Using “Risk Maps” to visually model & communicate risk

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Contents

- Problems with current approaches
- Risk Maps as Solution
- Risk Map Toolkit
- Risk Mapping for Enterprise Risk
- Risk Map Applications
- Final Remarks

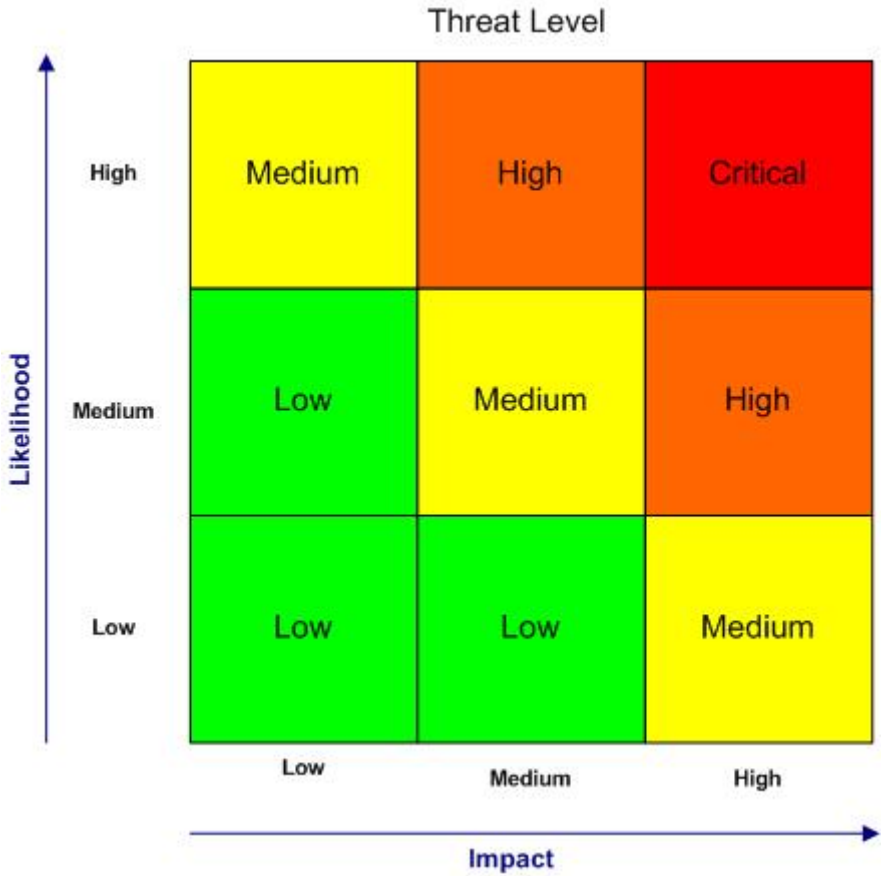
All Examples shown using AgenaRisk software

Problems with current approaches

Risk Register

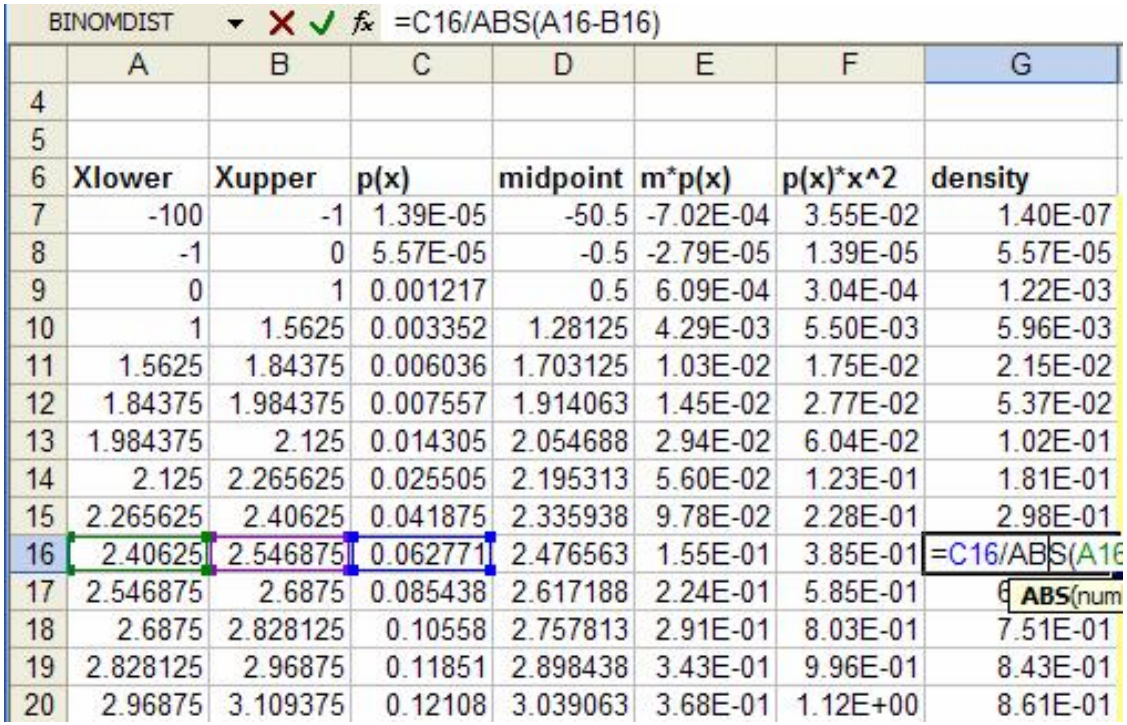
- “There are tight budget constraints”
- “The project overruns its schedule”
- “The company’s reputation is damaged externally by publicity about poor final system”
- “The customer refuses to pay”
- “The delivered system has many faults”
- “The requirements are especially complex”
- “The development staff are incompetent”
- “Key staff leave the project”
- “The staff are poorly motivated”
- “Generally cannot recruit good staff because of location”
- “There is a major terrorist attack”

Risk Heat Maps and Profiles



Risk = Likelihood x Impact

Spreadsheets



	A	B	C	D	E	F	G
4							
5							
6	**Xlower**	**Xupper**	**p(x)**	**midpoint**	**m*p(x)**	**p(x)*x^2**	**density**
7	-100	-1	1.39E-05	-50.5	-7.02E-04	3.55E-02	1.40E-07
8	-1	0	5.57E-05	-0.5	-2.79E-05	1.39E-05	5.57E-05
9	0	1	0.001217	0.5	6.09E-04	3.04E-04	1.22E-03
10	1	1.5625	0.003352	1.28125	4.29E-03	5.50E-03	5.96E-03
11	1.5625	1.84375	0.006036	1.703125	1.03E-02	1.75E-02	2.15E-02
12	1.84375	1.984375	0.007557	1.914063	1.45E-02	2.77E-02	5.37E-02
13	1.984375	2.125	0.014305	2.054688	2.94E-02	6.04E-02	1.02E-01
14	2.125	2.265625	0.025505	2.195313	5.60E-02	1.23E-01	1.81E-01
15	2.265625	2.40625	0.041875	2.335938	9.78E-02	2.28E-01	2.98E-01
16	2.40625	2.546875	0.062771	2.476563	1.55E-01	3.85E-01	=C16/ABS(A16
17	2.546875	2.6875	0.085438	2.617188	2.24E-01	5.85E-01	6
18	2.6875	2.828125	0.10558	2.757813	2.91E-01	8.03E-01	7.51E-01
19	2.828125	2.96875	0.11851	2.898438	3.43E-01	9.96E-01	8.43E-01
20	2.96875	3.109375	0.12108	3.039063	3.68E-01	1.12E+00	8.61E-01

Expert Judgement - “I Assume”

- On the one hand….
  - Obvious risk of being wrong
  - Dangerous if unverified, checked or agreed
  - Political
- On the other hand….
  - Absolutely necessary
  - Unavoidable
  - We employ people for a reason!
- Model Risk: If you want to analyse risk you are going to have to take them….

How good are people at estimating risk?

- Evidence from psychology is worrying!
  - Availability of more recent cases
  - Emphasis on easier to remember dramatic events
  - Large single consequence often outweighs multiple small consequences
- Framing Problem: Answer you get depends how you ask the question!

"What is the chance of disease?"
Vs
"Given positive test result what is the chance of disease?"
Vs
"Chance of disease given test positive?"

If you cannot trust people can you trust the data?

- Statistical validity restricted to controlled experiments
- Data sets must represent homogeneous samples and correlations clear
  - High correlation between shoe size and IQ!
- Do you even have the data?
  - New business ventures?
  - Rare events?

……

Age	Accidents
23	5
26	3
45	2
67	3
56	2
12	0
65	1
34	4

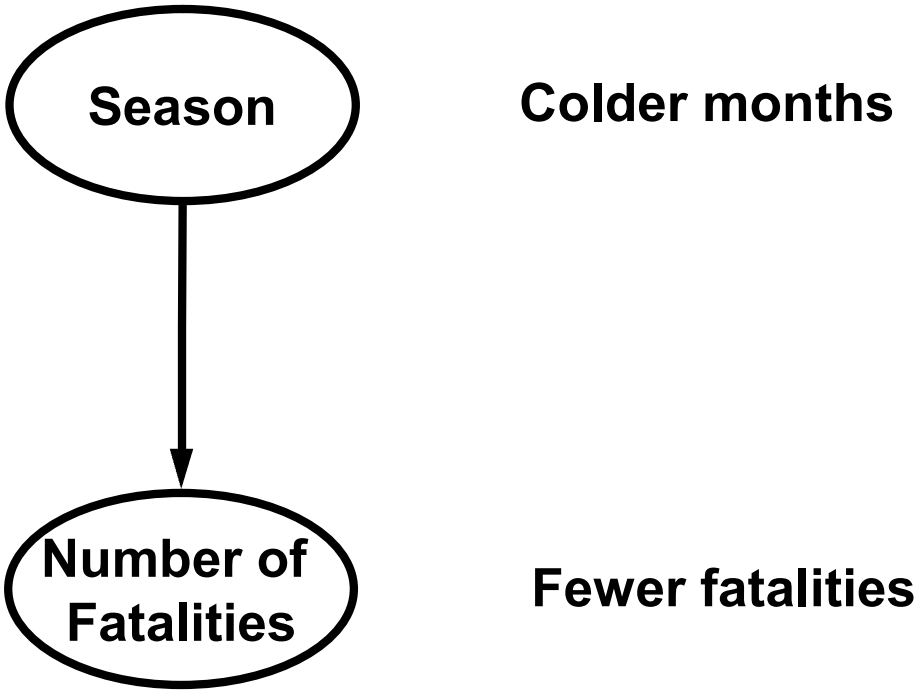
The lure of objective irrationality

Combining Subjective and Objective information

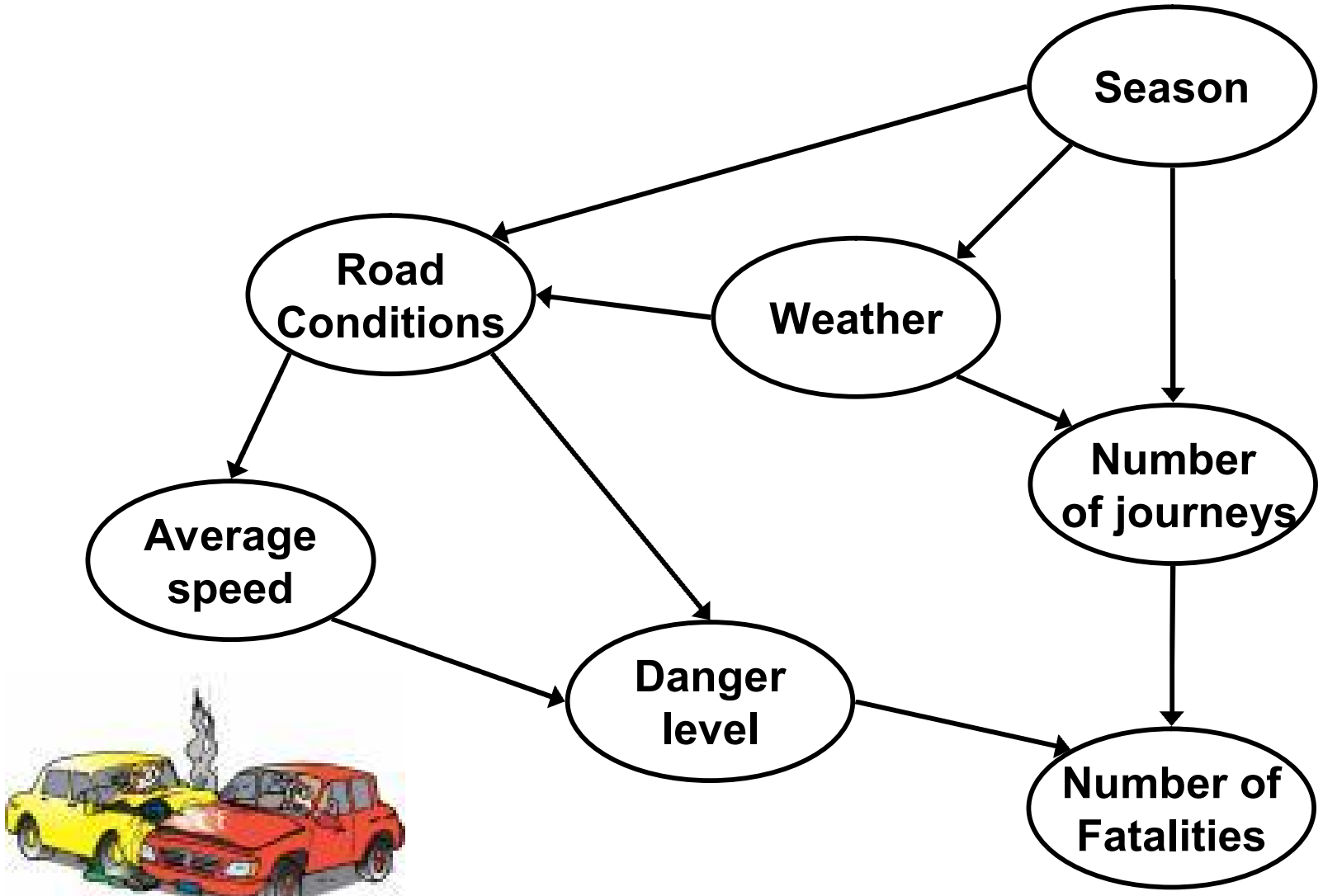
- Casino 1- Honest Joe's.
  - You visit a reputable casino at midnight in a good neighbourhood in a city you know well. When there you see various civic dignitaries (judges etc.). You decide to play a dice game where you win if the die comes up six.
  - What is the probability of a six?
- Casino 2 - Shady Sams.
  - More than a few drinks later the Casino closes forcing you to gamble elsewhere. You know the only place open is Shady Sam's but you have never been. The doormen give you a hard time, there are prostitutes at the bar and hustlers all around. Yet you decide to play the same dice game.
  - What is the probability of a six?

Risk Maps as a Solution

Assessing Risk of Road Fatalities: Naïve Approach



Assessing Risk of Road Fatalities: Causal model



Rev Thomas Bayes

Bayes' Theorem

A: 'Person has cancer' p(*A*) = 0.1 (*priors)*

B: 'Person is smoker' p(*B*) = 0.5

What is p(*A* | *B*)? (*posterior)*

p(*B* | *A*) = 0.8 (*likelihood)*

Posterior probability **Likelihood** **Prior probability**

$$p(A \mid B) = \frac{p(B \mid A)p(A)}{p(B)}$$

So p(*A*|*B*)=0.16

Decomposing (Exposing) Risk Measure

- Standard Definition:

Risk = Impact x Probability

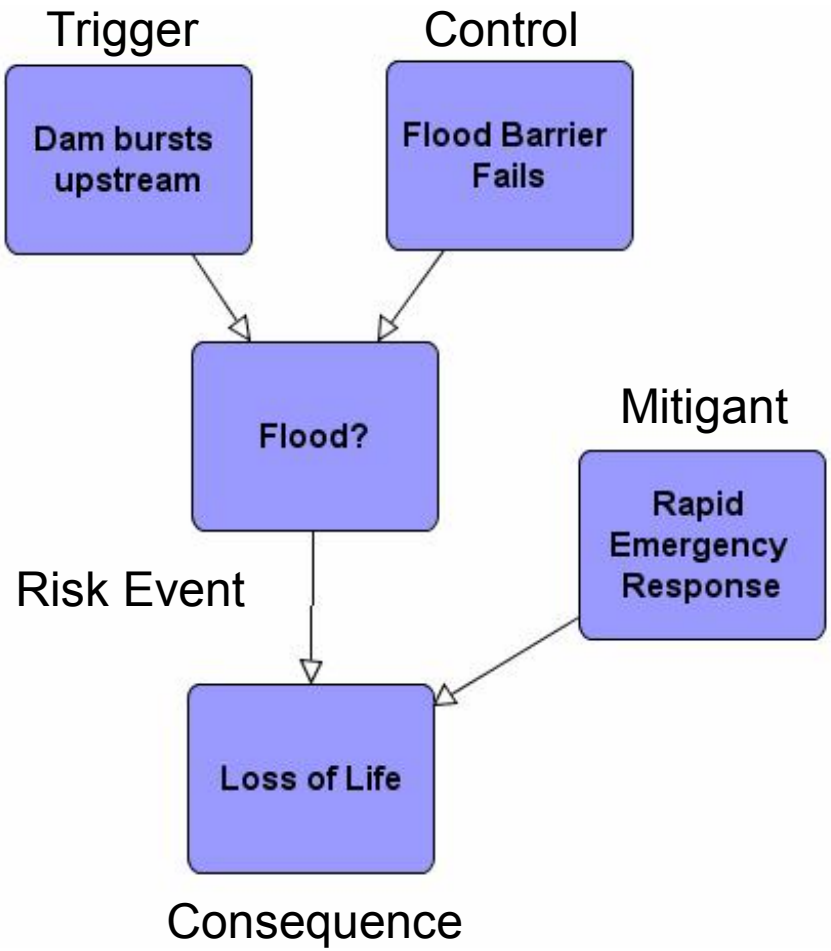
- Is this decomposition enough?

- Expose the assumptions!
  - What is the context driving the numbers?
  - Who's risk is it?
  - Is it a risk to me?
  - Is it really a risk?
  - An indicator of a risk?
  - A mitigant…..?

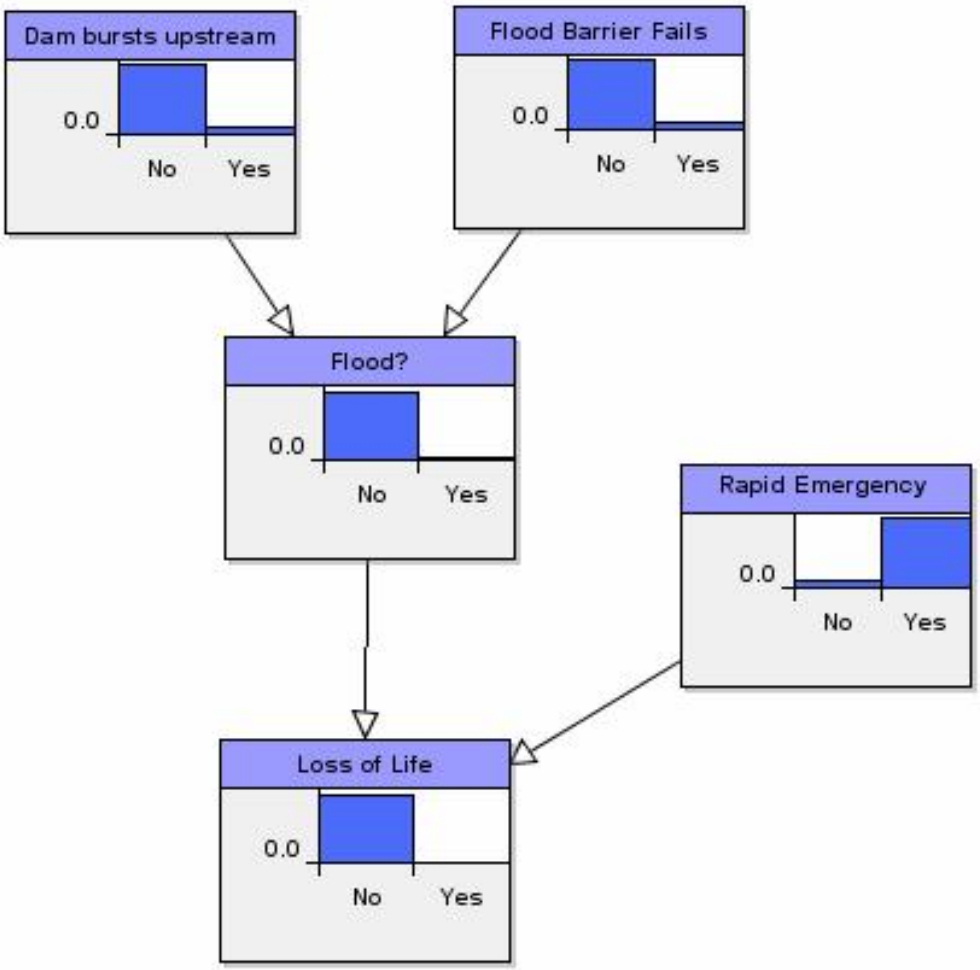
Causal Framework for Risk

- Replace oversimplistic measure of risk with a causal approach
- Characterise risk by event chain involving:
  - The risk itself (at least)
  - One consequence event
  - One or more trigger events
  - One or more mitigant events
- Context “tells a story” and depends on perspective

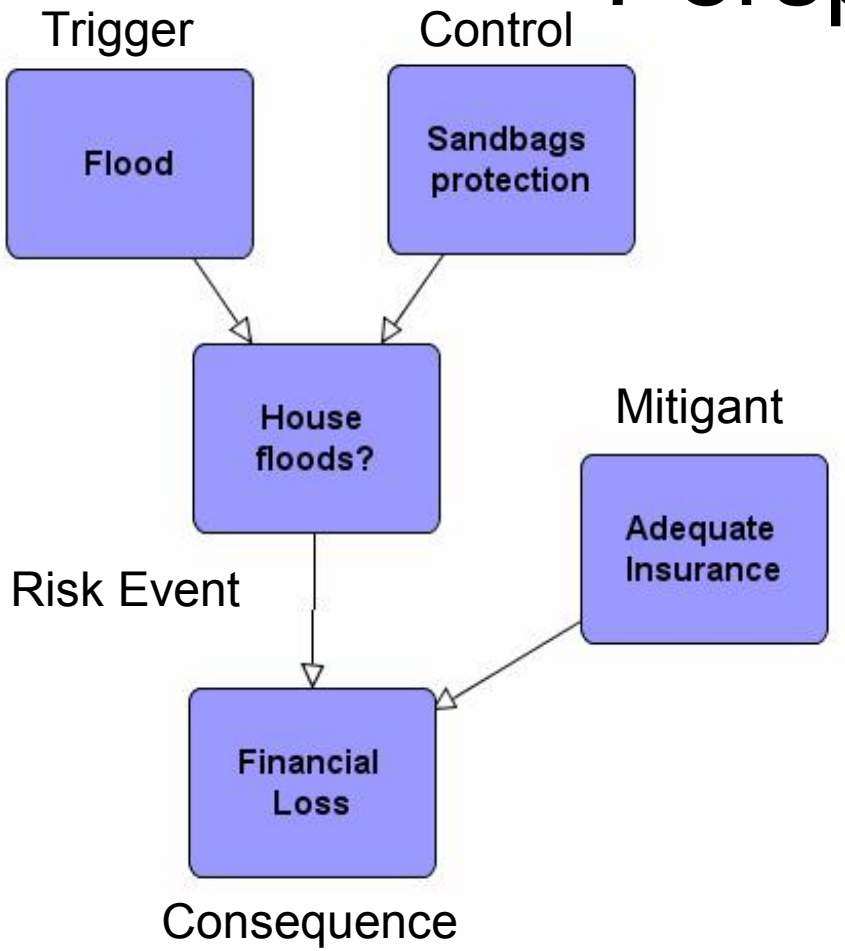
Town Flood Example



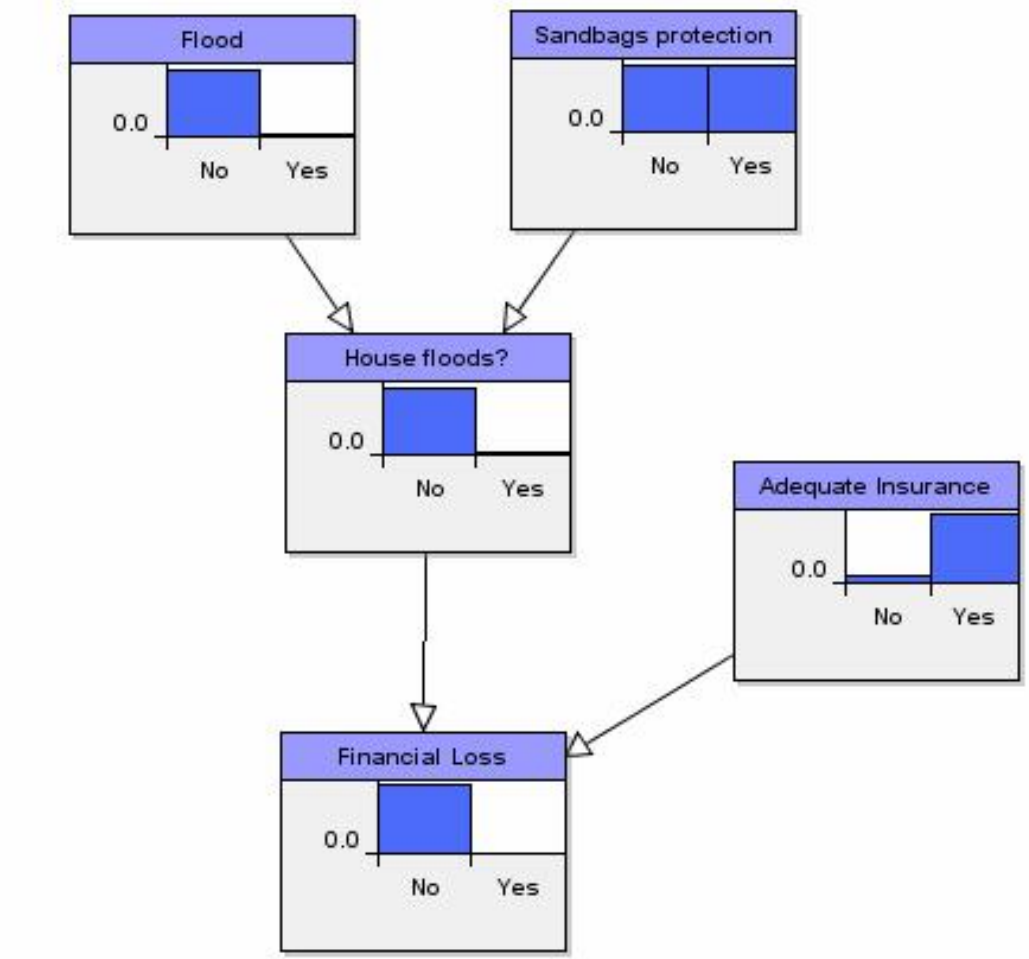
Calculation of Town Flood Risk



Flood Example – Homeowners Perspective



Calculation of Home Flood Risk



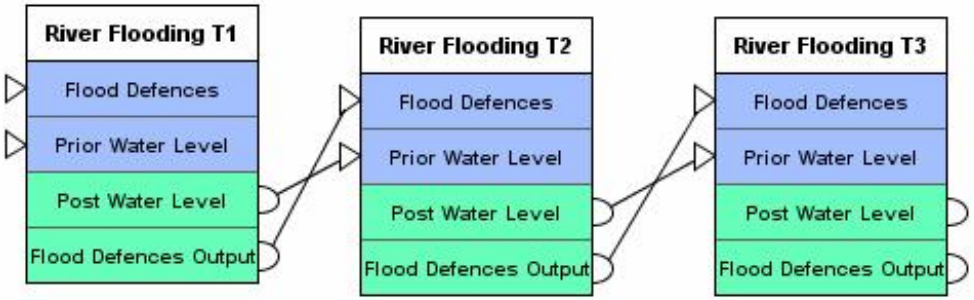
4 Steps to define a risk map

1. Consider set of events from given perspective
2. For each event identify triggers and controls
3. For each event identify consquences and mitigants
4. Define probabilities for risk nodes

Connecting Risk Maps using Building Blocks

- Connect risk maps via input/output risk nodes

- Create complex time based or complex structural models

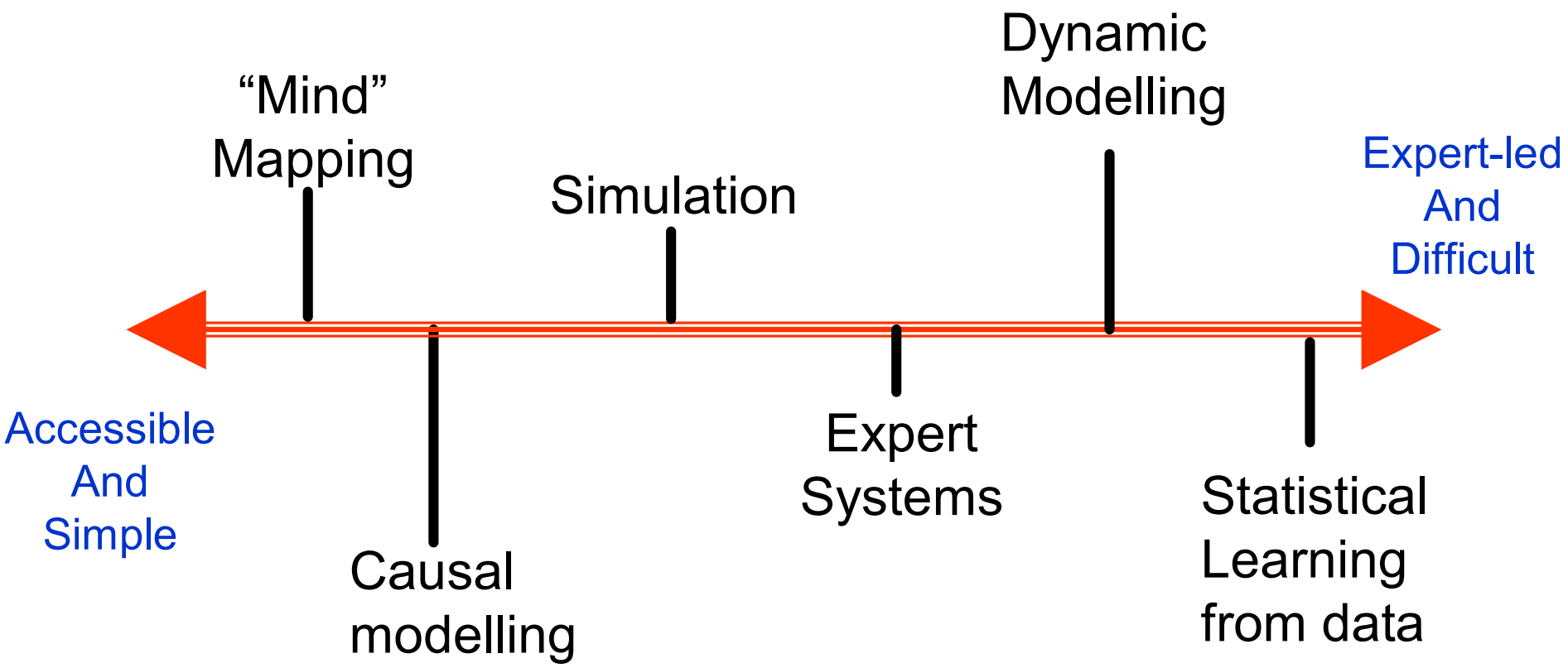


Benefits

- “A picture tells a thousand words”
- Explicitly quantifies uncertainty
- Connecting models “connects perspectives”
- Dynamic calculation of risk values
- Great for “what if” analysis

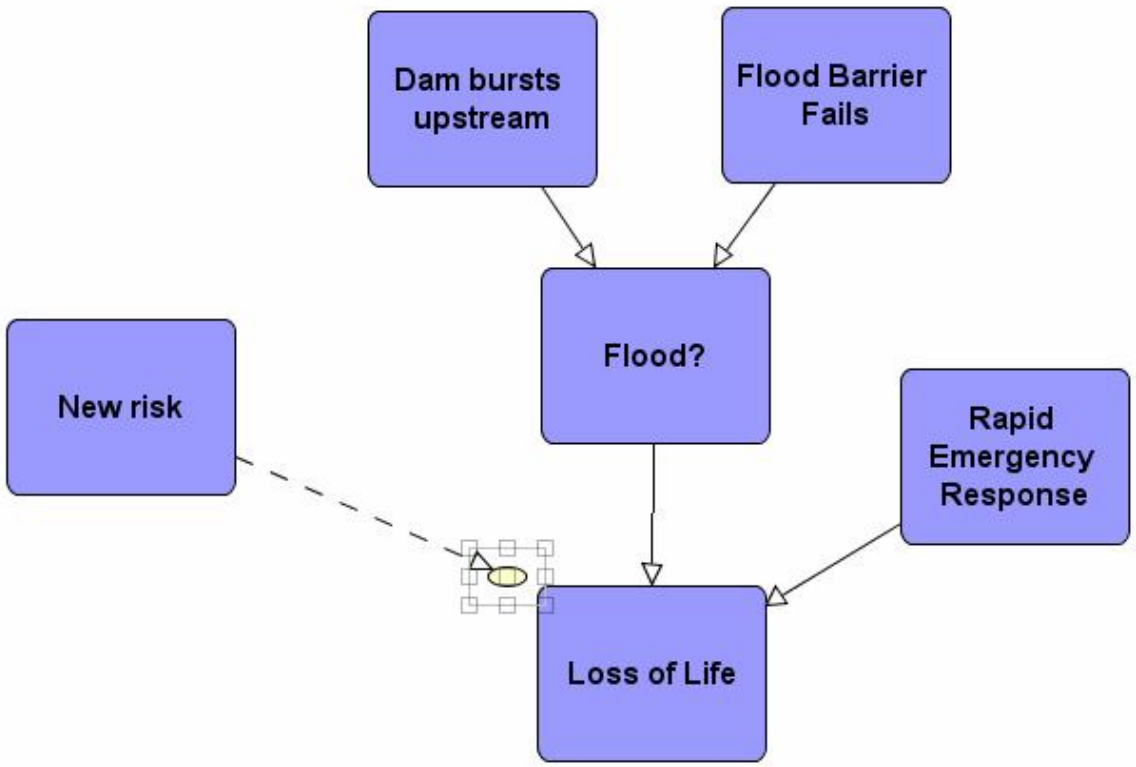
Risk Map Toolkit

Sophistication Spectrum



Risk Map

- Nodes represent
  - variables
  - events
  - quantities
- Links represent relationships
  - relevance
  - causality
- Easy to support and understand



Measuring Scales

- Risk Node Types
  - Boolean (Yes/No, True/False)
  - Labelled (Red, Blue, Green)
  - Numeric (Integer, Continuous, Discrete)
  - Ranked (High, Medium, Low)

Discrete Probabilities

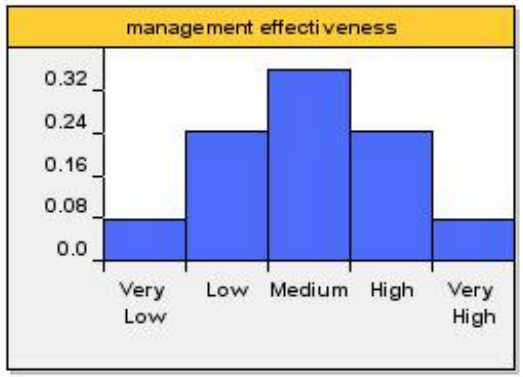
- Prior probabilities

No	0.9
Yes	0.1

- Conditional Probabilities

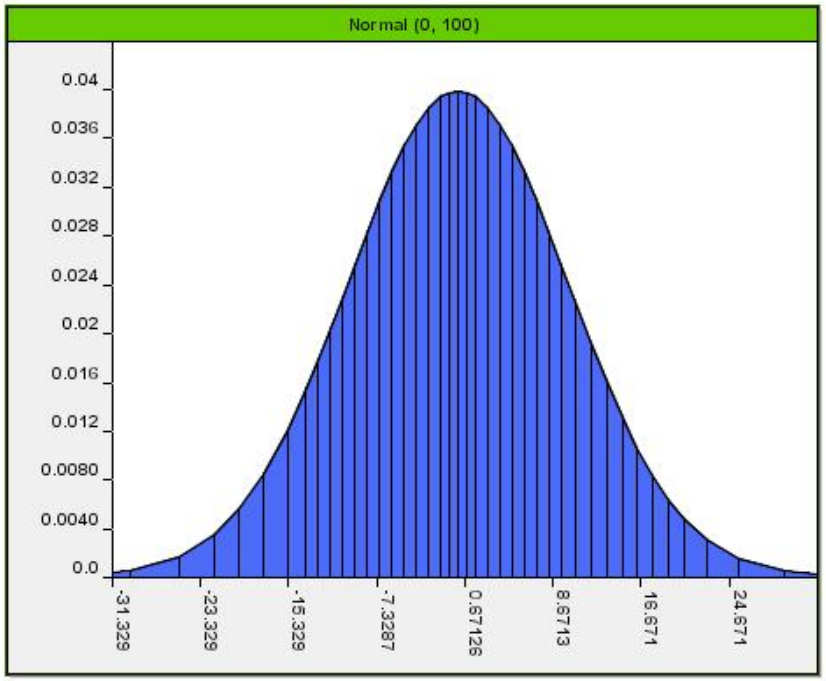
Dam bursts...	No		Yes	
Flood Barri...	No	Yes	No	Yes
No	1.0	0.8	0.9	0.0
Yes	0.0	0.2	0.1	1.0

- Result viewed as marginal probability distribution



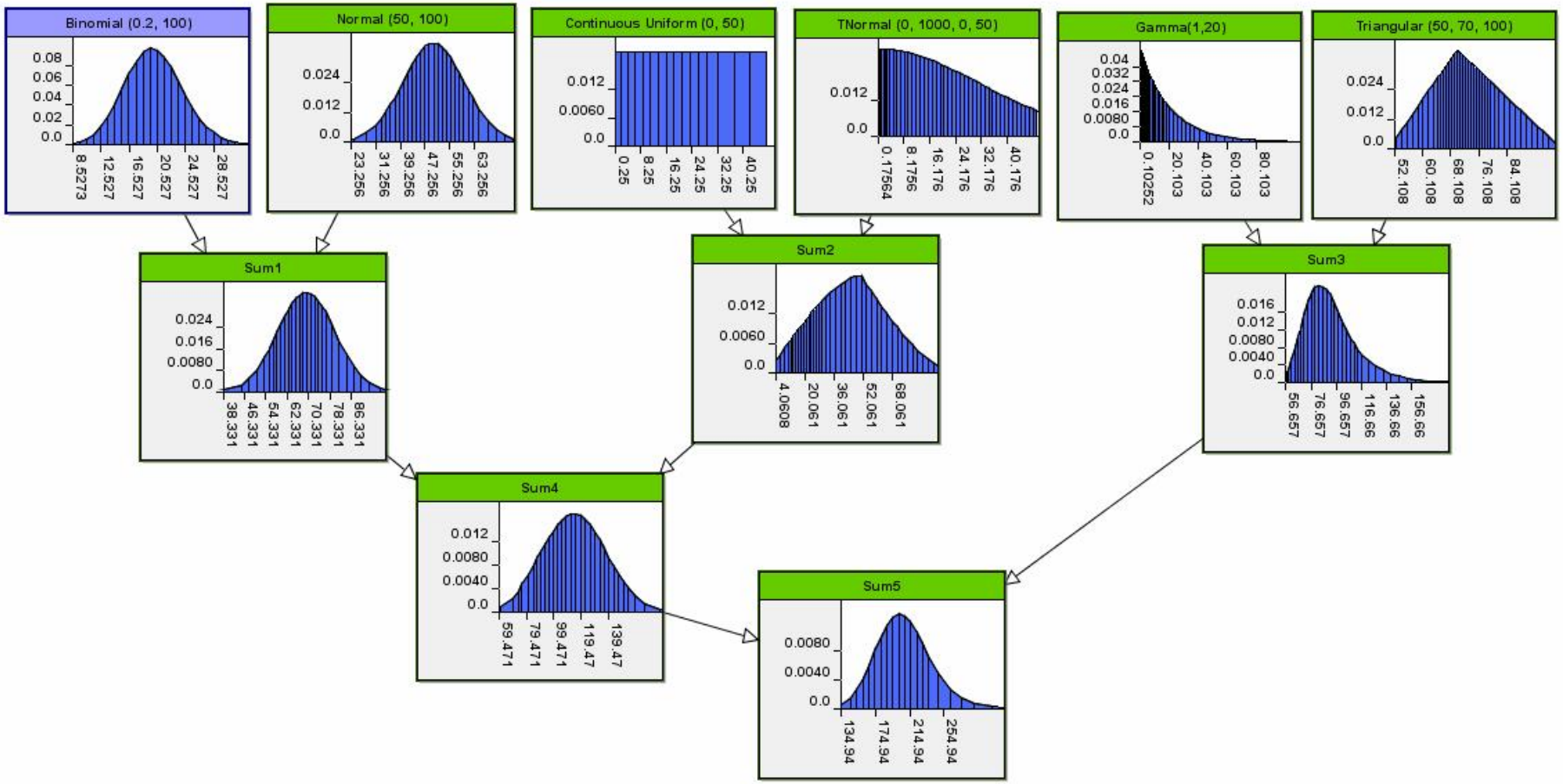
Continuous Probabilities by Simulation

Model Statistical Distributions E.g. Normal



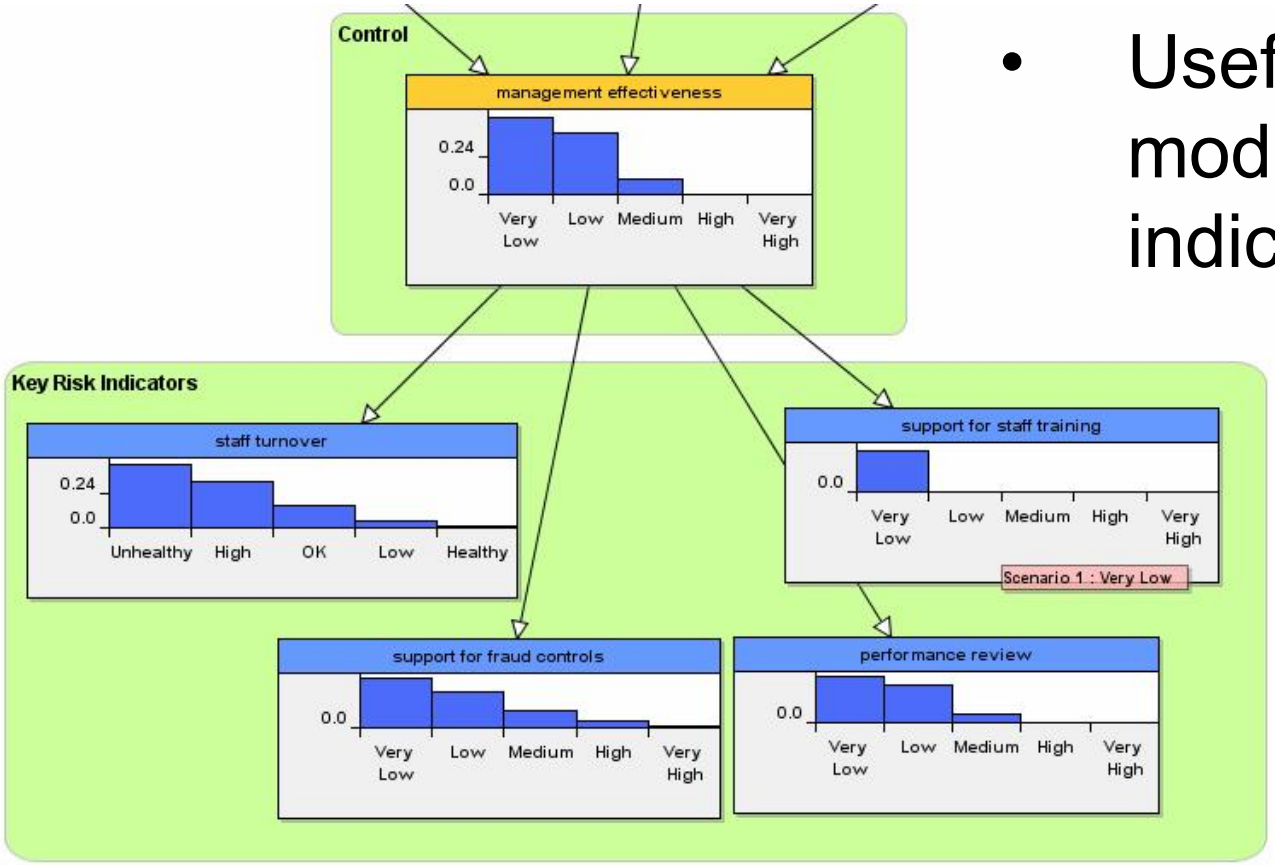
$$p(X) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/(2\sigma^2)}$$

Simulation Model

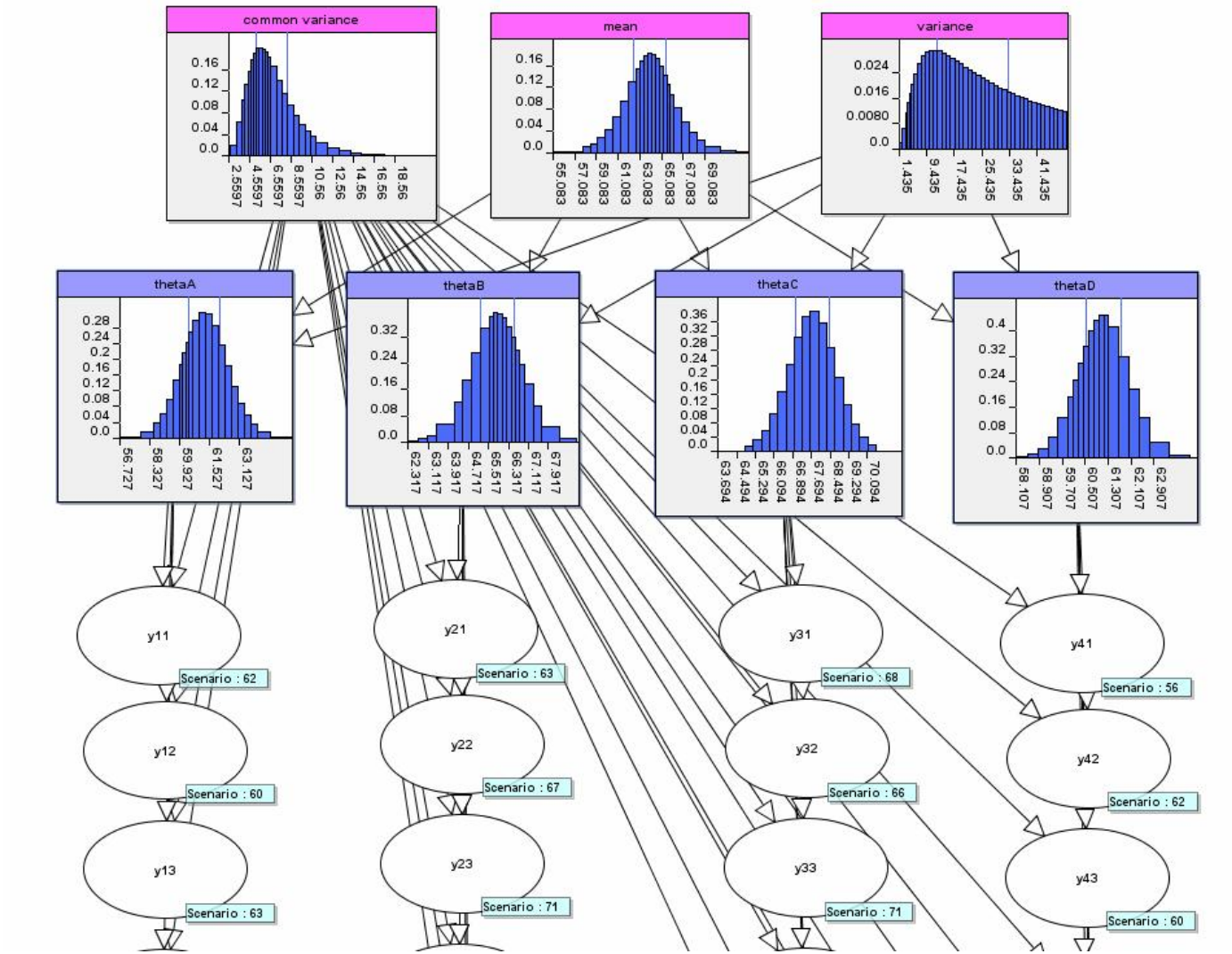


Backwards Reasoning

- Estimate causes from effects!
- Useful way to model uncertain indicators



Statistical Learning



Risk Mapping for Enterprise Risk

Key RCSA* Questions

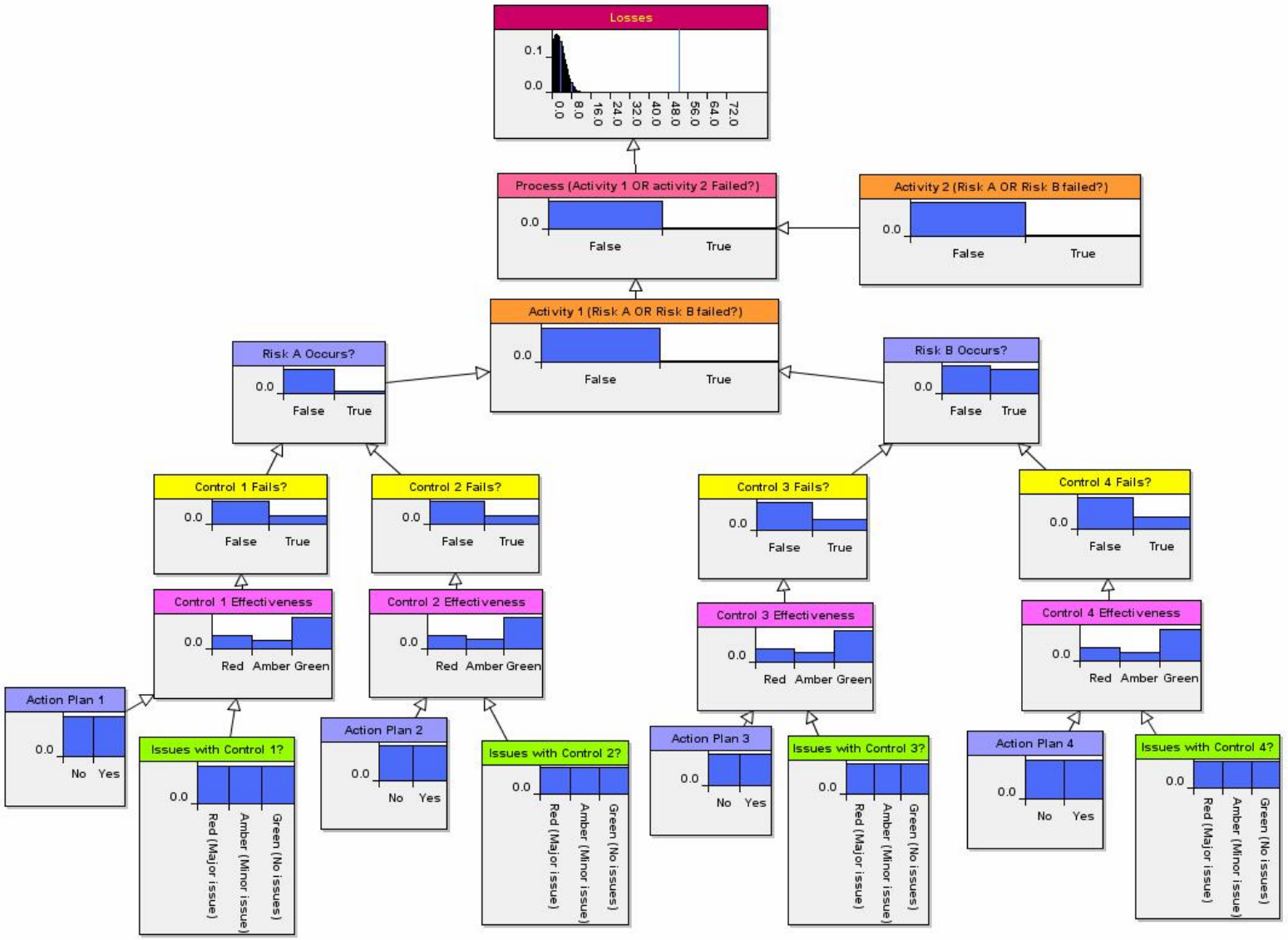
- What risks can occur?
- Can they occur in my process?
- How rare are they?
- How reliable are our controls?
- How good is our internal and external data?
- What is likely level of losses?
- What is worst case scenario?
- How can we improve?
- What should we improve?

* RCSA = Risk Control Self Assessment

Assessing Enterprise Risk

- Blend qualitative information with quantitative loss data
- COSO/CRSA style risk and business assessment
- Self-assessment data to predict process reliability in quantitative terms
- Measure and combine:
  - Process, Task reliability
  - Risks to reliability
  - Action plans
  - Issues
- Used to forecast VaR, ROI, capital charge, insurance levels.

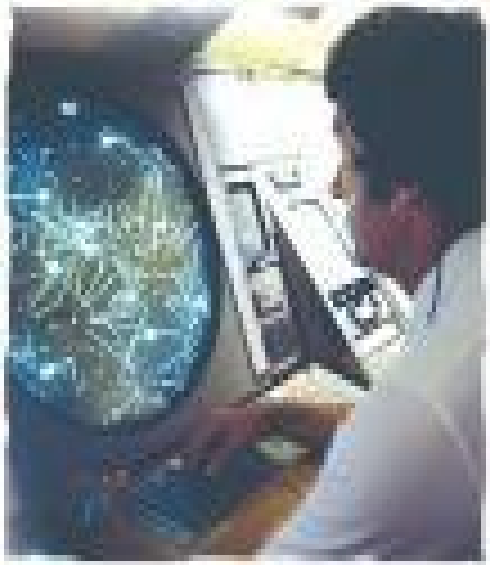
Risk Map for RCSA



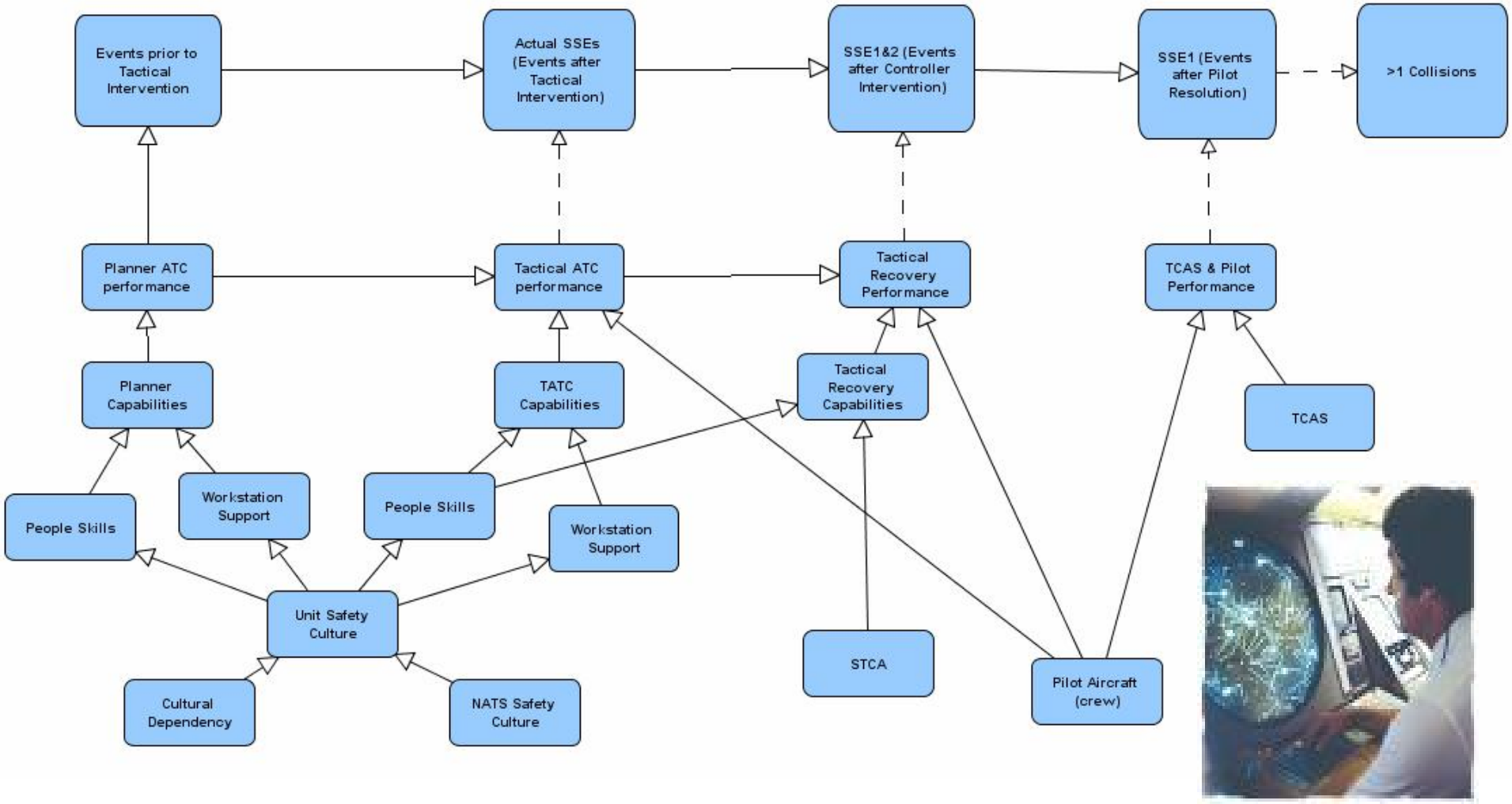
Risk Map Applications

“Risky” Applications

- Aircraft Mid-air collision
- Software defects
- Systems reliability
- Warranty return rates of electronic parts
- Operational risk in financial institutions



Aircraft Mid-Air Collision Prediction



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Final Remarks

- Structured Method
  - Based on 300 year old proven Bayes' theorem
  - Enabled by modern computer power & technology
  - Beyond current statistical & Monte Carlo techniques
  - Combines subjective judgements with data
- Risk Maps enable Visual Communication
  - Managing risk through pictures
  - Useable by risk novices as well as experts
  - Makes complex risk problems easily communicable
- AgenaRisk is Industrial Strength
  - Enables scalable, reusable & auditable risk models
  - Integrates easily with DBMS & Excel
  - Enables professional developers to build end-user applications

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Next Steps

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