eHive Workshop

part 2: How to create pipelines (configuration files)

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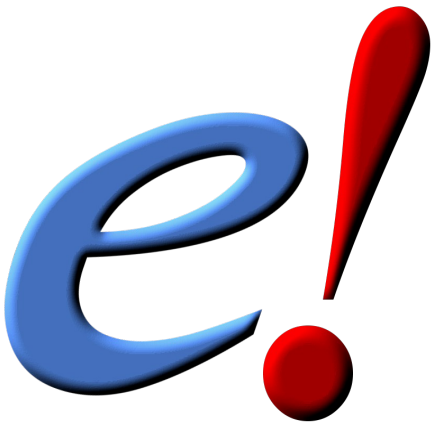


Before we begin:

- Please make sure you have correct setup from part 1:
  - You are running *screen -RD* on one of farm login nodes
  - ensembl (core) and ensembl-hive repositories are installed and up-to-date:

    $ cvs -q update -dP
  - $ENSEMBL_CVS_ROOT_DIR points to the directory holding the checkouts
  - Slides are here:
    $ENSEMBL_CVS_ROOT_DIR/ensembl-hive/docs/presentations/HiveWorkshop_Sept2013
  - $PERL5LIB includes ensembl/modules and ensembl-hive/modules
  - $PATH includes ensembl-hive/scripts
  - You have a username+password on our training MySQL server

    (set them in $EHIVE_* environment variables for the duration of the course)

- Do we need breaks?

Modularity of pipelines. PipeConfigs & Runnables

- A Hive pipeline is defined in a PipeConfig file which references one or more Runnable modules.

- Many tasks can be solved by using “universal” Runnables provided by the Hive (SystemCmd, SqlCmd, JobFactory, Dummy), but sometimes you have to write your own application-specific Runnables.

- We shall learn to use universal Runnables before making our own
(however it may be the opposite of what you do in practice)

- Hive’s “universal” Runnables live here:

  $ENSEMBL_CVS_ROOT_DIR/ensembl-hive/modules/Bio/EnsEMBL/Hive/RunnableDB/

- Hive’s PipeConfig files live here:

  $ENSEMBL_CVS_ROOT_DIR/ensembl-hive/modules/Bio/EnsEMBL/Hive/PipeConfig/

They are written in a subset of Perl.

The simplest pipeline : AnyCommands_conf.pm

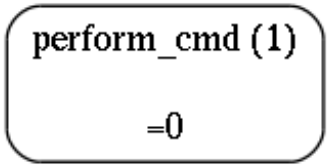
- Open the file - this is the smallest PipeConfig possible:

```
use base ('Bio::EnsEMBL::Hive::PipeConfig::HiveGeneric_conf');      #  or subclass

sub pipeline_analyses {
    return [
        {   -logic_name    => 'perform_cmd',
            -module        => 'Bio::EnsEMBL::Hive::RunnableDB::SystemCmd',
        },
    ];
}
```

```
$ init_pipeline.pl Bio::EnsEMBL::Hive::PipeConfig::AnyCommands_conf
```

```
$ generate_graph.pl -url $EHIVE_URL -out any_c_empty.png
```

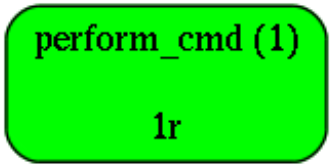


or open http://guihive.internal.sanger.ac.uk:8080/ instead

Seeding and running AnyCommands_conf.pm

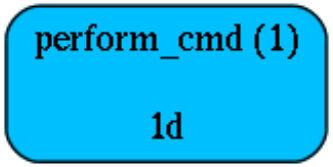
- No jobs - we will have to seed them:

```
$ seed_pipeline.pl -url $EHIVE_URL -logic_name perform_cmd \
    -input_id '{"cmd" => "echo Hello, world"}'
```



- and run:

```
$ runWorker.pl -url $EHIVE_URL
```



- Practical to a certain extent (analysis_capacity, batch_size, resources)

Analysis-wide parameters and substitution

- We can define values for old parameters and create new ones:

```
sub pipeline_analyses {
    return [
        {   -logic_name     => 'perform_cmd',
            -module         => 'Bio::EnsEMBL::Hive::RunnableDB::SystemCmd',
            -parameters => {
                "cmd" => "gzip #filename# ",
            },
        },
    ];
}
```

"cmd" defined on the analysis level

created a new parameter that can be defined by jobs

- Exercise:
  seed a few jobs and run them (you can copy some compressible files from ~lg4/work/pdfs)

- Automated seeding of jobs?

```
for filename in `find pdfs/ -name '*.pdf'` ; do
    seed_pipeline.pl -url $EHIVE_URL \
        -logic_name perform_cmd -input_id "{ 'filename' => '$filename' }";
done
```

Factories and dataflow : CompressFiles_conf.pm

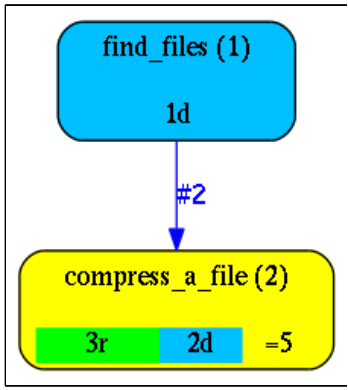
- Dataflow Rules can be used to make Jobs seed other Jobs
- Factory is an Analysis whose only aim is to seed other Jobs, create a “fan”, turn time into space
- Higher level input

```
sub pipeline_analyses {
    return [
        {   -logic_name => 'find_files',
            -module     => 'Bio::EnsEMBL::Hive::RunnableDB::JobFactory',
            -parameters => {
                'inputcmd'     => 'find #directory# -type f ',
                'column_names' => [ 'filename' ],
            },
            -flow_into => {
                2 => [ 'compress_a_file' ],
            },
        },
        {   -logic_name    => 'compress_a_file',
            -module        => 'Bio::EnsEMBL::Hive::RunnableDB::SystemCmd',
            -parameters    => {
                'cmd'       => 'gzip #filename#',
            },
            -analysis_capacity => 4,
        },
    ];
}
```

created a new higher level parameter

what to call the output

where the output should go



Dataflow conventions

- Each Dataflow Event is a pair (branch_number, hash_of_parameters+).
- In our example the 'find_files' job that we seed with

```
{ 'directory' => 'pdfs' }
```

generates the following Dataflow Events:

```
#2, { 'filename' => 'pdfs/first.pdf' }
#2, { 'filename' => 'pdfs/second.pdf' }
. . .
#2, { 'filename' => 'pdfs/last.pdf' }
#1, { 'directory' => 'pdfs' }
```

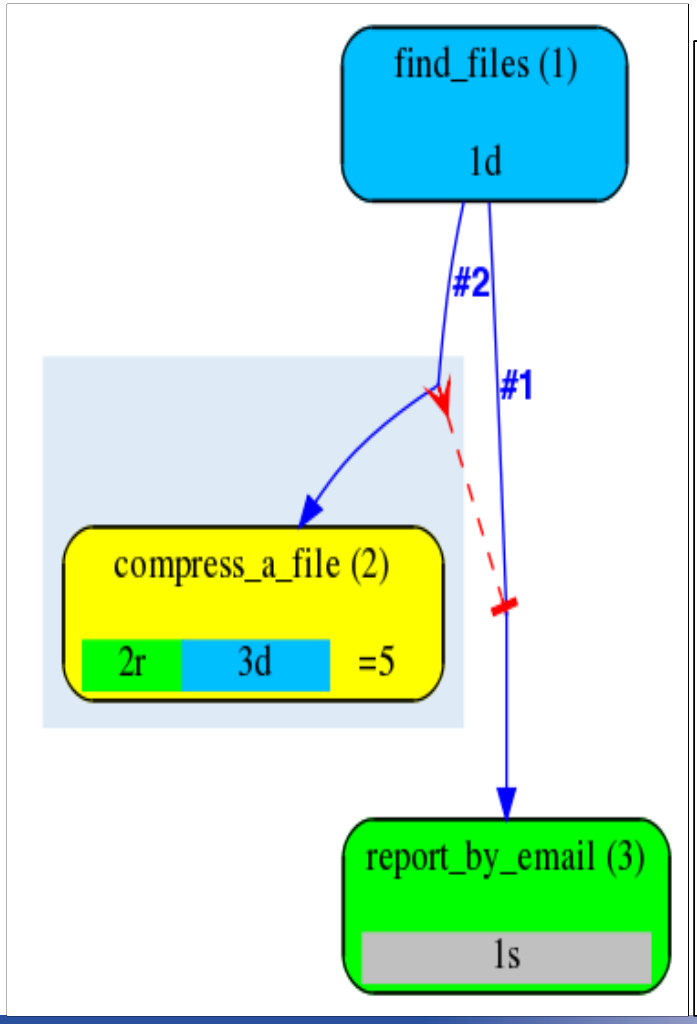
The "fan"

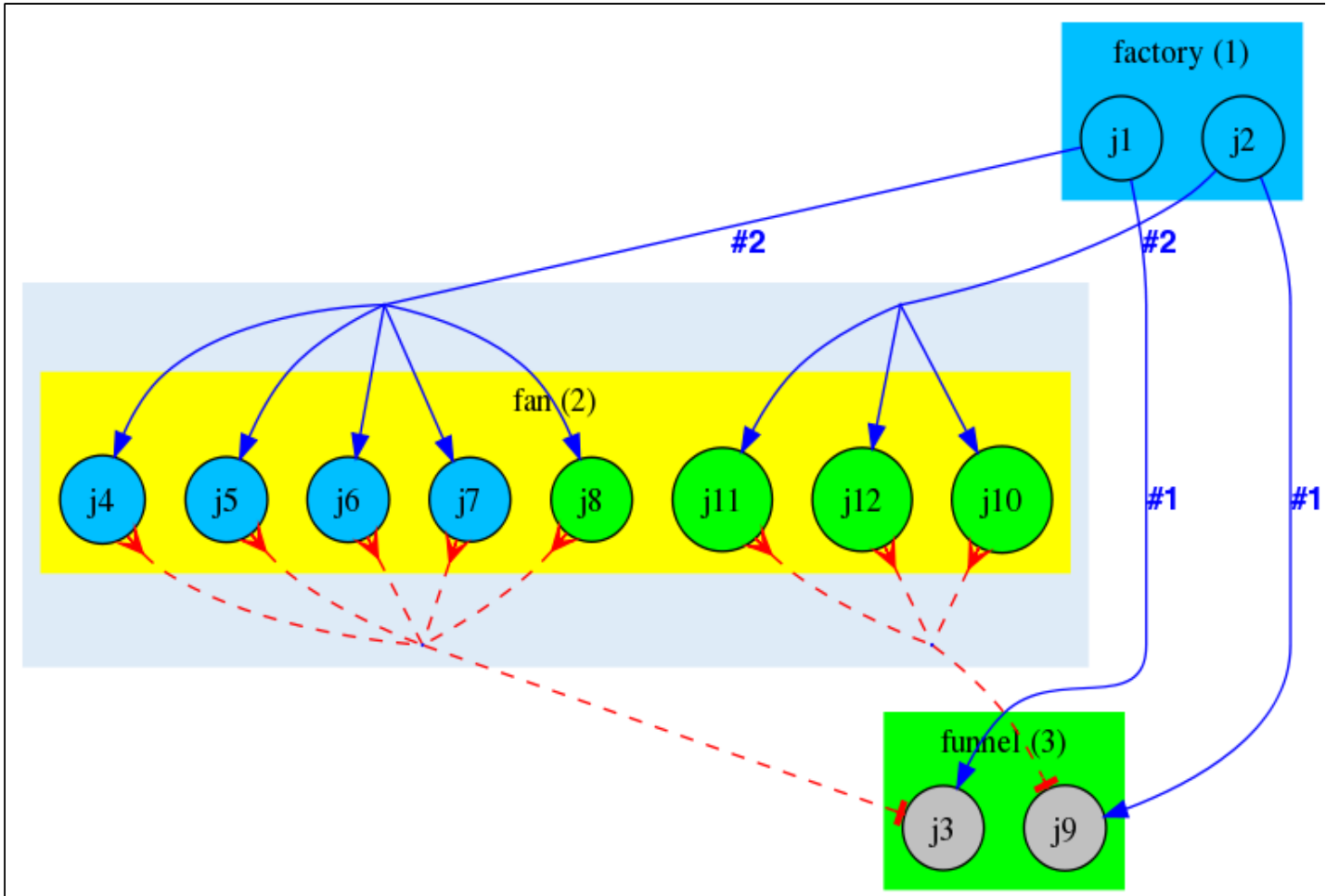
"autoflow" event,
helps to bind analyses consecutively

- "Reserved" branch numbers that have their own meaning (similar to UNIX file descriptors):
  - 1 is almost always present, it is the "continuation" after Job is 'DONE'
  - 2 is used by many Factory Runnables to emit the "fan" (of Jobs, etc)
  - -1 : "postmortem dataflow after MEMLIMIT" on LSF
  - -2 : "postmortem dataflow after RUNLIMIT" on LSF
  - 3, 4, 5... : unreserved, can be used for anything
- Each Runnable has its own set of branch_numbers that it may emit Dataflow Events into.
  Check its documentation or code to make sure the dataflow you are wiring is live.
  What happens if it's not?
- How to regain the single thread of control?

Regaining single thread of control: semaphored dataflow

- Built-in mechanism for converging individual threads back together.
- Based on semaphores that can block an individual job by a set of prerequisite jobs.





Semaphored dataflow in a PipeConfig

- Creating a funnel Analysis : let the pipeline send us a notification:

```
{       -logic_name    => 'report_by_email',
        -module        => 'Bio::EnsEMBL::Hive::RunnableDB::NotifyByEmail',
        -meadow_type => 'LOCAL',  # NB: farm nodes may not support sendmail
        -parameters    => {
            'email'   => $ENV{'USER'} . '@sanger.ac.uk',    # what if it's wrong?
            'subject' => 'pipeline has finished',
            'text'    => 'done compressing files in #directory#',
        },
},
```

- Linking two rules together happens in the emitting Analysis:

```
-flow_into => {
    '2->A' => [ 'compress_a_file' ],
    'A->1' => [ 'report_by_email' ],
}
```

creates a group of jobs that control a semaphore

creates one job that is controlled by the semaphore

- Try running.
  (solution: CompressFiles2_conf)
- A break?

Parameters and their implicit propagation

- Exercise 1:
  How do we set a default directory name for analysis 1?

- Exercise 2:
  Introduce another parameter `'only_files'` to define the wildcard pattern for filenames we want to compress

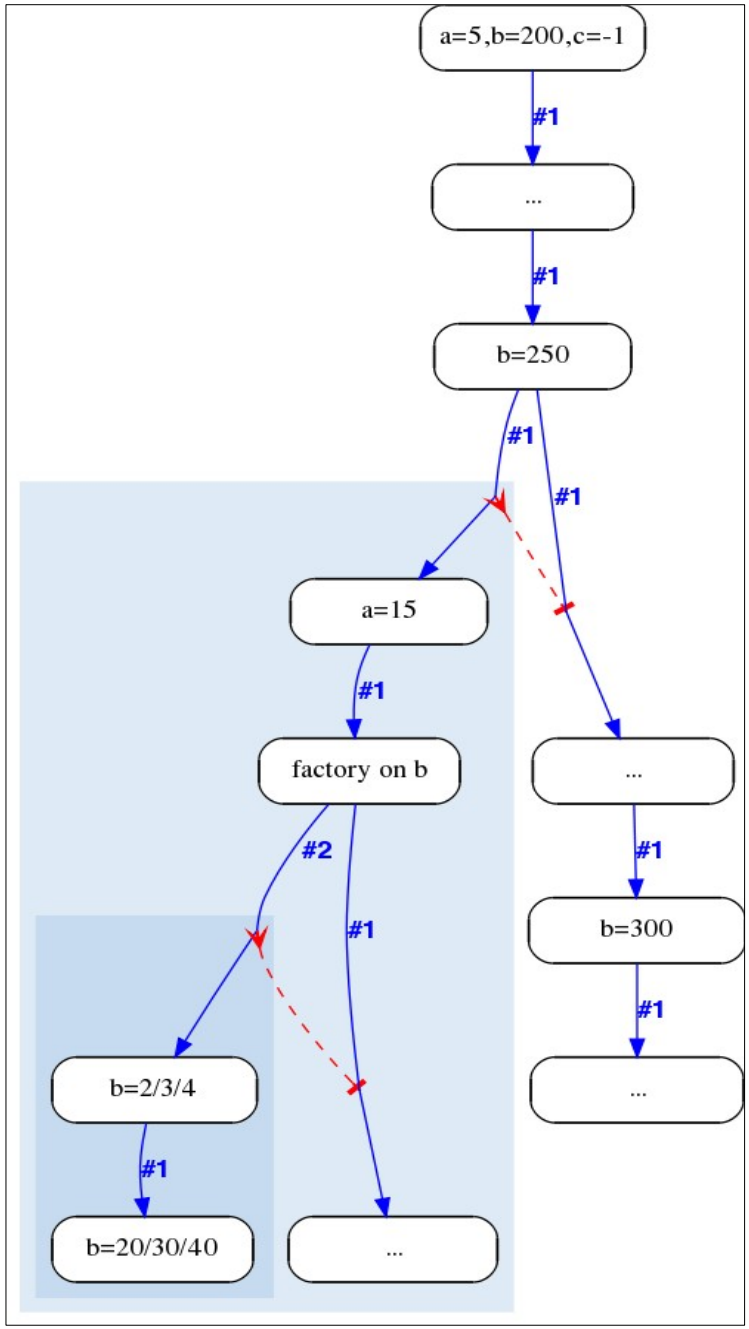
- What if we wanted to pass something to analysis 2 directly?
  Say, if we want the same analysis to act as decompressor:
  `'cmd' => 'gzip #gzip_flags# #filename#'`
  and then set `'gzip_flags'` to `'-d'` somehow/somewhere?

- First, pass the parameter to the job being seeded, then propagate it

- Explicit propagation using templates vs implicit propagation

How implicit parameter propagation works

```
{
    my $a=5; my $b=200 ;my $c=-1;
    …
    $b=250 ;
    …
        {
            my $a=15;
            for my $b (2,3,4) {
                $b *= 10;
            }
            …
        }
    …
    $b=300;
}
```



Using implicit parameter propagation

- What if we wanted to pass something to analysis 2 directly?
  Say, if we want the same analysis to act as decompressor:

```
'cmd'        => 'gzip #gzip_flags# #filename#'
```

- Implicit parameter propagation mechanism is off by default, switch it on using:

```
sub hive_meta_table {

    my ($self) = @_;
    return {
        %{$self->SUPER::hive_meta_table},
        'hive_use_param_stack'  => 1,
    };
}
```

- Can you now propagate 'gzip_flags' to analysis 2?
  (solution: CompressFiles3_conf)

Capturing data : another role of JobFactory

- Both SystemCmd and SqlCmd only run your command, no output is captured in any structured way.
  - So SqlCmd is usually used to INSERT, DELETE, UPDATE, CREATE/ALTER/DROP TABLE, but not with SELECT.

- JobFactory is not specifically creating Jobs - it simply transforms streams of “things” into Dataflow Events that may be converted into Jobs, stored in database tables, or accumulated. It is the wiring that defines what happens next.

```
{   -logic_name    => 'pre_compress_size',
    -module        => 'Bio::EnsEMBL::Hive::RunnableDB::JobFactory',
    -parameters    => {
        'inputcmd'      => "wc -c #filename# | sed -e 's/^ *//' ",
        'delimiter'     => ' ',
        'column_names'  => [ 'orig_size', 'orig_filename' ],
    },
},
```

- Insert and wire it correctly.
  - How to check whether we have captured anything?
  - How to pass it outside?

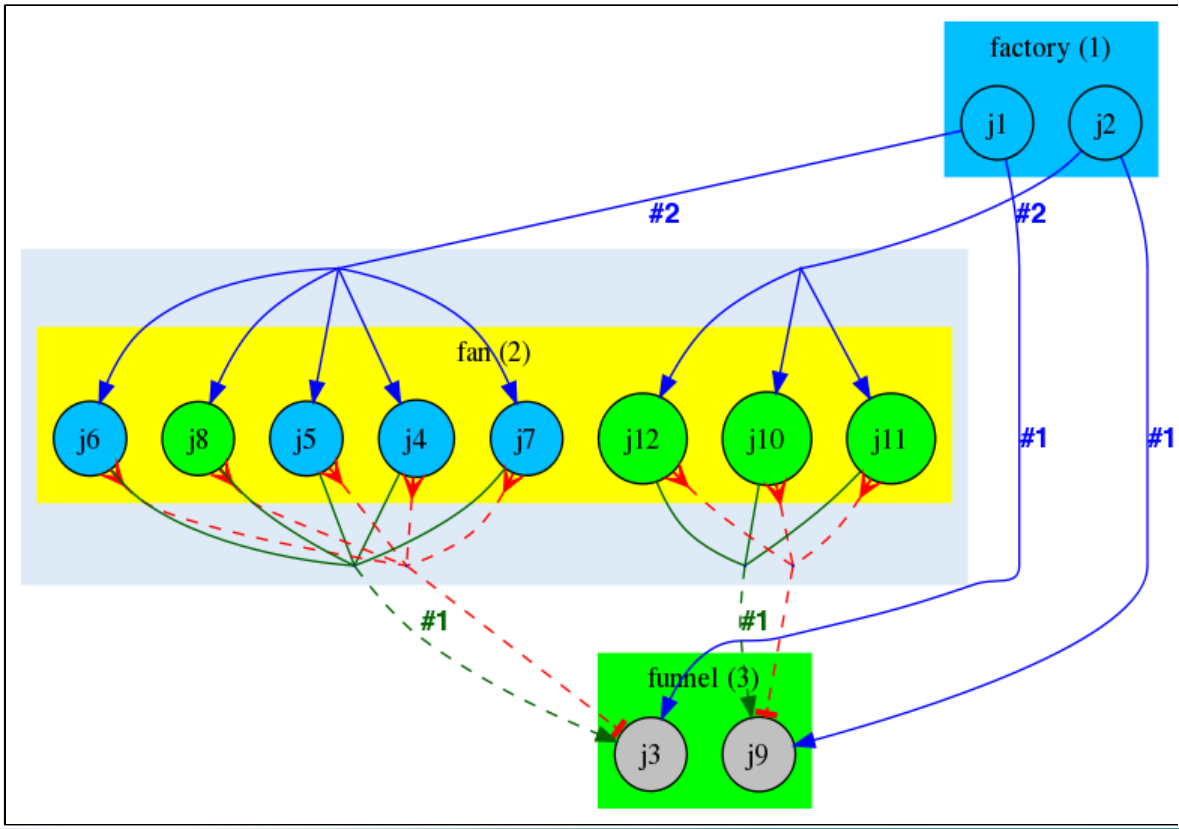
Accumulating data from a semaphore group

- How do we pass the data from the box into the funnel?
- The data can be passed from any job within the box into the correct funnel Job
- Different structures or combinations can be accumulated (hashes, arrays, piles, multisets)
- pseudo-Analysis names as targets for Dataflow (with or without templates).

- `':////accu?hash_name={key_name}'`
- `':////accu?array_name=[index_name]'`
- `':////accu?pile_name=[]'`
- `':////accu?multiset_name={}'`

- see LongMult_conf for example.

Flow the data into accu (which branch?).



Advanced parameter substitution : expressions

- What if we want to compute a value of #alpha#+1 rather than just a string?

```
'alpha_plus_one' => '#expr( #alpha#+1 )expr#'
```

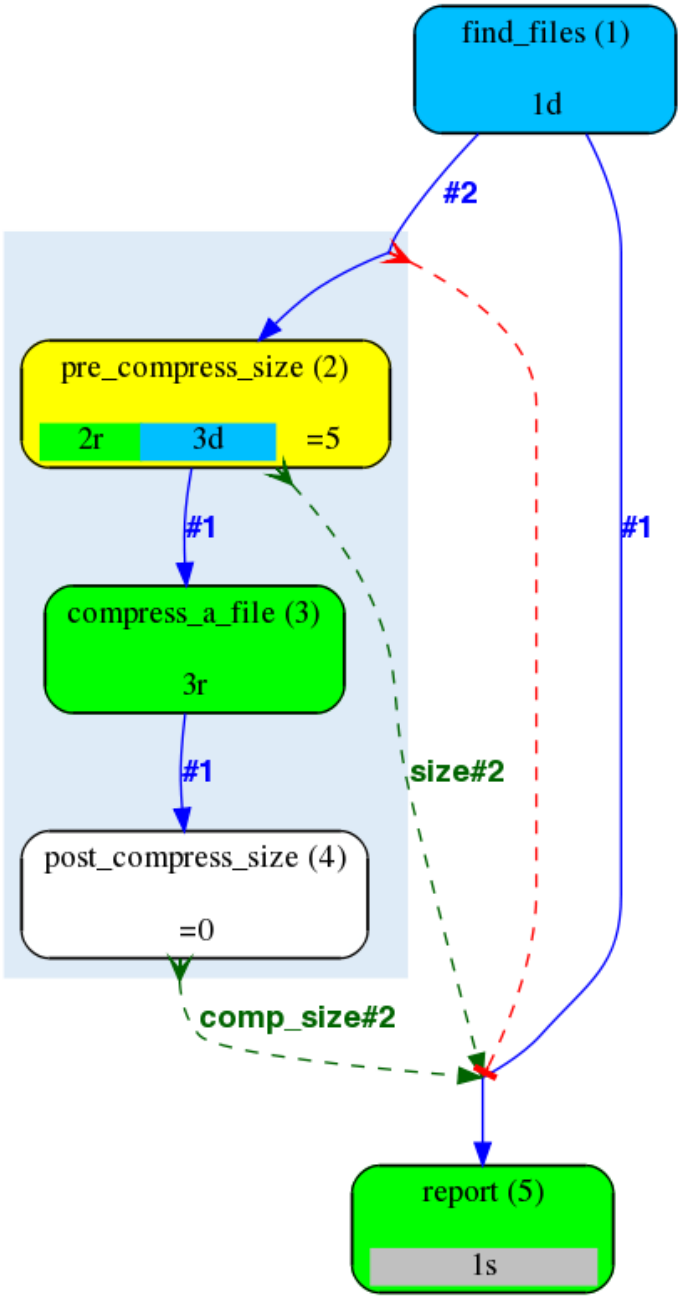
- Any Perl expression can be evaluated as follows:
  - first, #alpha# will be text-substituted with the value of alpha parameter
  - then the resulting string will be evaluated
  - put a space between dollar and the name ($ beta) if you want standard Perl interpretation of the variable
  - put curly braces around #alpha# if you want to dereference a reference:
    - @{ #array_ref# }
    - %{ #hash_ref# }

- We can flatten accumulated structures (that are not scalars) into scalars using #expr()expr# . For example,

```
'min_comp_size' => '#expr(min values %{#comp_size#})expr#',
'max_comp_size' => '#expr(max values %{#comp_size#})expr#',
'text'    => 'compressed sizes between #min_comp_size# and #max_comp_size#',
```

Exercise: accumulation + substitution

- Let's put it all together:
  - Factory on a directory to dataflow single filenames
  - compute their sizes and accumulate them
  - compress the files
  - compute the compressed sizes and accumulate
  - funnel flattens the accumulated structures and emails you the report
- Solution: CompressFiles4_conf



Questions?

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