Educational Technologies

Generating Parameterized Exercises

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14.02.2007

Background

- Active Math
  - Exercise generators

- Randomizer
  - Parameterized exercises
    - x+y=?
    - x: 1, 2, 3; y: 4, 6, 6
  - Variable replacement

Problem description

- Current randomizer
  - Pick values from a static list
- Our task
  - Pick values from given intervals
    - Open/closed, discrete/continuous
  - Generate complex expressions
    - Composition of elementary functions
    - Adapt used functions to user model

Selection from interval

- Parameter format
  - Discreet interval [1, 10]
  - OMDOC Format

```
<interval discreet="yes" left_open="no“ right_open="no">
    <OMOBJ><OMI>1</OMI></OMOBJ>
    <OMOBJ><OMI>10</OMI></OMOBJ>
</interval>
```

Selection from interval

- Random number generator provides [0, 1)
  - $r \in [0, 1)$, $n \in [a, b)$, $n=a+r(b-a)$
  - How to get the other cases?
- (0, 1]
  - Flip interval:
    - $r_0 \in [0, 1)$
    - $r=1-r_0 \Rightarrow r \in (0, 1]$
- [0, 1] and (0, 1)
  - $r \in [0, 1)$, $n \in [a, b]$, $n=a+r(b-a+2\varepsilon)$
  - $r \in [0, 1)$, $n \in (a, b)$, $n=a+\varepsilon+r(b-a-\varepsilon)$

Random Function Composition

- OMDOC format

```
<parameter name="constant">
        <OMOBJ><OMV name= "cool_function"/></OMOBJ>
        <function_composition>
                <OMV name= “x"/>
                <OMV name= “y"/>
         </function_composition>
</parameter>
```

Random Function Composition

- Compose from
  - $x+y$, $x-y$, $x \cdot y$, x/y, x^y, e^x, $\ln x$, $\sin x$, $\cos x$, $\tan x$, $\arcsin x$, $\arccos x$, $\arctan x$, $\sqrt{x}$, $\sqrt[y]{x}$
- Term rewriting

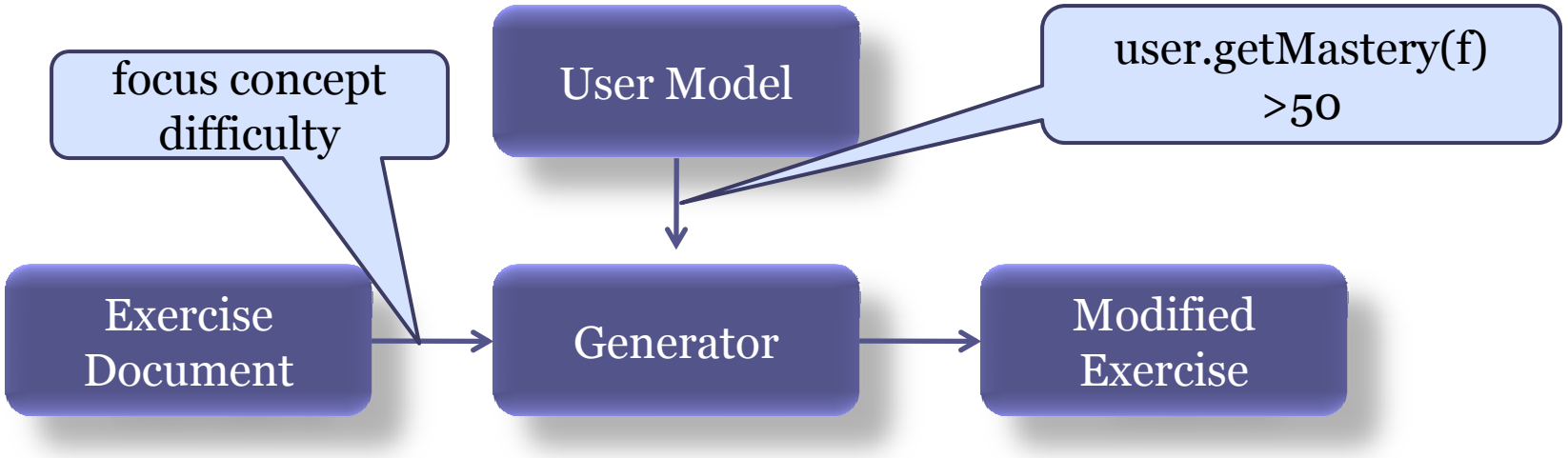
Expression	Rewrite rule	Result
x	$x \rightarrow \pi$	π
π	$x \rightarrow \sin(x)$	$\sin(\pi)$
$\sin(\pi)$	$x \rightarrow e^x$	$e^{\sin(\pi)}$

Random Function Composition

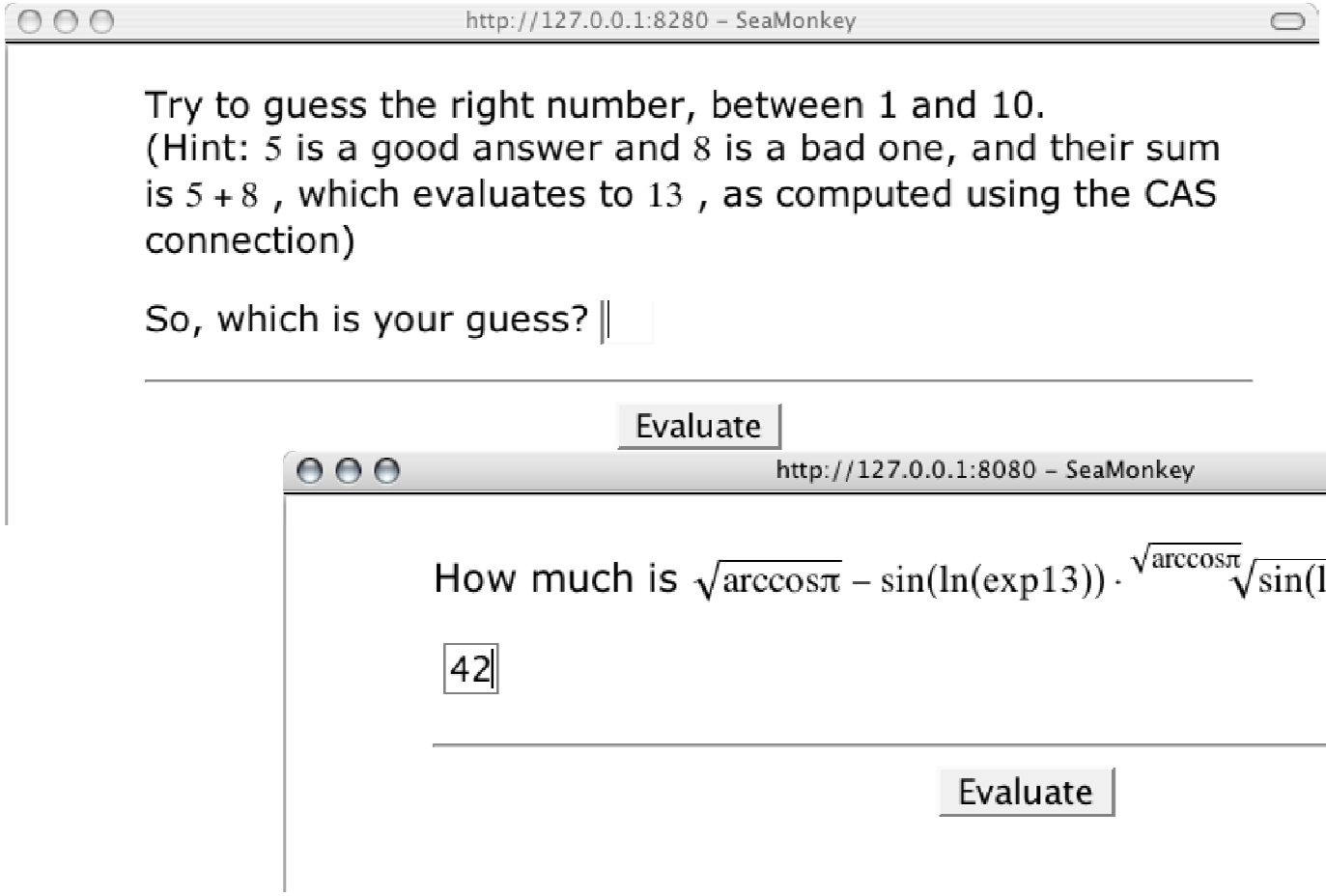
- User adaptation
  - Filtering of the function candidate list
  - Focus function guaranteed to be used
- Depth selection
  - Level of difficulty
    - very_easy: depth=1, for instance: $\sin(\pi)$
    - easy: depth=2, for instance: $e^{\sin(\pi)}$
    - medium: depth=3
    - difficult: depth=4
    - very_difficult: depth=5

Random Function Composition

- User adaptation diagram



Screenshots!



Thank you!