SFV Talk:
Part II: Annotation Command Programming in Isabelle

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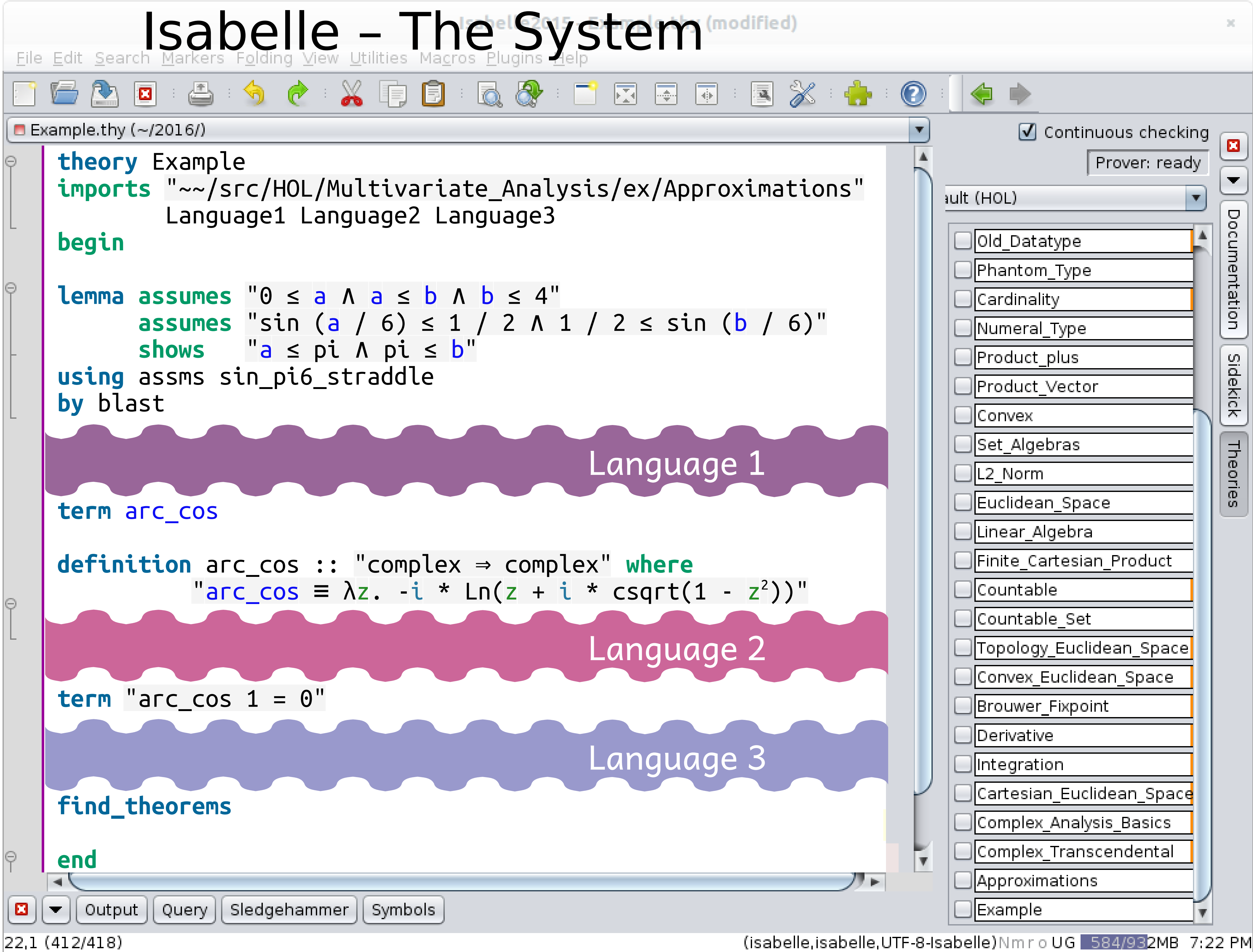
Isabelle – The System



Isabelle/C: annotations as comments

```
/*@ theory Example
    imports "~~/src/HOL/Multivariate_Analysis/ex/Approximations"
            Language1 Language2 Language3
    begin

    lemma assumes "0 ≤ a ∧ a ≤ b ∧ b ≤ 4"
          assumes "sin (a / 6) ≤ 1 / 2 ∧ 1 / 2 ≤ sin (b / 6)"
          shows   "a ≤ pi ∧ pi ≤ b"
    using assms sin_pi6_straddle
    by blast
*/
```

Language 1

```
/*@
    term arc_cos

    definition arc_cos :: "complex ⇒ complex" where
              "arc_cos ≡ λz. -i * Ln(z + i * csqrt(1 - z²))"
*/
```

Language 2

```
/*@
    term "arc_cos 1 = 0"
*/
```

Language 3

```
/*@
    find_theorems

    end */
```

Isabelle/C: annotations as comments

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/*@ theory Example
    imports "~~/src/HOL/Multivariate_Analysis/ex/Approximations"
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*/                                          Language 1    /*@
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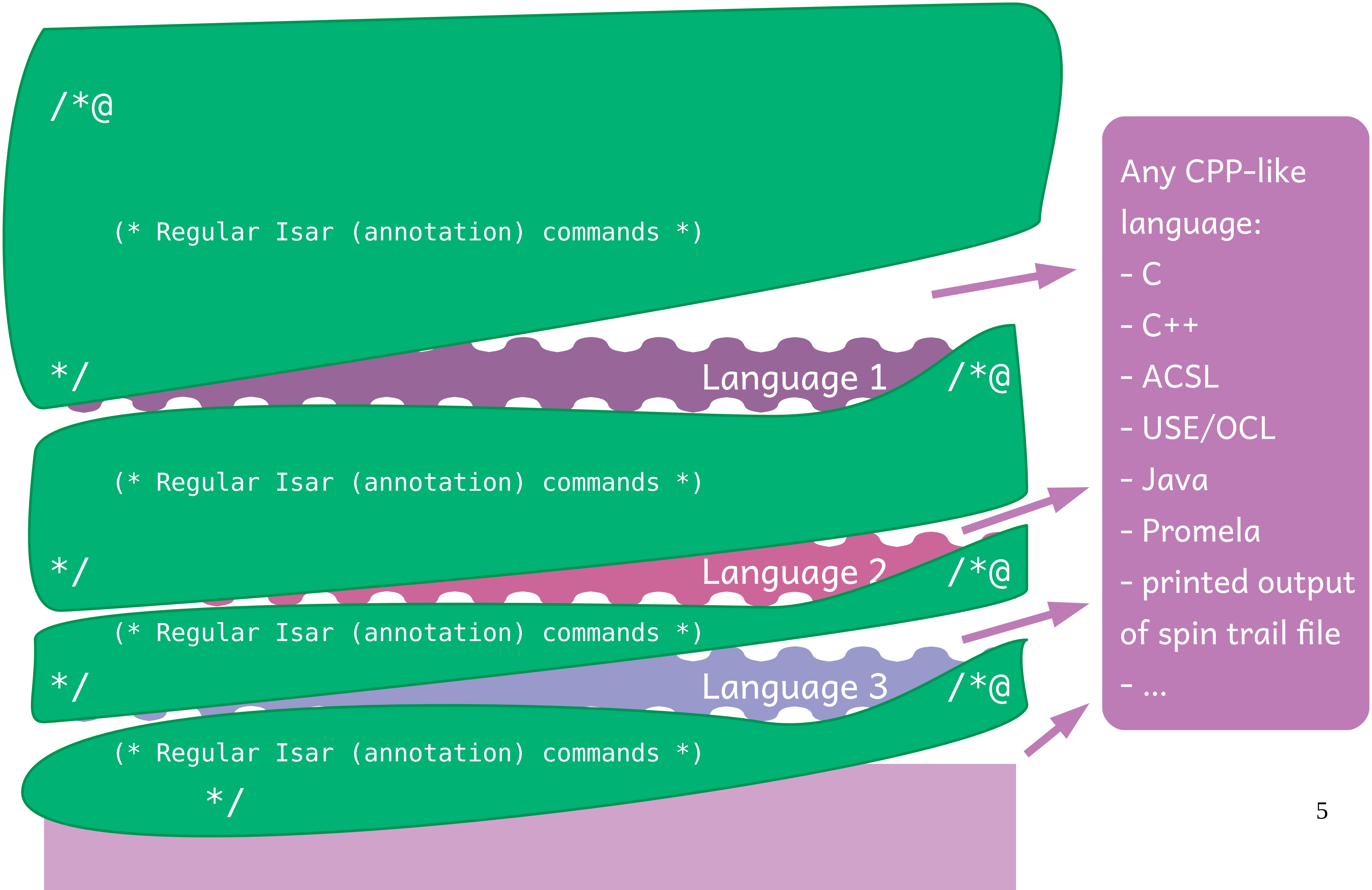
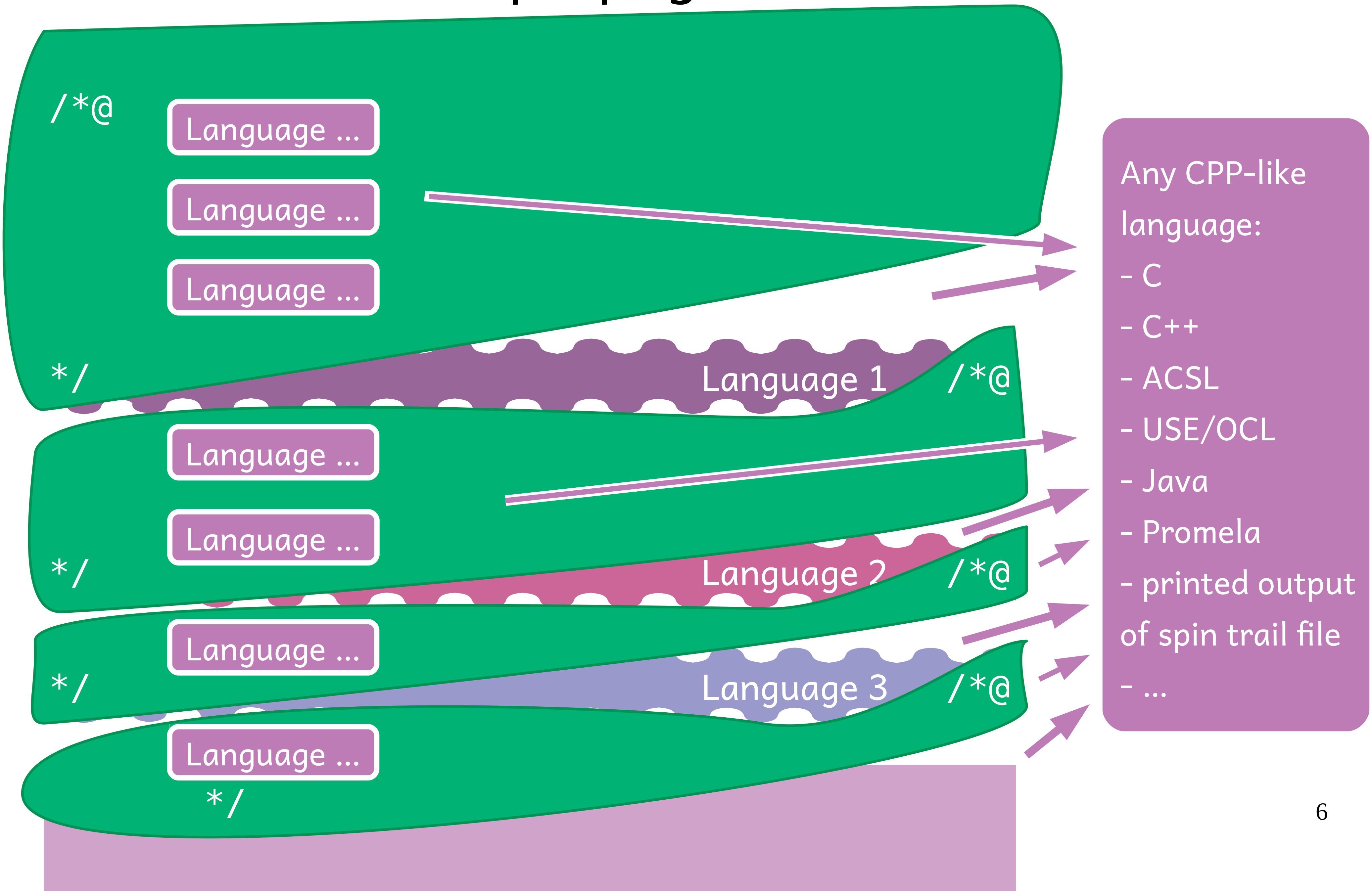
    definition arc_cos :: "complex ⇒ complex" where
               "arc_cos ≡ λz. -i * Ln(z + i * csqrt(1 - z²))"
*/                                          Language 2    /*@
    term "arc_cos 1 = 0"
*/                                          Language 3    /*@
    find_theorems

    end */
```

Isabelle/C supporting CPP-like languages



Isabelle/C: the art of environment propagation



Annotations in CPP-like Languages: A solved Problems?

- Semantics of an Annotation Command, Problems:
  - Resolving navigation ambiguity in annotations

```
int i = 123;                         /*@ annotation i??? */
for (int i = 0; i < n; i++) a+= a*i /*@ annotation i??? */
```

    How to prove that (the outer) i was equal to 123 while being in the loop?
    How to prove that (the inner) i will be set to 0 before entering the loop?
    How to prove that the outer i has a value different than the inner i?

  - Referring to C variables while in Isabelle propositions

```
/*@ assert(a > i) */
```

  - Dealing with the evaluation order of annotations

```
/*@ annotation_begin */ ... /*@ annotation_end */
```

    vs.

```
/*@ annotation_end */ ... /*@ annotation_begin */
```

    (why not, like Haskell toplevel where definitions can be permuted)

  - Propagating the Isabelle logical context during annotation evaluations (scheduling with directives, which must be all evaluated before parsing)

HOOKING UP BACK-ENDS

- General Mechanism to register a PIDE “command”:

  Outer_Syntax.command’: K_{cmd} -> ($\boldsymbol{\sigma}$ -> $\boldsymbol{\sigma}$) parser -> σ -> σ

- Isabelle/Isar : “setup ‹ some SML function of type : σ -> σ › “
  a shorthand for:
  “ML ‹ Theory.setup (some SML function of type : σ -> σ) › “

```
definition “[...]”

datatype LIST = NIL | CONS nat LIST

fun      height :: "LIST ⇒ nat"
where "height NIL          = 0               "
    | "height (CONS _ t) = Suc (height t)"
```

HOOKING UP BACK-ENDS

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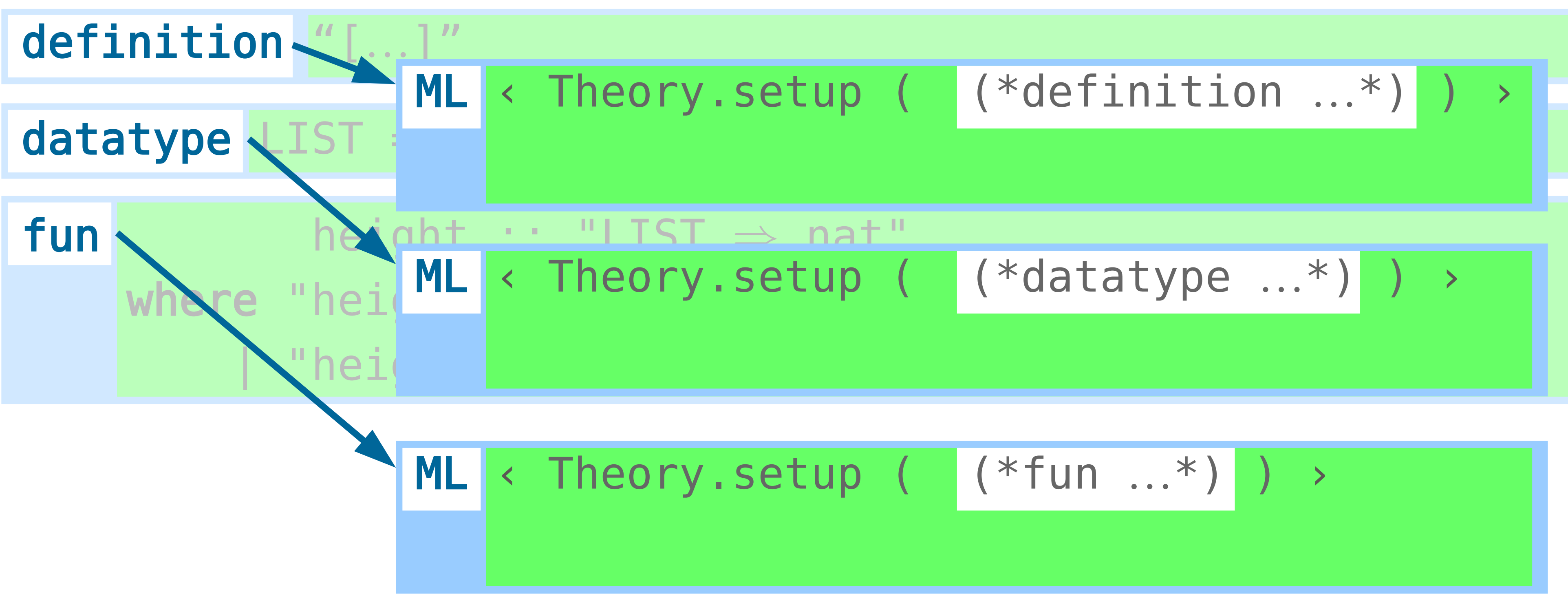

HOOKING UP BACK-ENDS

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- Isabelle/Isar : “setup ‹ some SML function of type : σ -> σ › “

- Analogously, Isabelle/C provides an infrastructure to define “Annotation Commands”

  C_Annotation.command : K_{cmd} -> (<n-expr> -> (σ -> σ)c_parser) -> unit
  C_Annotation.command': K_{cmd} -> (<n-expr> -> (σ -> σ)c_parser) -> σ -> σ

- … σ is the logical context of the Isabelle system

- … comprising in Isabelle/C an environment env and a stack of current parsed Shift-Reduce- AST’s

DEMO