Projects and technical details

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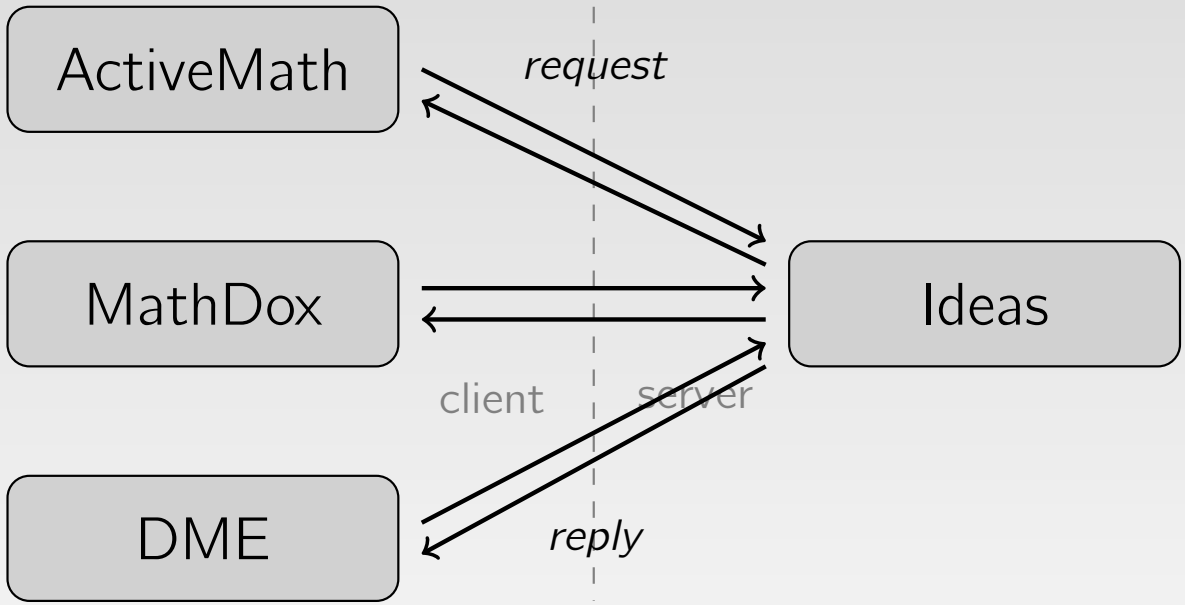
Introduction

- We have developed several exercises and projects related to our programming tutor
- For some of these, you need to adapt the software
- This lecture gives an overview of the software, and a brief introduction to the projects.

Feedback services



A hint request

```
<request service    = "onefirst"
         exerciseid = "math.lineq"
         encoding   = "string">
  <state>
  <expr>5*(x-1) == x/2</expr>
  </state>
</request>
```

A response

```
<reply result="ok" version="0.7.4 (0)">
  <elem ruleid="algebra.equations.linear.remove-div"
        location="[]">
    <argument description="factor">
      2
    </argument>
    <state>
      <prefix>
        [4,1,0]
      </prefix>
      <expr>
        10*(x-1) == x
      </expr>
    </state>
  </elem>
</reply>
```

Services

allfirsts.	all next steps that are allowed by a strategy
onefirst.	a single possible next step that follows a strategy. You can specify an order on steps, to select a single step among multiple possible steps
derivation.	a worked-out solution starting with the current program
ready.	is the program accepted as a final answer?
diagnose.	diagnoses a program submitted by a student

An examples exercise package

```
dnfExercise :: Exercise SLogic
dnfExercise = makeExercise
    { parser          = parseLogicPars
    , prettyPrinter   = ppLogicPars
    , equivalence     = withoutContext eqLogic
    , similarity      = withoutContext equalLogicA
    , isReady         = isDNF
    , strategy        = dnfStrategyDWA
    , navigation      = navigator
    , extraRules      = map liftToContext
                            (extraLogicRules ++ buggyRules)
    , randomExercise = useGenerator (const True)
                                    logicExercise
    ...
    }
```

Exercise

```
data Exercise a = Exercise
    { parser          :: String -> Either String a
    , prettyPrinter   :: a -> String
        -- syntactic and semantic checks
    , equivalence     :: Context a -> Context a -> Bool
    , similarity      :: Context a -> Context a -> Bool
    , ordering        :: a -> a -> Ordering
    , isReady         :: a -> Bool
        -- strategies and rules
    , strategy        :: LabeledStrategy (Context a)
    , navigation      :: a -> Navigator a
    , extraRules      :: [Rule (Context a)]
        -- testing and exercise generation
    , examples        :: [(Difficulty, a)]
    ...
    }
```

Structure of the software

The code for the programming tutor is built on top of our Ideas framework.

- `FPTutor/trunk/src/` describes the functional programming domain
- `Feedback/trunk/src` describes the Ideas framework

The Ideas framework

The Ideas framework consists of a number of directories, of which the following three are most interesting:

- `Common`: General machinery dealing with rewriting, strategies, contexts, exercises, etc.
- `Domain`: Domain reasoner instances dealing with several domaims such as linear algebra, logic, math, etc.
- `Service`: Implementing the various services we offer

The FPTutor framework

The FPTutor framework consists of a number of directories, of which these are the most interesting:

- `src/Domain/FP`: Domain reasoner instance for the programming domain
- `src/Domain/FP/Transformations`: Program transformations for normalisation
- `src/WebApp`: Web application implementation (HTML and JavaScript)
- `models`: directory containing model solutions
- `scripts`: directory with feedback scripts

Exercises, projects, slides, and notes

We have made all our (textual) material available on

`http://people.cs.uu.nl/johanj/homepage/Publications/CEFP/`

- Exercises: `exercises.pdf`
- Slides:
  - `slides1.pdf`: Introduction, overview, tutors, strategies
  - `slides2.pdf`: The strategy language
  - `slides3.pdf`: A strategy recogniser
  - `slides4.pdf`: Brief overview of the ideas framework. Introduction to the exercises/project work
- Lecture notes: `notes.pdf`

Software

Experiment on-line:

`http://ideas.cs.uu.nl/ProgTutor/`

Build the tutor on your own machine:

`http://ideas.cs.uu.nl/trac/wiki/Download`

Project 1: Adapting feedback I

A teacher should be able to add her own feedback to a model solution.

> $reverse = foldl$ {-# FEEDBACK Note ... #-} $(flip\ (:))\ []$

and it should be possible to disallow or enforce particular solutions described by a strategy:

> $reverse =$ {-# USEDEF #-} $foldl\ (flip\ (:))\ []$

Implement these ideas for adapting strategies.

Project 1: Adapting feedback II

We might want to add a property to a function, and use that in a strategy:

```
reverse =
    {-# PROP foldl op e == foldr (flip op) e . reverse #-}
  foldl (flip (:)) []
```

Inspiration for desirable properties can be obtained from the file `data/Default.hs` in the HLint distribution:

```
error  = zipWith (,) ==> zip
error  = foldr (&&) True ==> and
error  = (\x -> x) ==> id
```

Implement these ideas for adapting strategies.

Project 2: Automatic contract checking

We want the student's definition $reverse = <?>$ to satisfy the function contract:

> $(x : true) \to \{y \mid y \equiv reverse\ x\}$

for some model solution of *reverse*. If a student refines with $<?> \Rightarrow foldl\ <?_1>\ <?_2>$, this holds if both

> $assert\ ((x : true) \to (y : true) \to \{z \mid z \equiv flip\ (:)\ x\ y\}\ <?_1>$
> $assert\ (\equiv [])\ <?_2>$

Strategies (and normalisation) help in constructing such refinement (proof) steps.

Investigate if we can use contracts for blaming incorrect steps.

Conclusions

The Ideas framework is a sizable application, mainly written in Haskell

We welcome contributors to the framework, test users, etc.

All feedback is welcome

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