

Developing and maintaining Swiss Re's Internal Risk Model ICAM in MATLAB

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Key Takeaways

1. Swiss Re has developed a professional enterprise application with MATLAB
2. MATLAB and Swiss Re's internal risk model ICAM have been growing over the last decade
3. Measurable outcome: transparency, flexibility, maintainability

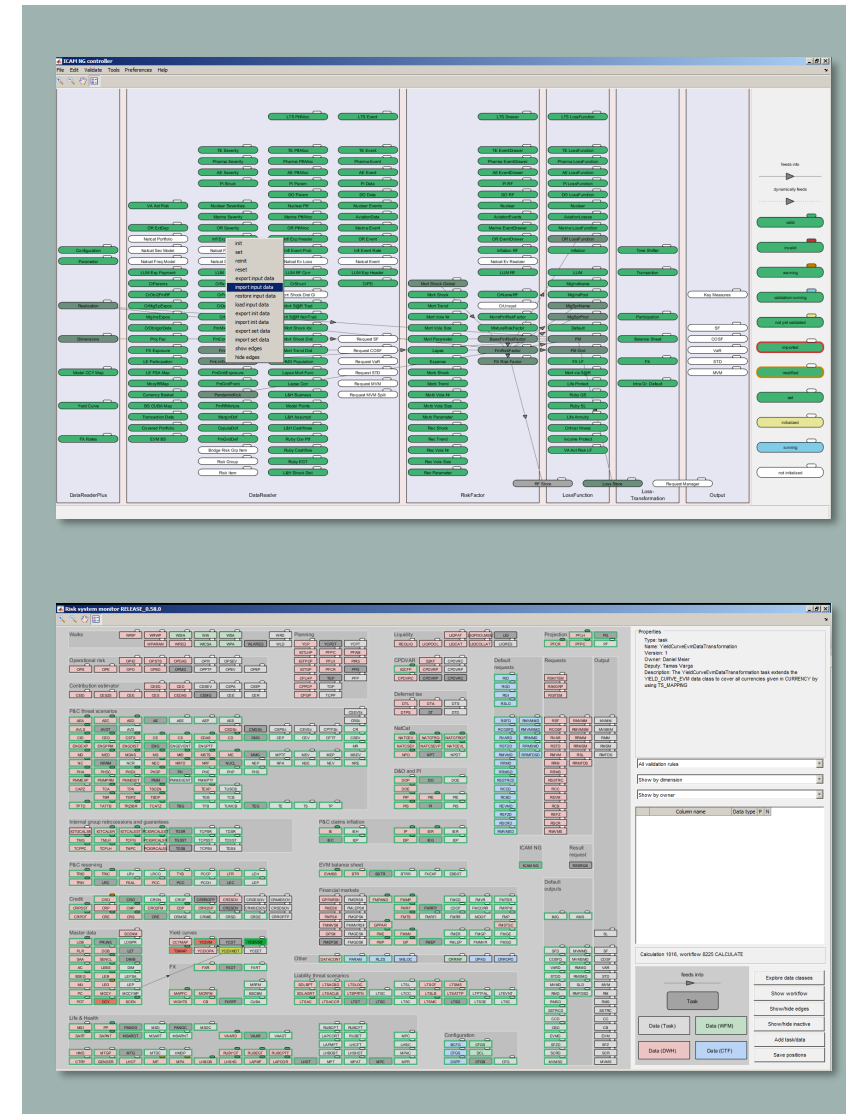


Swiss Re

- Swiss Re is the world's second largest reinsurer
- Founded in 1863, head quarters based in Zurich with offices in 25+ countries and 14'000+ employees
- Shareholders' equity 2016: USD 35.6bn
- Net premiums/fees earned 2016: USD 33.2bn
- CO₂ programme (2013-2020 Greenhouse Neutral Programme)
- Launch of Swiss Re Institute in 2017 (<http://institute.swissre.com>)

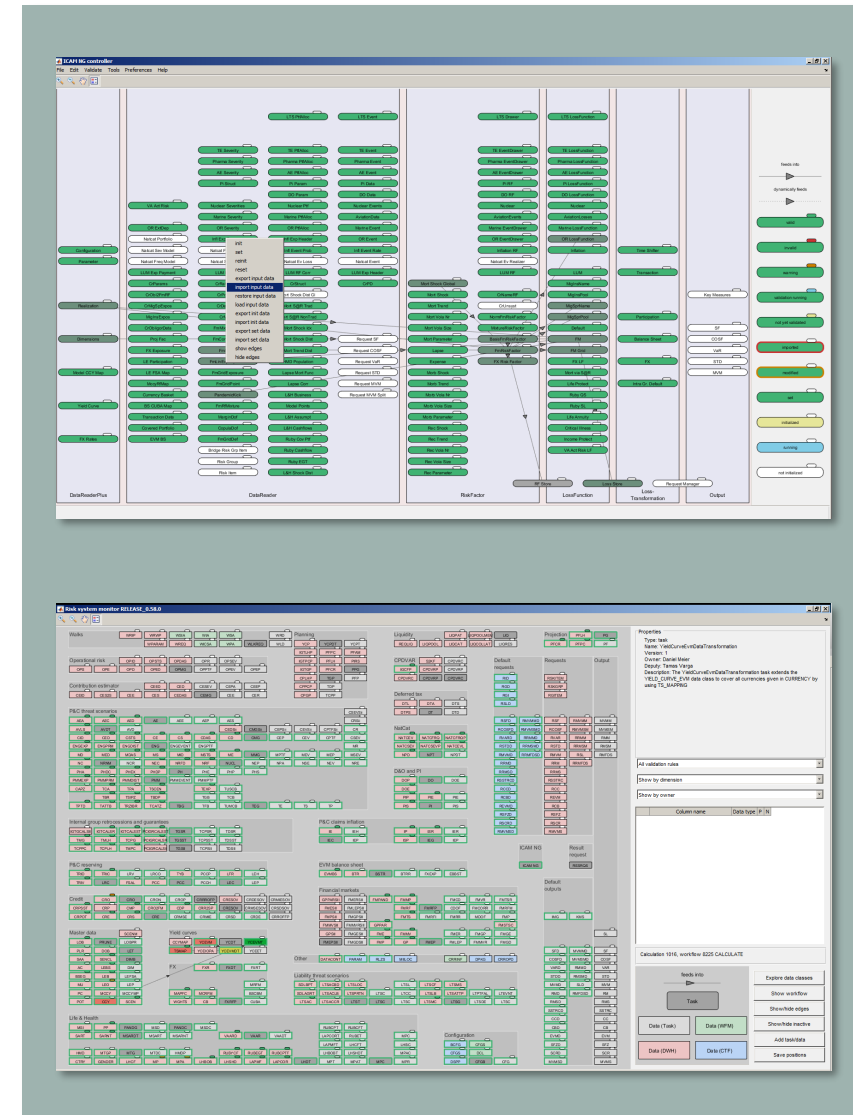
Swiss Re's Internal Risk Model ICAM (internal capital adequacy model)

- Long history of using an internal risk model to steer the company and for regulatory purposes: Swiss Solvency Test (SST) and Solvency II
- For a decade, Swiss Re has used **MATLAB** to implement its internal risk model **ICAM**
- ICAM is developed/maintained by **Risk Modelling**, a team of 13 people with a broad range of educational backgrounds



Swiss Re's Internal Risk Model ICAM (internal capital adequacy model)

- In 2017, Swiss Re concluded a major project called **IRAMP** (integrated risk analytics & modelling platform) to overhaul ICAM with key goals
 - transparency
 - flexibility for future developments, maintainability
 - speed
 - precision of risk measures (expected shortfall, value at risk, etc.)



Many different approaches to present ICAM...



Mathematical/actuarial/algorithmic approach



IT/technical approach

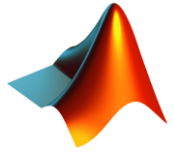


Economic/risk management approach



Educational/training approach

Many different approaches to present ICAM...

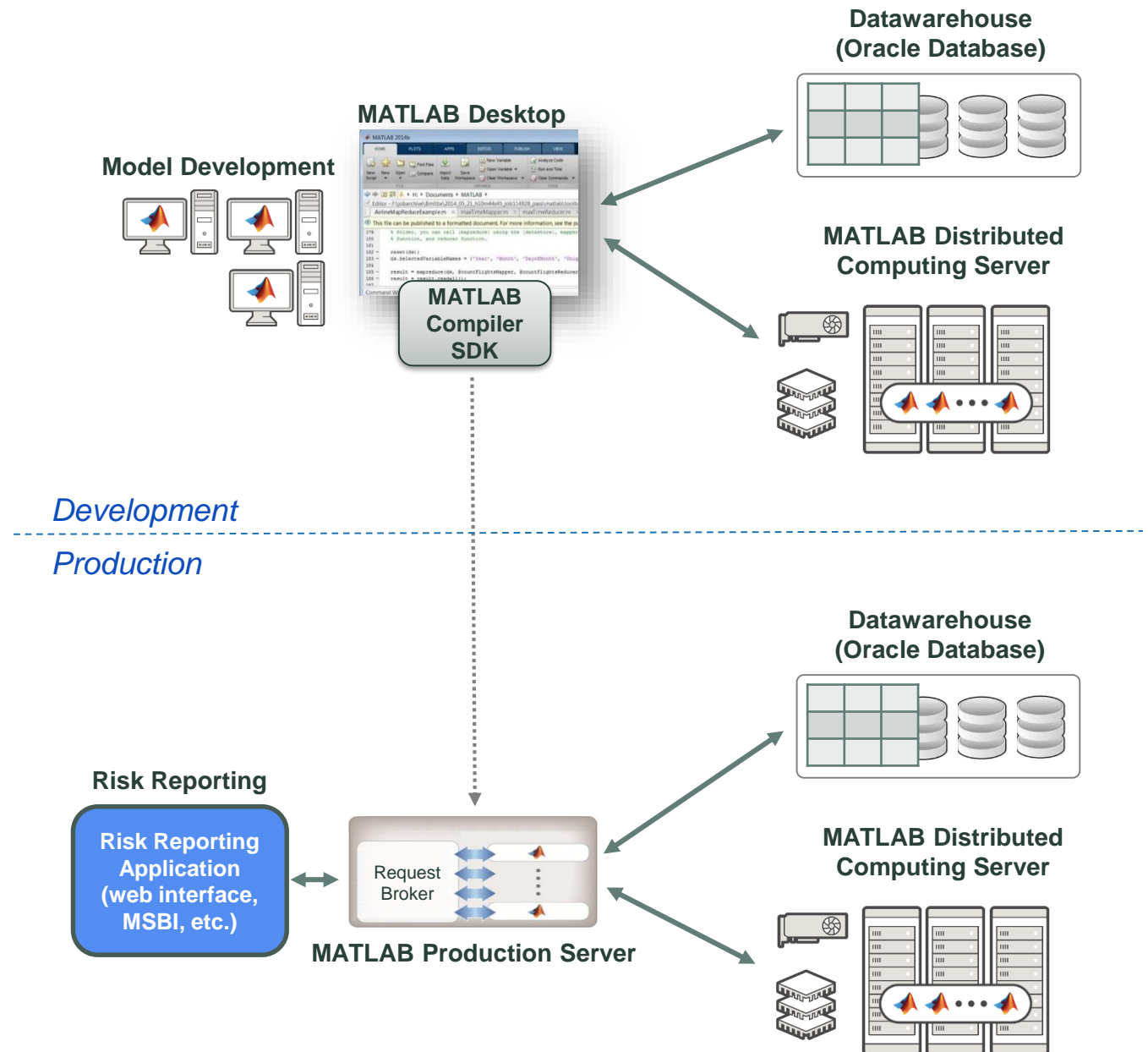


“MATLAB approach” – why and how are we using MATLAB?

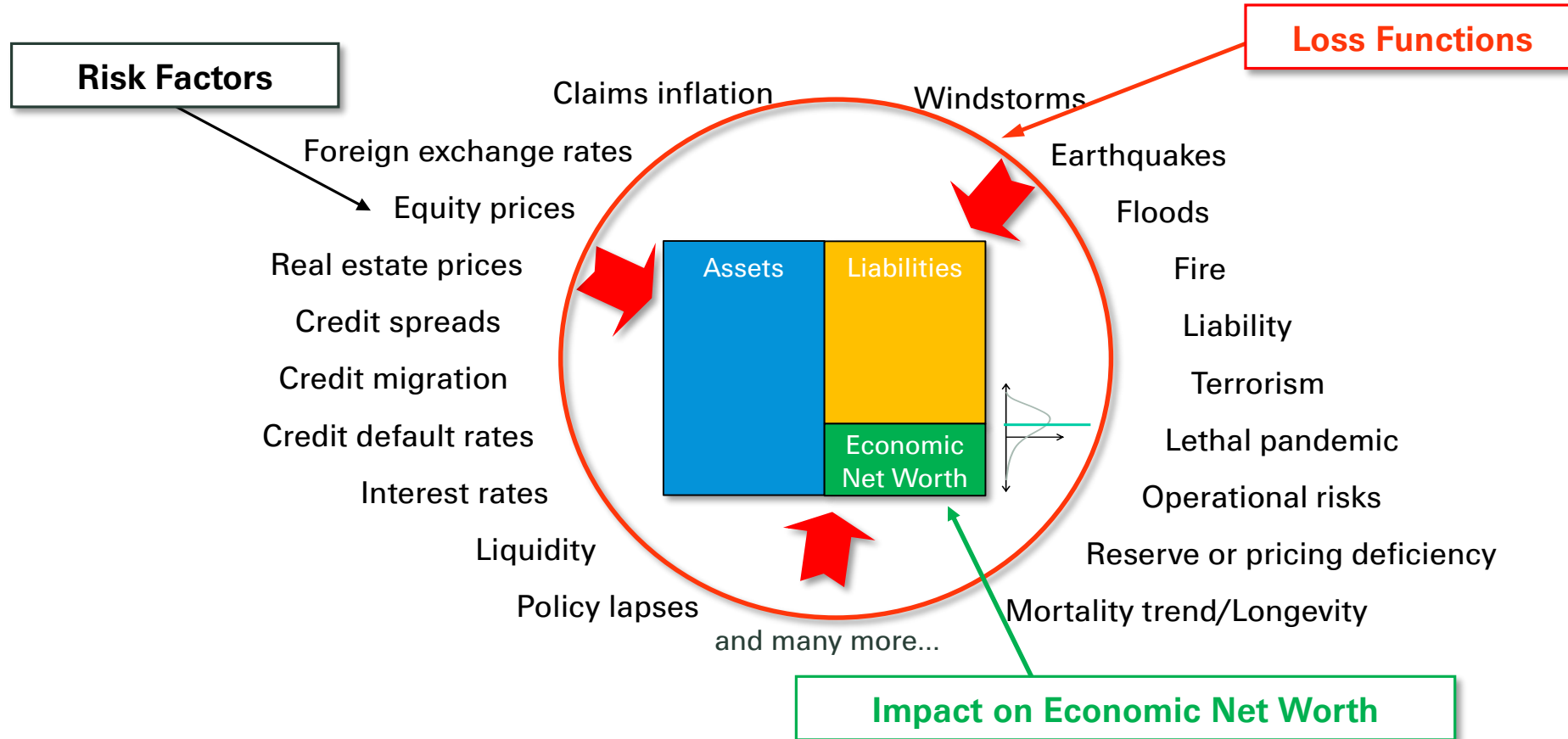
- All-in-one solution: parallel computing, data import/export, profiler, debugger, unit testing framework, GUIs, algorithm collection, speed, etc.
- Flexibility for Risk Modellers
- KISS principle (keep it safe, simple, smart, etc.)
- MathWorks is a strong partner to avoid FOMO (fear of missing out) while current tools landscape is growing too fast to follow

System Architecture

- Model development in development (and training) environment, 160 workers on MDCS, use of Parallel Computing Toolbox, 30+ users working directly with MATLAB
- Generation of risk reports in production environment, 224 workers on MDCS, risk reports essentially are consumed by the whole company as well as external stakeholders, e.g. regulators, auditors, rating agencies, etc.



ICAM Overview

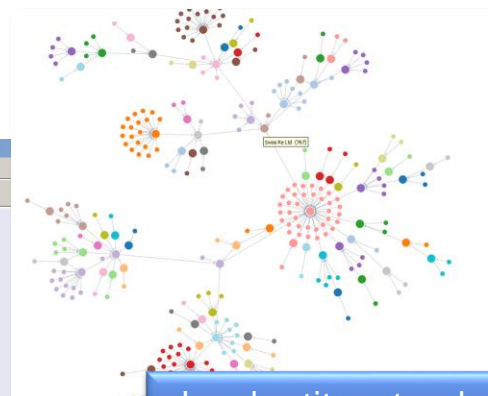


An integrated risk model is needed to understand the aggregate **joint** impact of all risk factors on the total economic balance sheet

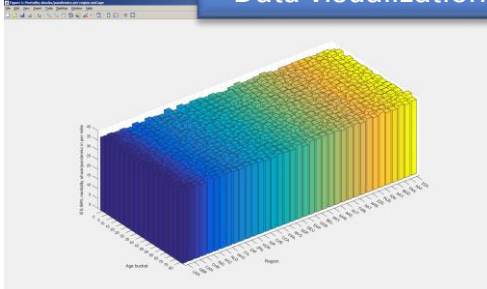
ICAM Demo (running on modified/artificial data)

ICAM main user interface

The interface is organized into several columns and rows of buttons. A central menu is open, listing actions such as 'init', 'set', 'reinit', 'reset', 'export input data', 'import input data', 'restore input data', 'load input data', 'export init data', 'import init data', 'export set data', and 'import set data'. The buttons are labeled with terms like 'LTS PFAloc', 'TE Severity', 'Pharma PFAloc', 'AE Severity', 'PI Struct', 'VA Act Risk', 'Nuclear Severities', 'OR ExDap', 'Natcat Portfolio', 'Natcat Sev Model', 'Natcat Freq Model', 'LUM Exp Payment', 'CrParams', 'CrObl2FmRF', 'CrMgSpExpos', 'MgInaExpos', 'CrObligorData', 'Proj Fac', 'Yield Curve', 'FX Rates', 'Currency Basket', 'BS CUBA Map', 'Transaction Data', 'Covered Portfolio', 'EVM BS', 'PandemicKick', 'FmRFMixure', 'OpulaDof', 'FmGridDof', 'Bridge Risk GIP Item', 'Risk Group', 'Risk Item', 'L&H Business', 'Model Points', 'L&H Assumpt', 'L&H Cashflow', 'Ruby Gov PFI', 'Ruby Cashflow', 'Ruby EQT', 'L&H Shock Dist', 'Mort Shock Global', 'Mort Shock', 'Mort Trend', 'Mort Voia N', 'Mort Voia Size', 'Mort Parameter', 'Mort Shock Dist', 'Mort Trend Dist', 'Lapse Mort Func', 'Lapse Corr', 'Morb Shock', 'Morb Trend', 'Morb Voia N', 'Morb Voia Size', 'Morb Parameter', 'Rec Shock', 'Rec Trend', 'Rec Voia N', 'Rec Voia Size', 'Rec Parameter', 'LTS Drawer', 'TE EventDrawer', 'Pharma EventDrawer', 'AE EventDrawer', 'PI RF', 'DO RF', 'Nuclear', 'AviatorEvent', 'Marine EventDrawer', 'OR EventDrawer', 'Inflation RF', 'Natcat Ev Realizer', 'LUM RF', 'CrName RF', 'CrUnsynt', 'NormFmRiskFactor', 'MatureRiskFactor', 'BaseFmRiskFactor', 'FmRiskFactor', 'FX Risk Factor', 'LTS LossFunction', 'TE LossFunction', 'Pharma LossFunction', 'AE LossFunction', 'PI LossFunction', 'DO LossFunction', 'Nuclear', 'AviatorLosses', 'Marine LossFunction', 'MgInaName', 'MgInaPool', 'MgSorName', 'MgSorPool', 'Default', 'FM', 'FM Grid', 'FX LP', 'Time Shifter', 'Transaction', 'Participation', 'Balance Sheet', 'FX', 'Request SF', 'Request COSF', 'Request VaR', 'Request STD', 'Request MVM', 'Request MVM Split', 'RF Store', 'Loss Store', 'Request Manager', 'Output', 'Key Measures', 'SF', 'COSF', 'VaR', 'STD', 'dynamically feeds', 'valid', 'invalid', 'warning', 'validation running', 'not yet validated', 'imported', 'modified', 'set', 'initialized', 'not'.



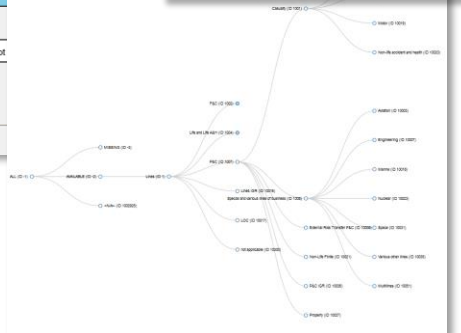
Data visualization



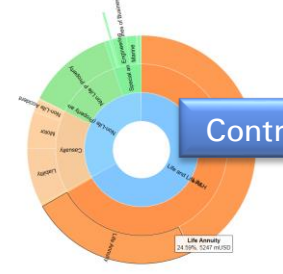
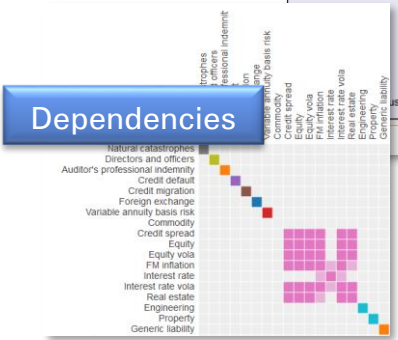
Export/modify/import functionality for all objects

Well-defined objects (risk factors, loss functions, loss transformations, etc.) keeping track of all dependencies

Master data hierarchies



Dependencies



ICAM Demo (running on modified/artificial data)

ICAM NG controller RELEASE_0.58.1
File Edit Validate Tools Preferences Help

Engineering PTF A Engineering Event
Property MM PTF A Property MM Event
LTS PTF Allocation LTS Event
Engineering Engineering
Property Man-made Property Man-made
Liability Threat Scen Liability Threat Scen

Portfolio manager

Selection 1: BSEG LF LHP LOB MCCY MU POT SAA SCEN TY
Selection 2: BSEG LF LHP LOB MCCY MU POT SAA SCEN TY

Node selection: Expand all Collapse all

Configuration
Parameter
Realization
Dimensions
MCCY Mapping
Yield Curve
FX Rates

Configuration
Parameter
Realization
Dimensions
MCCY Mapping
Yield Curve
FX Rates
DataReaderPlus

ALL AVAILABLE All Values of Potential Operational Man-made
MISSING Insurance Claims inflation
Natural catastrophes
Costing and reserving
Financial market and credit
<N/A> Life & health

Realization characteristics

CDF

PDF

Scatter plot

QQ plot

Risk measure/property	Value selection 1	Value selection 2
1 Shortfall 99% [mUSD]	11267	11267
2 VaR 99.5% [m USD]	8741	8741
3 Std [m USD]	2392.6	2393
4 Kurtosis	15.2	15.2
5 Shortfall 99%/Std	4.7	4.7

Dependency measure	Value
1 Correlation	1.00
2 Relative cosf 99% (2 to 1)	1.0
3 Relative cosf 99% (1 to 2)	1.0

ICAM in Numbers

- More than 400 data classes (tables) with about 4'000 data attributes (columns) in total
- About 50 tasks (transformations, pre-processing, etc.)
- About 250 classes for risk factors, loss functions, etc. in ICAM
- Currently about 150 data validation rules – number still growing
- About 400 unit tests
- About 70'000 lines of code
- About 15 user interfaces for risk exploration, as-if calculations, education, etc.

Conclusion and Summary

- Swiss Re has developed a professional enterprise application with MATLAB
 - the key goals transparency, flexibility, maintainability were achieved by making extensive use of what MATLAB offers, e.g. graphical user interfaces, object-oriented programming, unit tests, data exploration tools, profiler, debugger, etc.
- Forward-looking plans
 - further model development
 - internal (and external) trainings
 - explore potential cloud migration

MATLAB is an excellent all-in-one solution for developing and maintaining Swiss Re's complex internal risk model ICAM.



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