Chapel Futures

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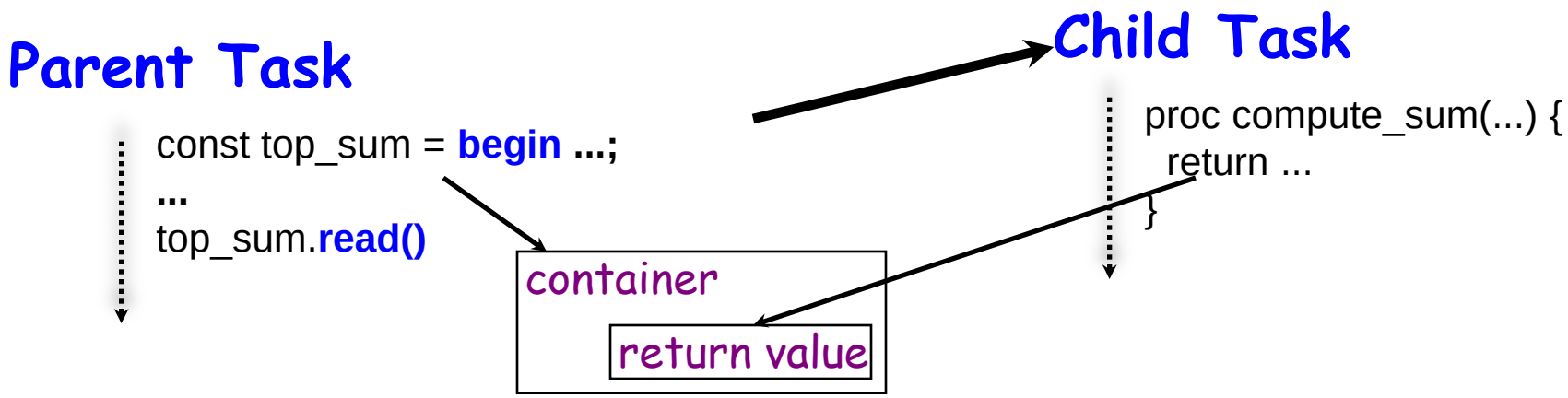
Futures: Begin Expressions

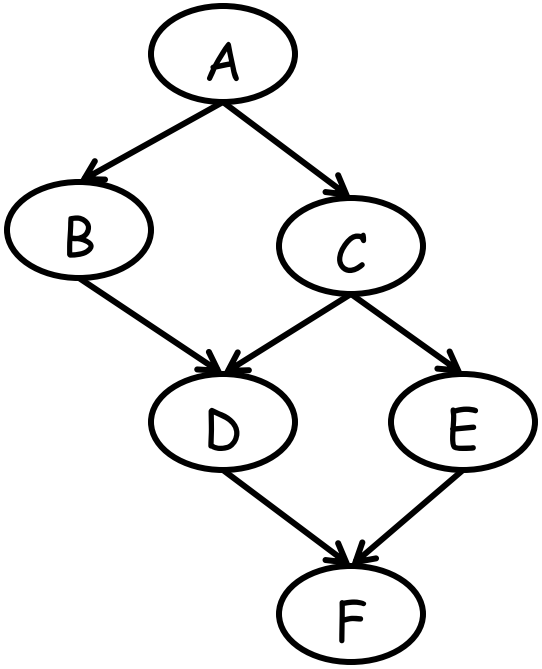
Example

```
// Parent task creates child task (begin-expression)
const top_sum: future(int) = begin compute_sum(X, low, mid);
. . .
// Later, parent examines the return value
var sum = top_sum.read() + ...;
```



Computation Graphs

- Express Computation DAGs
- More general than regular begin tasks + sync statements
- More structured than begin tasks + sync variables



Computation Graph

1. const A = **begin** fA(...);

2. const B = **begin** fB(A.**read(), ...);**

3. const C = **begin** fC(..., A.**read());**

4. const D = **begin** fD(B.**read()**, C.**read(), ...);**

5. const E = **begin** fE(C.**read(), ...);**

6. const F = **begin** fF(..., D.**read()**, E.**read());**

Futures

- Add support for begin expressions
  - —Task with return values
  - —read() operation blocks until value becomes available
  - —No race conditions in container accesses
  - —Can support arbitrary computation DAGs
- Operations, such as assignment and parameter passing, performed on unresolved futures without blocking
- No deadlock cycle can be created with read() calls
  - —If all futures are stored in immutable variables

Futures and Single variables

- Futures are higher level constructs than single variables
  - —Fits into Chapel's multi-resolution language design philosophy

- A future is guaranteed to have a specific producer task
- Easy for the implementation to determine the producer task for a given future.
- Can help in relating locales of future objects to locales for future tasks.

- Any one of a number of tasks can assign to the single variable
- Allows nondeterminism in the producer of the single value
- A single value may never be assigned (i.e. not guaranteed to have a producer) if it is not required

Current Status and Future Work

- Implement future as a library
  - —Implemented using sync variables
  - —Users can instantiate and use future objects
- Add future types and implement begin expressions
  - —Compiler support for begin expressions
- Add automatic coercions from future T to T
  - —Compiler adds type inference support and generates calls to read()

```
const x = begin foo() + begin bar();
```

- Add some form of statement-block expression
  - —Multiple statements inside begin expressions
- Compiler/Runtime Optimizations
  - —Avoid task creation for short-lived computations

Resources

- Available as a Subversion branch on sourceforge
  - http://svn.code.sf.net/p/chapel/code/branches/collaborations/futures
  - Contains multiple examples including SmithWaterman and Cholesky benchmarks (which show promising speedup)
- Mailing list thread
  - https://sourceforge.net/mailarchive/message.php?msg_id=30815892
  - http://sourceforge.net/p/chapel/mailman/chapel-users/thread/alpine.LNX.2.00.1309131418050.327%40bradc-lnx.us.cray.com/#msg31409942