Self-Checkpointing

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The Challenge

- Suppose your job will run for a long time
  - Reminder: Look at the "Ideal Jobs" table
  - But let's say more than about 8 hours
- Likely removed from the Execution Point before done: HTCondor will restart job somewhere else
- ***But!*** It starts over and loses all progress (*badput*)

Some Solutions

- **Ideal solution:** Break up job into shorter pieces
  - Try to get back into that “Ideal Jobs” column

- But this does not always work; for example, when one iteration depends on the previous one

- Another solution: **Self-checkpointing**

  The executable periodically saves its progress to disk – a *self*-made *checkpoint* – so that it can resume from that point if interrupted later, losing minimal progress

Requirements

- Your executable can self-checkpoint and resume progress from checkpoint file(s) upon restart
  - If you have the source code, you can probably do this
  - If not, the code must have the feature already
  - A wrapper script *may* be able to help, but seems tricky
- Using HTCondor ≥ 9.0.6 is good; ≥ 9.10.0 is best
  - CHTC and OSPool are both ≥ 9.10.0
- Job universe: vanilla (default) or Docker (container)

HTCondor Has 2 Ways to Checkpoint

- **Exit-driven self-checkpointing**
  - Since HTCondor ≥ 8.9.7
  - *Waaaay* better for most use cases, esp. in OSG
  - What is shown here

- Eviction-driven self-checkpointing
  - Not even worth talking about for OSG!
  - Documented in the HTCondor Manual
  - But don't use it 😁

Technical Details

HTCondor Submit File Changes

- Tell HTCondor what special exit code your software will use when checkpointing (85 is suggested):

```
checkpoint_exit_code = 85
```

- Tell HTCondor what files (on the Execution Point) to save (on the Access Point) and restore *when moved to a new Execution Point* — list files and directories, include output file(s) if cumulative:

```
transfer_checkpoint_files = foo.txt, ...
```

Example Submit File

```
executable = my_software
transfer_input_files      = my_input.txt
transfer_checkpoint_files = my_output.txt, temp_dir, temp_file.txt
transfer_output_files     = my_output.txt

request_cpus   = 1
request_memory = 1GB
request_disk   = 1GB

log    = example.log
output = example.out
error  = example.err

checkpoint_exit_code = 85

queue
```

Notes About Checkpointed Files

- If you omit **`transfer_checkpoint_files`**, HTCondor uses **`transfer_output_files`** (or its defaults)

- Consider Access Point storage needs; can estimate as:

  number of running jobs × *total size of checkpoint files*

  (OSPool uses your **`/home`** quota; elsewhere: ask admin)

- So, save only what you need! Because it identifies exact files, it can help to use **`transfer_checkpoint_files`**

Executable (Code) Changes

- Executable may run many times before finishing; external process (HTCondor) reruns it until *done*
- Periodically write state to file(s), then immediately exit with **`transfer_checkpoint_files`** (85)
- Any other exit code indicates *done* (good or error)
- At start-up, executable must check for presence of checkpoint file(s); **if absent**, start at beginning, but **if present**, read file(s) and resume from that point

Self-Checkpoint Frequency

- Balance overhead versus (risk of) lost computing
  - Writing to disk can be slow and restarts take time
  - Test early! Collect metrics (checkpoint & restart times)
- Look for natural checkpoint times
  - Generally, when there is the least data to write
  - Often between outermost iterations
  - Could use iteration count, time, …
- As a starting point, checkpoint every 1–2 hours

Debugging Tips

- For testing, you can force HTCondor to stop your job and run again (new sandbox, maybe new EP):

```
condor_vacate_job JobID
```

- If HTCondor has transferred checkpoint files back to the Access Point, you can get a copy with:

```
condor_evicted_files get JobID
```

Step-by-Step Example

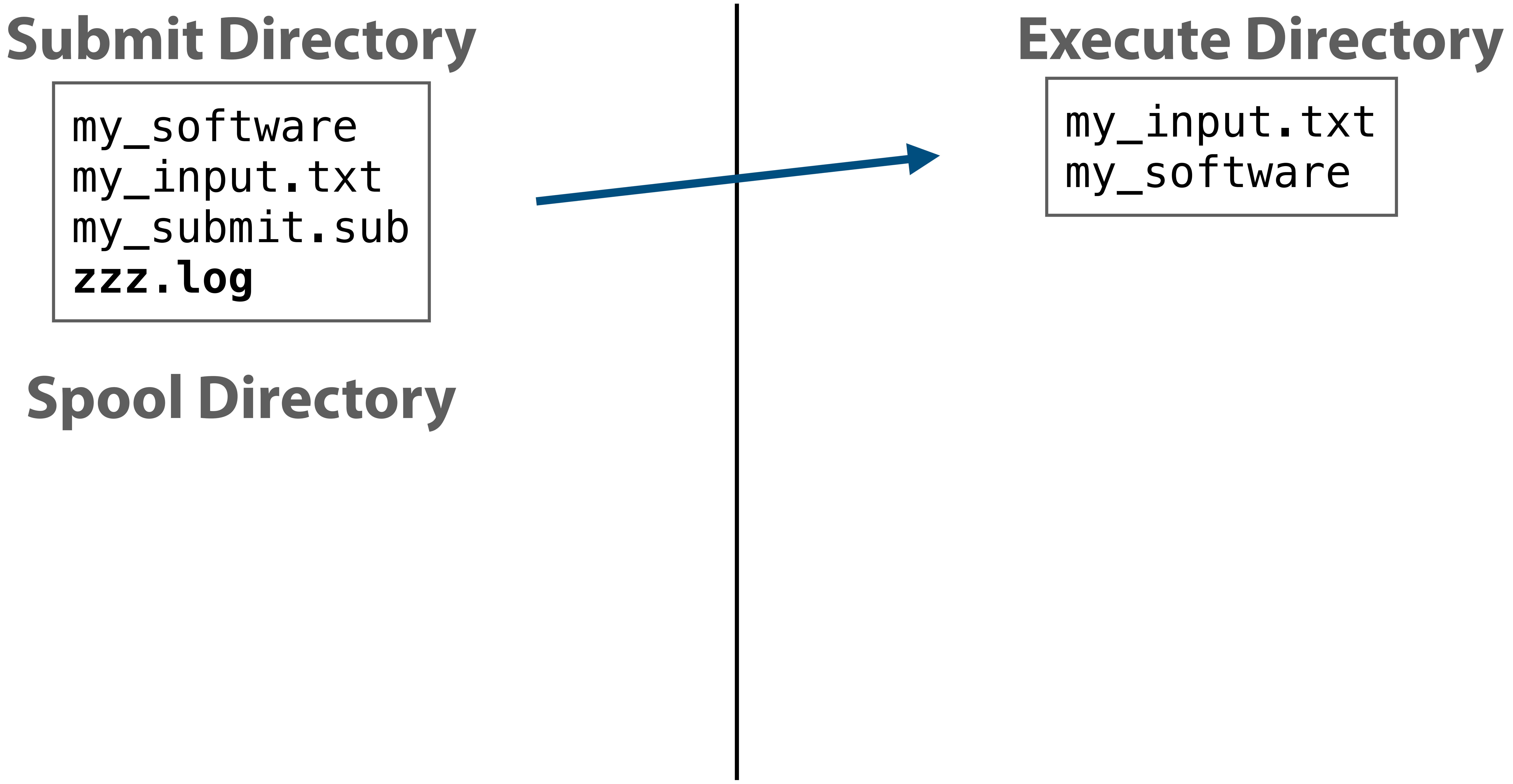
Example Step 1: Before Submit

Submit Directory

```
my_software
my_input.txt
my_submit.sub
```

```
executable = my_software
transfer_input_files = my_input.txt
transfer_checkpoint_files = my_output.txt, temp_dir,
                            temp_file.txt
transfer_output_files = my_output.txt

request_cpus   = 1
request_memory = 1GB
request_disk   = 1GB

log    = zzz.log
output = zzz.out
error  = zzz.err

checkpoint_exit_code = 85

queue
```

Example Step 2: Just Before Execute



Example Step 3: After 1 Minute

Submit Directory

```
my_software
my_input.txt
my_submit.sub
zzz.log
```

Spool Directory

Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/1.txt
temp-dir/2.txt
temp-file.txt
trash.txt
```

Example Step 4: After 1 Hour – exit(85)

Submit Directory

```
my_software
my_input.txt
my_submit.sub
zzz.log
```

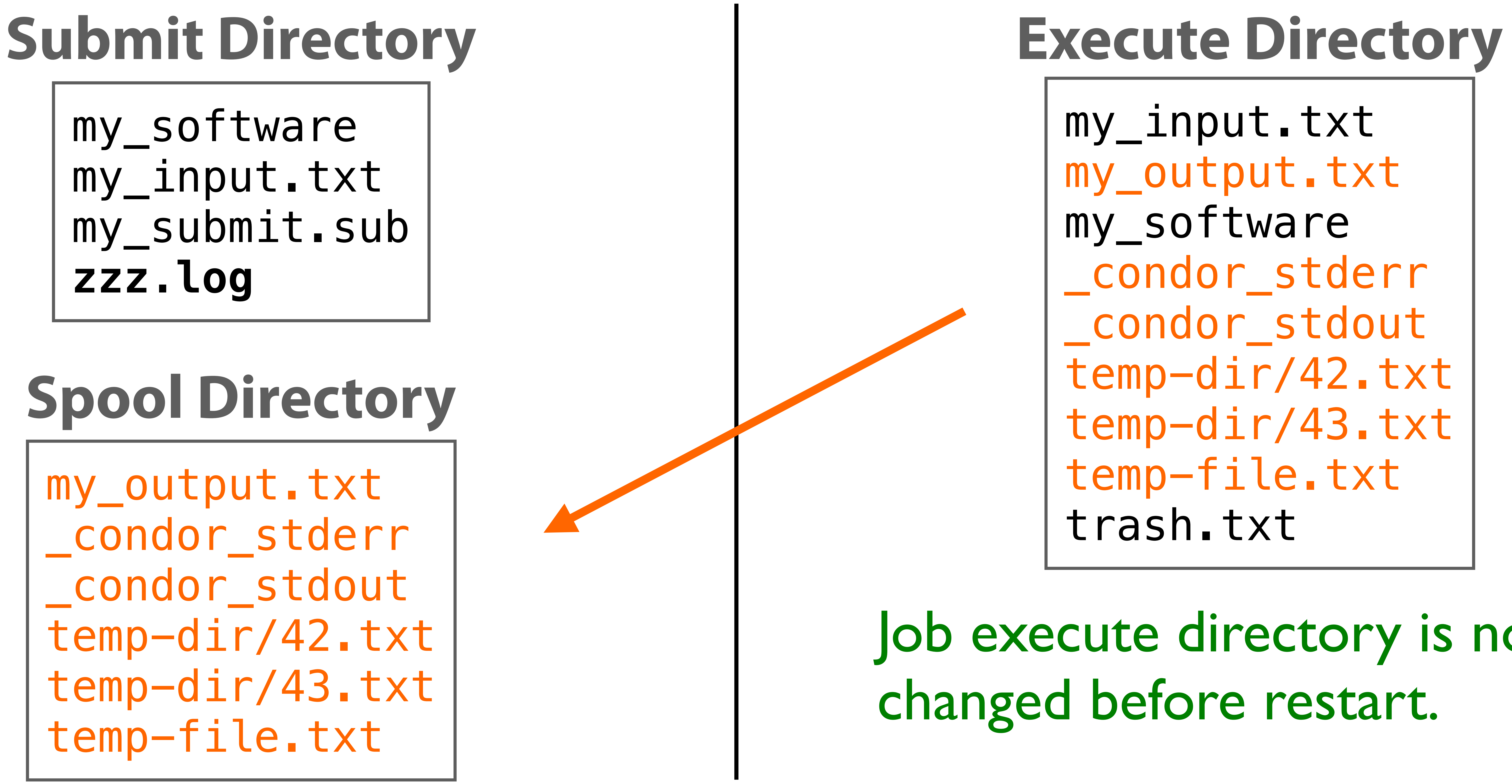
Spool Directory

Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
trash.txt
```

Example Step 5: Checkpoint Complete

```
transfer_checkpoint_files = my_output.txt, temp-dir, temp-file.txt
```



Submit Directory

```
my_software
my_input.txt
my_submit.sub
zzz.log
```

Spool Directory

```
my_output.txt
_condor_stderr
_condor_stdout
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
```

Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
trash.txt
```

Job execute directory is not changed before restart.

Example Step 6: 10 Min. Later – Eviction!

Submit Directory

```
my_software
my_input.txt
my_submit.sub
zzz.log
```

Spool Directory

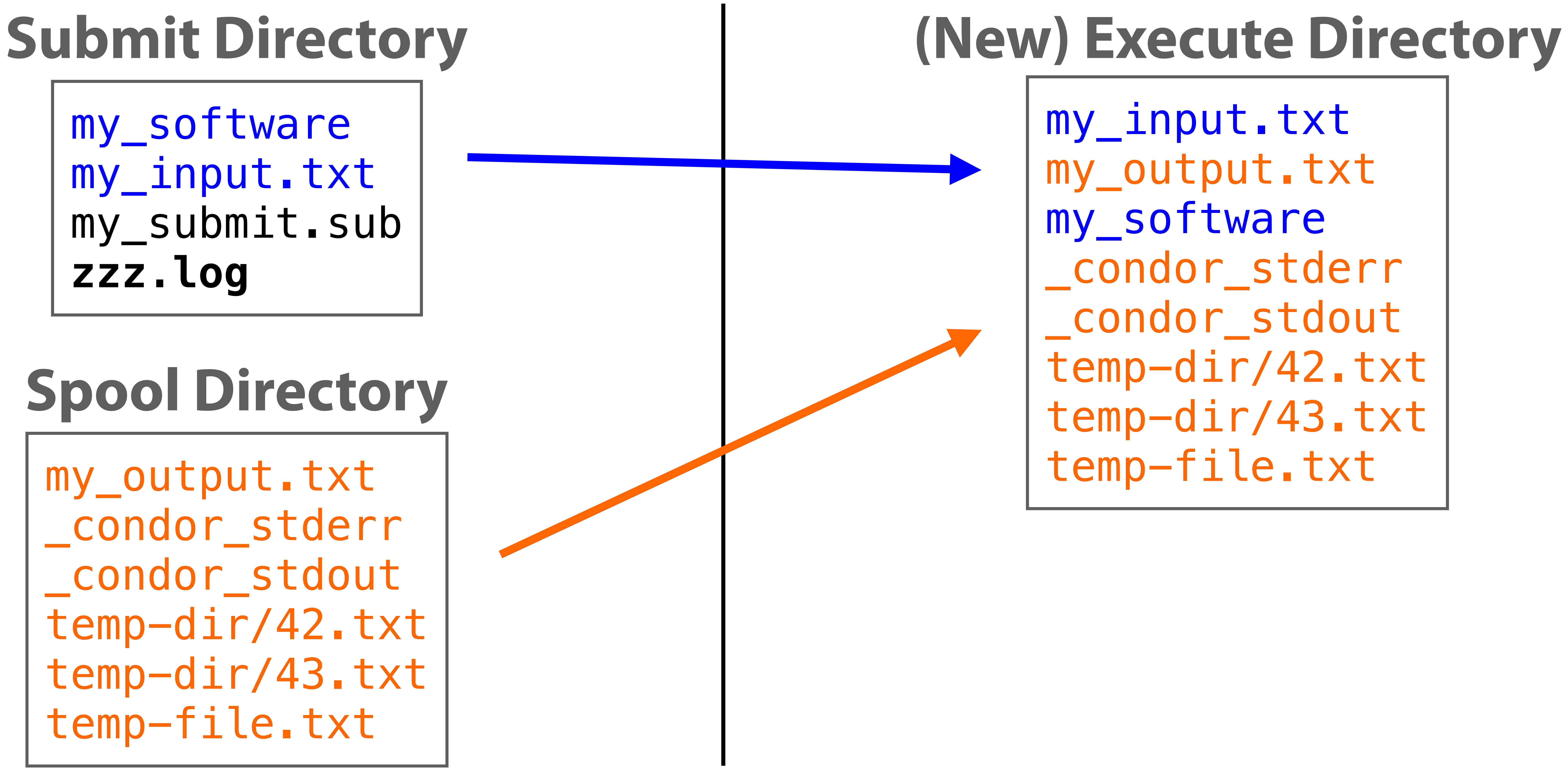
```
my_output.txt
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
```

Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/51.txt
temp-dir/52.txt
temp-file.txt
trash.txt
```

Lose changes since last checkpoint

Example Step 7: Restart on New Execute



Submit Directory

```
my_software
my_input.txt
my_submit.sub
zzz.log
```

Spool Directory

```
my_output.txt
_condor_stderr
_condor_stdout
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
```

(New) Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/42.txt
temp-dir/43.txt
temp-file.txt
```

Example Step 8: Job Completes Normally

```
transfer_output_files = my_output.txt
```

Submit Directory

```
my_software
my_input.txt
my_output.txt
my_submit.sub
zzz.err
zzz.log
zzz.out
```

(New) Execute Directory

```
my_input.txt
my_output.txt
my_software
_condor_stderr
_condor_stdout
temp-dir/98.txt
temp-dir/99.txt
temp-file.txt
trash.txt
```

Notes & Acknowledgements

- Official documentation:
  - https://htcondor.readthedocs.io/en/latest/users-manual/self-checkpointing-applications.html
  - Includes full working example (Python + submit)
  - The exercise is derived from that example
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