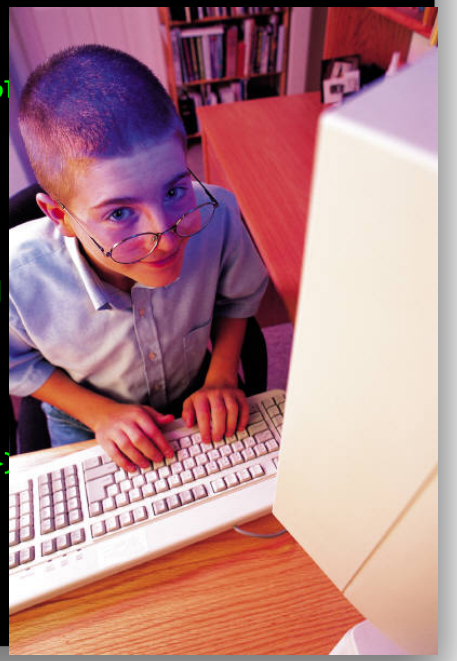
- egison
- egison-tutorial

‘egison-tutorial’

satoshi.egi — ssh — 128×38

```
EGISON /home/egi% egison-tutorial
Egison Tutorial for Version 3.2.3 (C) 2013-2014 Satoshi Egi
http://www.egison.org
Welcome to Egison Tutorial!
====================
List of tutorials.
1: Lv1 - Calculate numbers
2: Lv2 - Basics of functional programming
3: Lv3 - Define your own functions
4: Lv4 - Basic of pattern-matching
5: Lv5 - Pattern-matching against infinite collections
6: Lv6 (preparing) - Pattern-matching against graphs
7: Lv7 (preparing) - Modularize patterns
8: Lv8 (preparing) - Define your own matchers
====================
Please select a section to learn.
(1-8): 5
====================
We can write a pattern-matching against i
Please note that Egison really enumurate
e.g.
  (take 10 (match-all nats (set integer)
====================
> (take 10 (match-all nats (set integer)
{[1 1] [1 2] [2 1] [1 3] [2 2] [3 1] [1 4] [2 3] [3 2] [4 1]}
> (take 20 (match-all nats (set integer) [<cons $m <cons $n _>> [m n]]))
{[1 1] [1 2] [2 1] [1 3] [2 2] [3 1] [1 4] [2 3] [3 2] [4 1] [1 5] [2 4] [3 3] [4 2] [5 1] [1 6]
>
Do you want to proceed next? (Y/n):
====================
We can enumerate all two combinations of natural numbers as follow.
e.g.
  (define $two-combs (match-all nats (list integer) [<join _ (& <cons $x _> <join _ <cons $y _>>
  (take 100 two-combs)
====================
>
```

You’ll get Egison easily!



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Next plan: Extend other languages

- **Ruby** https://github.com/egisatoshi/egison-ruby

Non-linear patterns

Non-linear patterns are the most important feature of our pattern-mathcing system. Patterns which don't have `_` ahead of them are value patterns. It matches the target when the target is equal with it.

```
match_all([1, 2, 3, 2, 5]) do
  with(Multiset.(_a, a, *_)) do
    a #=> [2,2]
  end
end
```

```
match_all([30, 30, 20, 30, 20]) do
  with(Multiset.(_a, a, a, _b, b)) do
    [a, b] #=> [[30,20], ...]
  end
end
```

```
match_all([5, 3, 4, 1, 2]) do
  with(Multiset.(_a, (a + 1), (a + 2), *_)) do
    a #=> [1,2,3]
  end
end
```

Next plan: Extend other languages

- **Haskell (planning)**
  - We'd like to start something by the end of year.

Thank you for reaching this page!