New Tools and Tool Improvements

Chapel Team, Cray Inc.

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Outline

- The ‘mason’ Package Manager
- c2chapel
- chpldoc Improvements

The 'mason' Package Manager

Mason: Background

- **Contributed modules have been bundled into the release**
  - ‘Package’ modules, not part of standard library

- **Bundling such modules with releases is unsustainable**
  - Developers need to sign a CLA to contribute
  - Such modules need to be compatible with Chapel’s license
  - Core team needs to review each module
  - Availability gated by compiler release timing
  - These concerns inhibit healthy community growth

- **A package manager helps solve these problems**
  - Package development/release cycles distinct from compiler
  - Offloads CLA/license requirements to package authors
  - Provides a platform to grow the Chapel ecosystem

Mason: This Effort

- **Designed and implemented a package manager: mason**
  - "a skilled worker who builds by laying units of substantial material"
  - Heavily influenced by Rust’s Cargo
  - Version 0.1.0 - very basic functionality

- **Written entirely in Chapel**
  - An instance of eating our own dog food
    ... to help expose usability issues.
    ... to motivate stabilization of language and APIs.

Mason: This Effort

- **Command line tool: ‘mason’**
  - Builds, runs, and documents packages
- **Decentralized packages, centralized registry**
  - Source code exists somewhere else, like a GitHub repository
  - Packages exist as TOML files in a single repository
- **Dependencies are specified and downloaded per project**
  - Dependency resolution uses semantic versioning

Mason: Basic Usage

- Creating a Project
- Building
- Running
- Adding Dependencies

Mason: Creating a Project

- **Build mason with ‘make mason’ from $CHPL_HOME**
  - Symbolically links executable to same directory as ‘chpl’

- **Create a project with ‘mason new <project name>’**

```
> mason new MyPackage
Created new library project: MyPackage
```

  - Initializes an empty git repository

```
MyPackage/
  Mason.toml
  src/
    MyPackage.chpl
```

Mason: Creating a Project

- A default manifest, "Mason.toml", is created

```
[brick]
name = "MyPackage"
version = "0.1.0"
chplVersion = "1.16.0"

[dependencies]
```

Packages start as v0.1.0

Compatible with 1.16 or later

Zero dependencies

- A default source file is also generated

```
/* Documentation for MyPackage */
module MyPackage {
  writeln("New library: MyPackage");
}
```

Mason: Building

- **Compile your project with ‘mason build’**
- **Downloads registry and dependencies to $MASON_HOME**
  - Defaults to $HOME/.mason/
- **Creates a lock file, "Mason.lock", also in TOML format**
  - Ensures repeatable builds by locking in versions and configurations
  - ‘mason update’ - only update/generate the lock file

```
> cat MyPackage/Mason.lock
[root]
name = "MyPackage"
version = "0.1.0"
chplVersion = "1.16.0..1.16.0"
```

Mason: Running

- Use ‘mason run’ to execute your project

```
> mason run
New library: MyPackage
```

- Final directory hierarchy:

```
MyPackage/
  Mason.toml
  Mason.lock
  src/
    MyPackage.chpl
  target/
    debug/
      myPackage
```

Mason: Adding Dependencies

- **Add dependencies by modifying Mason.toml**
  - List module dependencies and versions

```
...
[dependencies]
Bob = "1.1.0"
Alice = "0.3.0"
```

  - Add 'use' statements to your project

```
use Bob, Alice;
```

- **Dependencies downloaded in next 'mason build'**
  - Mason will:
    - download modules to satisfy dependencies
    - put the modules in the compiler's module path

```
> mason build
Updating mason-registry
Downloading dependency: Bob-1.1.0
Downloading dependency: Alice-0.3.0
```

Mason: Adding Dependencies

- Lock file stores versions and source locations

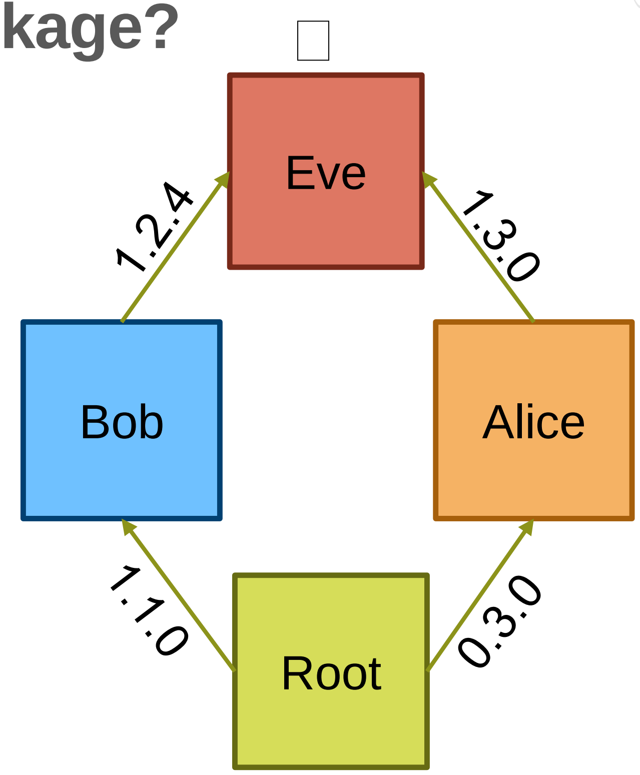
```
[root]
name = "MyPackage"
version = "0.1.0"
chplVersion = "1.16.0 .. 1.16.0"
dependencies = [...]

[Bob]
name = "Bob"
version = "1.1.0"
chplVersion = "1.16.0 .. 1.16.0"
source = "https://github.com/BobDev/Bob"
dependencies = [...]

[Alice]
...
```

Mason: Adding Dependencies

- **What if there are two versions of a package?**
- **Dependencies computed with IVRS**
  - "Incompatible Version Resolution Strategy"
  - Follows semantic versioning
    - Distinct major versions are incompatible
    - Use the latest minor version
    - Use the latest bug fix
  - Single version stored in lock file



Bob	Alice	Result (Eve)
1.0.0	2.0.0	Error
1.2.4	1.3.0	1.3.0
1.0.1	1.0.0	1.0.1

Mason: The Registry

- **Mason uses a centralized registry**
  - github.com/chapel-lang/mason-registry

- **Packages are defined by TOML files**

```
mason-registry/
  Bricks/
    Bob/
      1.1.0.toml
    Alice/
      0.3.0.toml
    Eve/
      1.2.4.toml
      1.3.0.toml
```

Mason: The Registry

- **Open a Pull Request to add your package**
  - Ensure source repo has ‘vX.Y.Z’ git tag, v0.1.0 in this example
  - Add a TOML file named after a version: MyPackage/0.1.0.toml

```
[brick]
name = "MyPackage"
version = "0.1.0"
chplVersion = "1.16"
author = "Chapel Lang"
source = "https://github.com/chapel-lang/MyPackage"

[dependencies]
```

Mason: The Registry

- **Search with ‘mason search <query>’**
  - Case-insensitive substring matches
  - Lists latest version of package
  - Empty query will list all packages

```
> mason search E
Alice (0.3.0)
Eve (1.3.0)
MyPackage (0.1.0)

> mason search bo
Bob (1.1.0)
```

Mason: The Registry

- **Mason can be configured to look elsewhere for registry**
  - MASON_REGISTRY – must be a valid git URL
    - Includes file paths – useful for offline environments
  - ‘mason env’, like ‘printchplenv’, lists relevant environment variables

```
> export MASON_REGISTRY=/path/to/shared/registry
> mason env
MASON_HOME: /users/eve/.mason
MASON_REGISTRY: /path/to/shared/registry *
```

Mason: Status

- **Included in 1.16 release**
- **Version 0.1.0 available for users to try out**
- **Some packages by Chris Taylor available on registry:**
  - MatrixMarket
  - LinearAlgebraJama

Mason : Next Steps

- **Testing and Deployment**
  - Introduce "Blessed" packages to be tested nightly
- **Security**
  - Verify package author identity
- **Improving offline experience**
  - Add commands for caching subset of packages locally
- **Managing C dependencies**
  - Use a backend C dependency manager to support C dependencies
- **Centralized package system**
  - Cache packages themselves, similar to crates.io
- **Next steps tracked in #7106**

c2chapel

c2chapel: Background

- **Chapel supports interoperability with C:**

```
extern proc printf(fmt : c_string, args ...) : void;

extern record myRecord {
  var data : c_ptr(int);
  var len  : c_int;
}
```

- **This is a tedious process for nontrivial C libraries**
  - SQLite, LAPACK, BLAS

- **Users should have a tool to help automate wrapping**

c2chapel: Background

- **Nikhil Padmanabhan (Yale) contributed ‘c2chapel’ script**
  - Python script leveraging ‘pycparser’ package
  - Handled simple function declarations

- **Spent a long time as a second-class utility**
  - Not included in release, only available on master
  - Lots of errors for common C features
  - No regular testing

c2chapel: This Effort

- **Expanded supported C features**
  - Restricted to C99 standard
- **Improved build process and testing**
- **Included in release**

c2chapel: This Effort - Functionality

- **Basic usage:**
  - Accepts C99 header as argument
  - Prints Chapel wrapper to stdout

```
> c2chapel foo.h
```

C99

```
// foo.h
struct misc {
  char a;
  char* b;
  void* c;
  int* d;
};
```

Chapel

```
// Generated with c2chapel version 0.1.0

// Header given to c2chapel:
require "foo.h";

// Note: Generated with fake std headers
extern record misc {
  var a : c_char;
  var b : c_string;
  var c : c_void_ptr;
  var d : c_ptr(c_int);
}
```

c2chapel: This Effort - Functionality

- **Expanded supported C features**
  - function pointers
  - structs with fields
  - typedefs
  - varargs
  - global enums

- **Better handling of standard headers**
  - Original script would break on things like “#include <stdlib.h>”
  - Often related to GNU extensions
  - ‘pycparser’ leverages ‘fake’ headers that redefine tricky constructs

```
typedef int __gnu_va_list;
```

c2chapel: This Effort - Functionality

- Example translations:

C99

```
struct allInts {
  int a;
  unsigned int b;
  long long c;
};


void msg(const char* fmt);
```

Chapel

```
extern record allInts {
  var a : c_int;
  var b : c_uint;
  var c : c_longlong;
}


extern proc msg(fmt : c_string) : void;
```

- More examples in $CHPL_HOME/tools/c2chapel/test/

c2chapel: This Effort - Build/Test

- **Built with 'make c2chapel' from $CHPL_HOME**
  - Placed in same directory as 'chpl' to be $PATH-visible
- **c2chapel installs 'pycparser' to a local virtualenv**
  - Leaves user's python environment untouched
  - Requires an internet connection during 'make'
- **'make check' from $CHPL_HOME/tools/c2chapel**
  - Runs various correctness tests
- **Now tested nightly on master**

c2chapel: Status and Next Steps

Status: c2chapel 0.1.0 included in the 1.16 release

- Significantly more capable and flexible
- Now easily available to users
- Can wrap SQLite, but not LAPACK/BLAS

Next Steps: Improve versatility and installation process

- Improve handling of GNU extensions
- ‘ref’ vs. c_ptr for formals
- Continue to expand testing for other C constructs
- Allow offline installation

chpldoc Improvements

chpldoc Improvements

Background: chpldoc is Chapel's code documentation tool

- Some known bugs remain, but otherwise stable

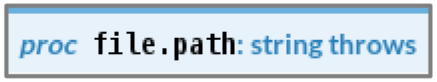
This Effort:

- Documented 'throwing' functions as such
- Added warning when end of doc comment doesn't match the start
  - Contributed by Krishna Keshav
- Added support for math equations in documentation via LaTeX

```
.. math:: a^2 + b^2
```

$\longrightarrow \boxed{a^2 + b^2}$

Impact: Cleaner/more accurate documentation



proc file.path: string throws

Next steps:

- Create a 'throws' section in documentation for throwing procedures
  - list possible errors the routine could throw
- Fix remaining known bugs, respond to user requests

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