

Introduction to Agda

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8th Summer School on Formal Techniques (SSFT'18)
Menlo College, California, US
21–25 June 2018

The Essence of Martin-Löf Type Theory

- Propositions-as-types (Curry-Howard correspondence)
- No propositions, just sets!
- Evidence is data, proofs are programs
- Constructivism: proofs have computational content
- Homotopy type theory: equality has content!
- Isomorphism-as-equality: $A \equiv B$ contains conversion functions between A and B

Agda: A Brief History

- Developed mainly at Chalmers / Gothenburg University
- Based on Martin-Löf Type Theory (1972–)
- ALF (Another Logical Framework, 1992): in SML
- Alfa (1996): interactive structure editor for well-typed things
- Agda 1 (1999): proof checking engine for Alfa, based on Cayenne
- Agda 2 (2007): rewrite by Ulf Norell

Agda's Relatives

- NuPRL (Cornell) / RedPRL (CMU): Extensional Type Theory
- Coq (INRIA): Impredicative Prop
- Idris (St Andrews): Haskell-like, focus on compilation
- Lean (MSR): Targets real-world verification; written in C++

Why choose Agda?

- Esthetic motivation: (c)lean syntax, Unicode, colors
- Ascetic motivation: proof terms only, no tactics
- Didactic motivation: good to learn Type Theory
- Foundational motivation: closest to Martin-Löf Type Theory
- Constructivist's motivation: see the content of proofs
- Developers's motivation: refactor/restructure proofs

Agda Features (✓ this tutorial)

- ✓ Dependent function types
- ✓ Curry-Howard
- ✓ Indexed data types
- ✓ **Dependent pattern matching**
- ✓ Interactive programming
- ✓ Unicode and mixfix operators
- (X) Records
- (X) Modules (parameterized)
- X Universe polymorphism
- X Standard library
- X Compilation
- X Coinduction, copatterns
- X Sized types
- X Without-K
- X Rewriting

Getting Agda

- Source distribution for GHC 7.10, 8.0, 8.2, 8.4
- Haskell platform + latest alex, happy, cpphs
- Current release: 2.5.3 (2.5.4 forthcoming!)

```
cabal install Agda
```

- Development version: 2.6.0 (including cubical Agda)

```
git clone https://github.com/agda/agda.git
cd agda
make
```

- You might end up in cabal hell...
- Agda wiki: <http://wiki.portal.chalmers.se/agda>
- Manual (WIP): <http://agda.readthedocs.org>

Installing the standard library I

- Use standard library v0.15 with Agda 2.5.3.
- Say you are in directory \$HERE (replace appropriately).

```
git clone https://github.com/agda/agda-stdlib.git
cd agda-stdlib
git checkout v0.15
cabal install
```
- Register it by adding the following line to \$HOME/.agda/libraries:

```
$HERE/agda-stdlib/standard-library.agda-lib
```
- To use the standard library in you project \$PROJECT, put a file \$PROJECT.agda-lib file in the project root containing:

```
depend: standard-library
include: $DIRS
```


Installing the standard library II

where \$DIRS is a list of directories where Agda searches for modules, for instance . (just the project root).

- If you want to refer to the standard library in all your projects, add the following line to \$HOME/.agda/defaults

```
standard-library
```

- Read the full story at <http://agda.readthedocs.io/en/latest/tools/package-system.html>!