The Actuarial Profession
making financial sense of the future

Life conference and exhibition 2010

Neil Cantle Neil Allan

How to really make sense of enterprise risks

Agenda

- What is risk ?
- Some ways to get underneath risk
- Looking beneath the surface
- Evolutionary forces

A theme...

It is not the towering sail, but the unseen wind that moves the ship

Risk

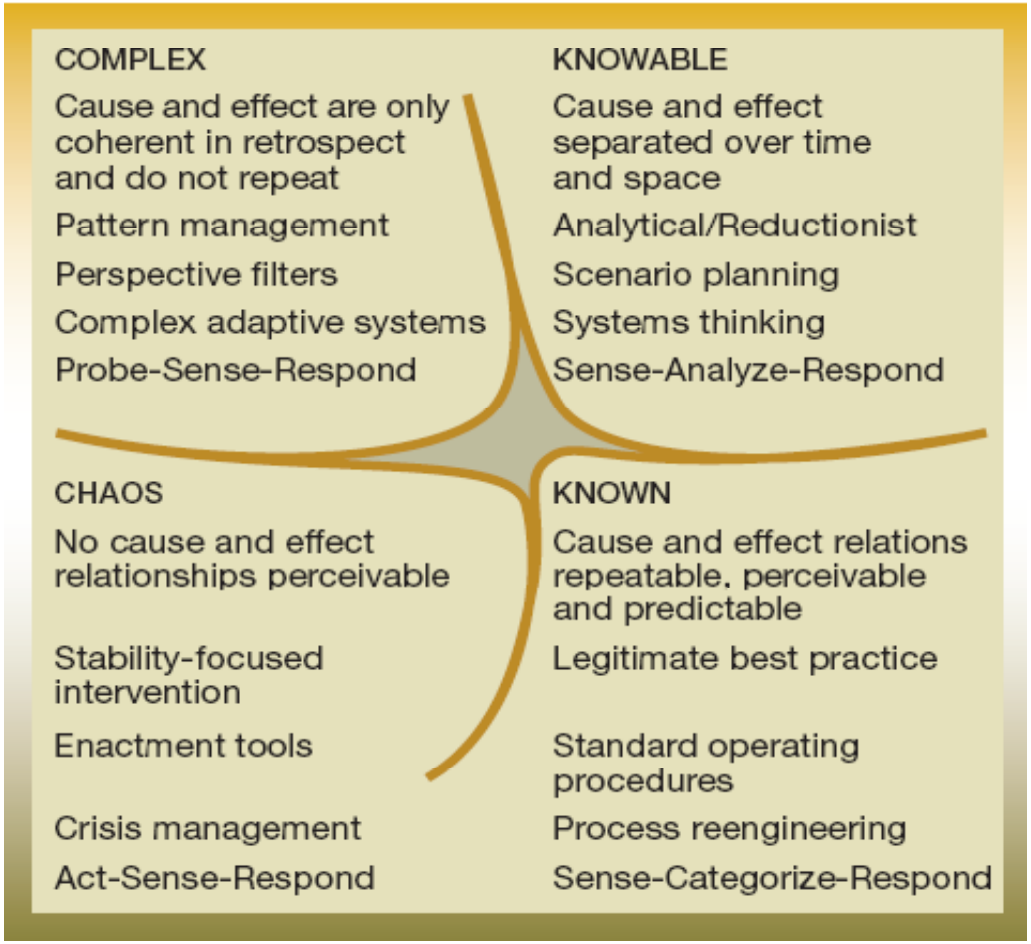
- Uncertainty = lack of complete certainty – i.e. existence of more than one possible outcome
- Risk = state of uncertainty where some of the possibilities involve an undesirable outcome (e.g. loss)

- Typically use these relative to business objectives for ERM

- So, understanding “risk” equates to working out what you are uncertain about in relation to achieving business goals

Cynefin framework

- What Rumsfeld meant...
- Consider different domains
- Typical methods OK for "known" and "knowable"
- Very poor at "complex"
- "Chaos" is about crisis management – survival!



Kurtz and Snowden 2003

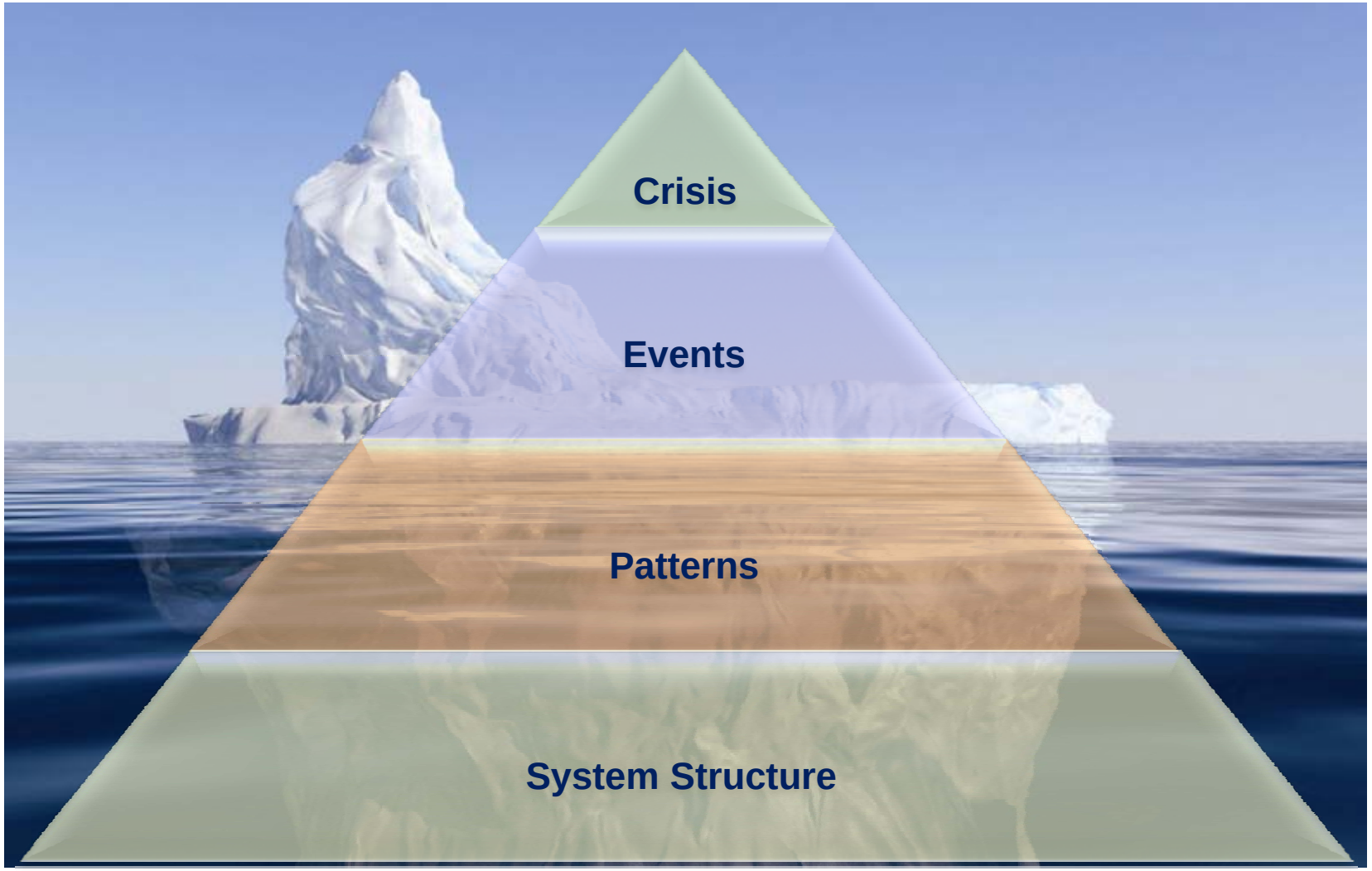
Understanding a crisis

Symptoms

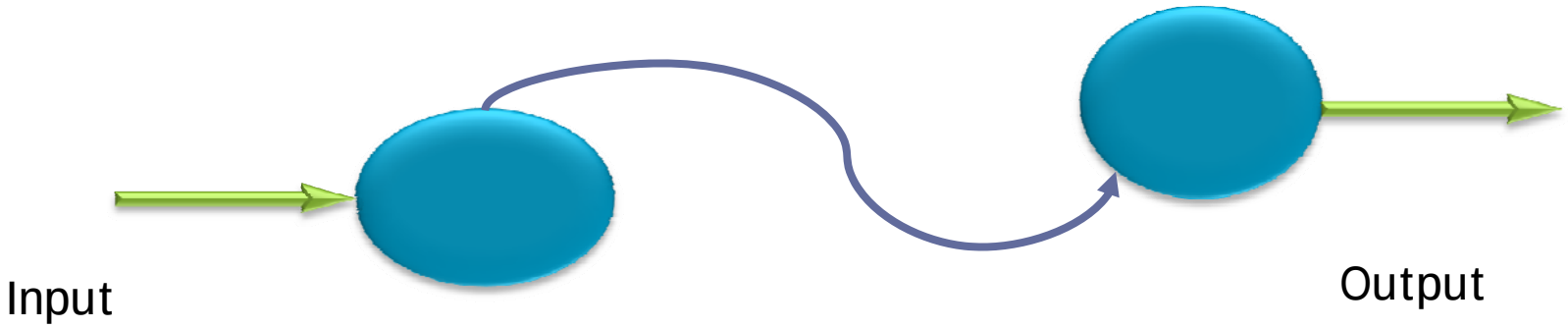
Causes

Sense-making

Understanding

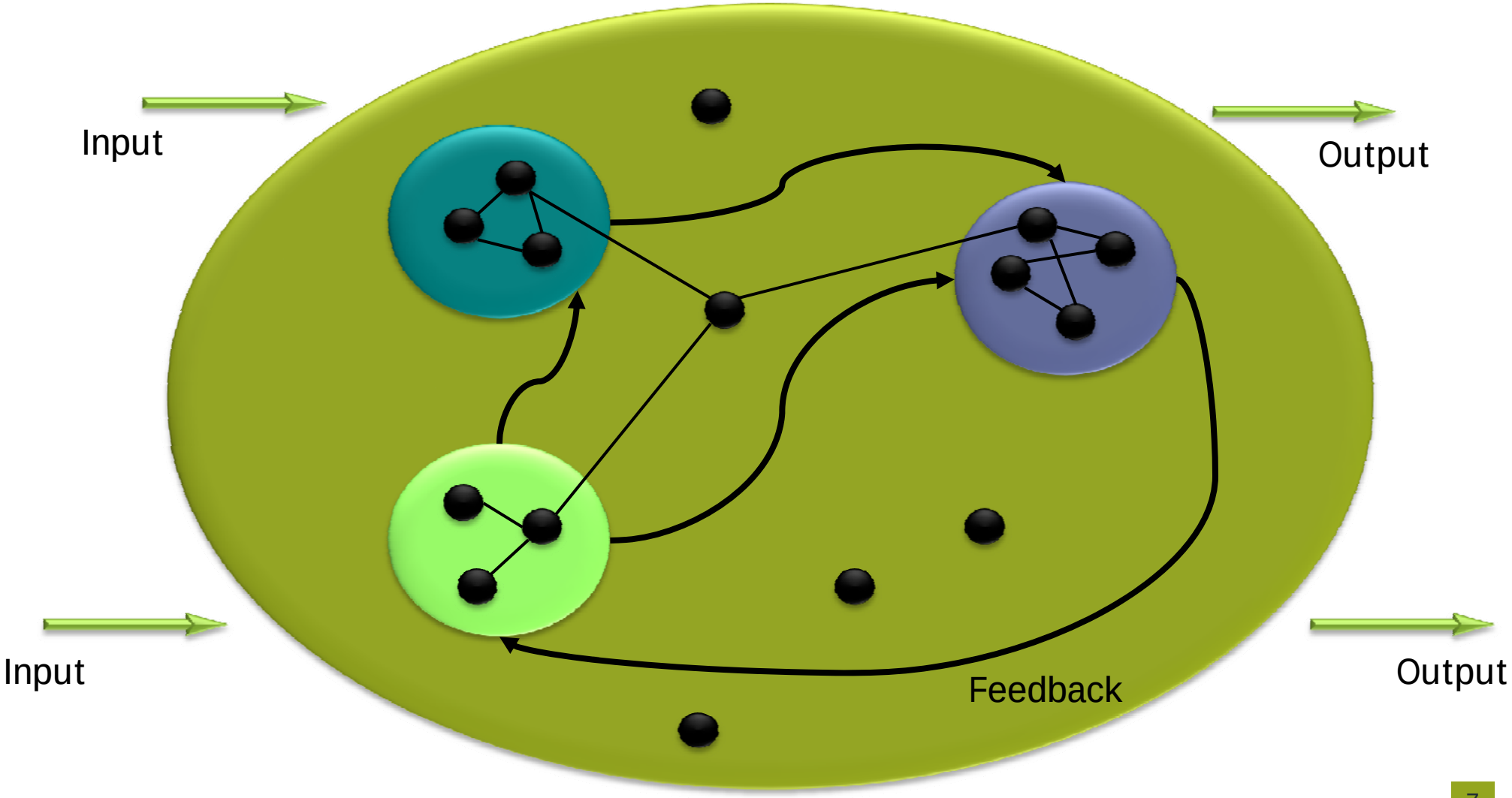


What is a system ?

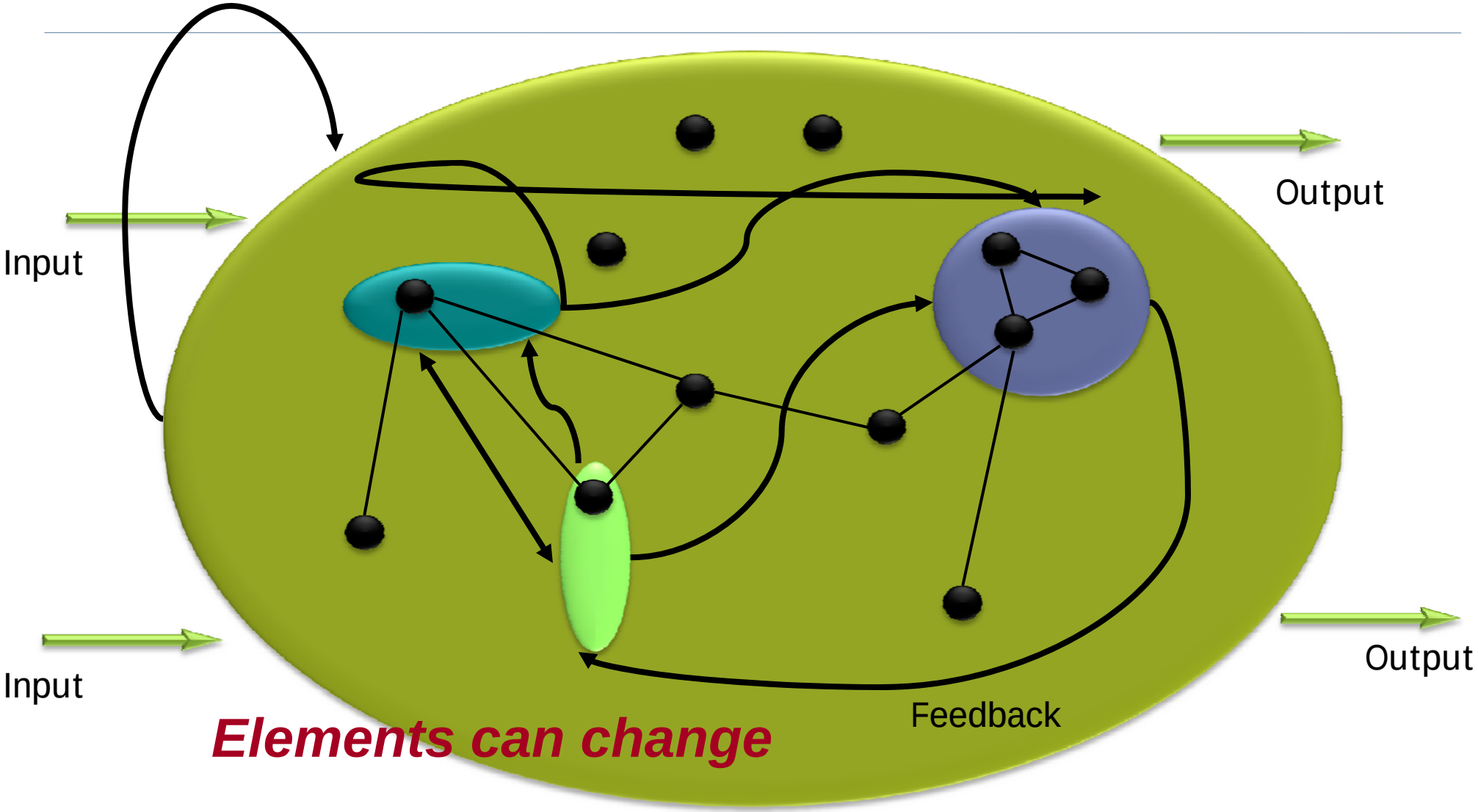


"a set of components interconnected for a purpose."

What is a *complex* system ?



What is a complex *adaptive* system ?

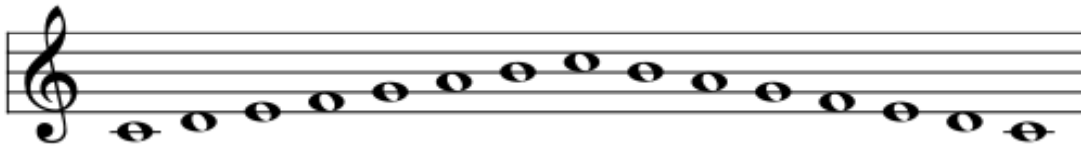


Complex Adaptive Systems

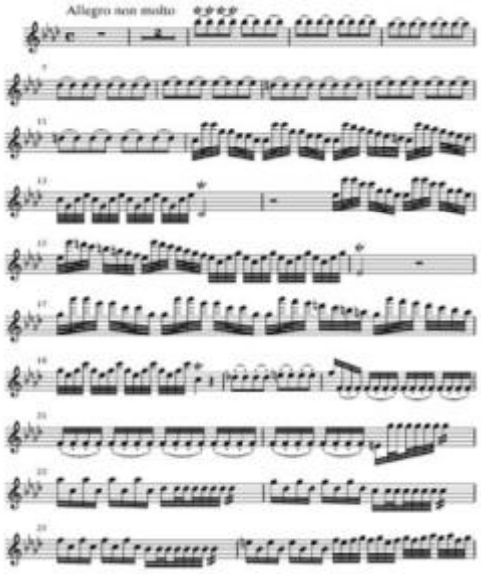
- Basic properties:
  - Has a purpose
  - Emergence – the whole has properties not held by sub components
  - Self Organisation – structure and hierarchy but few leverage points
  - Interacting feedback loops – causing highly non-linear behaviour
  - Counter-intuitive and non-intended consequences
  - Has tipping point or critical complexity limit before collapse
  - Evolves and history is important
  - Cause and symptom separated in time and space

Emergence – E.g. Music

You can explore the characteristics of individual notes



...but you cannot know the tune without knowing the interactions (score)

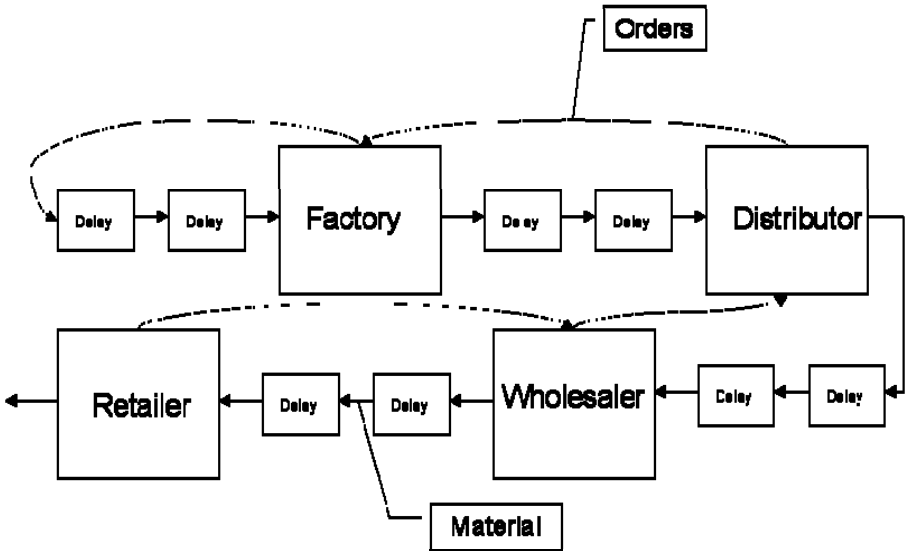


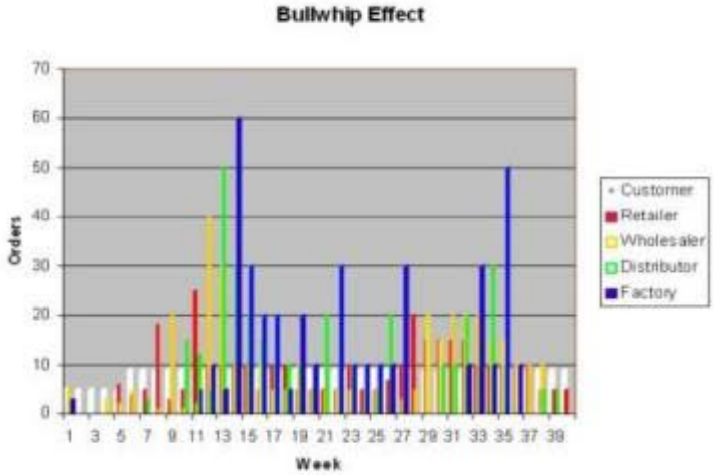
The problem with emergence

- People “understand” bits of risk, not the whole thing

Non-linearity

- The Beer Game (MIT, 1960's)





Source: www.beergame.org

Recap

- Risk is about uncertainty leading to “bad” things
- Companies can be classified as complex adaptive systems
- Risk is the emergent property of that system
- Understanding how the system behaves helps to reduce your uncertainty
- Hence leading to a better anticipation of risk drivers/outcomes

People Problems

- Typically things with “people” get simplified
  - Assume rational behaviour
  - Assume equilibrium reached (behaviours repeated)
- Reality
  - Mental models incomplete
  - Bounded rationality
  - Insufficient time to consider things
  - Unable to mentally rationalise feedback loops
  - Not in equilibrium (environment open to external inputs)

People Problems

- The weak link in risk assessment:
  - Humans cannot be rational even when they try to be
  - Even when they can be rational they aren't
  - Prefer to use other tools for decision-making (emotion, gut feel, suspicion)

"How do humans reason in situations that are complicated or ill-defined? Modern psychology tells that as humans we are only moderately good at deductive logic, and we make only moderate use of it. But we are superb at seeing or recognising or matching patterns – behaviours that confer obvious evolutionary benefits. In problems of complication, then, we look for patterns."

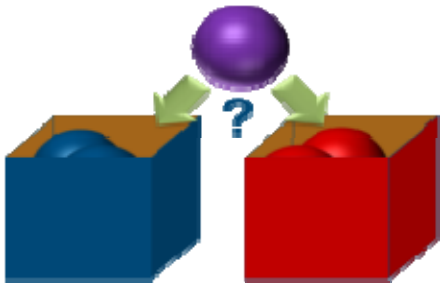
Brian Arthur "Inductive reasoning and bounded rationality" American Economic Review 84 #2 (1994)

People Problems

- Also relevant for emerging risk:
  - People are poor at assessing probability (especially conditional)
  - Mental models bias towards optimism $\Rightarrow$ hard to see need for change
  - Natural bias towards loss aversion $\Rightarrow$ asymmetric assessment of risk
  - Mental models become increasingly effective in a stable environment at the expense of flexibility
  - Stable environments naturally select resources with skills optimised for that environment rather than flexibility
  - Cultural norms a big influence on behaviour
  - Threshold for “following the crowd”

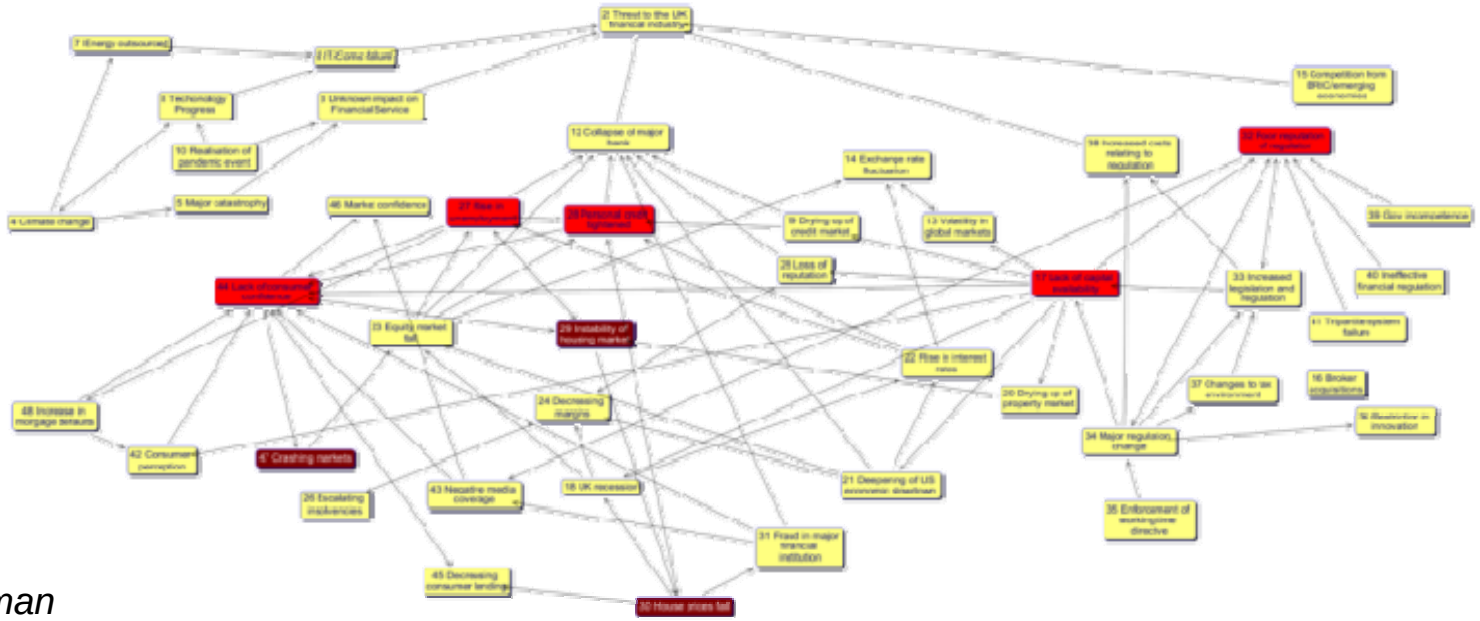
Looking for patterns

- Recognise that things will not occur the same way
  - Careful use of statistical models / update intelligently
  - Beware of extreme events using statistical models
- Emergence requires you to spot patterns not to prove your prior guess is “close enough”
  - Don’t lose vital information upfront

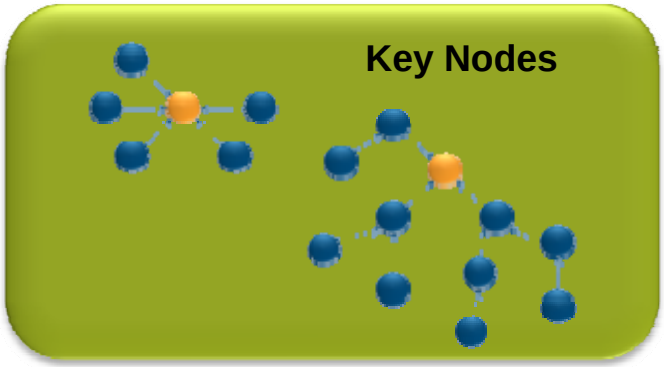


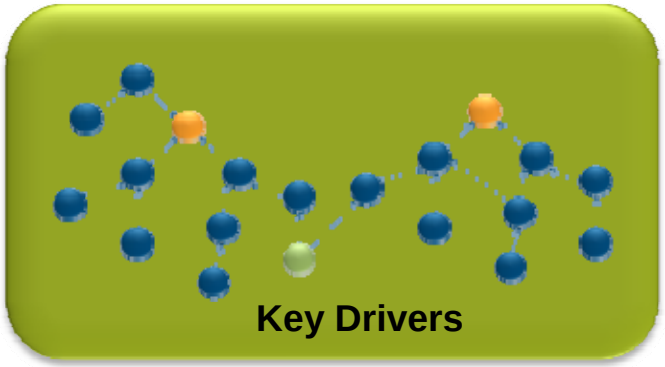
Risk classification systems usually use a single label which dangerously oversimplifies the data right at outset

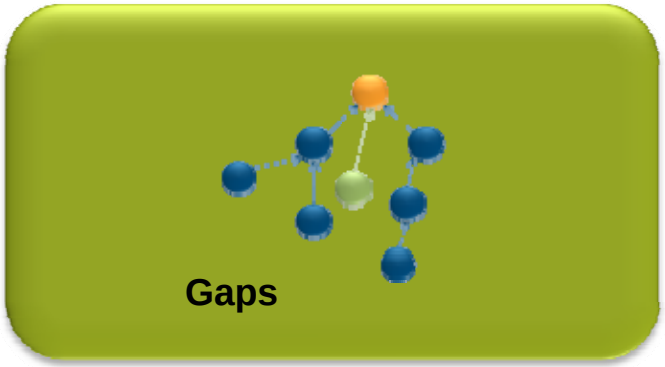
It’s all in your head



Source: Milliman







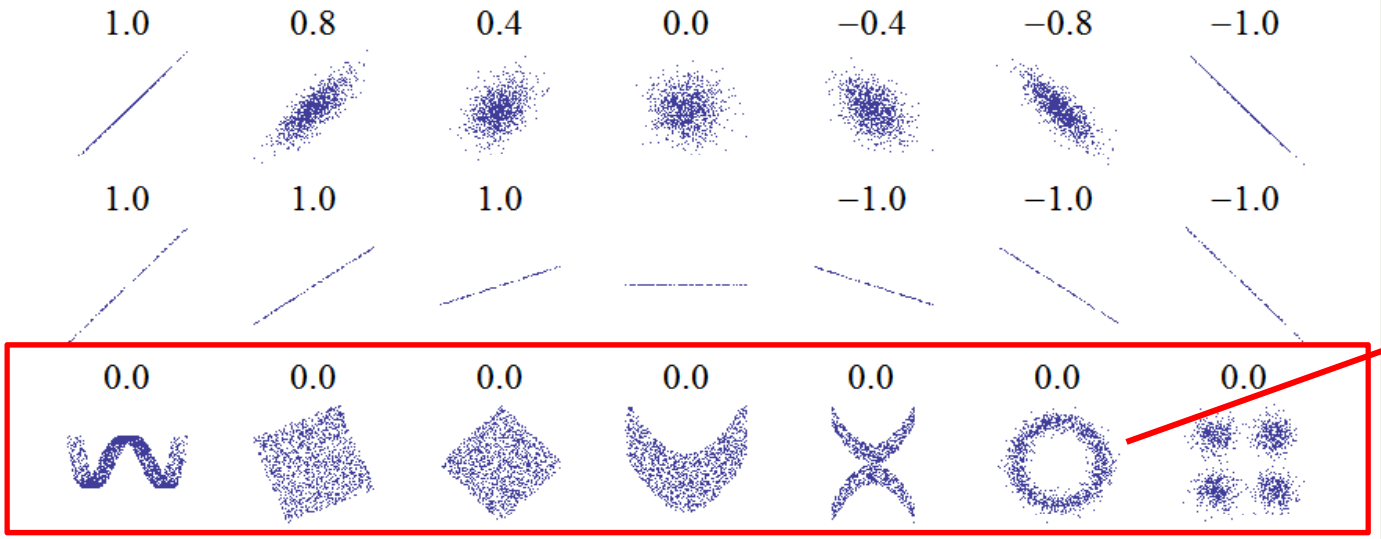
On the subject of information

$$\mathrm{I}(x) = -\log p(x)$$

Tools have to spot non-linear relationships

- Spotting relationships...

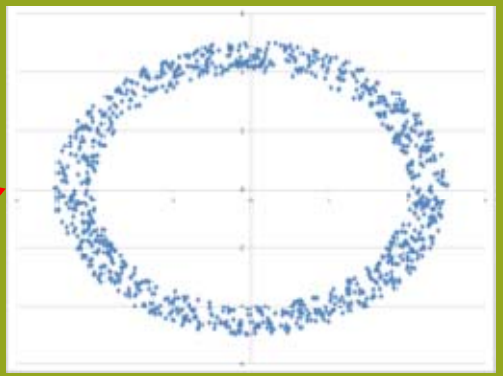
Different levels of correlation



Example

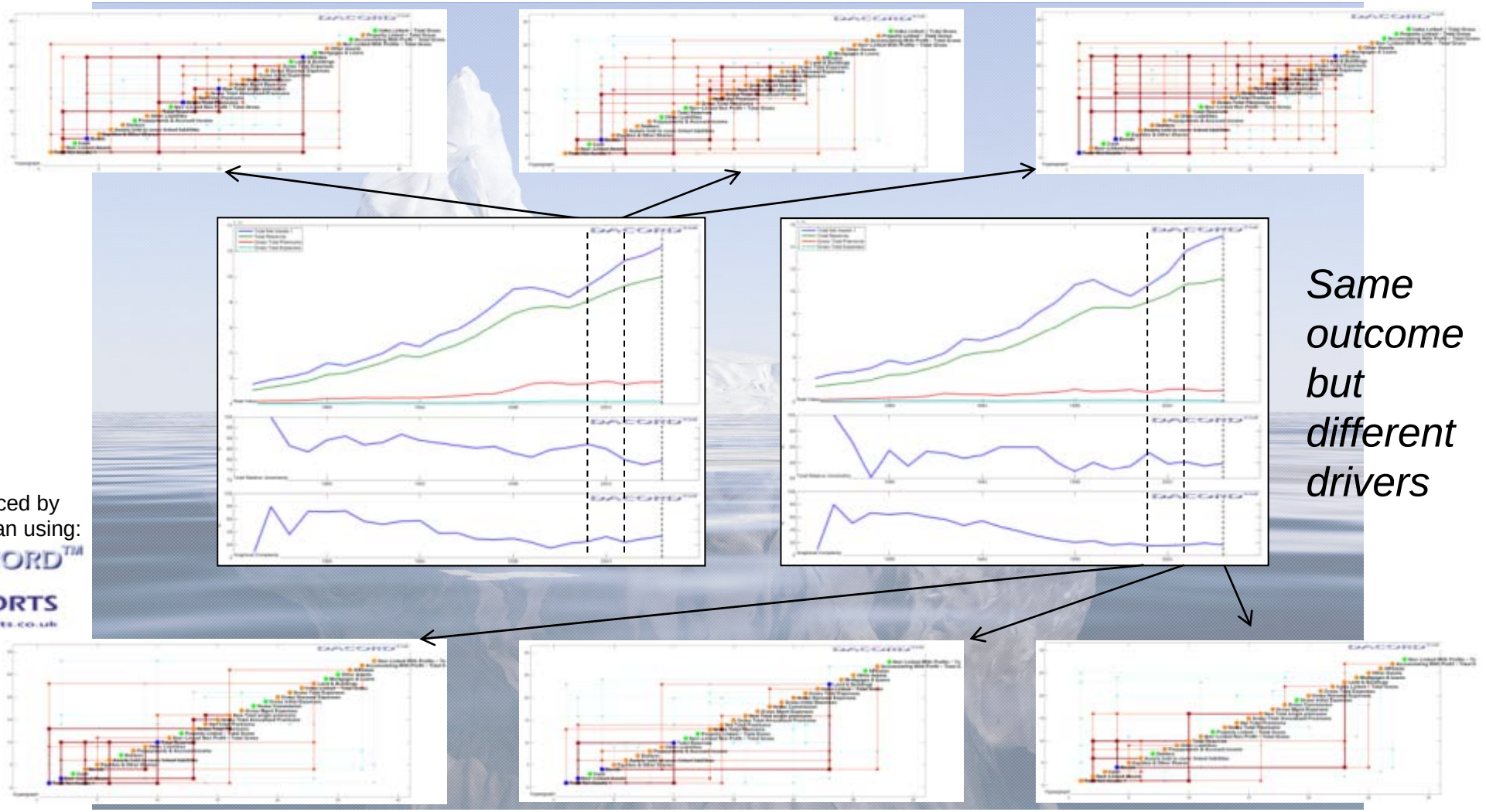
$\Theta \sim U[0,2\pi]$
$R \sim U[4, 5]$
$X = R \cos \Theta$
$Y = R \sin \Theta$

Sample of 1000



Correlation = 0.0
Mutual Info = 1.0

Looking beneath the surface



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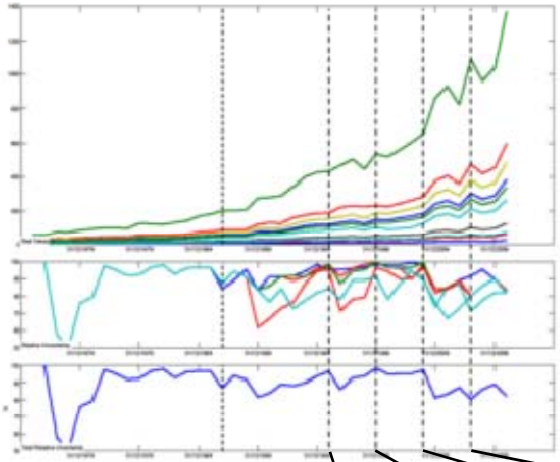
Same outcome but different drivers

Typical Tools



Trend of SCR components looks stable over time...

...but uncertainty differs between components...

...and overall uncertainty changes over time...

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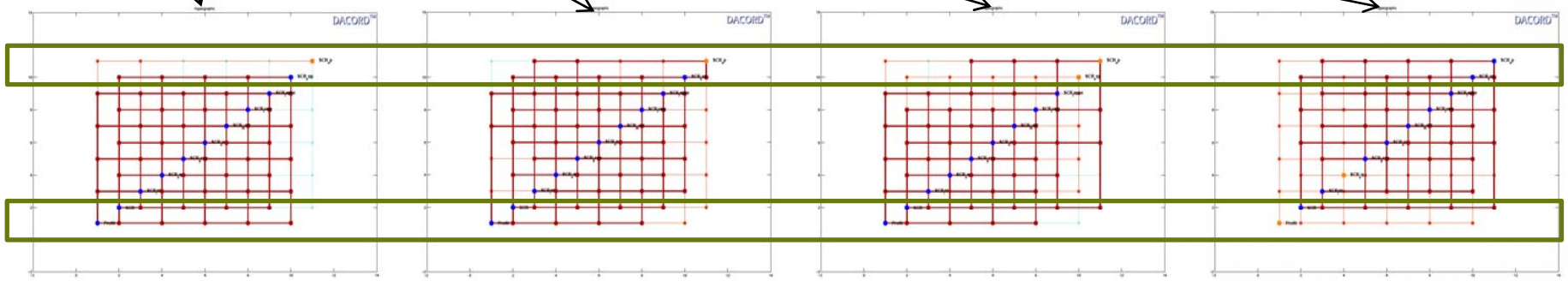
OpRisk gets more important

EqRisk gets less important

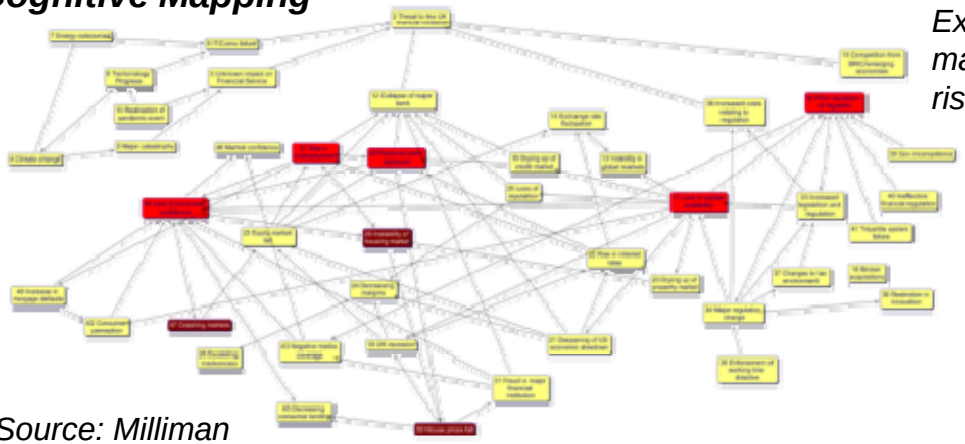


Recap – Tools

- Proper understanding of risk
  - Robust scenarios
  - Risk appetite alignment
  - Better models
  - Risk interactions
  - Anticipate risks
- Better measurement
- ...next how evolution brings insight

Some Of The Tools In Your Toolbox...

Cognitive Mapping

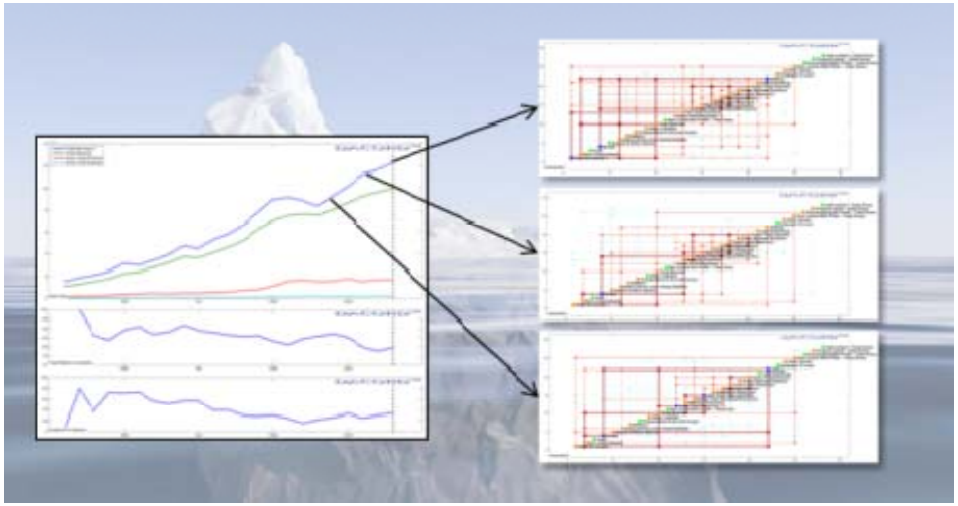


Example of cognitive map highlighting key risk areas and drivers

Source: Milliman

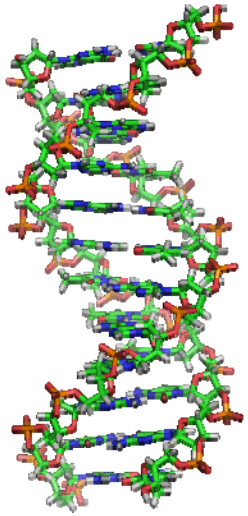
Complexity Metrics & Pattern Recognition

Signals below surface can be seen



Risk DNA & Evolution

Understand how risk drivers are adapting and creating new scenarios



Others

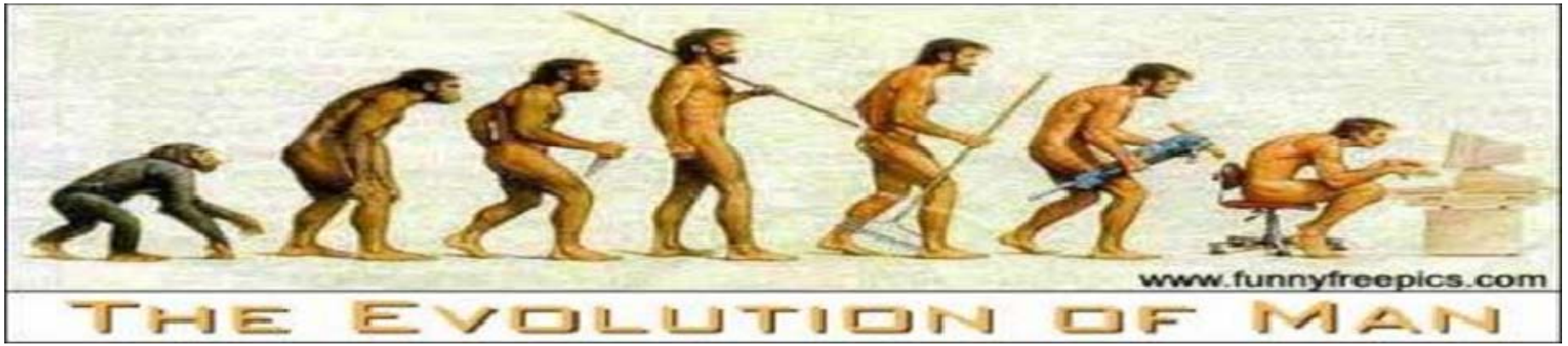
Structural modelling tools
Fuzzy measurement
Model checking
Systems dynamics
Etc.

Darwinian Approach to Enterprise Risk

An overview

- Why Enterprise risk might be an evolutionary process
- How can we model the risk evolution process
- What insight can evolution of risks provide
  - A rigorous classification system with relationships
  - A guide to emerging and dynamic risks
  - A unique organizational risk linage
  - Powerful connectivity measure
- Some examples

Evolution of risk



Does risk fit evolutionary criteria?

Darwinian Evolution Criteria	Risk Evolution Justification
Variation	Variation in risks is obvious
Competition	Some risks persist in an environment of aggressive risk reduction and mitigation
Inheritance	Risks spawn out of previous loses
Accumulation of modifications	History of failure, changes in regulation, technology etc causes modifications e.g. Fraud

Evolution of risk – does it apply to life insurance?

Comparison of Biological, Linguistic, Enterprise Risk

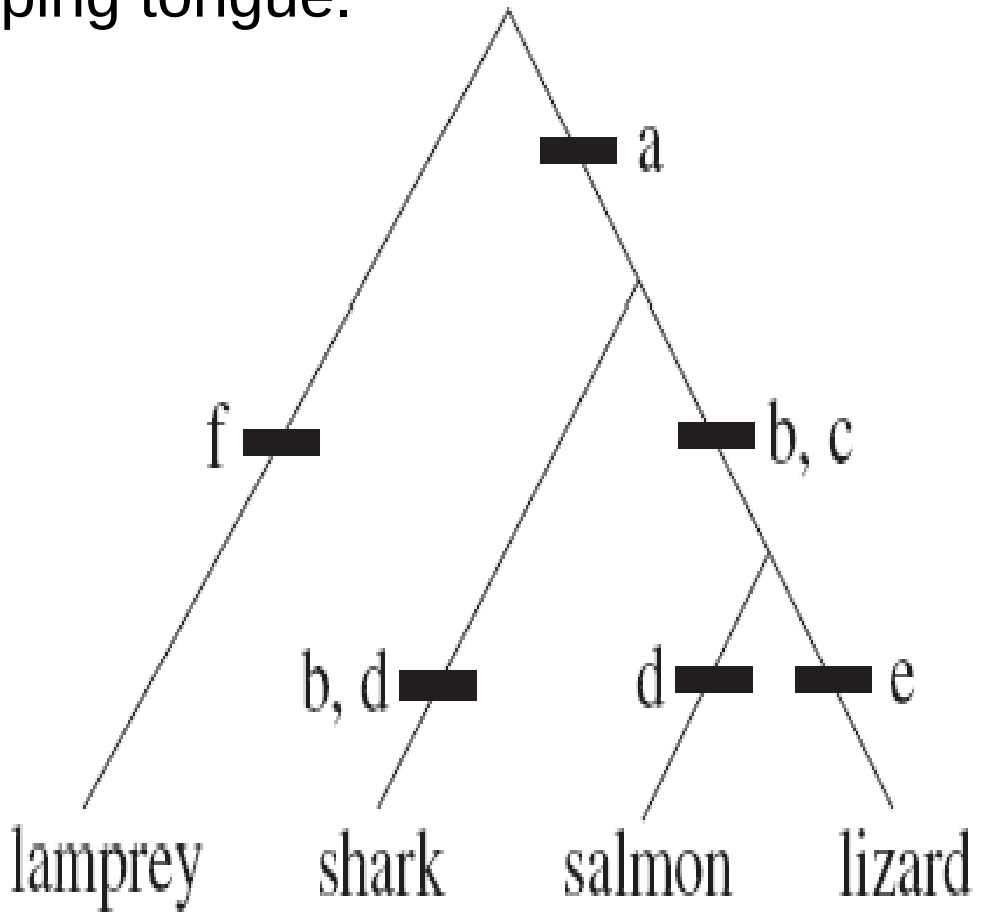
Biological Evolution	Linguistic Evolution	Enterprise Risk Evolution
Discrete characters	Vocabulary, syntax, sounds	Causes, loses, risk registers
Common ancestors	Words with common origin	Risks from common origin
Mutation	Innovation	Innovation, regulation
Natural selection	Social selection	Management selection
Horizontal gene transfer	Borrowing from other languages	Transfer of info between businesses and industries
Fossils	Ancient texts	Historic case studies
Species splitting into others	Language Lineage Splits	Risk categories (strategic, operational, financial etc)
Extinction	Language death	Risk eradication

After Pagel (2009) Nature

Biological Example

(a) paired fins, (b) jaws, (c) large dermal bones, (d) fin rays, (e) lungs, and (f) rasping tongue.

	a	b	c	d	e	f
lamprey	0	0	0	0	0	1
shark	1	1	0	1	0	0
salmon	1	1	1	1	0	0
lizard	1	1	1	0	1	0



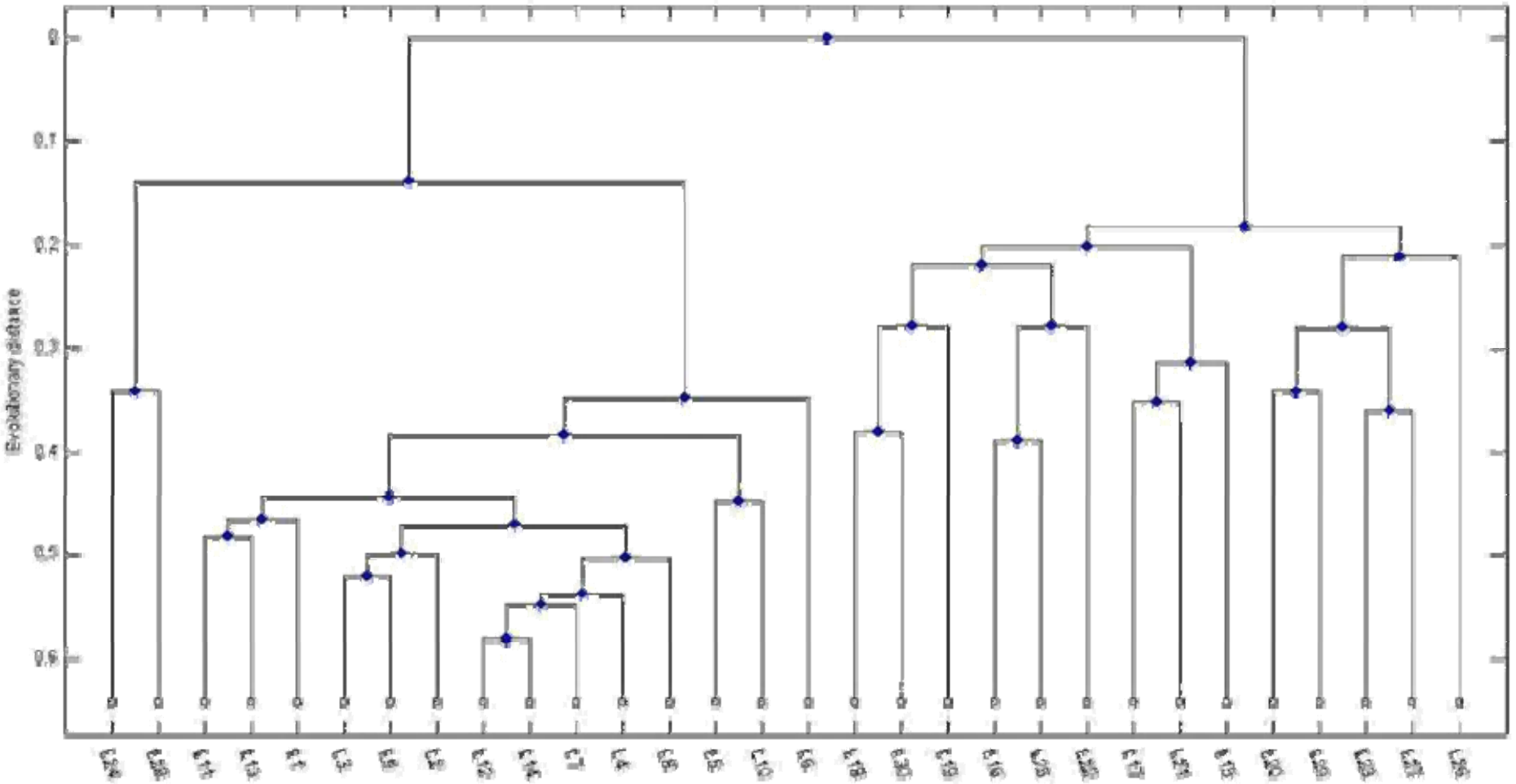
Typical set of coding characteristics

Strategic	1	Strategy		
Equity	2	Asset Allocation	3	Concentration
Credit	4	Investments	5	Reinsurance
Insurance	6	Insurance		
Operational	7	Unacceptable business practices	21	Mishandling of complaints
	8	Internal control violations	22	Mishandling of investment transactions
	9	Project failures	23	Liquidity needs unmet
	10	Communication failure	24	Mispricing/design of products
	11	Brand abuse	25	Mishandling of underwriting
	12	Violation of reporting regulations	26	Inadequate reinsurance
	13	Solvency	27	Inadequate claims management
	14	Violation of disclosure requirements	28	IT systems failure
	15	Customer due-diligence	29	Unauthorized access to data
	16	Product compliance	30	Inadequate functionality
	17	Mis-selling	31	Inappropriate skills
	18	Mishandling data	32	Staff act outside authority/competence
	19	Incomplete documentation	33	Business interruption
	20	Systemic reporting error	34	Adverse legal/regulatory change

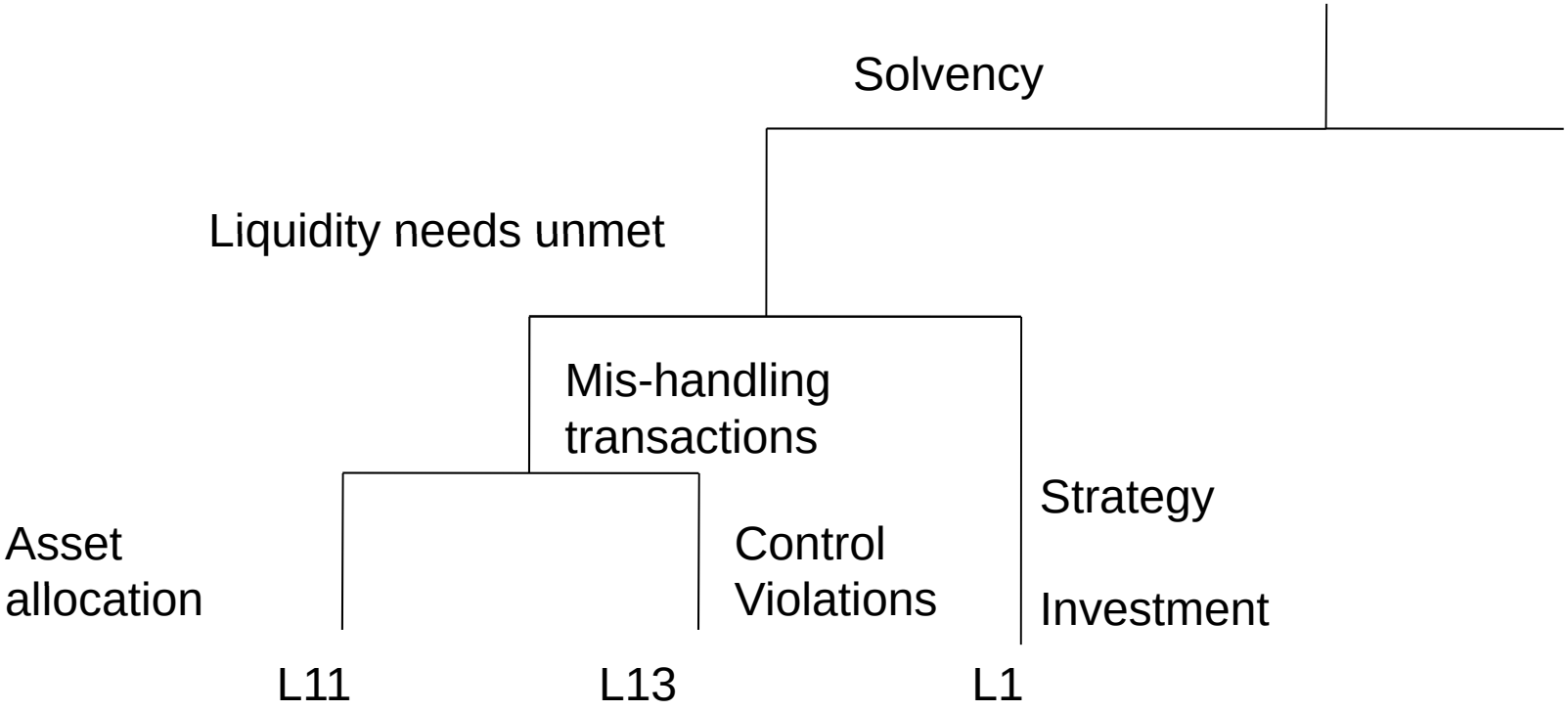
Extract of typical data set

	Strategy	Asset Allocation	Concentration	Investments	Reinsurance	Insurance	Unacceptable business practices	Internal control violations	Project failures	Communication failure	Brand abuse	Violation of reporting regulations
Loss	1.01	2.01	2.02	3.01	3.02	4.01	5.01	5.02	5.03	5.04	5.05	5.06
L1	1			1								
L2					1			1		1		
L3						1				1		
L4						1						
L5								1		1		1
L6									1	1		

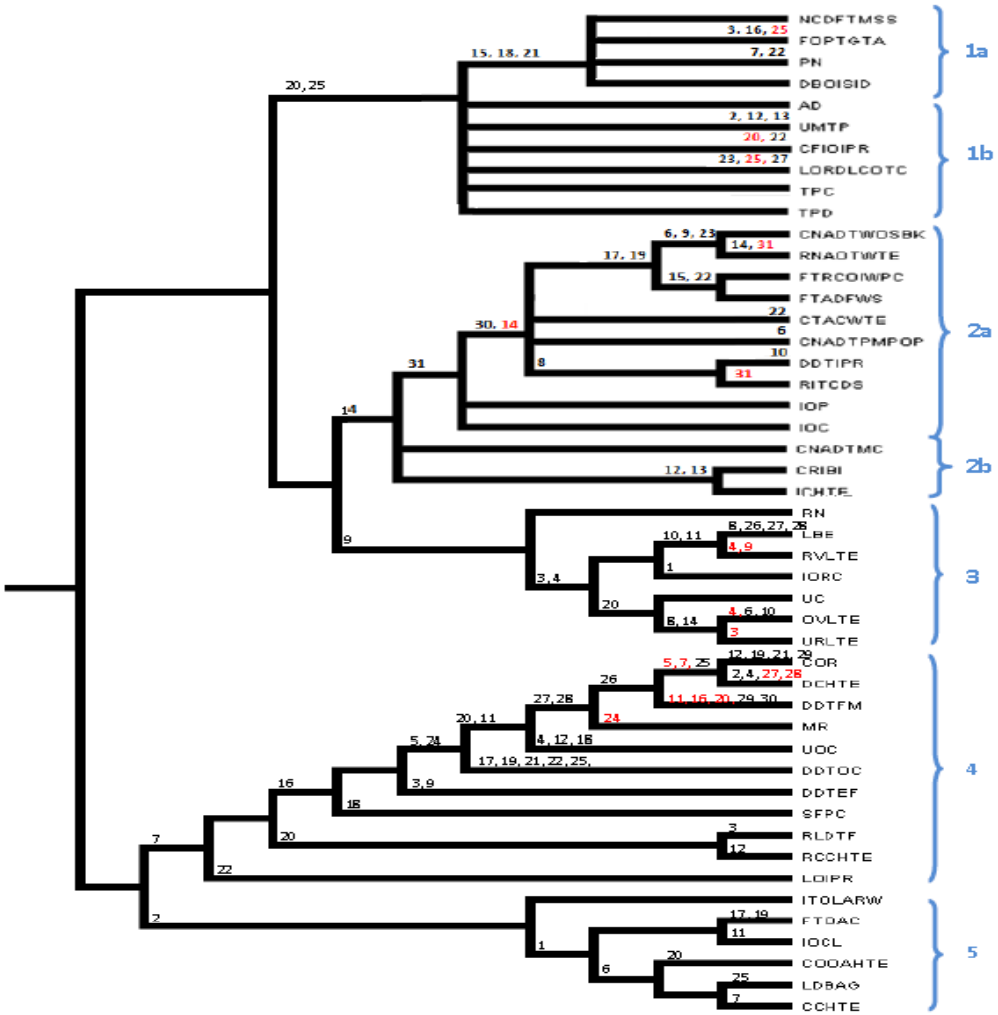
Phylogenetic analysis gives evolutionary Risk Tree



Implications of model tree



Different Clade behaviour and emerging risks



Clade 2a

Defining characters: Extreme economic conditions

Risk: Capital not available

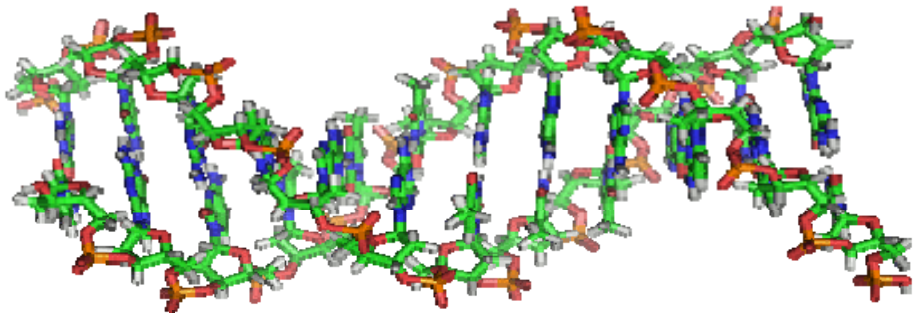
Emerging risk: Risk combines inadequate margins **and** unbalanced sharing of risks

Distance matrix reveals risk connectivity

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Liquidity challenge																					
2. Regulation changes 1	2.955																				
3. Violation of Privacy Protection	2.955	3.319																			
4. Trusted Insider Technology Risks	0.168	3.093	0.455																		
5. Business Continuity	0.168	3.093	2.955	0.455																	
6. Technology development	0.258	3.154	2.576	0.029	0.258																
7. Product	0.109	2.576	3.028	0.258	0.258	0.455															
8. Geographical	2.762	0.455	3.319	2.955	2.955	3.028	0.258														
9. Regulation changes 2	0.168	0.455	2.955	0.455	0.455	2.576	0.109	0.455													
10. Succession Planning	0.065	2.762	2.955	0.168	0.168	0.258	0.109	2.762	0.168												
11. Model complexity	0.168	3.093	2.955	0.455	0.455	2.576	0.258	2.955	0.455	0.168											
12. Convergence of Products	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.168	0.168	0.168	0.455										
13. Regulation changes 3	0.258	3.028	2.576	0.109	2.576	0.168	0.168	2.870	0.258	0.258	2.576	0.258									
14. Poor decision making	0.168	2.955	3.093	0.455	0.168	0.258	0.258	2.762	0.455	0.168	0.455	0.168	2.576								
15. Misunderstanding of risks	0.168	3.093	2.955	0.455	0.168	2.576	0.258	2.762	0.455	0.168	0.455	0.455	2.576	0.455							
16. HR policies	0.258	3.154	2.576	0.258	0.258	0.455	0.455	3.028	2.576	0.258	2.576	2.576	0.168	0.258	0.258						
17. Long-term planning	0.258	2.576	3.154	2.576	2.576	2.762	0.168	2.576	0.258	0.109	0.258	0.109	0.455	0.258	2.576	2.762					
18. Tech infrastructure	0.168	3.093	3.093	0.455	0.065	0.258	0.258	2.955	0.455	0.168	0.455	0.455	2.576	0.065	0.455	0.258	2.576				
19. Tax rules	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.455	0.168	0.168	0.455	0.065	0.258	0.455	0.455	2.576	0.258	0.455			
20. Regulation differences	0.168	0.455	3.093	0.455	0.455	2.576	0.029	0.168	0.168	0.168	0.455	0.065	0.258	0.455	0.455	2.576	0.258	0.455	0.065		
21. Tax management	0.065	2.762	2.955	0.168	0.168	0.258	0.029	0.455	0.168	0.065	0.168	0.065	0.258	0.168	0.168	0.258	0.258	0.168	0.065	0.065	
22. Infrastructure	0.168	3.093	3.093	0.455	0.065	0.258	0.258	2.955	0.455	0.168	0.455	0.455	2.576	0.065	0.455	0.258	2.576	0.000	0.455	0.455	0.168

Recap

- Risks have a unique sequence, very much like a DNA
- Collective risk systems evolve and co-evolve
- The path-dependency is an important aspect of a risk
- A risk's evolutionary progression can be analysed
- Predictions made about how risks might develop
- It is an efficient way to classify and manage risks



Summary

- We can frame companies/industries as complex adaptive systems
- Complex adaptive systems give out signals
- Using the right scientific tools you can spot them
- Interactions are the important part
- Early warnings are possible
- Don’t throw away information – look for patterns
- Try not to guess what is going on before you look at the data
- Evolution is informative about possible future trends
- Improved understanding facilitates better models/management

Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.