Taskfarm

A Client/Server Framework for Supporting Massive Embarrassingly Parallel Workloads

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7th March 2024

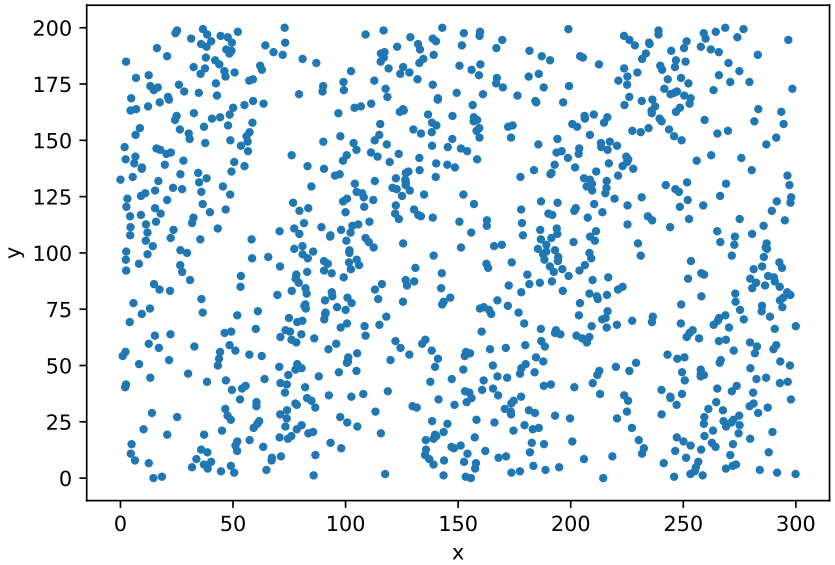
Outline

The Problem

- processing raw satellite data from ESA CryoSat mission
- data consist of point data in space and time along satellite paths
- create grid of ice elevation change

The Problem

Approach



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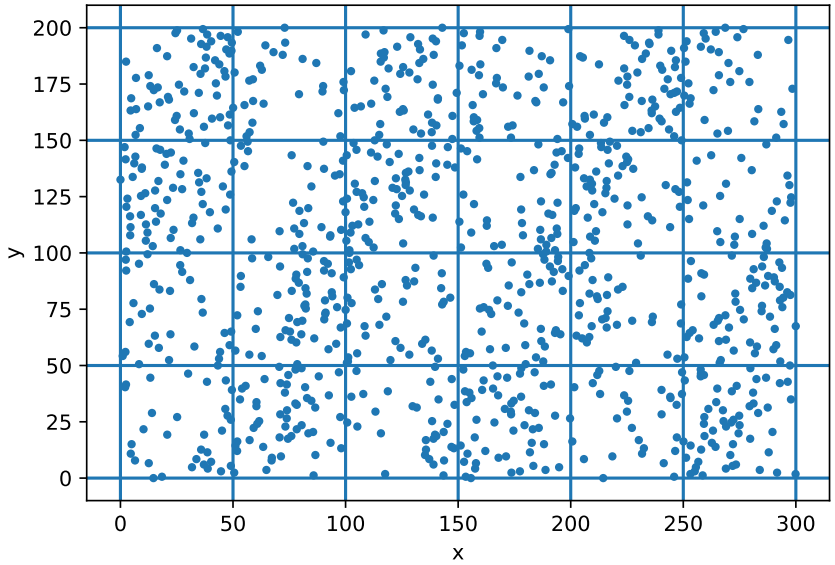

- define grid

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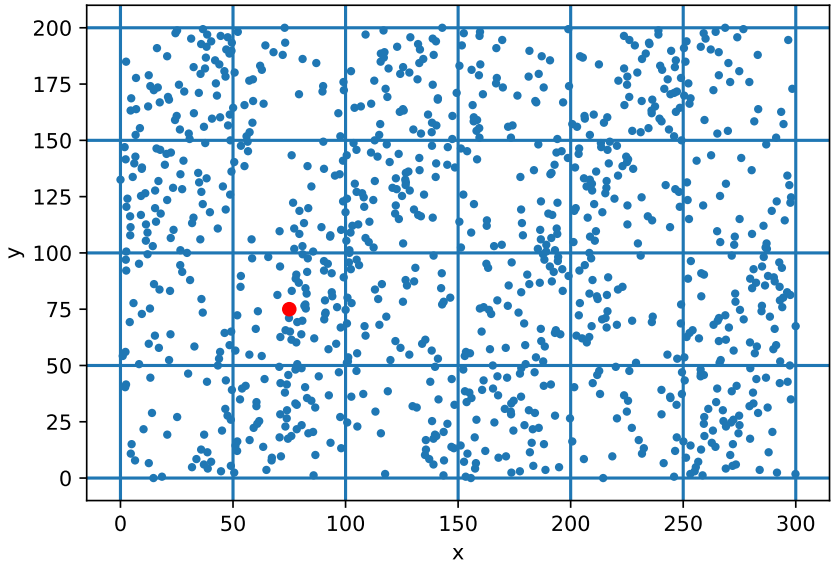

- define grid
- for each post

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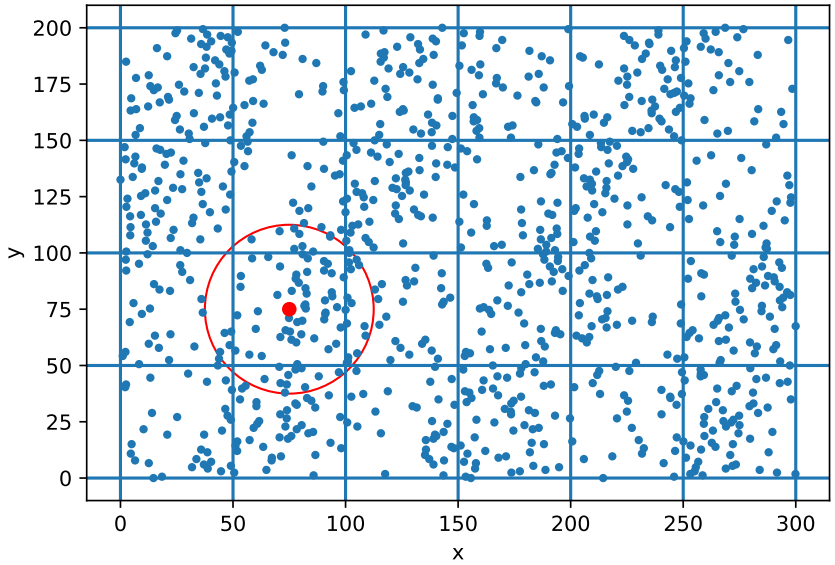

- define grid
- for each post
- consider all points that fall within radius r

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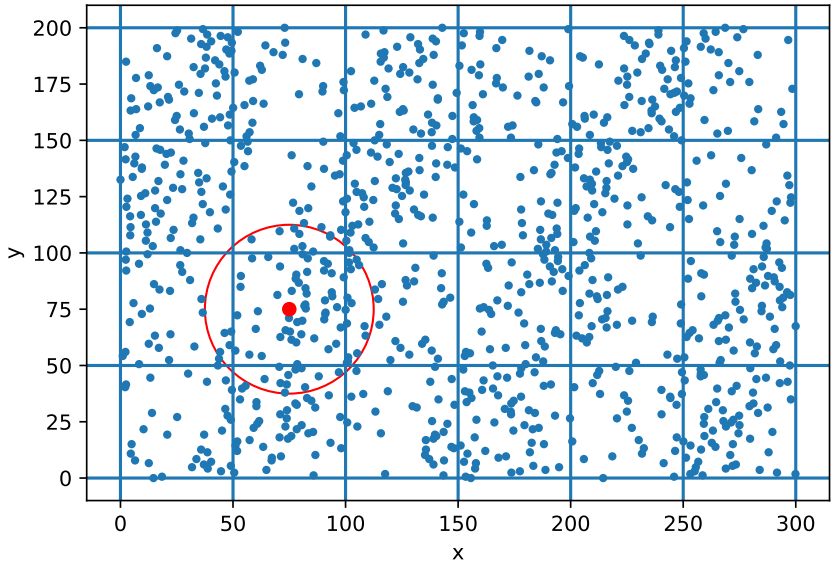

- define grid
- for each post
- consider all points that fall within radius r
- fit

$$z(x, y, t) = c_0 x + c_1 y + \dot{h} t + c_2$$

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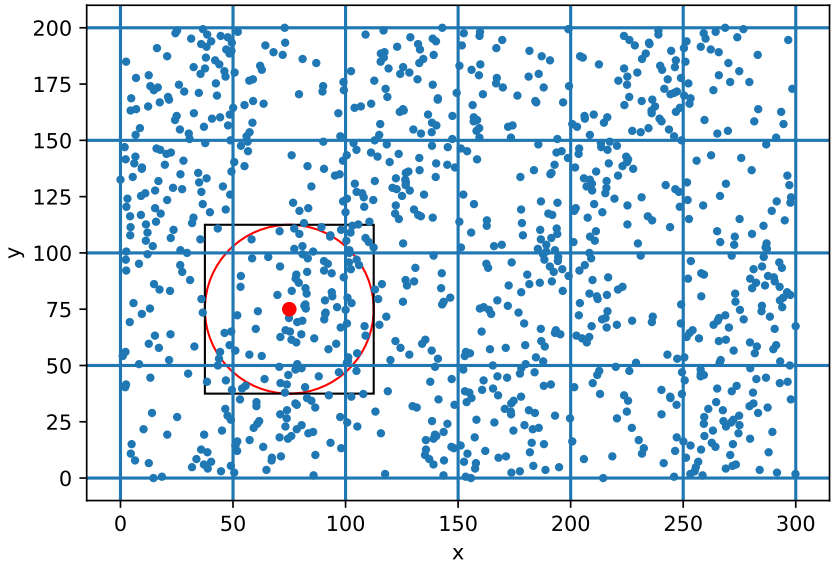

- consider points within square $2r$ centred on post

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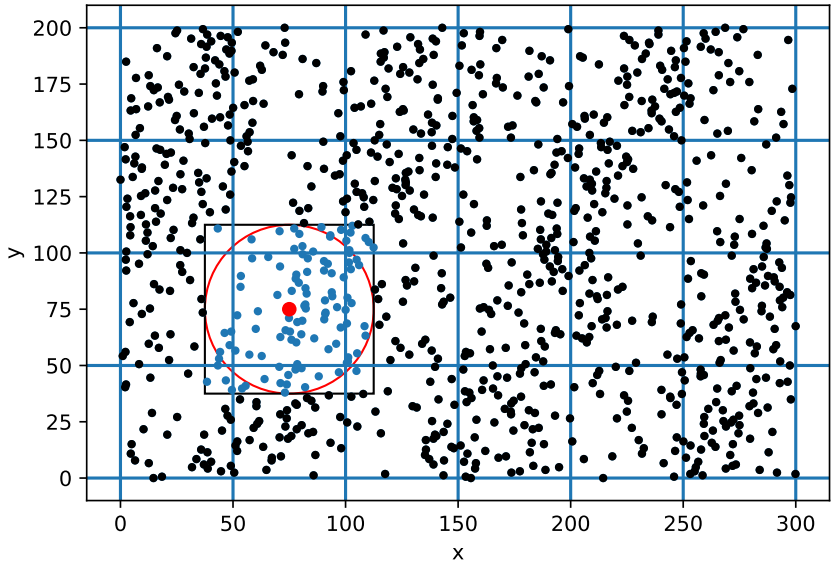

- consider points within square $2r$ centred on post
- calculate distance of each point to centre

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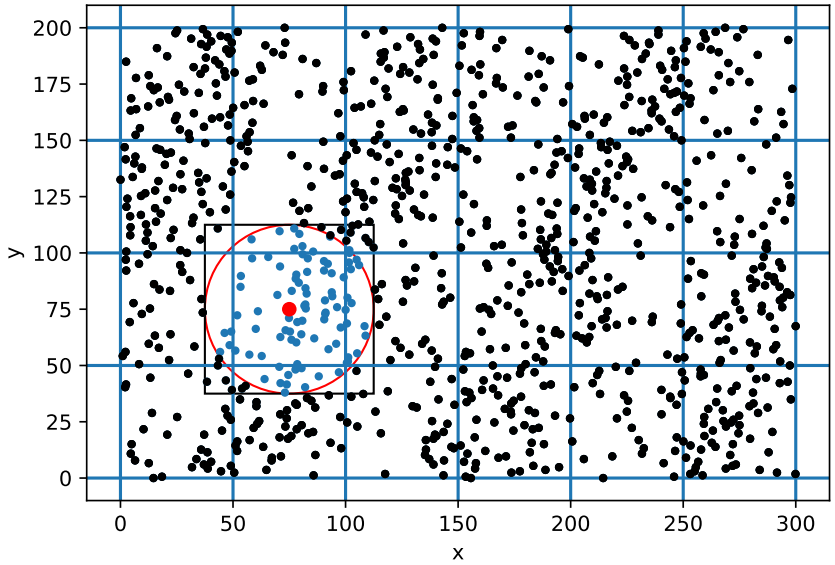

- consider points within square $2r$ centred on post
- calculate distance of each point to centre
- only use points with distance $< r$ for fitting

The Problem

Challenge

- big data, for Antarctica >1TB

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- lat/lon grid at poles has singularity

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Challenge

- big data, for Antarctica >1TB
- lat/lon grid at poles has singularity
- data set grows

Implementation

embarassingly parallel

Implementation

$$\text{embarassingly parallel} \Rightarrow \text{taskfarm}$$

Implementation

embarassingly parallel $\Rightarrow$ taskfarm

- define projection

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- define output grid

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- define projection
- define output grid
- tile output grid
- compute ice elevation change for each post
- assemble tiles

Implementation

Input

- load data, project it and dump into chunked point DB

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- chunks are stored in deep directory structure
- path is linearised chunk index (in hex)

Implementation

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- identify required chunks and load them

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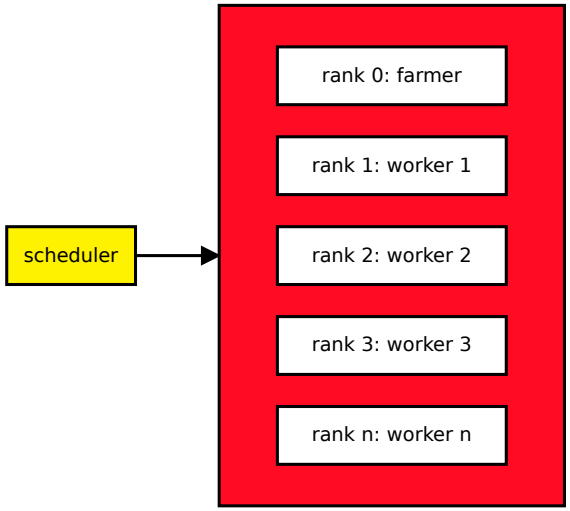
  - fit data
- store tile

Taskfarm

MPI



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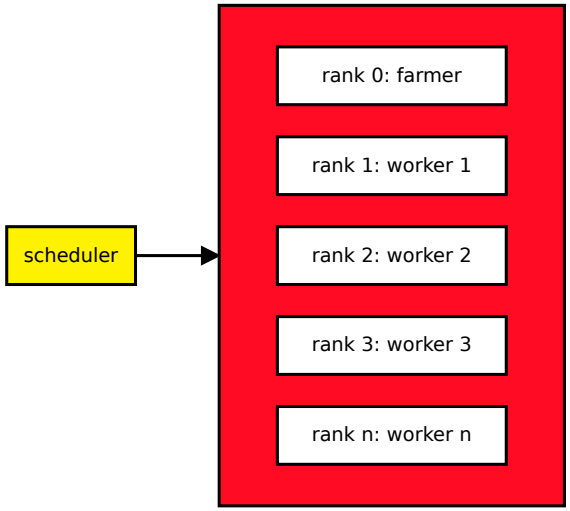

good a programming model we all know and love

Taskfarm

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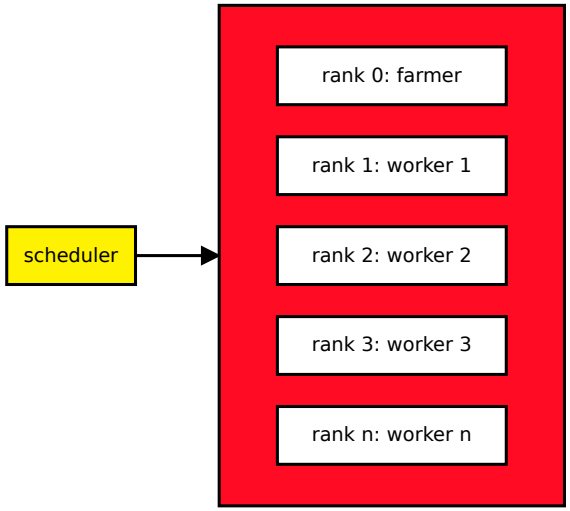

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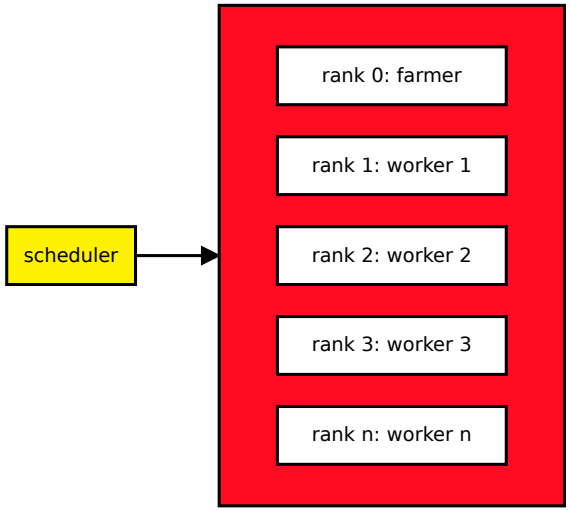

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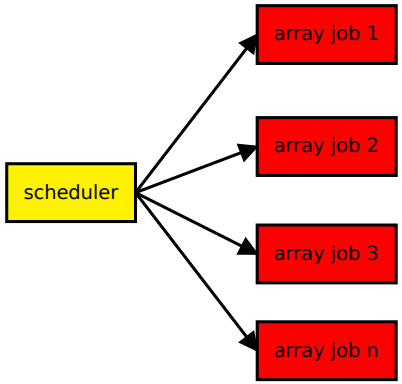
bad the size of the task farm is fixed

ugly the entire farm burns down when a worker crashes

Taskfarm

Array Job



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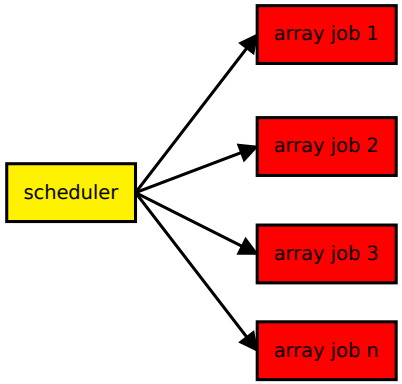

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- the farm can dynamically grow/shrink
- crashing jobs don't take the farm down

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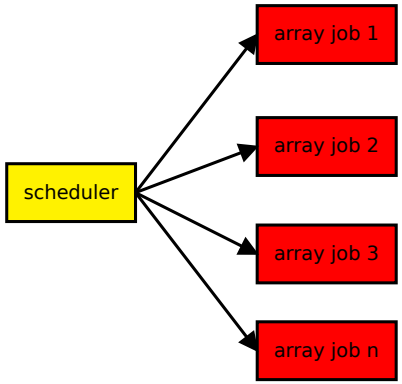

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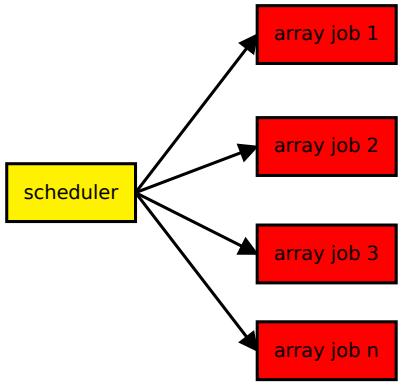

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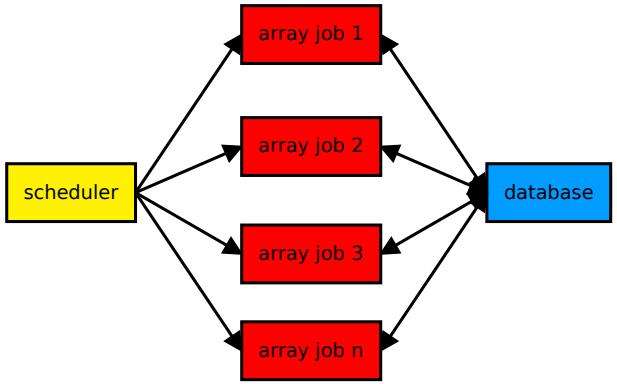
ugly when the farm gets huge it is hard keeping track

Taskfarm

Database



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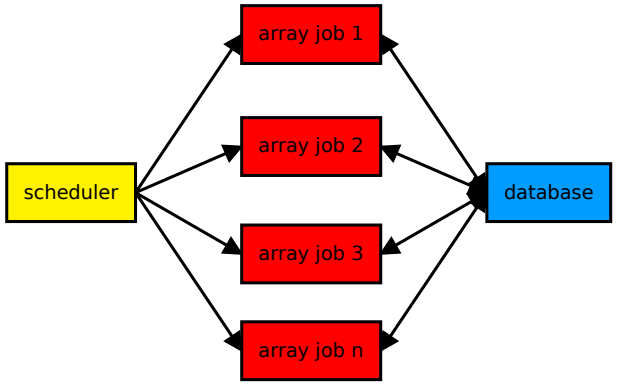

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- can use auxiliary programs to monitor progress

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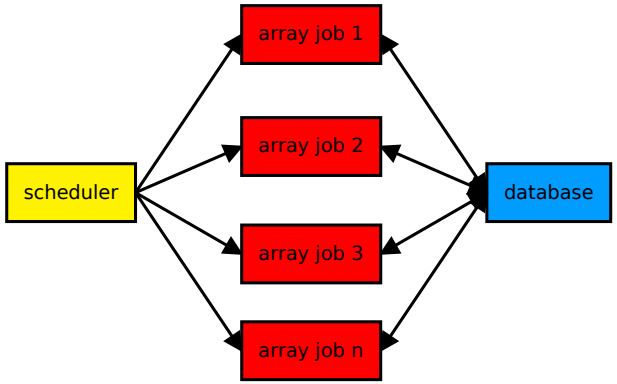

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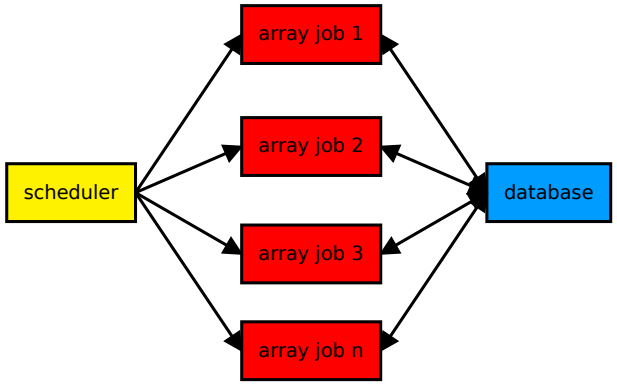

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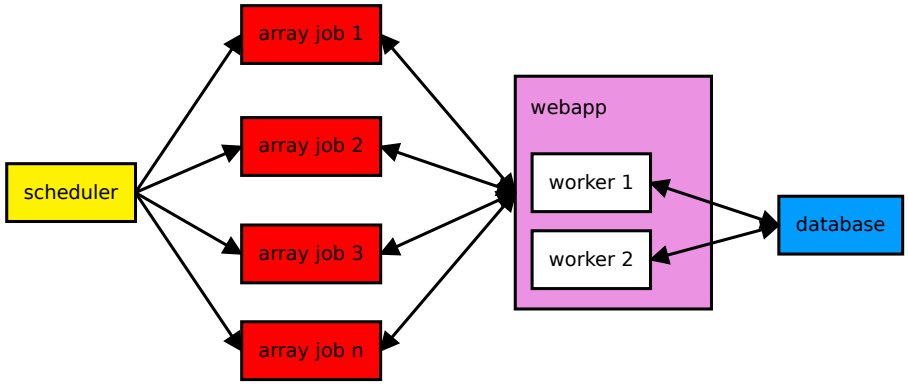
ugly limited number of parallel connections

Taskfarm

Webapp



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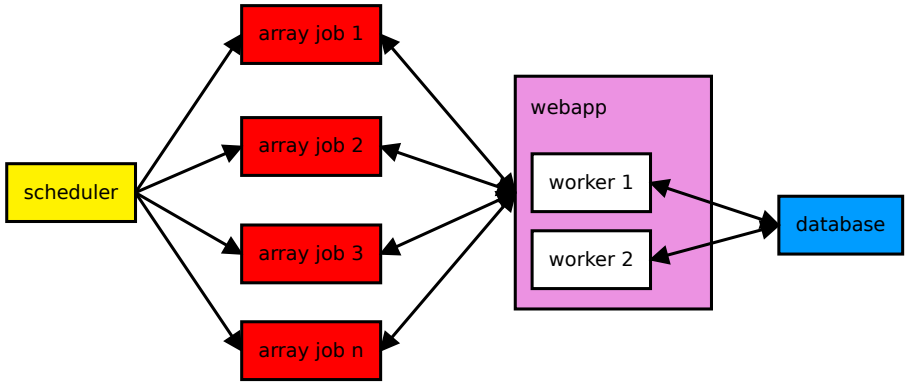

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- can have many parallel connections
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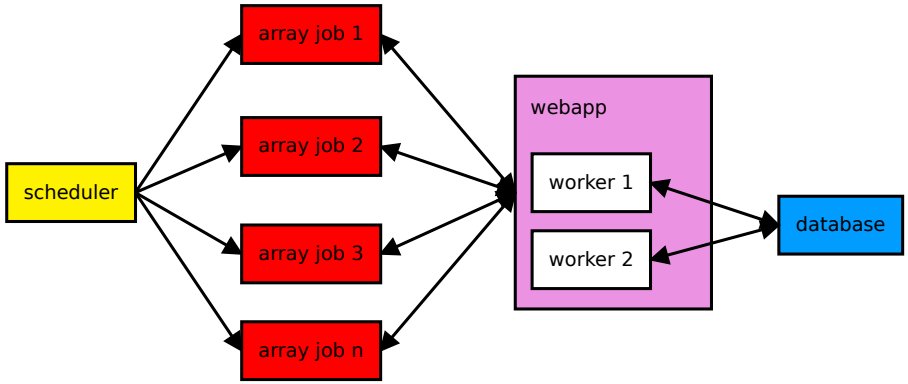

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- can check taskfarm status from outside cluster

bad need to host the web app somewhere

Taskfarm

Implementation

- flask
- flask-sqlalchemy
- flask-httpauth
- a database with row locking, eg postgresgl
- gunicorn
- web server

Taskfarm

Example Code

```
from taskfarm_worker import TaskFarmWorker

# connect to taskfarm
tf = TaskFarmWorker(
     'user', 'secret',
     'da8eb1c10eac4cefb39c8889d6d7170a',
     url_base='http://localhost:5000/api/')
print(tf.percentDone)

# loop over the tasks
for t in tf.tasks:
     print("worker {} processing task {}"
           .format(tf.worker_uuid, t))
     # do some work
     # update the percentage done
     tf.update(50)
     # do some more work and update percentage
     tf.update(100)
     # mark task as completed
     tf.done()
```

Software Publishing

- documentation - sphinx + read the docs

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- unit testing of both server and client

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