One Parallel Language to Rule them All?
Chapel for HPC, Data Analytics, Machine Learning, …

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What is Chapel?

**Chapel:** A productive parallel programming language
- portable
- open-source (GitHub, Apache 2.0)
- extensible
- a collaborative effort
- a work-in-progress
- designed primarily for High Performance Computing (HPC)

**Goals:**
- Support general parallel programming
  - any parallel algorithm on any parallel hardware
- Make parallel programming far more productive
  - as programmable as Python
  - as fast as Fortran
  - as portable as C
  - as scalable as MPI
  - as fun as your favorite language
Sample Chapel Programs

Explicit parallelism and locality

```chapel
coforall loc in Locales do
  on loc {
    const locTasks = here.maxTaskPar;
    coforall tid in 1..locTasks do
      writeln("Hello from task \n of \n " + 
        "running on \s\n",
        tid, locTasks, here.name);
  }
```

Abstract parallelism and locality

```chapel
use CyclicDist;
config const n = 1000;
var D = {1..n, 1..n}
  dmapped Cyclic(startIdx = (1,1));
var A: [D] real;
forall (i,j) in D do
  A[i,j] = i + (j - 0.5)/n;
writeln(A);
```
Chapel for Data Analytics?

~4 years ago: Nah, seems like Hadoop is serving users well

Then, spoke to Hadoop programmers:
- Not as general, programmable, flexible as desired
- Wishlist matched Chapel well:
  - parallelism, scalability
  - large, distributed data structures
  - productivity-oriented features
- Since then: Spark also arrived on the scene

So:
- Began looking into data analytics within Chapel
- But, what to study…?
Twitter Community Detection Benchmark

Computation steps:
- Read in gzip files storing JSON-encoded tweets
- Find pairs of Twitter users that @mention each other
- Construct a graph from such users
- Run a label propagation algorithm on that graph
- Output the community structure resulting from label propagation
Twitter Graph Creation: Chapel vs Spark*

* Lots of caveats. Chapel and Spark implementations are not necessarily optimal. Computing mutual mentions only. 420 files, XC30 36-cores/locale, Chapel version used gasnet, fifo, gnu, fe29555c. Spark 1.5.2
Twitter study running out of steam… What’s Next?

To make a splash in…
  …data analytics
  …machine learning
  …your favorite parallel, scalable application area

  …what features would a parallel language need?

  …what killer apps / demonstrations should it pursue?

  …what should we do with Chapel?

*We’re interested in collaborating with experts in such areas*
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The Chapel Team at Cray (Summer 2016)

14 full-time employees + 2 summer interns + 1 visiting academic
(one of each started after this photo was taken)
Chapel Collaborations

http://chapel.cray.com/collaborations.html
Questions?
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Example Tweet in JSON format

- Tweets have ~63 fields stored in nested structures

```json
{ "coordinates": null, "created_at": "Fri Oct 16 16:00:00 +0000 2015", "favorited": false, "truncated": false, "id_str": "28031452151", "entities": { "urls": [ { "expanded_url": null, "url": "http://chapel.cray.com", "indices": [ 69, 100 ] } ], "hashtags": [], "user_mentions": [ { "name": "Cray Inc.", "id_str": "23424245", "id": 23424245, "indices": [ 25, 30 ], "screen_name": "cray" } ] }, "in_reply_to_user_id_str": null, "text": "Let’s mention the user @cray – here is an embedded url
```
Reading JSON Tweets

// define Chapel records whose fields reflect only
// the portions of the JSON data we care about

record TweetUser {
    var id: int;
}

record TweetEntities {
    var user_mentions: list(TweetUser);
}

record User {
    var id: int;
}

record Tweet {
    var id: int,
    user: User,
    entities: TweetEntities;
}

proc process_json(...) {
    var tweet: Tweet;

    while true {
        // “%~jt” format string:
        //      j: JSON format
        //      t: any record
        //      ~: skip other fields
        got = logfile.readf("%~jt",
                          tweet,
                          error=err);
        if got && !err then
            handle_tweet(tweet);
        if err == EFORMAT then ...;
        if err == EEOF then break;
    }
Processing Tweets: Productivity Comparison

Spark
- RDDs are immutable
- Algorithm written in terms of mapping a fn on data

Chapel
- Chapel arrays are mutable
- Algorithm written in terms of parallel loops