

Software Metrics: Roadmap

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Outline

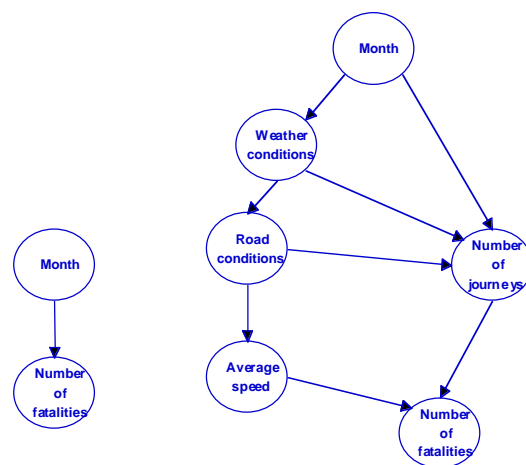
- Motivation
- Introduction to Bayesian Networks
- BBNs for software risk assessment:
- Defect prediction
- Resource Prediction
- Conclusions

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Motivation and Introduction to BBNs

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Predicting road fatalities

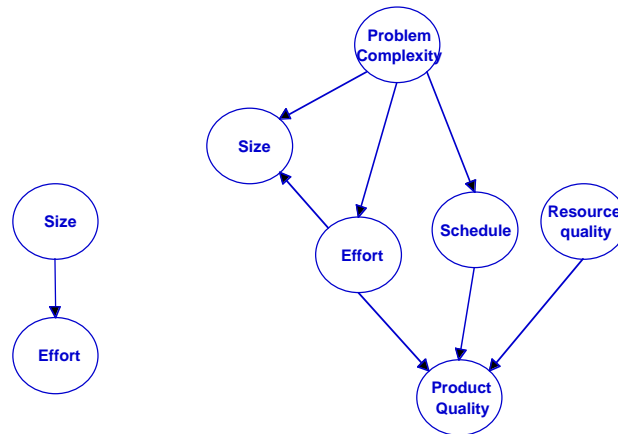


Naïve model

Causal/explanatory model

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Predicting software effort



Naïve model

Causal/explanatory model

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Typical software/systems assessment problem

“Is this system sufficiently reliable to ship?”

You might have:

- Measurement data from testing
- Empirical data
- Subjective process/resource information
- Proof of correctness
-

None alone is sufficient

So decisions inevitably involve expert judgement

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What we really need for assessment

We need to be able to incorporate:

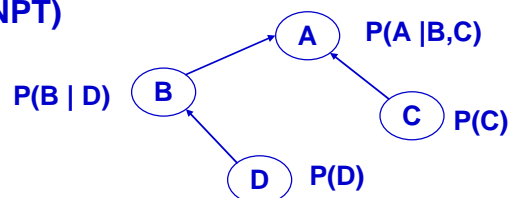
- uncertainty
- diverse process and product information
- empirical evidence *and* expert judgement
- genuine cause and effect relationships
- incomplete information

We also want *visibility* of all assumptions

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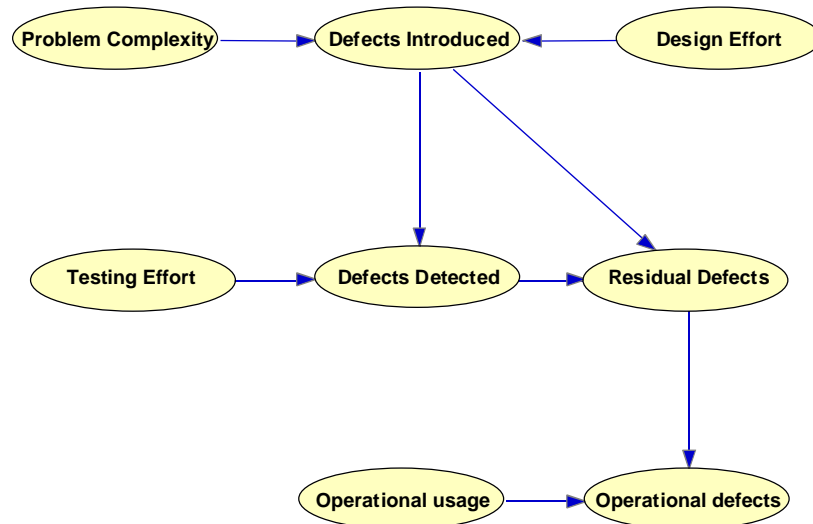
Bayesian Belief Nets (BBNs)

- Powerful graphical framework in which to reason about uncertainty using diverse forms of evidence
- Nodes of graph represent uncertain variables
- Arcs of graph represent causal or influential relationships between the variables
- Associated with each node is a probability table (NPT)



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Defects BBN (simplified)



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Bayes' Theorem

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

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

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

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

$$p(A|B) = \frac{\overset{\text{Likelihood}}{p(B|A)} \overset{\text{Prior probability}}{p(A)}}{p(B)}$$

Posterior probability

So $p(A|B)=0.16$

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BBNs for Software Risk Assessment: Defect Prediction and Resource Prediction

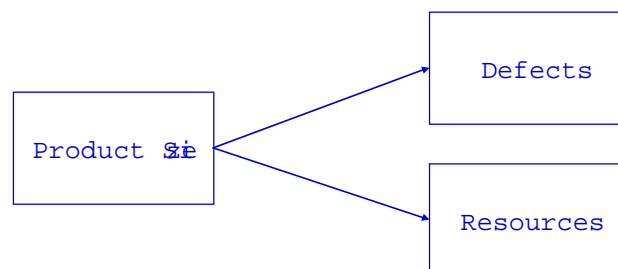
See:

Fenton and Neil "Software Metrics and Risk",
<http://www.agena.co.uk/resources.html>

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The Classic size driven approach

- LOC surrogate for different notions of size
- LOC used as driver in prediction models
- Drawbacks of LOC led to complexity metrics and function points
- ...But approach to both defects prediction and resource prediction remains 'size' driven



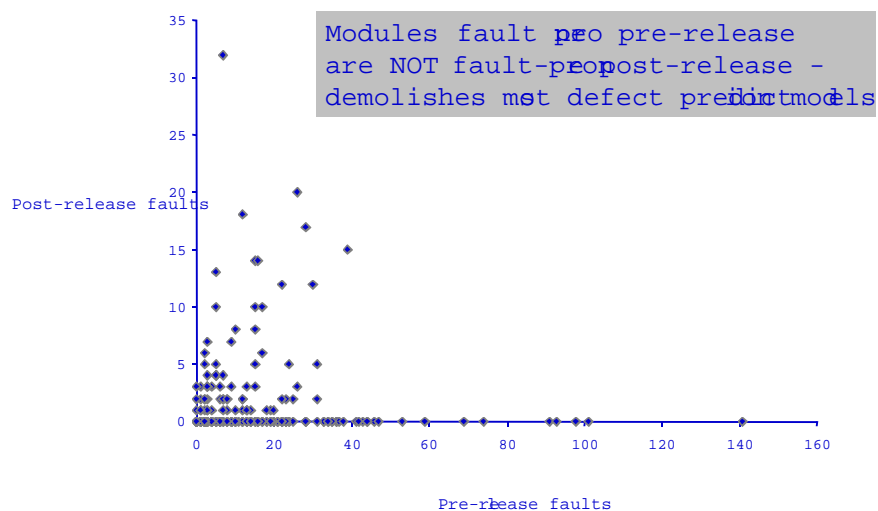
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Problems with size-driven approach

- Size/complexity not causal factors
- Obvious causal factors not modelled
- Black box models hide crucial assumptions
- Cannot handle uncertainty
- Cannot be used for real risk assessment

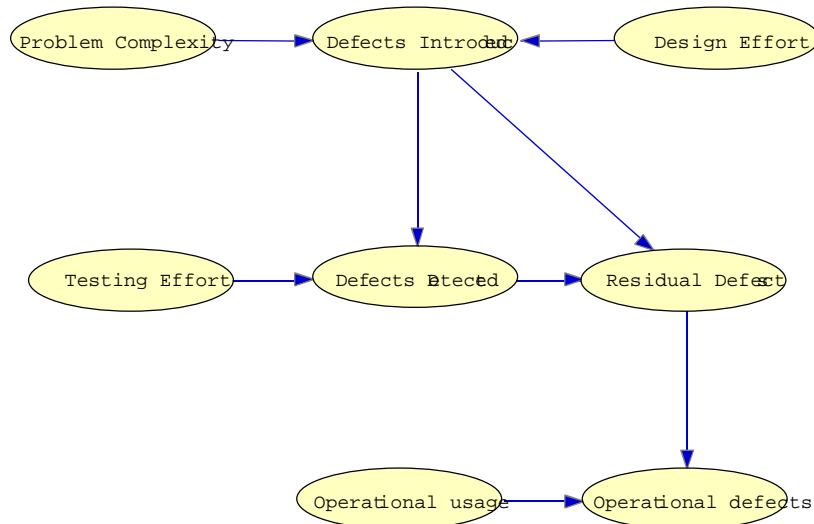
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Pre-release vs post-release faults



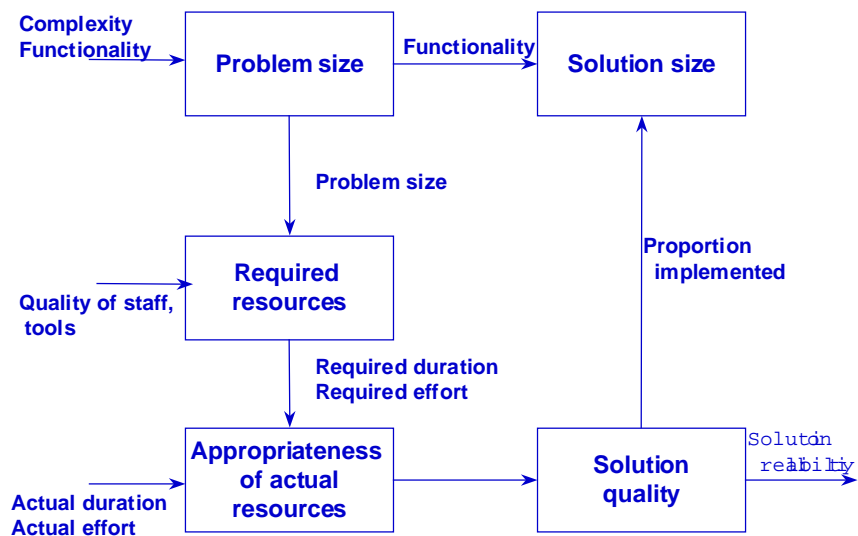
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Defects BBN (simplified)

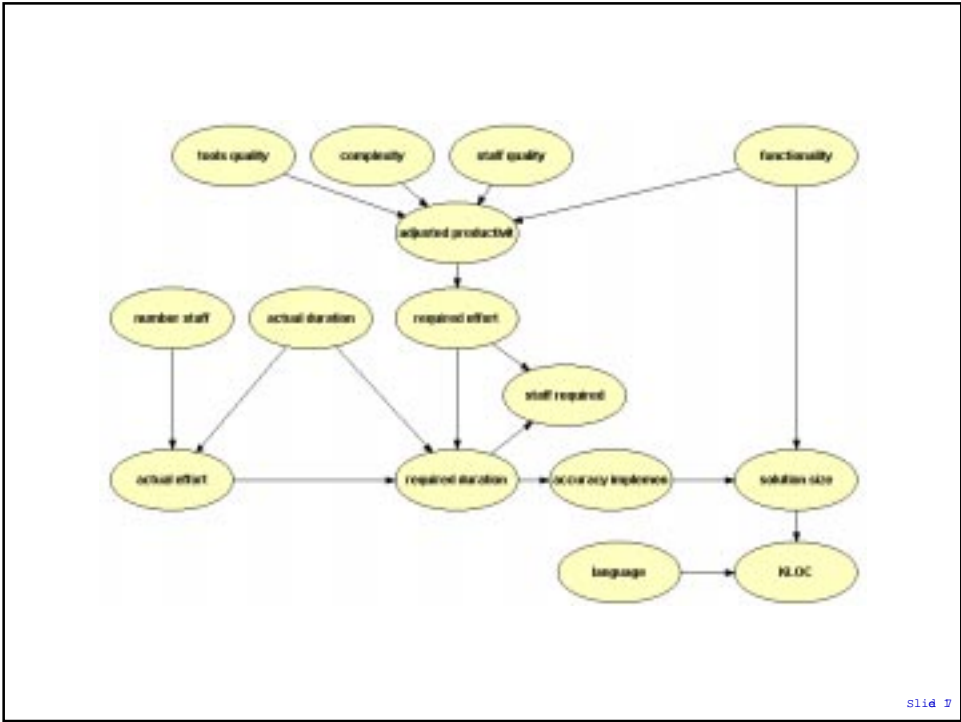


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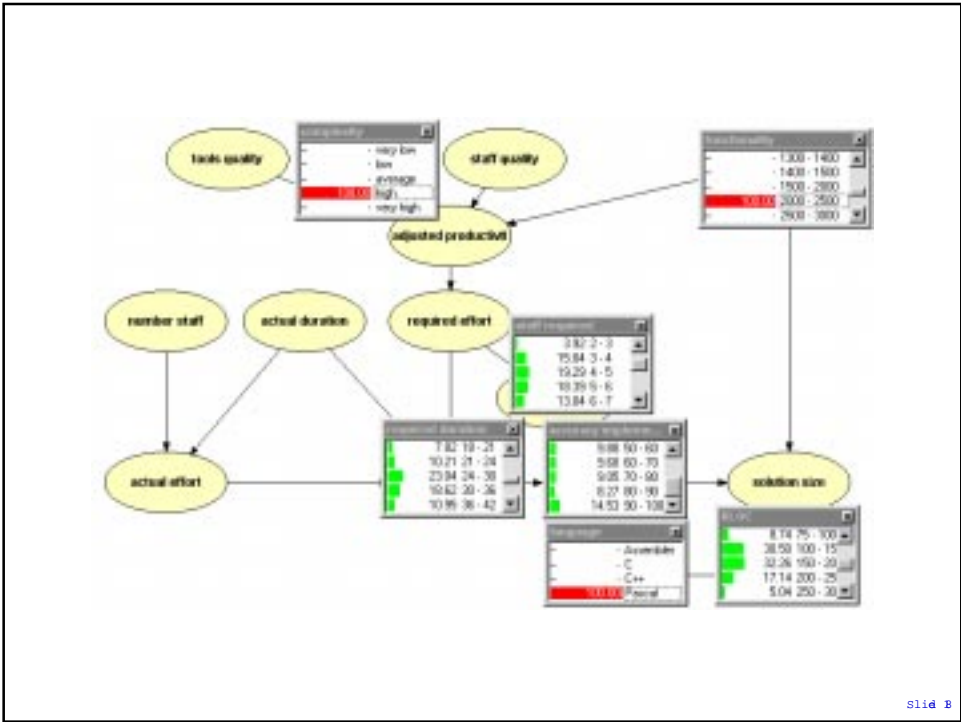
Schematic of 'resources' BBN



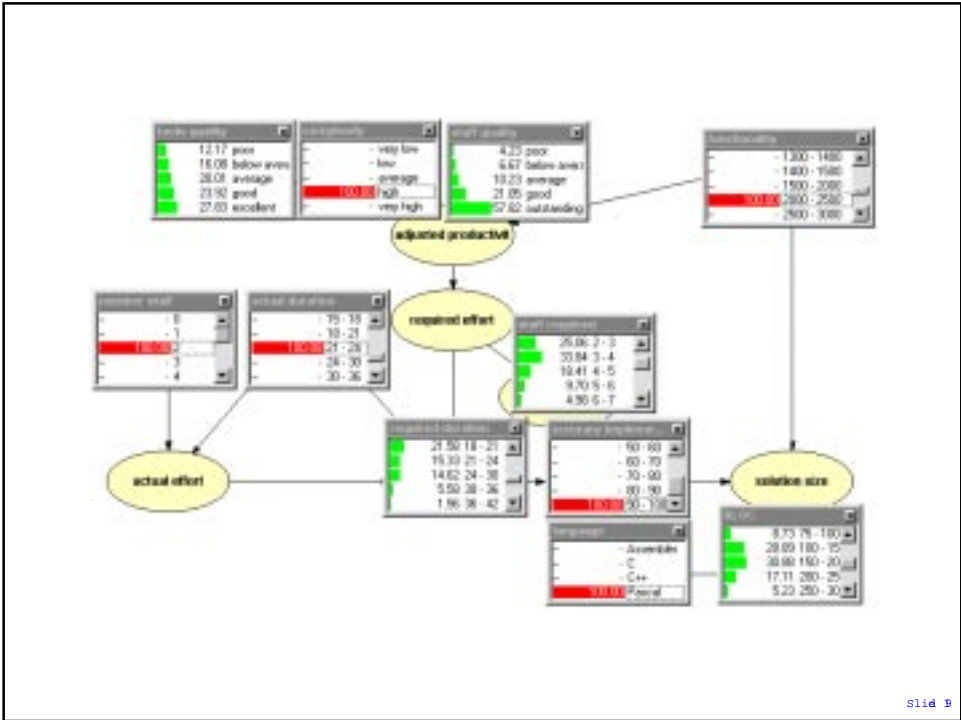
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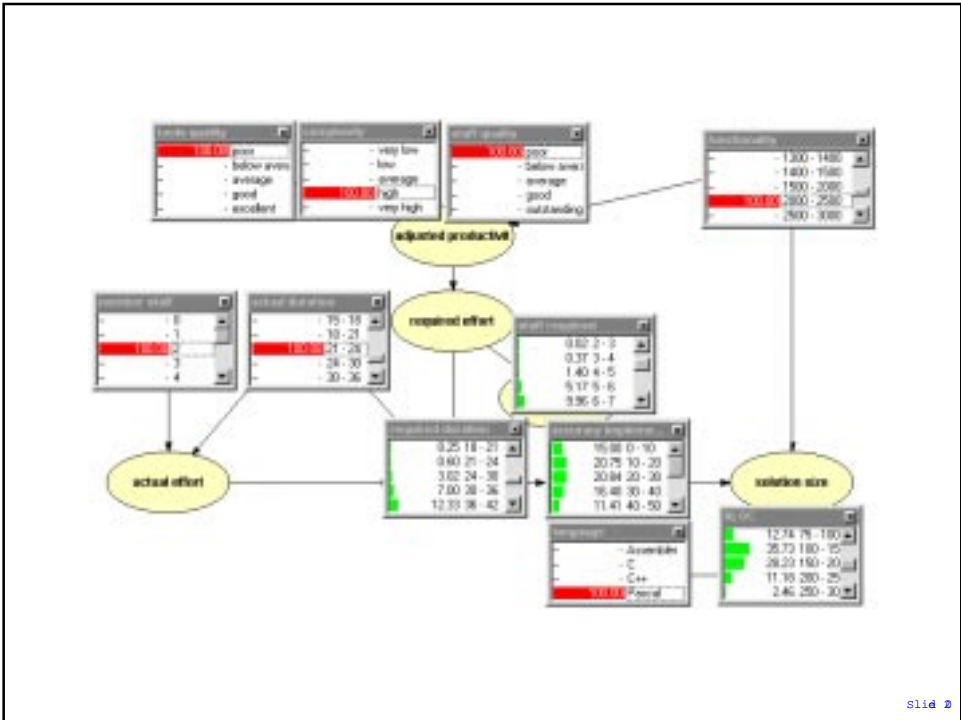
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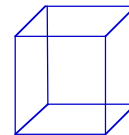
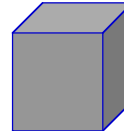
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Software defects and resource prediction summary

- **Classical approaches:**
 - Mainly regression-based black-box models
 - Predicted_attribute = $f(\text{size})$
 - Crucial assumptions often hidden
 - Obvious causal factors not modelled
 - Cannot handle uncertainty
 - Cannot be used for real risk assessment
- **BBNs provide realistic alternative approach**



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Our recent BBN applications

- Provide safety or reliability arguments for critical computer systems (DATUM, SHIP, DeVa and SERENE projects)
- Provide improved reliability predictions of prototype military vehicles (TRACS project)
- Predict general software quality attributes such as defect-density and cost (IMPRESS project)
- Assess safety of PES components in the railway industry
- Provide predictions of insurance risk and operational risk
- Predict defect counts for software modules in consumer electronics products.

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Conclusions: Benefits of BBNs

- BBN represents model of software process *and* product open to empirical analysis
- Help risk assessment and decision making in practice
- Model cause-effect relationships, uncertainty
- Incorporate expert judgement
- Combine diverse types of information
- Rigorous, mathematical semantics
- Good tool support

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Web sites

www.agenaco.uk
www.dcs.qmw.ac.uk/radar

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