

Old and Newer methods for Bayesian updating

Roger Jelliffe, M.D.

USC Lab of Applied Pharmacokinetics

Four types of Bayesian updating

1. **Maximum A posteriori Probability (MAP).**
2. **Multiple Model (MM) Bayesian updating.**
3. **Hybrid Bayesian (MAP + MM) updating.**
4. **Interacting Multiple Model (IMM) Bayesian updating**

Maximum A posteriori Probability (MAP).

- Can reach out toward an unusual patient
- But the MAP point misses the true patient
- Held back toward the prior
- Also, only 1 point. No graphic view of uncertainties.
- What to do?

QUANT BAYES' THEOREM:

1. DETERMINE ASSAY ERROR EXPLICITLY.
2. USE IN CURRENT BAYESIAN OBJ FUNCTION

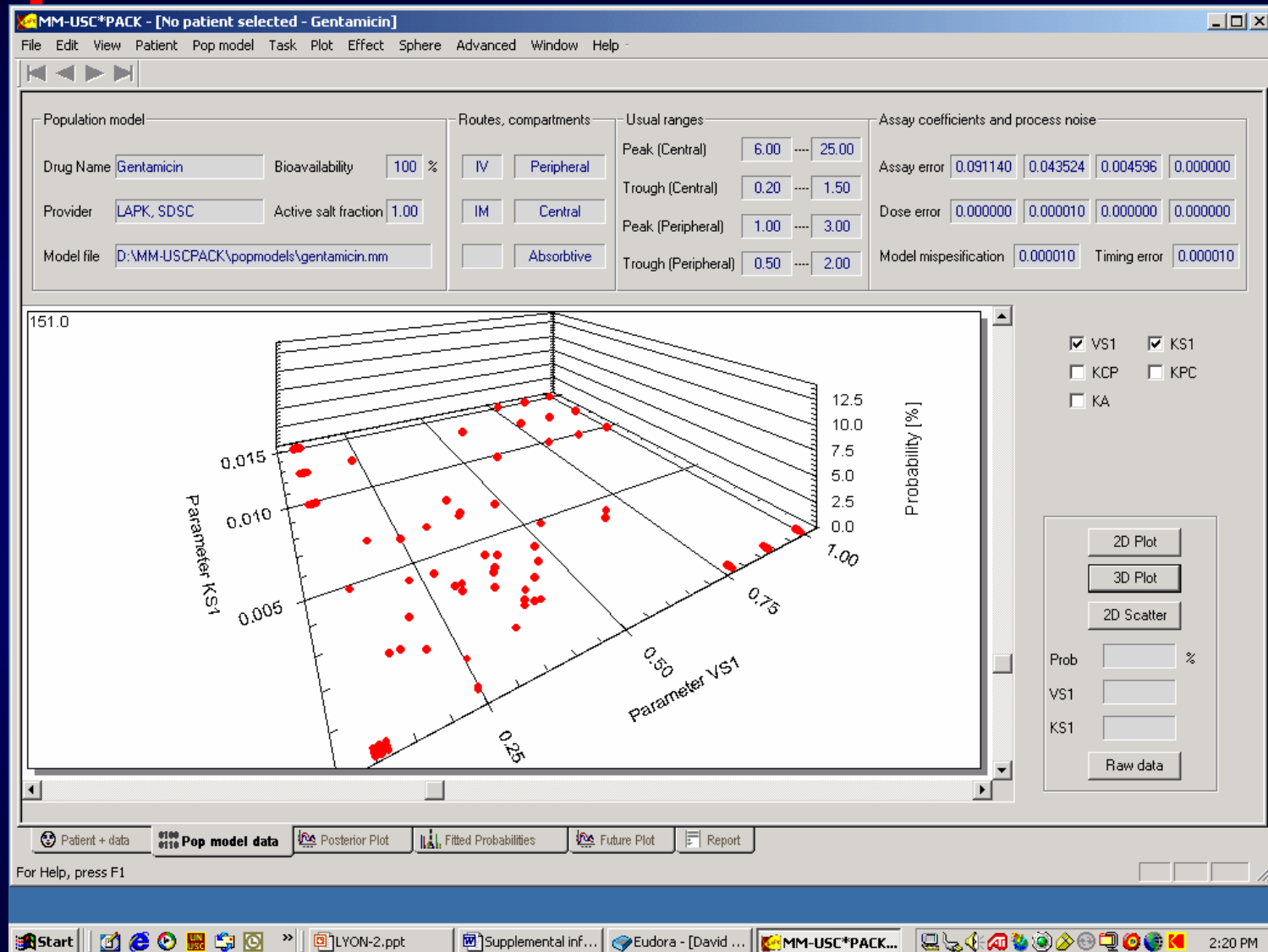
$$\text{MINIMIZE SUM } \frac{(C_{\text{obs}} - C_{\text{mod}})^2}{SD^2_{C_{\text{obs}}}} + \text{SUM } \frac{(P_{\text{pop}} - P_{\text{mod}})^2}{SD^2_{P_{\text{pop}}}}$$

PRIOR PROB	NEW INFO	CONSIDER PRIOR+NEW	POST PROB	THERAPY	
				GOALS	CONTROL
POP MODEL	SERUM CONC'S	OBJ FUNCT	INDIV MODEL	LOOK AT PT, THINK	CALC DOSES

2. Multiple Model (MM) Bayesian updating.

- Support points don't change. Values of support points stay the same**
- Use Bayes' theorem to compute the Bayesian posterior probability of each support point, given patient's data**
- Problem: will not reach out beyond pop param ranges. May miss unusual patient. What to do?**

Pop model has definite boundaries

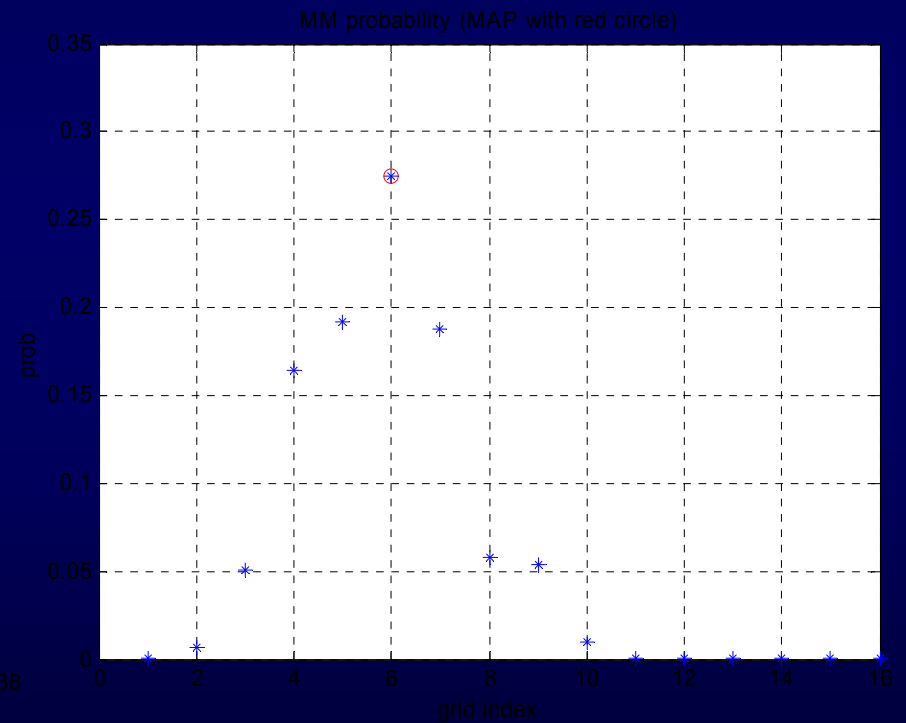
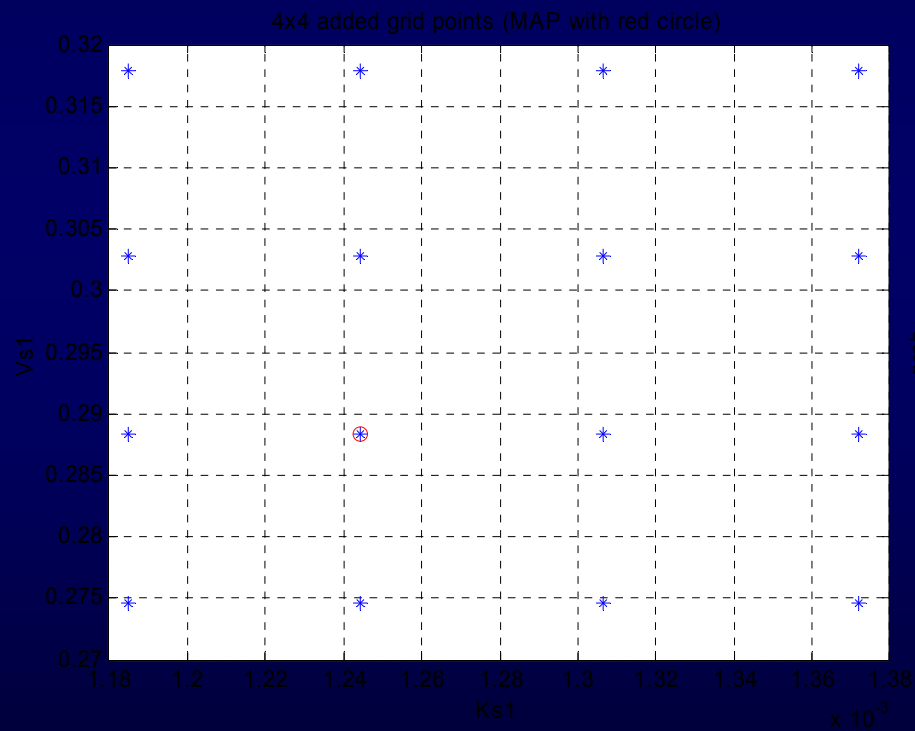


3. Hybrid Bayesian posterior updating

- Start with MAP Bayesian. It reaches out, **but not fully**. Pop prior holds it back.
- Add new support points nearby, inside and outside, to precondition the pop model for the new patient data.
- Then do MM Bayesian on ALL the support points.
- We are implementing this now. Out soon.

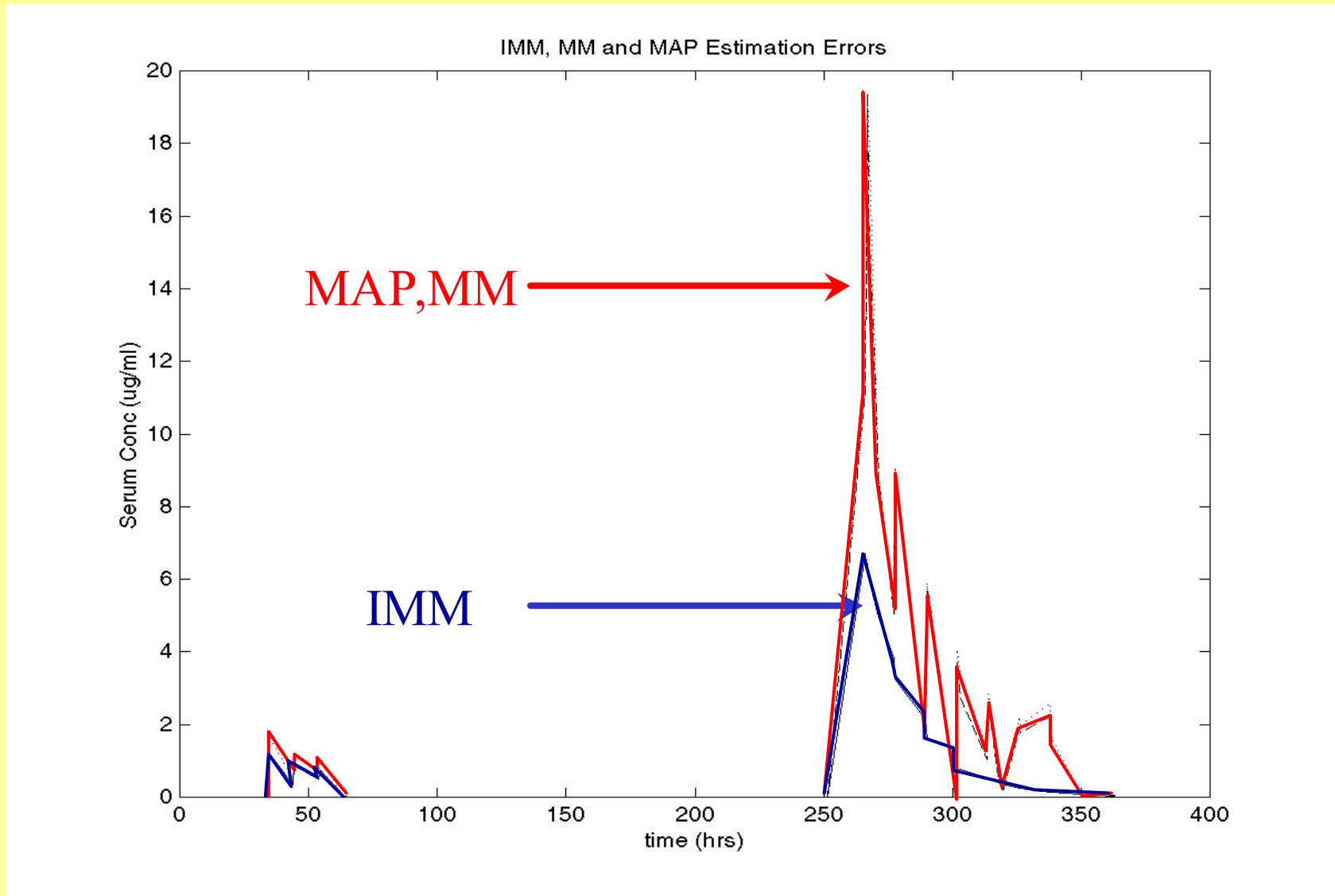
Test Case

Probabilities calculated on a 4x4 grid about optimal 5 percent increase/decrease between grid points



4. Bayesian for very unstable patients: interacting multiple model (IMM)

- Limitation of all current Bayesian methods: assume **only 1** set of fixed parameters to fit the data.
- Sequential MAP or MM Bayesian same as fitting all at once.
- Relax this assumption. Let the “true patient” **change** during data analysis if more likely to do so.
- Hit evasive targets better. IMM.



Errors in tracking serum conc: Sequential MAP, MM, and IMM Bayesian posteriors