

# Icicle

write once, run once

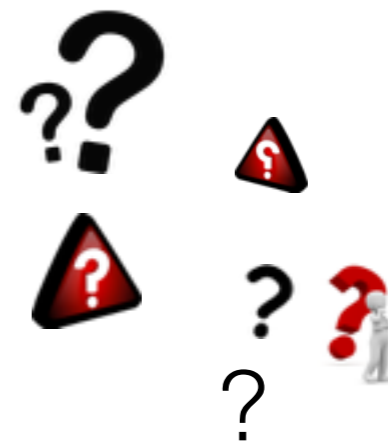
Amos Robinson, Ambiata / UNSW



Many data



Many data



Many queries





Many hours



One big query!

# Icicle



Many queries

One loop

# Restrictions

No sorting

No nested queries

No joins

Aggregate returns

# Small data

1PG asx	{“open”:1000, “close”:1000}	2013-12-13
1PG asx	{“open”:899, “close”:800}	2014-05-05
1PG asx	{“open”:1500, “close”:1600}	2014-09-23
1PG asx	{“open”:10300, “close”:10400}	2015-02-12
1PG asx	{“open”:19000, “close”:18850}	2015-07-03
1ST asx	{“open”:22000, “close”:17500}	2015-06-09
3DM asx	{“open”:4000, “close”:4000}	2005-11-29
3DM asx	{“open”:3100, “close”:3100}	2006-04-28
3DM asx	{“open”:3599, “close”:3599}	2006-09-19
3DM asx	{“open”:23000, “close”:23900}	2007-02-13
3DM asx	{“open”:9800, “close”:10000}	2007-07-10



# Company code

1PG	asx	{“open”:1000, “close”:1000}	2013-12-13
1PG	asx	{“open”:899, “close”:800}	2014-05-05
1PG	asx	{“open”:1500, “close”:1600}	2014-09-23
1PG	asx	{“open”:10300, “close”:10400}	2015-02-12
1PG	asx	{“open”:19000, “close”:18850}	2015-07-03
1ST	asx	{“open”:22000, “close”:17500}	2015-06-09
3DM	asx	{“open”:4000, “close”:4000}	2005-11-29
3DM	asx	{“open”:3100, “close”:3100}	2006-04-28
3DM	asx	{“open”:3599, “close”:3599}	2006-09-19
3DM	asx	{“open”:23000, “close”:23900}	2007-02-13
3DM	asx	{“open”:9800, “close”:10000}	2007-07-10

# Table name

1PG   asx	{“open”:1000, “close”:1000}	2013-12-13
1PG   asx	{“open”:899, “close”:800}	2014-05-05
1PG   asx	{“open”:1500, “close”:1600}	2014-09-23
1PG   asx	{“open”:10300, “close”:10400}	2015-02-12
1PG   asx	{“open”:19000, “close”:18850}	2015-07-03
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3DM   asx	{“open”:3100, “close”:3100}	2006-04-28
3DM   asx	{“open”:3599, “close”:3599}	2006-09-19
3DM   asx	{“open”:23000, “close”:23900}	2007-02-13
3DM   asx	{“open”:9800, “close”:10000}	2007-07-10

# Open price

1PG asx	{“open”:1000, “close”:1000}	2013-12-13
1PG asx	{“open”:899, “close”:800}	2014-05-05
1PG asx	{“open”:1500, “close”:1600}	2014-09-23
1PG asx	{“open”:10300, “close”:10400}	2015-02-12
1PG asx	{“open”:19000, “close”:18850}	2015-07-03
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3DM asx	{“open”:3100, “close”:3100}	2006-04-28
3DM asx	{“open”:3599, “close”:3599}	2006-09-19
3DM asx	{“open”:23000, “close”:23900}	2007-02-13
3DM asx	{“open”:9800, “close”:10000}	2007-07-10

# Close price

1PG asx	{“open”:1000, “close”:1000}	2013-12-13
1PG asx	{“open”:899, “close”:800}	2014-05-05
1PG asx	{“open”:1500, “close”:1600}	2014-09-23
1PG asx	{“open”:10300, “close”:10400}	2015-02-12
1PG asx	{“open”:19000, “close”:18850}	2015-07-03
1ST asx	{“open”:22000, “close”:17500}	2015-06-09
3DM asx	{“open”:4000, “close”:4000}	2005-11-29
3DM asx	{“open”:3100, “close”:3100}	2006-04-28
3DM asx	{“open”:3599, “close”:3599}	2006-09-19
3DM asx	{“open”:23000, “close”:23900}	2007-02-13
3DM asx	{“open”:9800, “close”:10000}	2007-07-10

# Date

1PG asx	{"open":1000, "close":1000}	2013-12-13
1PG asx	{"open":899, "close":800}	2014-05-05
1PG asx	{"open":1500, "close":1600}	2014-09-23
1PG asx	{"open":10300, "close":10400}	2015-02-12
1PG asx	{"open":19000, "close":18850}	2015-07-03
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3DM asx	{"open":3100, "close":3100}	2006-04-28
3DM asx	{"open":3599, "close":3599}	2006-09-19
3DM asx	{"open":23000, "close":23900}	2007-02-13
3DM asx	{"open":9800, "close":10000}	2007-07-10

# Grouped by company

1PG   asx	{“open”:1000, “close”:1000}	2013-12-13
1PG   asx	{“open”:899, “close”:800}	2014-05-05
1PG   asx	{“open”:1500, “close”:1600}	2014-09-23
1PG   asx	{“open”:10300, “close”:10400}	2015-02-12
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3DM   asx	{“open”:3599, “close”:3599}	2006-09-19
3DM   asx	{“open”:23000, “close”:23900}	2007-02-13
3DM   asx	{“open”:9800, “close”:10000}	2007-07-10

# Grouped by company

1PGI asxI	{“open”:1000, “close”:1000}	2013-12-13
1PGI asxI	{“open”:899, “close”:800}	2014-05-05
1PGI asxI	{“open”:1500, “close”:1600}	2014-09-23
1PGI asxI	{“open”:10300, “close”:10400}	2015-02-12
1PGI asxI	{“open”:19000, “close”:18850}	2015-07-03

1STI asxI	{“open”:22000, “close”:17500}	2015-06-09
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3DMI asxI	{“open”:4000, “close”:4000}	2005-11-29
3DMI asxI	{“open”:3100, “close”:3100}	2006-04-28
3DMI asxI	{“open”:3599, “close”:3599}	2006-09-19
3DMI asxI	{“open”:23000, “close”:23900}	2007-02-13
3DMI asxI	{“open”:9800, “close”:10000}	2007-07-10

# Grouped by company

1PGI asxI	{“open”:1000, “close”:1000}	2013-12-13
1PGI asxI	{“open”:899, “close”:800}	2014-05-05
1PGI asxI	{“open”:1500, “close”:1600}	2014-09-23
1PGI asxI	{“open”:10300, “close”:10400}	2015-02-12
1PGI asxI	{“open”:19000, “close”:18850}	2015-07-03
1STI asxI	{“open”:22000, “close”:17500}	2015-06-09
3DMI asxI	{“open”:4000, “close”:4000}	2005-11-29
3DMI asxI	{“open”:3100, “close”:3100}	2006-04-28
3DMI asxI	{“open”:3599, “close”:3599}	2006-09-19
3DMI asxI	{“open”:23000, “close”:23900}	2007-02-13
3DMI asxI	{“open”:9800, “close”:10000}	2007-07-10



# Ordered by date

1PG asx	{"open":1000, "close":1000}	2013-12-13	↓
1PG asx	{"open":899, "close":800}	2014-05-05	
1PG asx	{"open":1500, "close":1600}	2014-09-23	
1PG asx	{"open":10300, "close":10400}	2015-02-12	
1PG asx	{"open":19000, "close":18850}	2015-07-03	
1ST asx	{"open":22000, "close":17500}	2015-06-09	↓
3DM asx	{"open":4000, "close":4000}	2005-11-29	↓
3DM asx	{"open":3100, "close":3100}	2006-04-28	
3DM asx	{"open":3599, "close":3599}	2006-09-19	
3DM asx	{"open":23000, "close":23900}	2007-02-13	
3DM asx	{"open":9800, "close":10000}	2007-07-10	

# Mean

sum open / count

mean close

1PG 22299

1PG 21714

1ST 22000

1ST 7500

3DM 3777

3DM 3785

# Count by weekday

group (day\_of\_week time) in count

1PG { Mon: 6, Tue: 5, Wed: 3  
, Thu: 3, Fri: 4 }

1ST { Tue: 1 }

3DM { Mon: 3, Tue: 7, Wed: 6  
, Thu: 1, Fri: 5 }

# Days where close above open

`filter (close > open) in count`

1PG 2

1ST 0

3DM 2

# Days where close above open

```
filter (close > open) in count
```

Element Double

# Days where close above open

```
filter (close ≥ open) in count
```

```
Double -> Double -> Bool
```

# Days where close above open

`filter` `(close > open)` `in count`

Element Bool

# Days where close above open

```
filter (close > open) in count
```

Aggregate Int



# Days where close above open

filter (close > open) in count

Aggregate Int

# Days where close above mean

```
filter (close > mean open) in count
```

# Two loops!!!

filter (close > mean open) in count

1. Loop over data
2. Find mean
3. Go back to start
4. Loop over data
5. Perform count

# Days where close above mean

filter (close > mean open) in count

Element Double -> Aggregate Double

# Days where close above mean

filter (close > mean open) in count

Aggregate Double

# Days where close above mean

```
filter (close > mean open) in count
```

Element Double

# Days where close above mean

```
filter (close > mean open) in count
```

Error!

Element Double /= Aggregate Double

Query plans



# Sum open

sum open

```
query asx {  
  fold s = 0  
    then s + open  
  
  output sum_open = s  
}
```

# Count

count

```
query asx {  
  fold c = 0  
    then c + 1  
  
  output count = c  
}
```

# Mean open

sum open / count

```
query asx {  
  fold s = 0  
    then s + open
```

```
  fold c = 0  
    then c + 1
```

```
  output mean_open = s / c  
}
```

# Mean close

sum close / count

```
query asx {  
  fold s = 0  
    then s + close  
  
  fold c = 0  
    then c + 1  
  
  output mean_close = s / c  
}
```

# Fusion

sum open / count

sum close / count

```
query asx {  
  fold s = 0  
    then s + open  
  fold c = 0  
    then c + 1
```

```
output mean_open  
       = s / c
```

```
}
```

```
query asx {  
  fold s = 0  
    then s + close  
  fold c = 0  
    then c + 1
```

```
output mean_close  
       = s / c
```

```
}
```

# Renaming

sum open / count

sum close / count

```
query asx {  
  fold s1= 0  
    then s1+ open  
  fold c1= 0  
    then c1+ 1
```

```
output mean_open  
  = s1/ c1
```

```
}
```

```
query asx {  
  fold s2= 0  
    then s2+ close  
  fold c2= 0  
    then c2+ 1
```

```
output mean_close  
  = s2/ c2
```

```
}
```

# Appending

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1  
  
  fold s2= 0  
    then s2 + close  
  fold c2= 0  
    then c2 + 1  
  output mean_close = s2 / c2  
}
```

# Common subexpression elimination

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1  
  
  fold s2= 0  
    then s2 + close  
  fold c2= 0  
    then c2 + 1  
  output mean_close = s2 / c2  
}
```



# Common subexpression elimination

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1  
  
  fold s2= 0  
    then s2 + close  
  fold c2= 0  
    then c2 + 1  
  output mean_close = s2 / c2  
}
```

# Common subexpression elimination

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1  
  
  fold s2= 0  
    then s2 + close  
  fold c2= 0  
    then c2 + 1  
  output mean_close = s2 / c1  
}
```

# Common subexpression elimination

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1
```

```
  fold s2= 0  
    then s2 + close
```

```
  output mean_close = s2 / c1  
}
```

# Common subexpression elimination

```
query asx {  
  fold s1= 0  
    then s1 + open  
  fold c1= 0  
    then c1 + 1  
  output mean_open = s1 / c1  
  
  fold s2= 0  
    then s2 + close  
  
  output mean_close = s2 / c1  
}
```

# Finally

Restricted languages are easier to optimise!