Epistemic Uncertainty: Previous Approaches

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Epistemic Uncertainty:

Discrete Representation of Continuous Distribution
Logic Trees for Ground Motions

- Examples of SSHAC L3 and L4 Ground Motion Studies
  - TIP (1995)
  - Yucca Mtn (1998)
  - PEGASOS (2004)
  - BCHYDRO (2010)
  - SWUS (2014)

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TIP (1995)

- SSHAC Level 4
- Type of Question
  - What is the median PSA at 5 Hz for a magnitude 6 earthquake at a distance of 20 km for a rock site?
- Answer
  - Scalar for each M,R,F pair
  - Discretize a continuous distribution
    - 5%, 50%, 95% values
    - Mutually exclusive, collectively exhaustive (MECE)
TIP (1995)

Yucca Mtn

- SSHAC Level 4
- Concept
  - Experts would consider many discrete M,R cases and make sure that the epistemic distribution was appropriate
- Type of Question
  - What is the median PSA at 5 Hz for a magnitude 6 NML earthquake at a distance of 10 km on the HW a rock site?
  - About 60 (M,R) Pairs and 9 frequencies
- Answer
  - Scalar for each case M,R,F
  - Describe a continuous distribution (may be asymmetric)
    - Mu, SigmaMu+, and SigmaMu-
  - Mutually exclusive, collectively exhaustive
Yucca Mtn

Used variable weights for GMPEs
Parameterized as sigma Mu
- Mag, dist, mech, period dependent

Yucca Mtn

• Difficulties
  – Too many evaluations needed (~540 cases H & V)
    • Experts all used weights on alternative models (empirical GMPEs, PS simulations, FF simulations) to develop an algorithm for determining the weights
      – Algorithms based on relative merits of models
      – Answer intended to be a description of statistical distribution
    • Used symmetric distributions
  – Results treated as independent for each case
    • No correlation between cases (e.g. different mag or dist scaling)
EPRI (2004)

• SSHAC level 3
• Concept
  – Define model clusters based on class of model with weights for each cluster
  – Address statistical uncertainty within each cluster
• Question
  – What is the weight for the cluster?
  – What are the weights of a GMPEs within each cluster?
• Answer
  – Vector PSA(M,R,F)
  – Weights capturing relative merits of clusters
  – Representative set of GMPEs and weights that discretize continuous distribution of GMPEs within each cluster
• Difficulties
  – Clusters evaluated for their merits, not for the range of ground motion models sampled
  – Not mutually exclusive, collectively exhaustive
  – Creates new models (not published models)

PEGASOS (2004)

• SSHAC Level 4
• Concept
  • If experts using weights on GMPEs to make their evaluation, then acknowledge this and directly ask about weights on GMPEs
• Type of Question
  – What at the weights on GMPEs for a given M,R,Freq range?
    • M5 – M7.5
    • Dist 0-150 km
    • Freq 0.3 to 50 Hz (plus pPGA)
• Answer
  – Vector PSA (M,R,F)
  – M,R,Freq dependent weights for GMPEs and point source models
• Difficulties
  – No longer a simple discretization of a continuous distribution
  – Weights represent relative merits of models
  – Not mutually exclusive, collectively exhaustive

Used mag-dist dependent Weights on GMPEs

Fig. 5.20: Comparison of the epistemic uncertainty of the median peak acceleration for magnitude 6.0 earthquake and a normal mechanism

BCHYDRO (2010)

- SSHAC Level 3
- Concept
  - Scaled backbone approach for subduction earthquakes
  - Weights on published GMPEs for crustal earthquakes
- Question
  - What are the weights on the GMPEs?
- Answer for subduction zones
  - Vector PSA for (M,R,F)
  - Backbone GMPE
  - Suite of scaled versions of the backbone GMPE
    - Uncertainty scale factor increases for larger magnitudes
  - Statistical weights for the scaled GMPEs
    - Discretize continuous distribution
    - Mutually exclusive, collectively exhaustive
- Difficulty
  - Does not address changes in the magnitude or distance scaling
Scaled Backbone Approach

- Advantages of scaled backbone
  - Weights on logic trees
    - Leads to models that are mutually exclusive
    - Models are collectively exhaustive in terms of ground motion levels
    - Easier to treat GMPE weights as probabilities

- Disadvantages of scaled backbone
  - Does not capture uncertainties in scaling (e.g. distance slope, magnitude slope)
    - Leads to over-estimation of width of fractiles
  - Creates new models (not published models)
SWUS (2014)

- SSHAC Level 3
- Concept
  - Develop a representative set of GMPEs that span the full range of technically defensible models
  - Capturing changes in magnitude and distance scaling
  - Mutually exclusive and collectively exhaustive in the Sammon’s map space
- Question
  - What are the GMPEs?
  - What are the weights on the GMPEs?
- Answer
  - Vector PSA (M,R) for each F
  - Statistical weights for the GMPEs
    - Discretize continuous distribution in Sammon’s map space
    - Mutually exclusive, collectively exhaustive
- Difficulty
  - Large number of GMPEs
  - Independent at each frequency (does not capture correlation across freq)

SWUS Epistemic Uncertainty
Discrete Representation of Continuous Distribution in 2 Dimensions
## Summary

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