Beam as a Risk Engine
Presenter Profiles
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Leading Engineering Excellence in Risk Technology with interest in Predictive Analytics in Finance, DevOps, High Performance Computing & Simulation

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Financial professional with over twenty-five years experience across Capital Markets, including transformation in Risk execution, regulatory change and location strategy.
What is Credit Risk

A brief oversight into the build up of Credit Risk within Markets.
How does Credit Risk Arise
How does Credit Risk rise

Thousands of Counterparties

Thousands of deals

Trade

Portfolio values can go up and down.
Managing Credit Risk

What if a counterparty gets into difficulty?

This is called **Credit Risk** and needs to be managed.
Exposure to each counterparty depends on how the **financial markets move**.

We can’t **predict** the future.

There is **structure** in Financial Markets. We can model this statistical structure.

Monte-Carlo Analysis allows us to estimate risks bases on plausible future scenarios. This leads to **many billions of valuations** to scan plausible future scenarios – reaching out 50+ years.
What are Risk Engines

An oversight of what a Risk Engine does and how they have evolved.
What is a Risk Engine
what does a Risk Engine do?

A Risk Engine is typically a transformation engine. It takes trades and market data as input and transforms it into Risk metrics.

The transformation is usually an approved quantitative analytics process (typically in C++). The risk metrics produced at trade level need to go through a map-reduction process to have them regrouped by netting sets on a Counterparty basis.
Traditional Risk Engines

task based engines - execution

Manager

Broker

task queue

Broker

Engines

Grid Engine
Traditional Risk Engines

Task based engines – map-reduction

Grid Engine

Tasks

Results

Map Reduce

Reports
Beam based Risk Engines
transformation and map-reduce in one pass
Beam based Risk Engines
inner workings
Beam for Counterparty Credit Risk

How HSBC uses Beam to drive the Counterparty Credit Risk metrics.
Counterparty Credit Risk
global scope

Nos of batches processed per day by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Batches/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>21</td>
</tr>
<tr>
<td>EUROPE</td>
<td>10</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>5</td>
</tr>
</tbody>
</table>

Trade counts per day by region across all batches

<table>
<thead>
<tr>
<th>Region</th>
<th>Trades/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>1.4m</td>
</tr>
<tr>
<td>EUROPE</td>
<td>3.4m</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>0.6m</td>
</tr>
<tr>
<td>Grand Total</td>
<td>5.4m</td>
</tr>
</tbody>
</table>

Average trade count per batch by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Trades/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>67,000</td>
</tr>
<tr>
<td>EUROPE</td>
<td>340,000</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>129,000</td>
</tr>
</tbody>
</table>
Counterparty Credit Risk volumes

Total trade value by notional processed per region (in billions of USD) per day

<table>
<thead>
<tr>
<th>Region</th>
<th>Batches/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>8,000</td>
</tr>
<tr>
<td>EUROPE</td>
<td>21,000</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>4,500</td>
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</table>

Grand Total 746

Number of computations executed per day in the beam batches (in billions)

<table>
<thead>
<tr>
<th>Region</th>
<th>Trades/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>193</td>
</tr>
<tr>
<td>EUROPE</td>
<td>466</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>87</td>
</tr>
<tr>
<td>Grand Total</td>
<td>746</td>
</tr>
</tbody>
</table>

Data volume handled (in MB) per day

<table>
<thead>
<tr>
<th>Region</th>
<th>Trades/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td>61,244</td>
</tr>
<tr>
<td>EUROPE</td>
<td>69,723</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>18,749</td>
</tr>
<tr>
<td>Grand Total</td>
<td>149,716</td>
</tr>
</tbody>
</table>
Counterparty Credit Risk
weekly usage patterns – vCPU’s
Counterparty Credit Risk
daily usage patterns – vCPU’s
Counterparty Credit Risk
resource usage metrics

Disk Space Allocation
1 hr interval  query

Memory utilization / Number of workers in operation
1 hr interval  query

Total shuffle data processed
1 hr interval  query

Memory Utilization
1 hr interval  query
Counterparty Credit Risk
deops considerations

• Advance planning with your Cloud provider (Google, in this case) on primary and secondary locations for high volume.
• Take in account additional resources such as shuffle slots if using Cloud Dataflow in Google. Its availability in the regions also needs to be in sync with the location of the primary and secondary location of the managed service.
• A particular worker type might suit you beam run better.
• Consider best machine type to suit your batch dynamics.
Counterparty Credit Risk
resilience planning

- Workout likelihood of stock out events occurring (Black Friday, Cyber Monday)
- Review your reservation strategy
- Define a fallback strategy (outside of reservation periods)

For example:

N2D-highmem-32 → N2-highmem-32 → N1-highmem-32

Fallback machines should suit the profile of the job and must have abundance of availability for the chosen region & zone in which you will operate.
Conclusions
Beam as a Risk Engine

conclusions

• Generation of risk metrics is transformation process usually involving a directed acyclic graphing (DAG) process.

• Monte-Carlo simulation-based risk generations involves evaluating billions of points and is generally (not always) and embarrassingly parallel problem.

• Post processing of risk metrics generally involves large amounts of regrouping based on the desired dimension on which to group by.

• Beam offers a natural language to cater for all of these requirements.
• When the transformative analytics is available in Python (or any Beam native language), the case to use Beam for generating risk metrics becomes compelling.
Thank you