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Strata CONFERENCE + HADOOP WORLD

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Best Practices for Reproducible Research: Vignettes in Quant Finance

Chang She
@changhiskhan
LAMBDA·FOUNDRY

Outline

- Why reproducibility matters
- What is quantitative finance
- Reproducible research → Organize
  - Version → Code
  - Test → Configurations
  - Data
- Conclusions

About me

- MIT ’05, quant equities/FX 2006-2012
- LF, data tooling, financial analytics

python™

pandas

$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$

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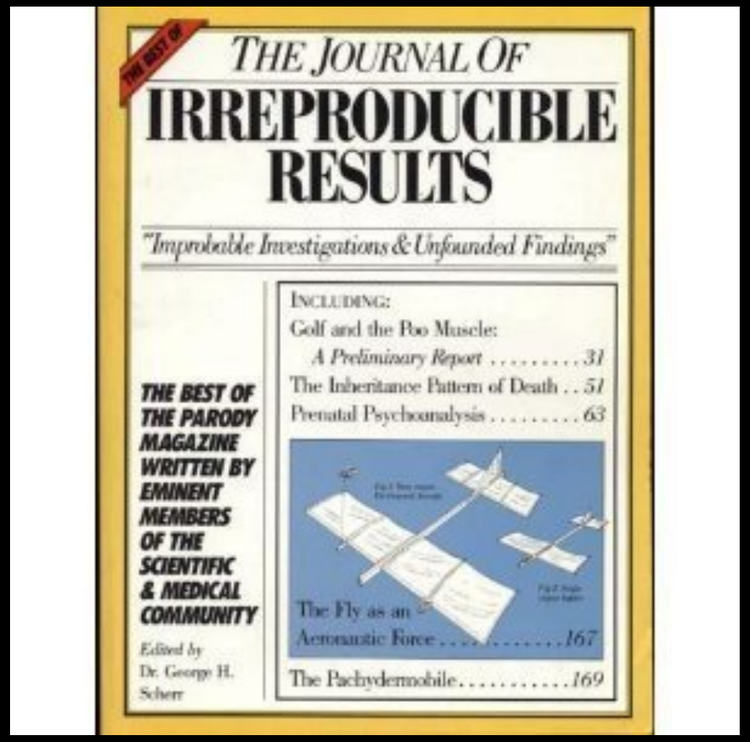
BARCLAYS CAPITAL

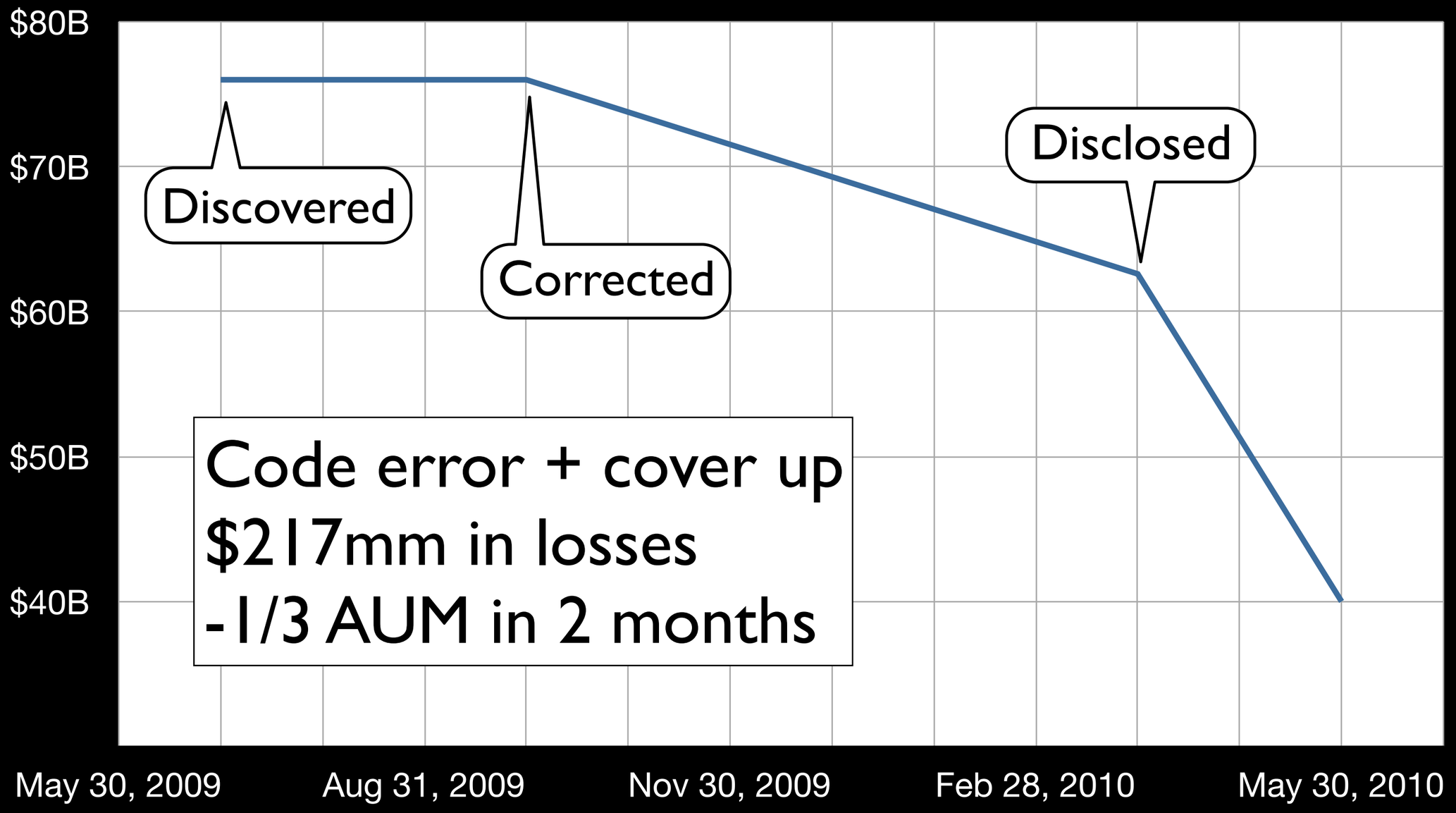
AQR

Data *Science*

- Reproducibility is a cornerstone of modern science
- Not just an academic exercise
- Big data => reproducibility is an organizational effort



AXA Rosenberg AUM



Relevant questions

- Are my results correct?
- Can anyone produce the same results?
- How do results differ across environments?
- How quickly can I attribute breakages?

Quantitative finance (by marketing)

1: Get Data

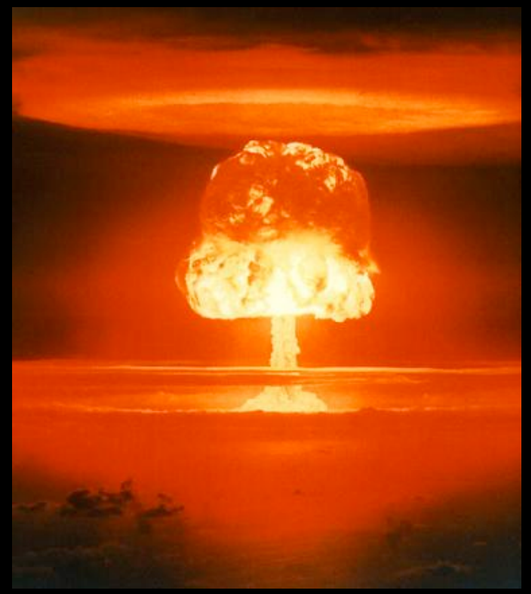
2: Magic Sauce

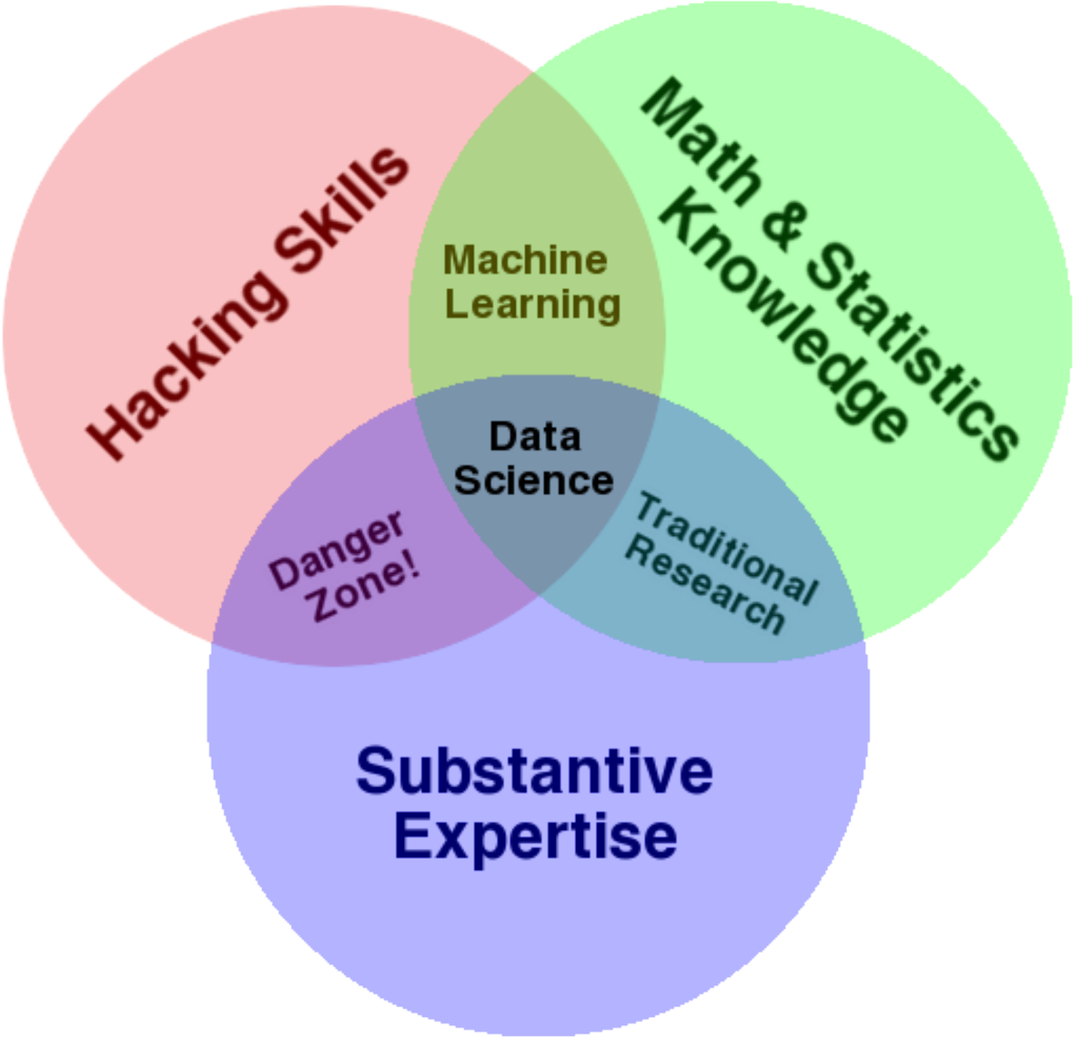
3: Profit!

Quantitative finance (by critics)

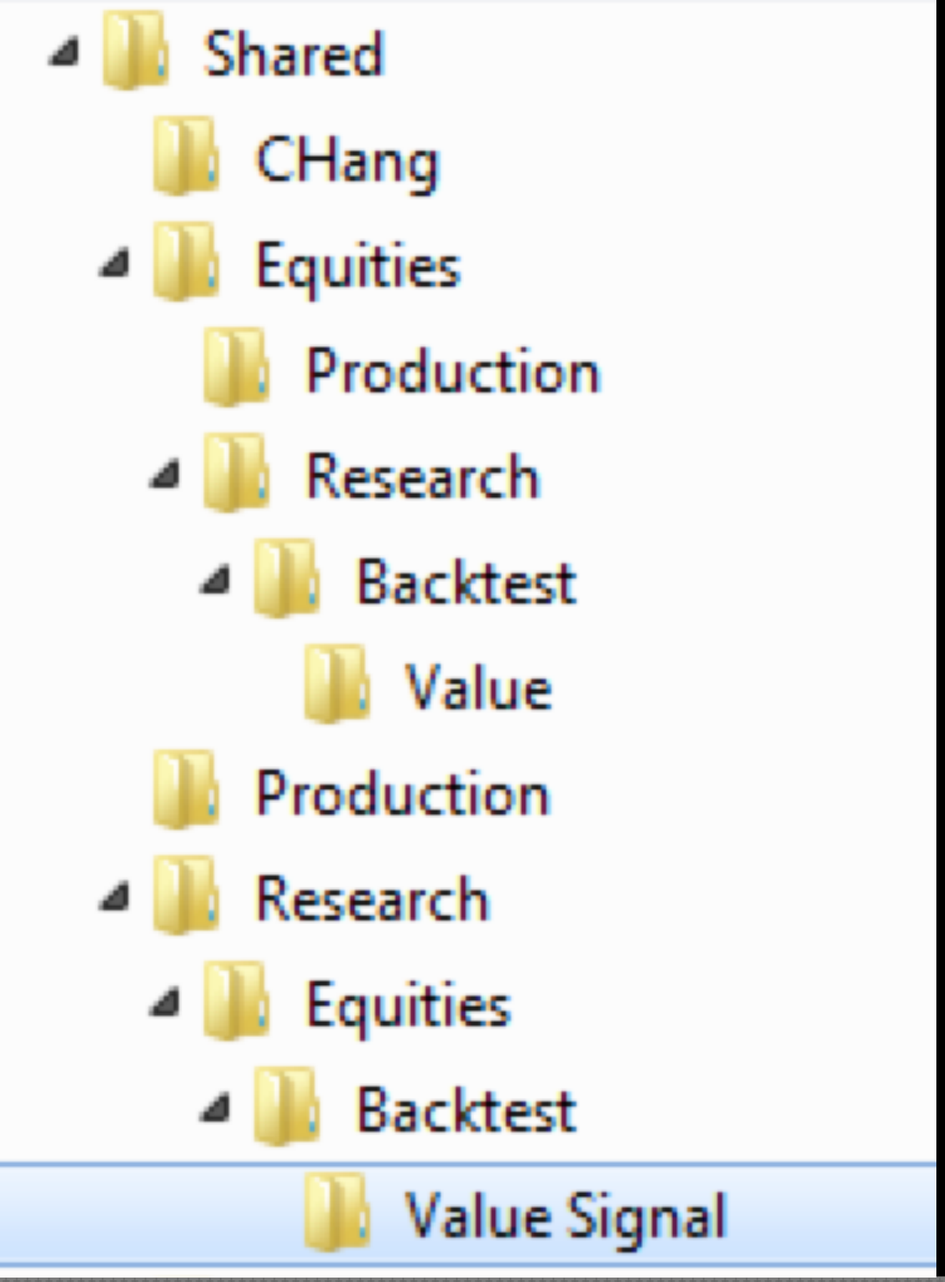
+

→





Courtesy of: Drew Conway



How NOT to organize

- Which folder has the backtest results for the value signal?
- Friends don't let friends organize files like this

Why use the shared network drive?

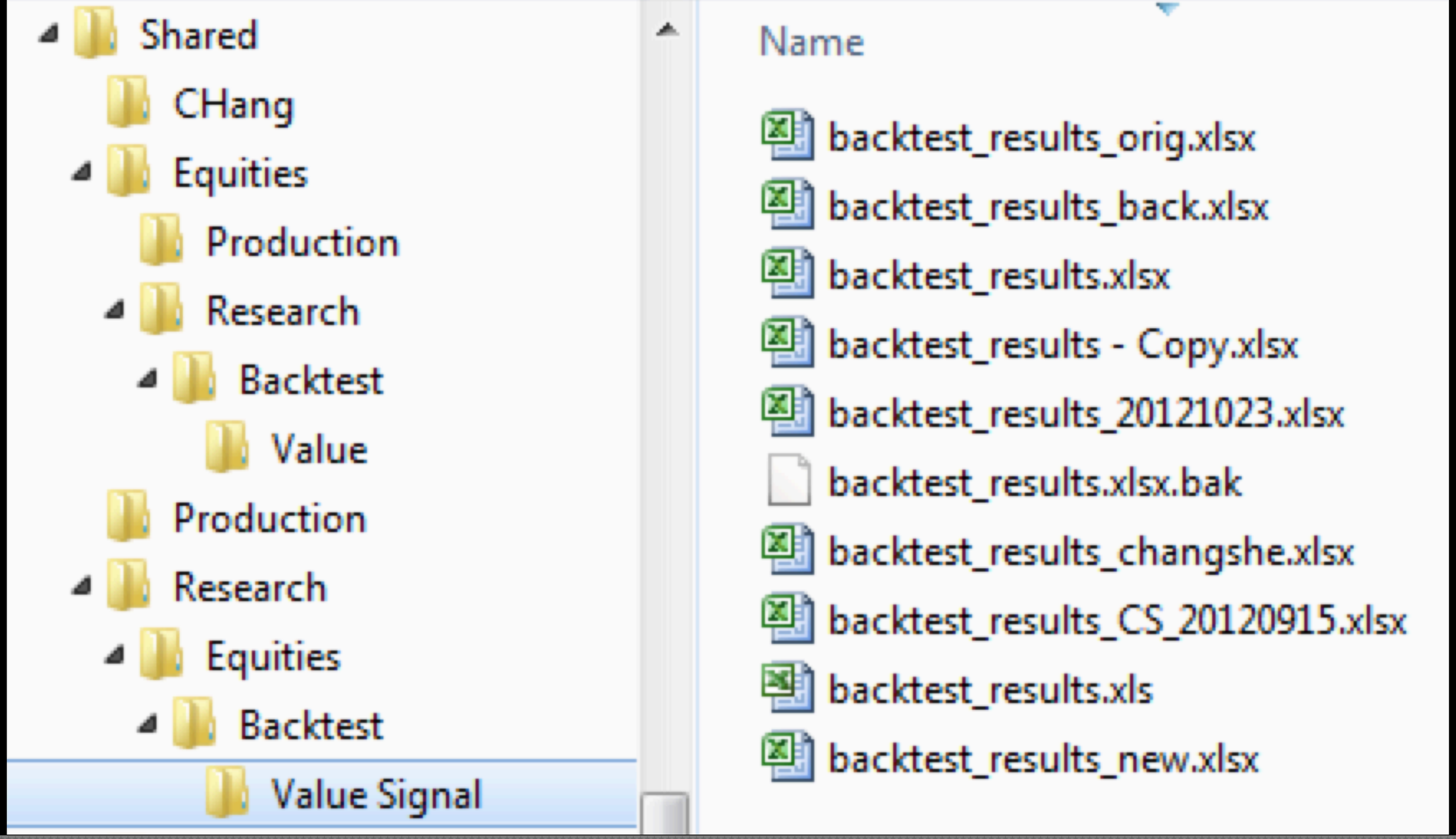
- Backup
- Collaboration
- Presentation
- Version control

Solutions

- Right tools
- Save code with results
- Save version numbers for key libraries

What are “the right tools”?

- Backup and sync
- Easy sharing
- Version control


Shared
CHang
Equities
Production
Research
Backtest
Value
Production
Research
Equities
Backtest
Value Signal
Name
backtest_results_orig.xlsx
backtest_results_back.xlsx
backtest_results.xlsx
backtest_results - Copy.xlsx
backtest_results_20121023.xlsx
backtest_results.xlsx.bak
backtest_results_changshe.xlsx
backtest_results_CS_20120915.xlsx
backtest_results.xls
backtest_results_new.xlsx

(Version) Control all the things!

- Code
- Configurations
- Data

Code version control

- Choose the right tool for your workflow
- High activation energy for financial researchers

Code version control

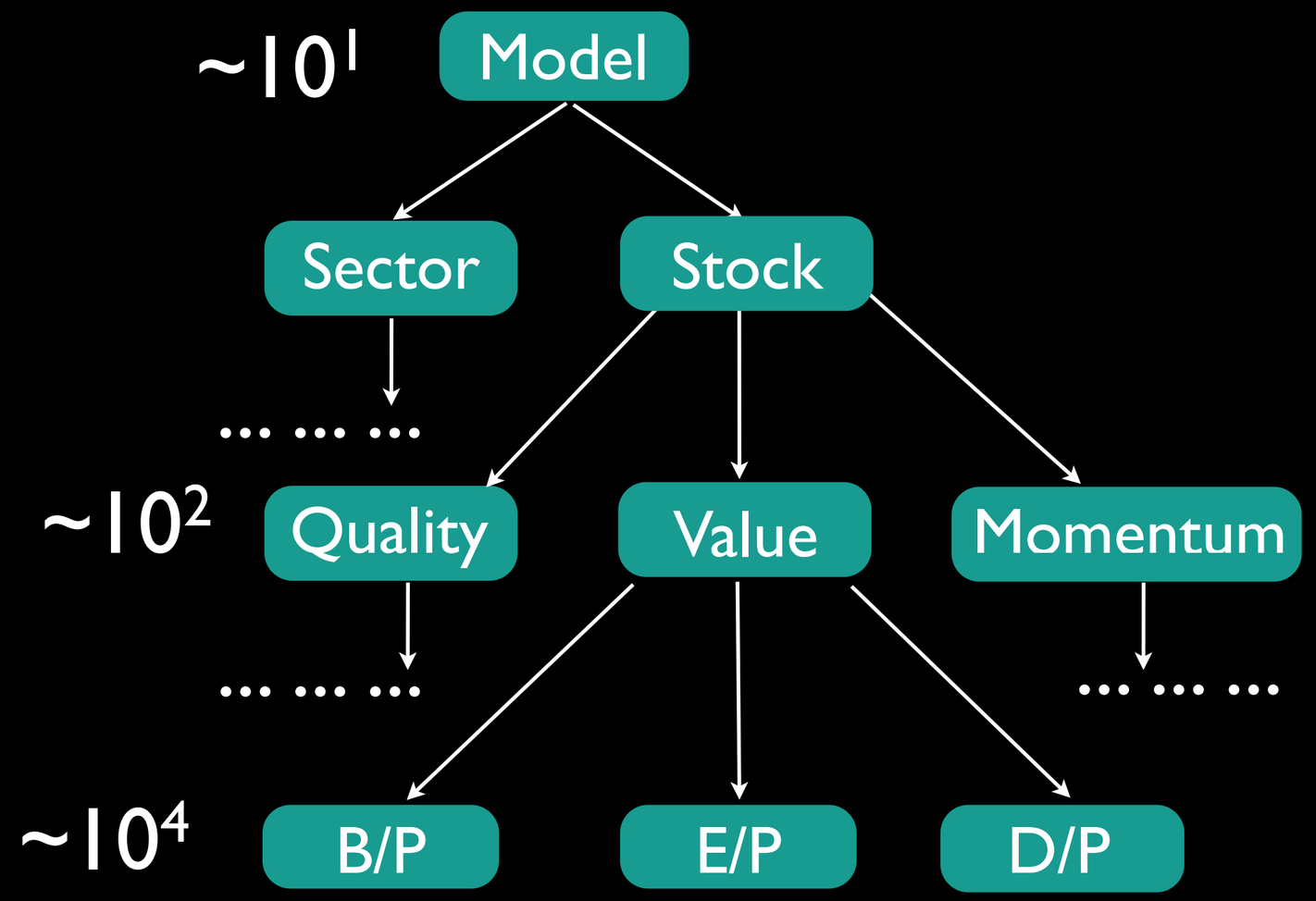
- Stop building models in Excel
  - Traceability
  - VBA, or “I don’t want to live on this planet anymore”

Code versioning tools

- Distributed vs Centralized
- How do you collaborate?
- What's least disruptive to your workflow?

~~parameter hell~~ Configurations

- Factor tree
- Model settings
- Factor settings
- Risk model
- Trading cost model
- Constraints



Configuration version control

- Too many dials
- Version changes often unrecorded
- Multiple time dimensions

```
def get_factor_config(factor, date):
    sqlstr = """\
        SELECT * FROM Factors
        WHERE FactorName='%s' AND
            '%s' BETWEEN StartDate and EndDate
            """
    rs = database_query(sqlstr % (factor, date), CON)
    return FactorConfig.from_sql(rs)


class Factor(object):


    def config(self, date):
        value = get_factor_config(self.id, date)
        return value
```

call database

wrapper

```
2  def get_factor_config(factor, date):
3      sqlstr = """\
4          SELECT * FROM Factors
5          WHERE FactorName='%s' AND
6              '%s' BETWEEN StartDate and EndDate
7              """
8      rs = database_query(sqlstr % (factor, date), CON)
9      return FactorConfig.from_sql(rs)
10
11
12 class Factor(object):
13
14     _config = None
15
16     def config(self, date):
17         if (self._config is None or
18             self._config.StartDate > date or
19             self._config.EndDate <= date):
20             self._config = get_factor_config(self.id, date)
21         return self._config
```

memoize

Configuration versioning

- Part of the problem can be solved with additional date information
- But lots of ad-hoc wrapper code. (“Wait...which tables have start/end dates again?”)
- What if a particular research study requires changing historical values?

Designing parameter version control

- Centralized entry point for configuration querying
- Get and set version date / tag / hash
- Runs in different anchoring modes
  - Single anchor - use current configurations
  - Multiple anchor - switch at pre-defined dates
  - Floating anchor - match data date / version


IF DATA CHANGES AND NO ONE KNOWS ABOUT IT
DID IT REALLY CHANGE?
memegenerator.net

Data

- Scale problems
- Boundaries of control
- Proprietary point-in-time databases

Data versioning

- Distribution
- Diff / Merge
- Performance

Data versioning design issues

- Store locally only as needed
- Need a structure aware diff tool
- Scale of data means cannot all be “full” versions
- Quick access means cannot all be change-sets

Data versioning design issues

- Need some full save-points (e.g., per day or month)
- Just store change-sets for other points
- A way to “upgrade” partial save-points to full if accessed very frequently

Dependency hell

- Firm-wide research platform
  - Must have full scientific computing stack
  - Cloneable VMs

- New research tools: http://www.pgbovine.net/cde.html


I DON'T ALWAYS TEST MY CODE
BUT WHEN I DO I DO IT IN PRODUCTION
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Testing in the financial industry

- Cavalier attitude
- Lack of good processes
- Over-reliance on compile time checks
- Reinventing the wheel, on purpose!

Testing

- Testing is worth the time
- Versioning <==> Testing
- Continuous integration

Unit testing

- Independent of configuration and data versions
- Data loading/cleaning/munging code
- Data transformation/computation code

Loading/cleaning/munging

```
assert data.name == expected

assert (isnull(data) == exp).all()

assert data.shape == expected

assert I am using Python + pandas
```

Core computations

```
assert result.std() == expected

assert calc() == alternate(ddof=1)

assert ar_reg(test_data) == exp
```

Data testing

```
assert has_dataitems(expected)

assert data.dtype == expected

assert data.count() == expected
```

Data testing

```
assert abs(returns) < expected

assert sector_code in GIC_CODES

assert problem_data == expected
```

Model testing

- `assert model(test) == expected`
- `assert model_today == model_yest`
  - Data versioning
- Reasonable run time

Conclusion

- Organize, with an eye for collaboration
- Version, EVERYTHING
- Test, fully and rigorously