Lucas-Interpretation from Users' Perspective

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Outline

1. User's Views
   - **Demo**: Programmers' View
   - **Demo**: Students' View
2. Lucas-Interpretation
   - The Language
   - The Interpreter
   - Where is Interaction from?
   - Summary
3. Conclusions for Users
   - Usability for Programmers
   - Self-explaining System for Students

Outline

Programmers' View

Demonstration

Summary:

- Programming is painful presently . . .
  - program syntax checked as Isabelle term
  - rewrite-sets for execution compiled by hand
- . . . thus migration to Isabelle's function package
- functional programs without input / output — where comes user-interaction from ???

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Students' View

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Summary: Students require these services for learning …

1. check user input automatically, **flexibly** and reliably:
   Input establishes a *proof situation* (for *automated* proving) with respect to the logical context
2. give explanations on request by learners:
   All underlying mathematics knowledge is **transparent** due to the “LCF-paradigm” in Isabelle
3. propose a next step if learners get stuck:
   “next-step-guidance” due to Lucas-Interpretation.

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Another program with tactics ≈ break-points

```
.    partial_function diffeq_2_mass_oscil (m, l_0, [c_1, c_2],
                                     d, springs, dampers, sums) =
1      let
11       begin_parallel
1101         springs = Take springs “forces of springs”
111        parallel
1111         dampers = Take dampers “forces of dampers”
112        parallel
1121         sums = Take sums “mass times acceleration equals sur
12       end_parallel
13       diffeq = Take sums “”
14       diffeq = Substitute [ springs, dampers ]
15       diffeq = Rewrite_Set normalise
16       diffeq = Rewrite_Set vectorify “switch to vector representat
2      in
21       diffeq
```

Outline

Lucas-Interpretation (LI)

I: program * location * environment $\xrightarrow{\textit{interpret}}$ location * environment

Lucas-Interpretation (LI)

LI:

program
* location
* environment

interpret →

location
* environment
* calculation

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formula or tactic

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  * theories
    * context
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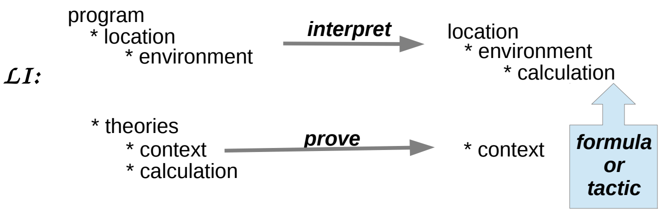

Lucas-Interpretation (LI)

computation

LI:

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prove →

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deduction

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computation *semantics of programming languages – settled!*

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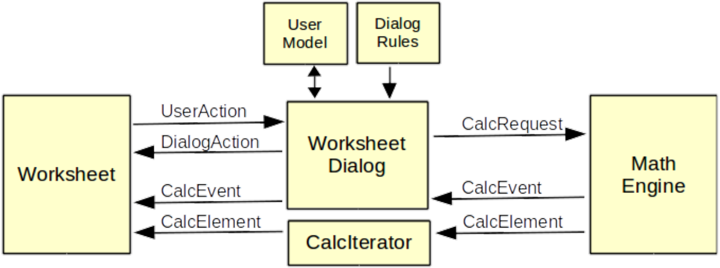
The Dialogue Module



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Lucas-Interpretation is a novel contribution, which

1. interprets a functional language
   - "purely functional" no input / output: interaction $\longrightarrow$ Pt.3
   - programmer concerned with mathematics only
   - TODO: embed into Isabelle's function package
2. controls input / output as side-effects
   - regards tactics as "break points" (like debugger)
   - hands over control at tactics $\longrightarrow$ Pt.3
3. delegates user-interaction
   to a Dialogue Module:
   - "dialogue authoring" by respective experts (`DialogRules`)
   - adaptive to courses
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Usability for Programmers

Programming in $\mathcal{ISAC}$

- becomes comparable with Mathematica/Maple/...

  if $\mathcal{ISAC}$ adopts Isabelle's function package
- is embedded into mechanising mathematics, i.e.
  - development of theories (definitions, laws, ...)
  - development of libraries of specifications
  - development of verified Computer Algebra
- is separated from users' interaction:
  interaction is a side-effect managed by Lucas-Interpretation
  - mathematicians focus mathematics
  - interaction is covered by dialogue authors

Outline

Self-explaining system . . .

. . . while step-wise applying a method (**solving**)

- during trial & error learning:
  - feedback on input steps (formula | tactic)
  - <next> step by system, if got stuck
  - "next-step guidance" by dialogue component:
    - suggest next step partially
    - suggest next steps for selection
    - auto-complete partial input
- in changing levels of abstraction:
  - formal *justification* for each *formula*
  - *justification* = meta-, *formula* = object-language
  - another "meta-level": instructions in program
  - . . .

. . . while **modelling** and **specifying** an engineering problem: $\longrightarrow$ another talk

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Thank you for Attention!

F. Haftmann, A. Lochbihler & W. Schreiner.
Towards abstract and executable multivariate polynomials in Isabelle.
Isabelle Workshop 2014, http://www.infsec.ethz.ch/people/andreloc/publications/haftmann14iw.pdf.