Functional Reporting
Edward Kmett
Overview

1. Who We Are
2. Getting FP in the Door
   Monoids, Reducers, Iteratees, Performance Attribution
3. Ermine
   “Haskell with Row Types”
4. Reporting
   EDSL Inception and JMacro RPC
5. Open Source
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Who We Are

Over 4,500 customers including

- Investment Management Firms
- Private Equity Funds
- Investment Banks
- Advisory Firms
- Corporations
- Universities
Who We Are

Products Include

- S&P Capital IQ Platform
- ClariFI
- AlphaWorks
- Compustat
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Getting FP in the Door

- Monoids
- Reducers
- Performance Attribution
- Factor Backtesting
Monoids

class Monoid m where
  mappend :: m -> m -> m
  mempty :: m

newtype Sum a = Sum { getSum :: a }
instance Num a => Monoid (Sum a) where
  mempty = Sum 0
  mappend (Sum m) (Sum n) = Sum (m + n)
Monoids

class Monoid m where
  mappend :: m -> m -> m
  mempty :: m

>>> foldMap Sum [1,2,3]
6

This is really all written in Scala!
Reducers

class Monoid m where
    mappend :: m -> m -> m
    mempty  :: m

data Reducer a b =
    forall m. Monoid m => R (a -> m) (m -> b)

reduce :: Reducer a b -> [a] -> b
reduce (R am mb) xs = mb (foldMap am xs)

In practice you probably want an efficient cons and/or snoc operation as well.
Simultaneous Reduction

instance (Monoid a, Monoid b) => Monoid (a,b)

instance Applicative (Reducer a) where
  pure a = R (\_ -> ()) (\() -> a)
  R am mf <*> R an nx = R (am &&& an) $ 
  \(m,n) -> mf m $ nx n

mean = (/) <$> sum <*> length

This really needs a strict pair.
Simultaneous Reduction

instance Num b => Num (Reducer a b)
instance Fractional b => Fractional (Reducer a b)

mean = sum / length
Performance Attribution

OLD AND BUSTED
- Implemented in Java
- Needed Full Dataset in Memory
- Hard to Extend
- Results are Serialized Objects

NEW HOTNESS
- Implemented in Scala
- Runs in Constant Memory
- Easily Extended
- Drastic Speed Improvements
- Results Flattened via Combinators to Database
Performance Attribution

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- Implemented in Java
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GLOSSED OVER
- Multi-Pass Algorithms
- Iteratees
- Caching
- Aggregation by Sectors
- Missing Data
## REPORT INFORMATION

General information about the Portfolio Attribution Report run in ModelStation and exported to create this workbook.

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio Name</td>
<td>Dow Long / Short</td>
</tr>
<tr>
<td>Benchmark</td>
<td>4 stock</td>
</tr>
<tr>
<td>Returns Attribution</td>
<td>Beginning of period holdings</td>
</tr>
<tr>
<td>Risk Model</td>
<td>Capital IQ Risk Model</td>
</tr>
<tr>
<td>Analysis Period</td>
<td>110/11/30 – 111/2/30</td>
</tr>
</tbody>
</table>

## RETURNS

These statistics summarize the characteristics of the returns (losses) of the portfolio over the duration of the analysis period. If a benchmark was included in the ModelStation analysis, benchmark-relative statistics are also provided for the period.

## BRINSON ATTRIBUTION

These charts and tables show the cumulative attribution of the Brinson effects. Periodic data is linked using Carino smoothing.
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Ermine
Ermine
“Haskell with Row Types”

FEATURES

• Not Scala
• Portable Core that can run on the JVM
• Implementations in Scala and Haskell
• Strong Type System
  • Novel Row Types
  • Polymorphic and Constraint Kinds
  • Rank-N Types via a derivative of HMF
• Fits our Domain
  • Built-In Database Support
  • Can Be Exposed to End Users
  • Prototype Structured Code Editor
  • Full Control Over Error Messages

It actually has many differences with Haskell.
PREVIOUS APPROACHES

Commonly row polymorphism is modeled via has, lacks, and/or subsumes constraints.

\[
\text{cons}_1 : \forall (a : *) (r : \rho). (r / \bot) \Rightarrow \alpha \rightarrow [..r] \rightarrow \{1 : \alpha | r\}
\]

\[
\text{tail}_1 : \forall (\alpha : *) (r : \rho). (r / \bot) \Rightarrow \{1 : \alpha | r\} \rightarrow \{r\}
\]

\[
\text{join} : \forall (r : \rho) (s : \rho). [..r] \rightarrow [..s] \rightarrow [.. r || s]
\]

This is easily checked, but now **inference** flows unidirectionally through join.
Row Polymorphism

**IN ERMINE**

We use a single constraint type: “can be partitioned into”

\[ a \leftarrow (b,c) \]

says the fields in row type a can be partitioned into **disjoint** sets of fields b and c.

**join** :

\[
\begin{align*}
& ( d \leftarrow (a,b) \\
& , e \leftarrow (b,c) \\
& , f \leftarrow (a,b,c) \\
\) \Rightarrow [..d] \rightarrow [..e] \rightarrow [..f]
\end{align*}
\]
**IN ERMINE**

We can have existentials in our constraint types. E.g.

\[
\text{forget} : \text{MonadState } s \ m \Rightarrow m \ a \rightarrow m \ a
\]

\[
\text{forget } m = \text{do } s \leftarrow \text{get}; a \leftarrow m; \text{put } s; \text{return } a
\]

has type parameters that don’t occur on the right hand side of the (⇒) determined by functional dependencies. We could give this type:

\[
\text{forget} : (\exists s. \text{MonadState } s \ m) \Rightarrow m \ a \rightarrow m \ a
\]

Using this we can model “Has” and “Lacks” or “Disjoint” via type aliases!

\[
\text{type } \text{Has } a \ b = \exists c. a \leftarrow (b, c)
\]

\[
\text{type } a \mid b = \exists c. c \leftarrow (a, b)
\]
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Reporting
A Language in our Language

Portfolio Information
Portfolio Name: big portfolio
Portfolio ID: -
Benchmark: Russell Top 50 Index ("RTF")
Risk Model: Global Fundamental Short Term

Date Range: 4/30/2012 to 4/30/2013
Currency: US Dollar (USD)
Grouping: GICS Industry
Exclude Cash: No

Portfolio Overview

<table>
<thead>
<tr>
<th>Port</th>
<th>Bench</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Return</td>
<td>28.98</td>
<td>14.37</td>
</tr>
<tr>
<td>Realized Risk</td>
<td>16.29</td>
<td>12.28</td>
</tr>
<tr>
<td>Latest Predicted Risk</td>
<td>12.99</td>
<td>8.69</td>
</tr>
<tr>
<td>Factor Risk</td>
<td>9.79</td>
<td>8.33</td>
</tr>
<tr>
<td>Stock Specific Risk</td>
<td>8.54</td>
<td>2.47</td>
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<tr>
<td>Portfolio Value($mm)</td>
<td>0.15</td>
<td>-</td>
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<tr>
<td># of Securities</td>
<td>17</td>
<td>52</td>
</tr>
<tr>
<td>Annualized Total Return</td>
<td>28.98</td>
<td>14.37</td>
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</table>

Industry Weight

<table>
<thead>
<tr>
<th>Port</th>
<th>Bench</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet Software and Ser...</td>
<td>55.11</td>
<td>3.23</td>
</tr>
<tr>
<td>Automobiles</td>
<td>12.98</td>
<td>0.00</td>
</tr>
<tr>
<td>Capital Markets</td>
<td>11.40</td>
<td>0.00</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>5.70</td>
<td>10.54</td>
</tr>
<tr>
<td>Food Products</td>
<td>4.78</td>
<td>1.24</td>
</tr>
<tr>
<td>Diversified Financial Serv...</td>
<td>3.28</td>
<td>6.55</td>
</tr>
<tr>
<td>Commercial Services and...</td>
<td>1.51</td>
<td>0.00</td>
</tr>
<tr>
<td>Electric Utilities</td>
<td>1.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Industrial Conglomerates</td>
<td>1.49</td>
<td>4.43</td>
</tr>
<tr>
<td>Trading Companies and D...</td>
<td>0.83</td>
<td>0.00</td>
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<tr>
<td>Biotechnology</td>
<td>0.71</td>
<td>1.16</td>
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<tr>
<td>Other</td>
<td>0.73</td>
<td>72.85</td>
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</table>

Security Weight

<table>
<thead>
<tr>
<th>Port</th>
<th>Bench</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Inc. (NasdaqGS:GOOG)</td>
<td>55.11</td>
<td>3.06</td>
</tr>
<tr>
<td>Volkswagen AG (DB:VOW)</td>
<td>12.98</td>
<td>0.00</td>
</tr>
<tr>
<td>The Goldman Sachs Group, ...</td>
<td>9.75</td>
<td>0.00</td>
</tr>
<tr>
<td>Johnson &amp; Johnson (NYSE:JNJ)</td>
<td>5.70</td>
<td>3.36</td>
</tr>
<tr>
<td>Nestle S.A. (SWX:NESSN)</td>
<td>4.78</td>
<td>0.00</td>
</tr>
<tr>
<td>JPMorgan Chase &amp; Co. (NY...</td>
<td>3.28</td>
<td>6.68</td>
</tr>
<tr>
<td>ABM Industries Incorpor...</td>
<td>1.51</td>
<td>0.00</td>
</tr>
<tr>
<td>Electricite de France SA (E...</td>
<td>1.50</td>
<td>0.00</td>
</tr>
<tr>
<td>General Electric Company (...</td>
<td>1.49</td>
<td>3.39</td>
</tr>
<tr>
<td>Gluskin Sheff + Associates,...</td>
<td>1.18</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>97.28</td>
<td>12.49</td>
</tr>
</tbody>
</table>

Portfolio Return Chart

Portfolio Characteristics

<table>
<thead>
<tr>
<th>Port</th>
<th>Bench</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Capitalization</td>
<td>204,448.67</td>
</tr>
<tr>
<td>P/E</td>
<td>11.56</td>
</tr>
<tr>
<td>P/BV</td>
<td>2.80</td>
</tr>
<tr>
<td>P/Sales</td>
<td>3.61</td>
</tr>
<tr>
<td>Div Yield</td>
<td>2.79</td>
</tr>
<tr>
<td>Return on Equity %</td>
<td>16.79</td>
</tr>
<tr>
<td>Total Debt/Equity</td>
<td>102.27</td>
</tr>
<tr>
<td>Forward P/E</td>
<td>13.01</td>
</tr>
<tr>
<td>EPS 3 Yr CAGR %</td>
<td>28.36</td>
</tr>
</tbody>
</table>

Industry Attribution

<table>
<thead>
<tr>
<th>Alloc Eff</th>
<th>Select Eff</th>
<th>Inter Eff</th>
<th>Total Eff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet Software and...</td>
<td>8.54</td>
<td>0.12</td>
<td>2.23</td>
</tr>
<tr>
<td>Automobiles</td>
<td>1.78</td>
<td>-0.05</td>
<td>-1.15</td>
</tr>
<tr>
<td>Capital Markets</td>
<td>1.59</td>
<td>0.02</td>
<td>0.18</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>-0.65</td>
<td>0.33</td>
<td>-0.17</td>
</tr>
<tr>
<td>Food Products</td>
<td>0.41</td>
<td>-0.04</td>
<td>-0.20</td>
</tr>
<tr>
<td>Diversified Financial Serv...</td>
<td>-0.54</td>
<td>-0.82</td>
<td>0.31</td>
</tr>
<tr>
<td>Commercial Services ...</td>
<td>-0.34</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Electric Utilities</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Industrial Conglomer...</td>
<td>-0.11</td>
<td>-0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Trading Companies and D...</td>
<td>-0.28</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other</td>
<td>3.80</td>
<td>1.02</td>
<td>-1.37</td>
</tr>
<tr>
<td>Total</td>
<td>14.18</td>
<td>0.56</td>
<td>-0.13</td>
</tr>
</tbody>
</table>

Security Contribution

<table>
<thead>
<tr>
<th>Top 5</th>
<th>Avg Wgt</th>
<th>Return</th>
<th>Contr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Inc. (NasdaqGS:GOOG)</td>
<td>53.86</td>
<td>36.33</td>
<td>19.16</td>
</tr>
<tr>
<td>Volkswagen AG (DB:VOW)</td>
<td>14.17</td>
<td>16.33</td>
<td>2.78</td>
</tr>
<tr>
<td>The Goldman Sachs Group, ...</td>
<td>9.33</td>
<td>28.98</td>
<td>2.53</td>
</tr>
<tr>
<td>Johnson &amp; Johnson (NYSE:JNJ)</td>
<td>5.53</td>
<td>35.63</td>
<td>1.92</td>
</tr>
<tr>
<td>Nestle S.A. (SWX:NESSN)</td>
<td>5.01</td>
<td>10.34</td>
<td>1.02</td>
</tr>
<tr>
<td>Bottom 5</td>
<td>Avg Wgt</td>
<td>Return</td>
<td>Contr</td>
</tr>
<tr>
<td>ABM Industries Incorpor...</td>
<td>1.59</td>
<td>-0.25</td>
<td>-0.18</td>
</tr>
<tr>
<td>Sumitomo Corporation (T...</td>
<td>1.03</td>
<td>-9.04</td>
<td>-0.14</td>
</tr>
<tr>
<td>Geron SpA (BIT:GE)</td>
<td>0.28</td>
<td>-24.41</td>
<td>-0.12</td>
</tr>
<tr>
<td>Granville Pacific Capital ...</td>
<td>0.01</td>
<td>-3.91</td>
<td>0.00</td>
</tr>
<tr>
<td>Advanced Power Compon...</td>
<td>0.02</td>
<td>241.45</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Reporting Example
One Report
Multiple Interpreters

The same report specification can run under wildly different interpreters. E.g.

- HTML + AJAX
- Excel
- PDF
- Java Swing
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Open Source

SCALA VERSION
- [https://github.com/ermine-language/ermine-legacy](https://github.com/ermine-language/ermine-legacy)

HASKELL VERSION
- [https://github.com/ermine-language/ermine](https://github.com/ermine-language/ermine)

NEW CORE INTERPRETER
- [https://github.com/ermine-language/ermine-scala-core](https://github.com/ermine-language/ermine-scala-core)

JMACRO-RPC
Questions?