Practical R in the London Market

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UMACS

Underwriting Management and Actuarial Consultancy Services

15 July 2013

Overview

1. *Brief into to UMACS;*
2. *Why does UMACS use R?*
3. *Case studies;*
4. *Practical barriers to R usage in the London Market*
5. *The future of R in pricing*

Who are UMACS?

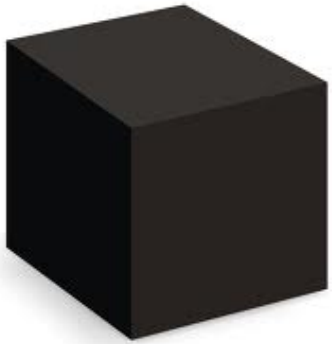
UMACS has technical expertise in the London Market, but strong focus on practical solutions which deliver bottom line value for the business.

- ✓ London Market actuarial consultancy
- ✓ Set up in 2007 by Tony Jones and Fiachra McLoughlin
- ✓ Expanded to14 people in 2013, covering a range of pricing, capital modelling and reserving projects for Lloyds syndicates, brokers and International Reinsurers
- ✓ Emphasis on delivering bottom line results through technical expertise and a strong focus on practical solutions
- ✓ R is a close fit for many UMACS projects and our clients

Why does UMACS use R?

UMACS uses R to deliver cutting edge techniques in a practical way

- ✓ R is fast e.g. Excel simulation models, running reports
- ✓ R is portable (both in terms of code and software)
- ✓ R can be easier to follow than an Excel sheet or proprietary software (R is not a black box)
- ✓ R can draw from others work e.g. internal (functions/modules) and packages (actuar, ggplot, ChainLadder)
- ✓ R is free
- ✓ R can do things other software can not and is **highly bespoke**
- ✓ **R is just as useful for quick calculations as large, formal processes**



Vs

UMACS Case Studies

Real world case studies

- ✓ Pricing PD/BI example – dealing with complex coverages
- ✓ Capital - Stoch reserving (res risk), ELT simulation, fitting dist e.g. SHELF, expert
- ✓ RI options - explore different options quickly
- ✓ LCM returns and cat modelling
- ✓ Automated MI reports e.g. Benchmark pricing
- ✓ Using R as an Excel add-in

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UMACS Case Studies

Example 1 - ELT simulation

EventID	Frequency	PERSPVALU	STDDEVC_DF	STDDEVI_DF	EXPVALUE_DF	PERSPVALU	STDDEVC_B	STDDEVI_BR	EXPVALUE_BR	PERSPVAL	STDDEVC_C	STDDEVI_OT	EXPVALUE_OT	PERSPVAL	STDDEVC_B	STDDEVI_BH	EXPVALUE_BH
1	1.00E-04	46,770	47,677	716,160	935,397	40,209	5,957	53,400	1,206,267	-	-	-	-	-	-	-	-
2	1.00E-04	72,797	84,727	310,983	1,455,947	25,608	5,957	53,400	768,227	-	-	-	-	-	-	-	-
3	1.00E-04	95,412	56,753	205,165	1,908,233	51,662	11,756	91,908	1,549,864	-	-	-	-	-	-	-	-
4	1.00E-04	17,882	40,907	192,127	357,649	12,163	6,187	71,173	364,891	-	-	-	-	-	-	-	-
5	1.00E-04	80,377	45,914	199,001	1,607,539	26,124	9,008	58,703	783,727	5,834	14,373	190,659	1,709,205	5,390	14,373	190,659	1,709,205
6	1.00E-04	9,069	94,908	431,625	181,375	6,318	10,692	52,612	189,541	-	-	-	-	-	-	-	-
7	1.00E-04	71,587	10,792	76,590	1,431,740	53,037	4,635	53,504	1,591,112	-	-	-	-	-	-	-	-
8	1.00E-04	66,025	64,468	226,224	1,320,506	27,952	8,052	73,541	838,560	-	-	-	-	-	-	-	-
9	1.00E-04	64,135	52,829	220,479	1,282,704	19,426	9,509	80,602	582,781	-	-	-	-	-	-	-	-
10	1.00E-04	16,175	56,577	280,331	323,492	7,737	8,246	47,313	232,119	-	-	-	-	-	-	-	-
11	1.00E-04	43,352	49,498	199,709	867,042	8,043	3,370	63,592	241,292	-	-	-	-	-	-	-	-
12	1.00E-04	89,078	-	-	1,781,563	81,959	3,301	62,141	2,458,781	-	-	-	-	-	-	-	-
13	1.00E-04	66,500	66,032	316,724	1,329,992	4,469	8,294	62,990	134,074	-	-	-	-	-	-	-	-
14	1.00E-04	52,090	43,351	198,643	1,041,800	32,164	5,720	58,951	964,926	-	-	-	-	-	-	-	-
15	1.00E-04	77,556	72,633	351,760	1,551,120	36,089	5,914	96,635	1,082,675	-	-	-	-	-	-	-	-
16	1.00E-04	87,056	248,646	719,971	1,741,118	63,711	16,541	104,176	1,911,336	-	-	-	-	-	-	-	-
17	1.00E-04	94,786	48,979	138,240	1,895,715	21,057	4,150	54,591	631,708	-	-	-	-	-	-	-	-
18	1.00E-04	32,151	-	-	643,017	4,047	4,399	77,601	121,398	-	-	-	-	-	-	-	-
19	1.00E-04	80,682	-	-	1,613,641	72,186	4,907	83,915	2,165,592	-	-	-	-	-	-	-	-

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5	1.00E-04	80,377	45,914		5,390	14,373	190,659	1,709,205
6	1.00E-04	9,069	94,908		-	-	-	-
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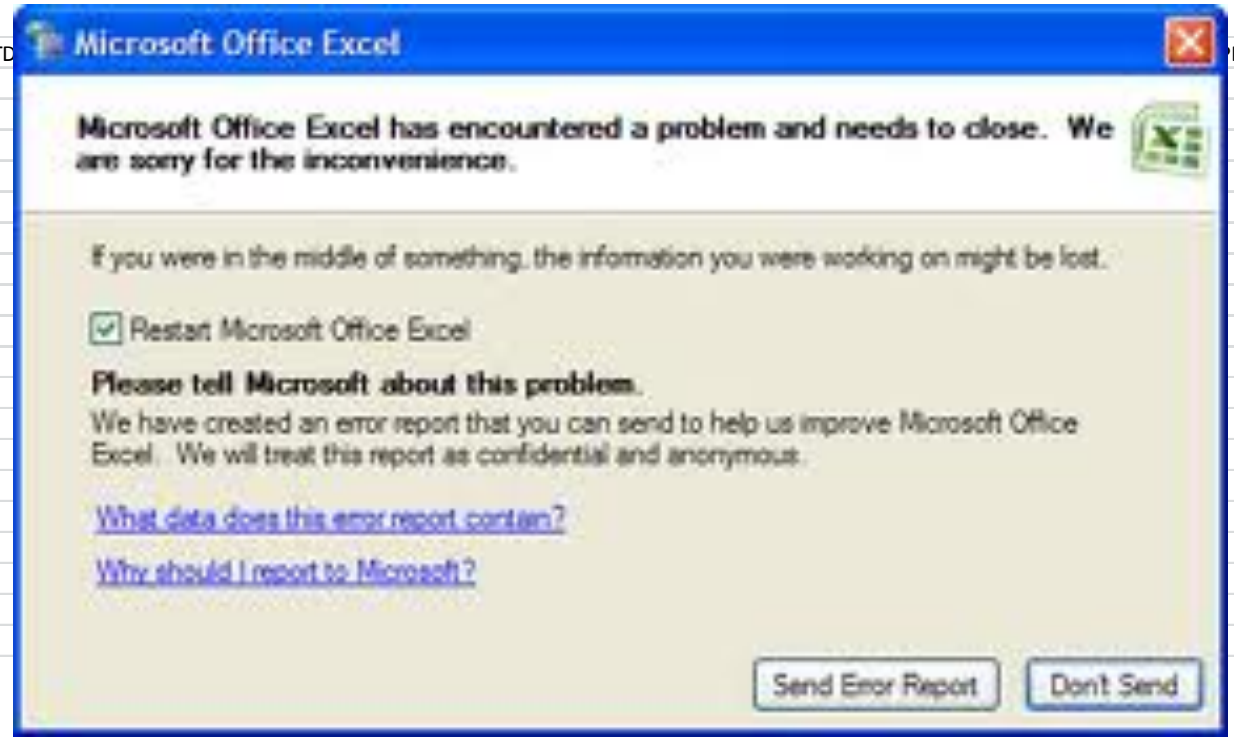
18	1.00E-04	32,151	-		-	-	-	-
19	1.00E-04	80,682	-		-	-	-	-



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19	1.00E-04	80,682	-	-	1,613,641	72,186	4,907	83,915	2,165,592	-	-	-	-	-	-	-	-

```
#STEP 2 - running the simulation to get gross losses
data <-read.csv('C:\\Users\\edward.UMACS\\Desktop\\LCM Q2\\07May2013.csv', header=TRUE)
gross <- multi_elt(data, n=n_sims)
```

UMACS Case Studies

Example 1 - ELT simulation

- AEP and OEP results
- By class, by peril
- Mean, different return periods
- Gross/Net/Final Net
- RI utilisation, ratios and exhaustion

Region	Peril	Class	Year	Gross	Net	Final Net
UC	QK	DF	1	46	46	46
UC	QK	DF	2	307,682	307,682	307,682
UC	QK	DF	3	28,077	28,077	28,077
UC	QK	DF	4	5,883,232	5,000,000	5,176,646
UC	QK	DF	5	-	-	-
UC	QK	DF	6	-	-	-
UC	QK	DF	7	-	-	-
						-
						-
UC	QK	DF	10	-	-	-
UC	QK	DF	11	-	-	-
UC	QK	DF	12	0	0	0
UC	QK	DF	13	343,970	343,970	343,970
UC	QK	DF	14	-	-	-

EXCEL – 2 DAYS
R – 30 SECONDS

Pricing example

- Problem – how do we price for correlated perils with a common limit/deductible?
- Can become very convoluted in Excel trying to apply First Loss scales to account for the correlations…
- Simulation a better approach

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loc	pdTIV	pdMPL	pdStdDed	pdBaseRat	biTIV	biMPL	biStdDed	biBaseRate	rankCorre	N	Lyr1_Attach	Lyr1_Limit
1	500,000,000	250,000,000	1,000,000	0.100%	500,000,000	400,000,000	41,095,890	0.200%	0.20	100,000	-	100,000,000
2	250,000,000	125,000,000	1,000,000	0.100%	250,000,000	200,000,000	20,547,945	0.200%	0.50	100,000	-	50,000,000
3	100,000,000	40,000,000	1,000,000	0.100%	200,000,000	160,000,000	16,438,356	0.200%	0.80	100,000	-	50,000,000
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8	250,000,000	125,000,000	1,000,000	0.100%	250,000,000	200,000,000	20,547,945	0.200%	0.50	100,000	-	50,000,000
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10	500,000,000	250,000,000	1,000,000	0.100%	500,000,000	400,000,000	41,095,890	0.200%	0.20	100,000	-	100,000,000

Pricing example

- Two correlated perils (PD and BI) with a common policy limit
- Each has its own TIV, MPL, freq and severity distribution
- We run 100k sims and correlate the distributions, then apply the policy limit to the sum of the losses
- Outputs show individual (marginal) freq and severity as well as combined FGU and loss to the layer
- Accounting for the correlation structure is very hard to achieve without simulation
- VBA simulations are much longer, verbose and the statistical abilities more limited

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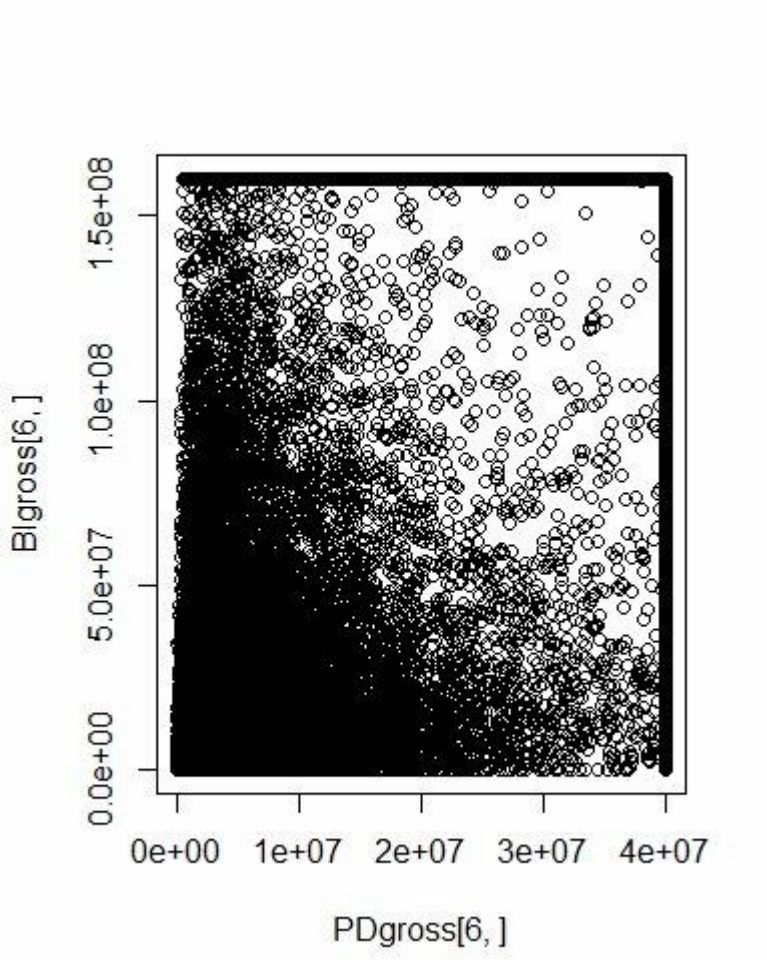
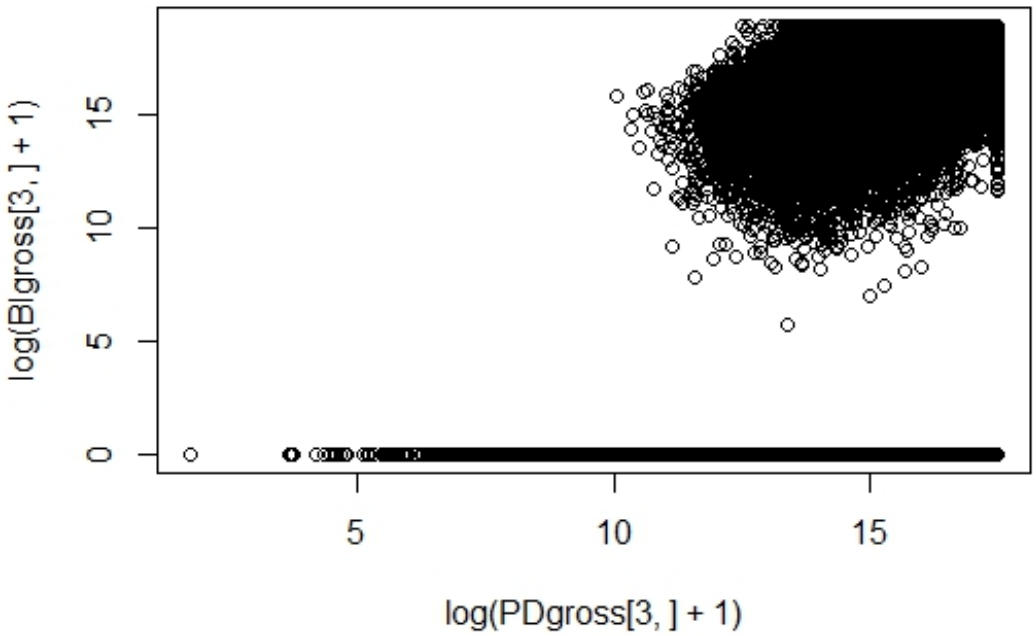
```
#1. Create list of correlation matrices
S <- lapply(rankCorrel,CorrelMatrix2way)
#List of paired gaussian variables
AB <- mapply(rmvnorm,mean=list(c(0,0)),sig=S,n=N,SIMPLIFY=FALSE)
#Map back to [0,1]x[0,1]
U <- lapply(AB,pnorm)
```

These 3 lines do 100k sims of paired rank-correlated variables, *for each location*, using a Gaussian Copula in <1 second

Pricing example





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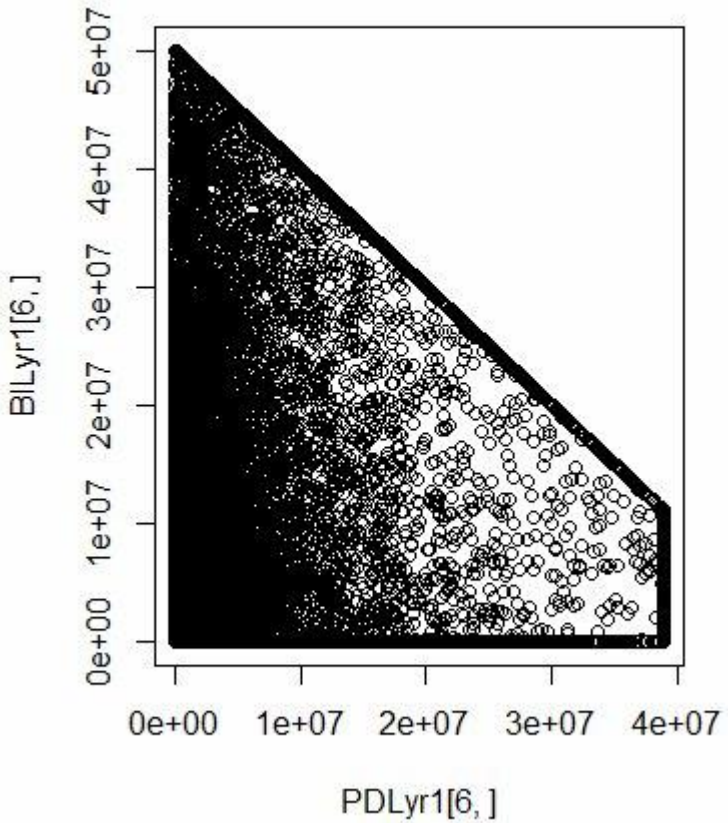

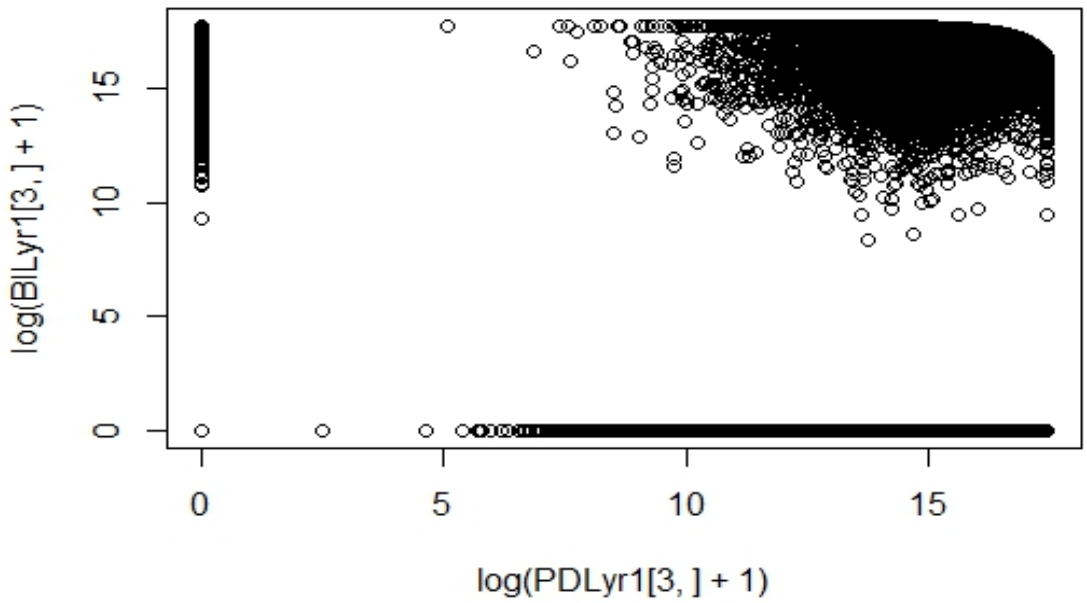

Fitting to expert judgement

User is prompted for severity and frequency percentiles and other inputs

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n_sev_tmp <- readline(prompt="How many severity percentiles do you have?   ")
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R fits a freq severity model e.g. Neg Binomial and Severity from a selection (LogNormal/Pareto/GPD/Gamma etc) and simulates 100k simulations under the supplied terms

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sev <- fit_sev(sev_p, sev_q)
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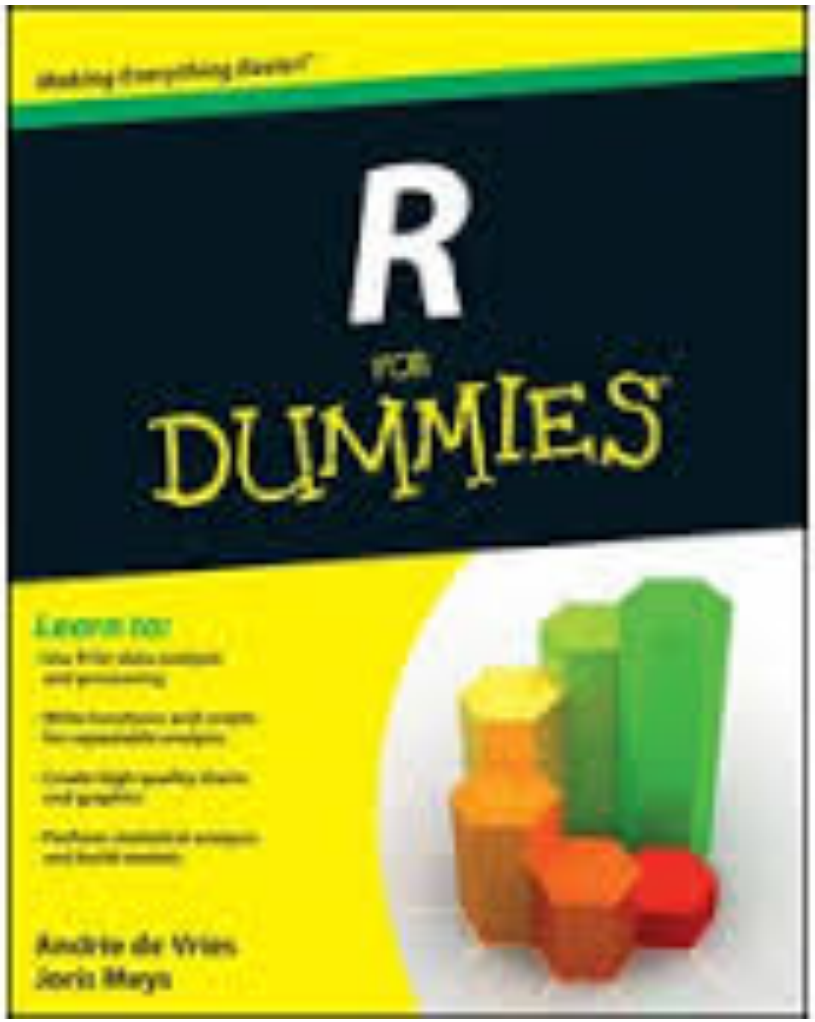
```
sev <- fit_sev(sev_p, sev_q)
```

The user is shown the distribution of gross/net losses e.g. mean and 99.5th to check the inputs

```
 hist(rfrechet(10000,sev_params[1], sev_params[2], sev_params[3]), main="Fitted Frechet severity distribution")
  readline(prompt = “Do you want to change your severity inputs?”)
```

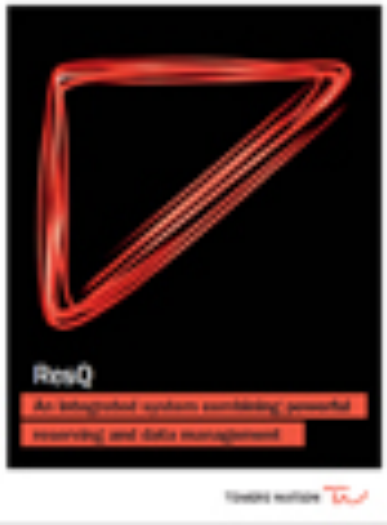
This runs in c. 2 seconds and provides an interactive method of validating Expert judgement for capital models

Barriers to Entry - skills



Barriers to Entry - IT

Barriers to Entry – Incumbent advantage



@RISK

Overcoming the barriers

Gaining the skills

- Graduates increasingly have R skills – if you ask for them!
- R consultants e.g. Mango solutions
- Actuarial consultants skilled in R e.g. UMACS
- LondonR evenings
- Culture that encourages learning – CPD!
- Books e.g.

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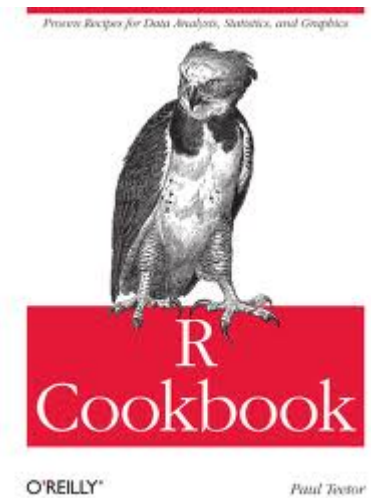
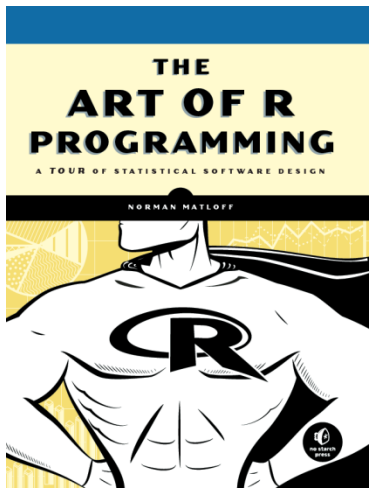
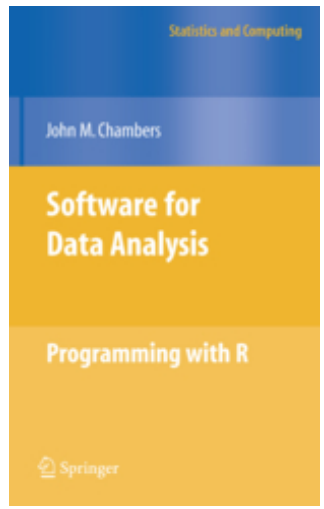


Beginner



Intermediate



Advanced

Overcoming the barriers

Can we trust R?

1. Open source is not wikipedia…
2. Open Source has no theoretical limits to validation
3. Core development team and contributors arguably largest skills base in statistical software
4. Wide range of sophisticated users - the biggest players in academia, pharma, finance use R.
5. You should test all software. R is set up to be testable!

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Who do you call if R breaks?

Can we sue R?

Overcoming the barriers

Excel warranty

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Overcoming the barriers

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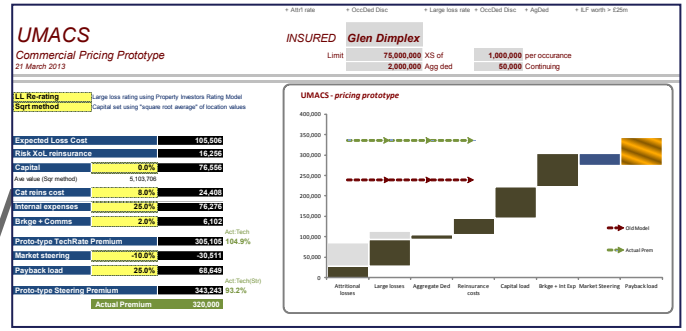
The future of R in the London Market

Evolution of Pricing & incorporating R

- The ‘Minimum Underwriting Standards’ implemented at Lloyds;
- Pricing Actuaries have multiplied (though varied roles);
- Catastrophe models become deeply engrained; (LCM etc)
- Little resistance to Pricing Models on the underwriting side;
- More requests for change and underwriters demand a ‘good’ pricing tool to support their business;
- Organisation level ‘platform’ developments with large-scale IT;
- Much more visibility at board and exec level.



Core platforms but with flexibility for change & enhancement

- **Who owns the calculations + code?**
- **Complexity of calculations are increasing significantly?**
- **Visibility + flexibility for change?**
- **Can R provide a useful balance?**

Questions?

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