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Penalized Bayesian Methods for Product Ranking Using Both Positive and Negative References

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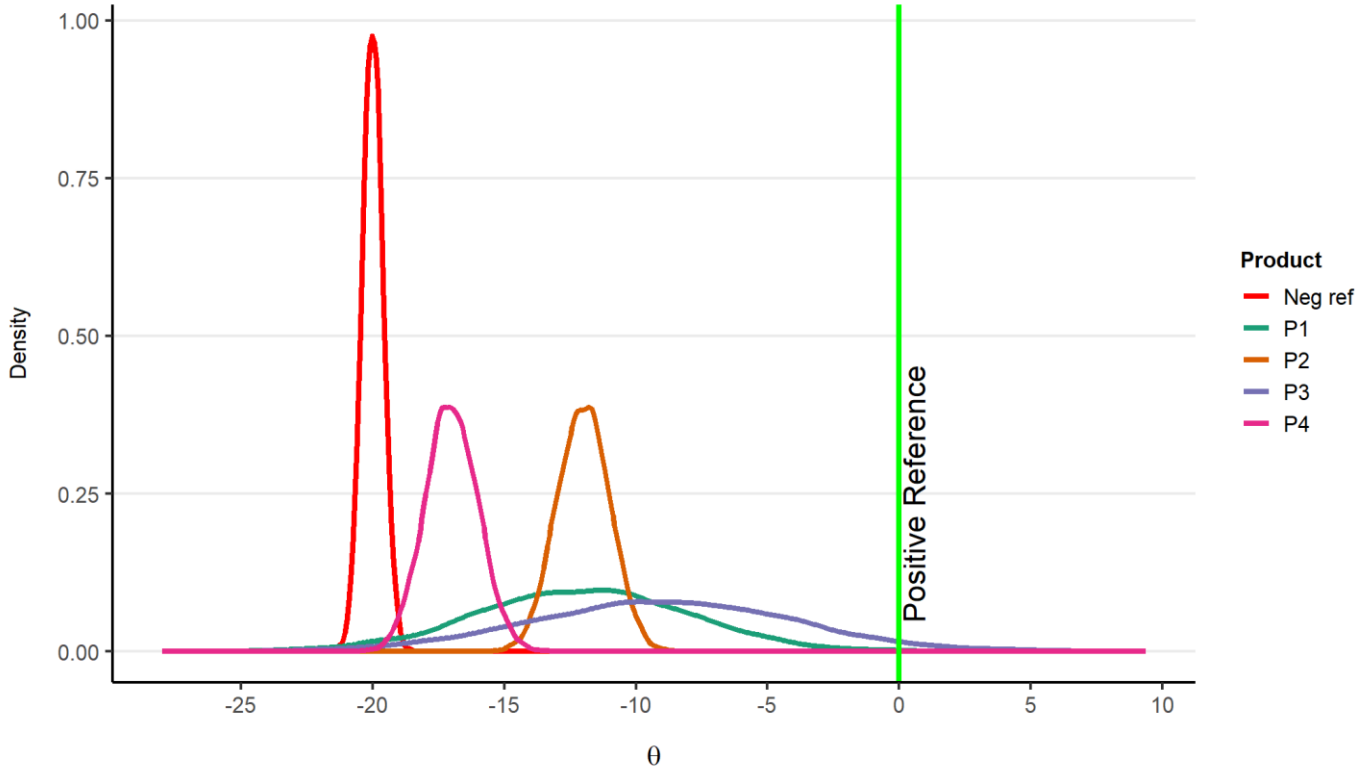
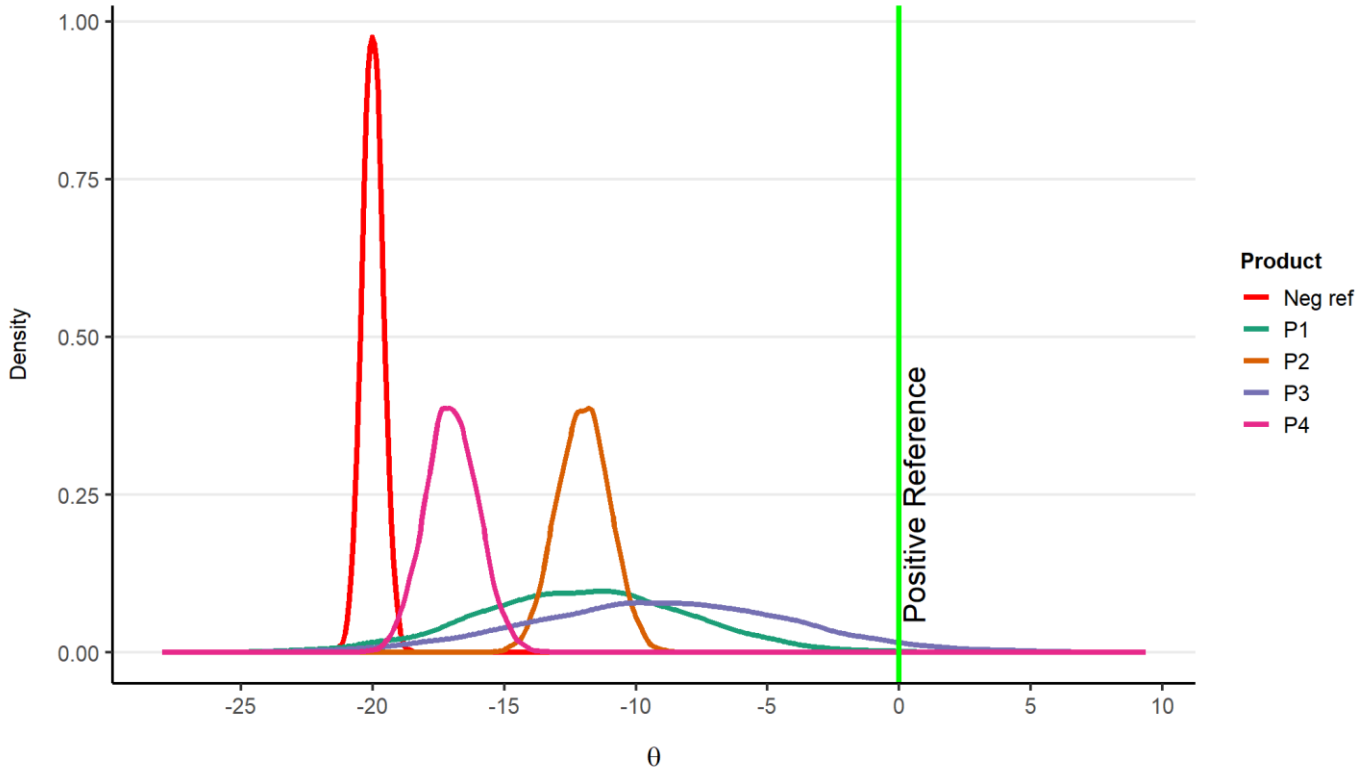
Context and data

- Overall comparison of posterior mean efficacy distributions of 4 products with regards to
  - One positive reference: maximum possible efficacy (not achievable in practice)
  - One negative reference: fifth product known to have the worst efficacy
- Each comparison summarized by one unique metric (then used to rank products)



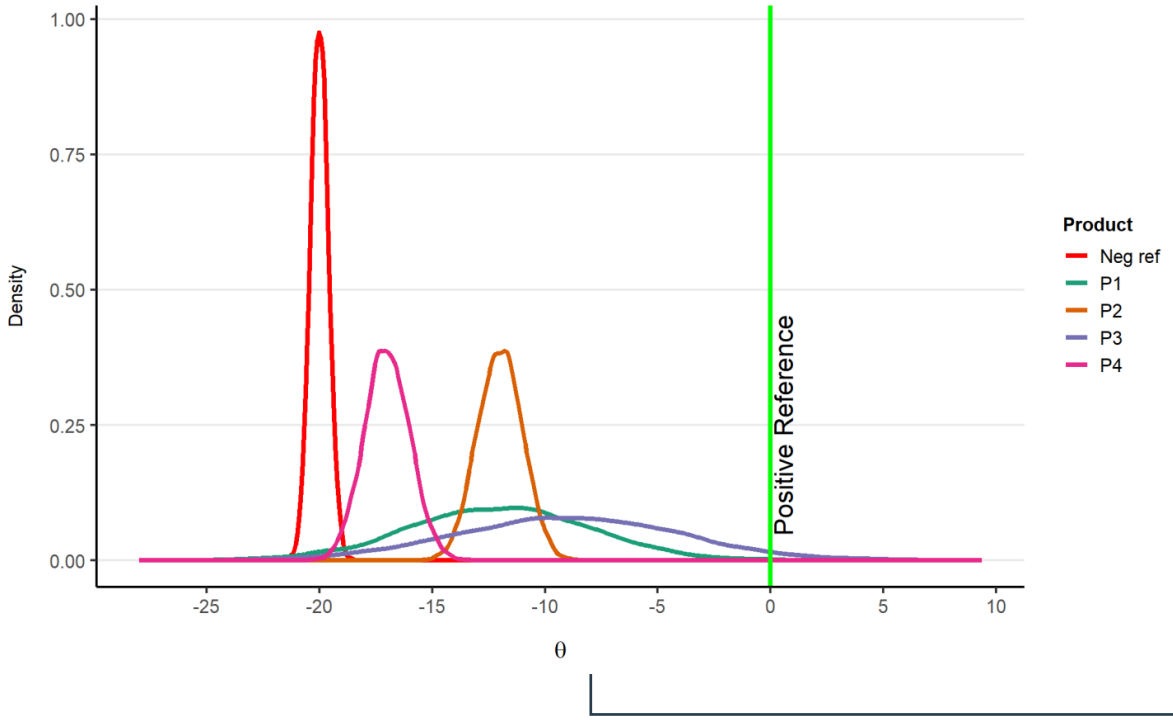
Context and data

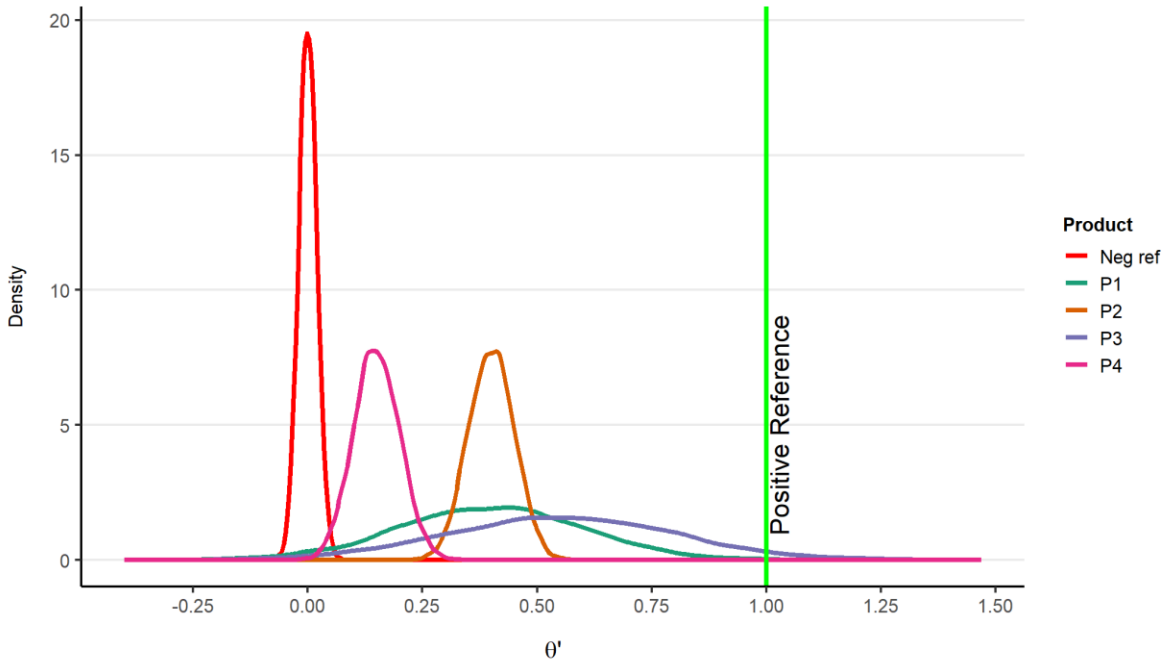
- Overall comparison of posterior mean efficacy distributions of 4 products with regards to
  - One positive reference: maximum possible efficacy (not achievable in practice)
  - One negative reference: fifth product known to have the worst efficacy
- Each comparison summarized by one unique metric (then used to rank products)
- **Minimal risk mindset to define the metric; the best product must present a trade-off between having**
  - **1) high probability to be above the negative reference**
  - **2) small uncertainty on the posterior distributions**
  - **3) high chances to be like the positive reference**



Step 1: (Quasi-)Normalization

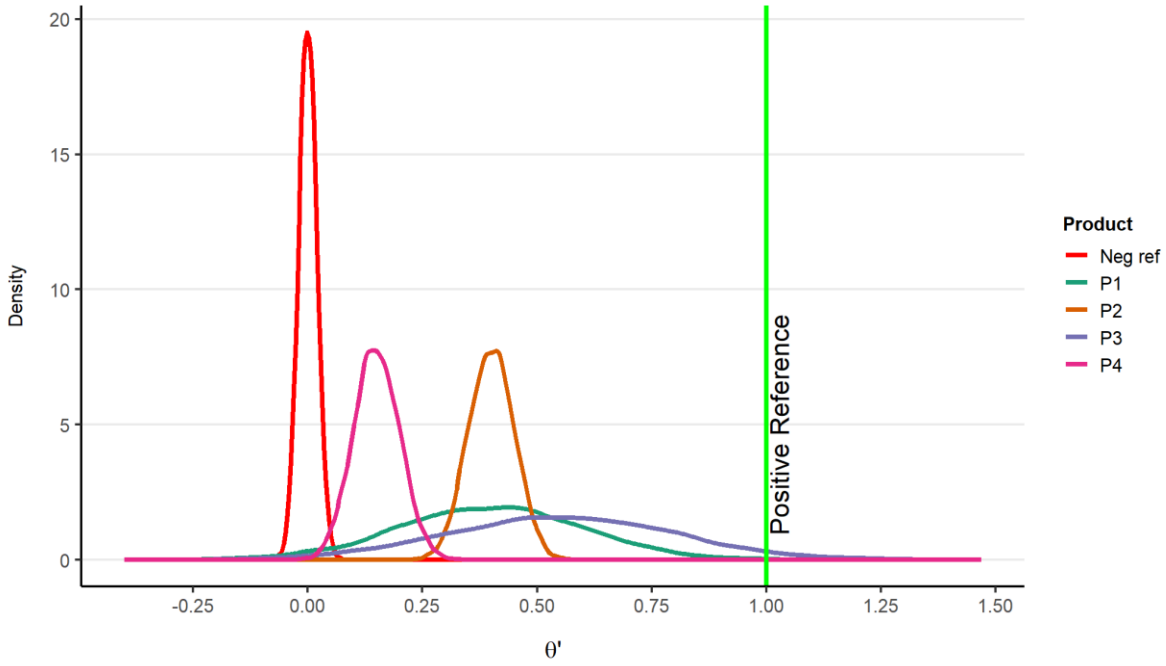
- Make the range of the θ_i independent of the data
- Following steps can be run the same way for every data

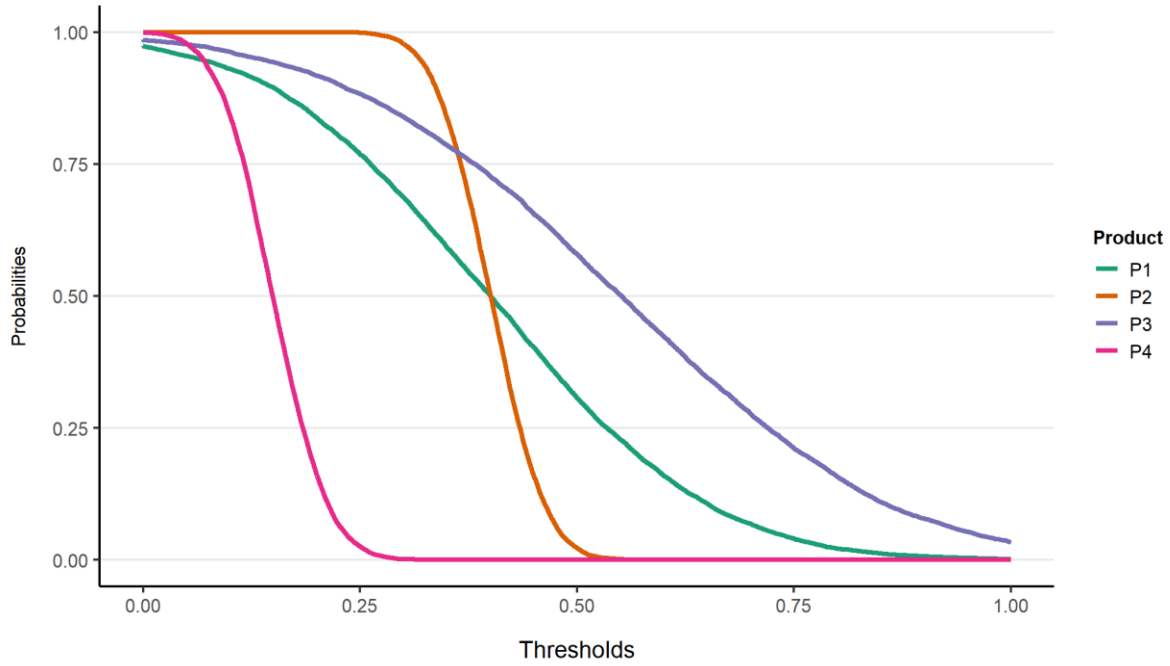




Step 2: Probabilities to be comparable

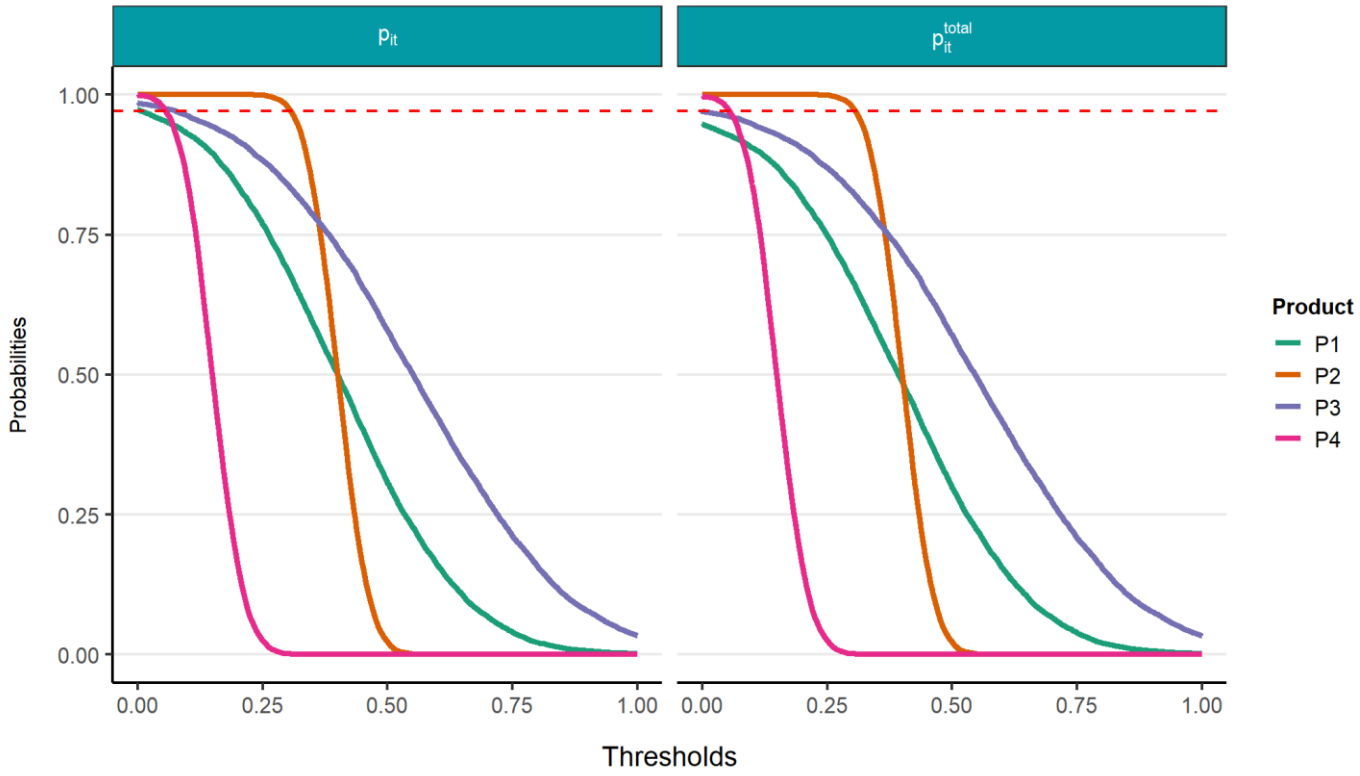
- Compute the probabilities for a product to be comparable to the positive reference accounting for its variability
  - It is the inverse of the cumulative distribution function for each product





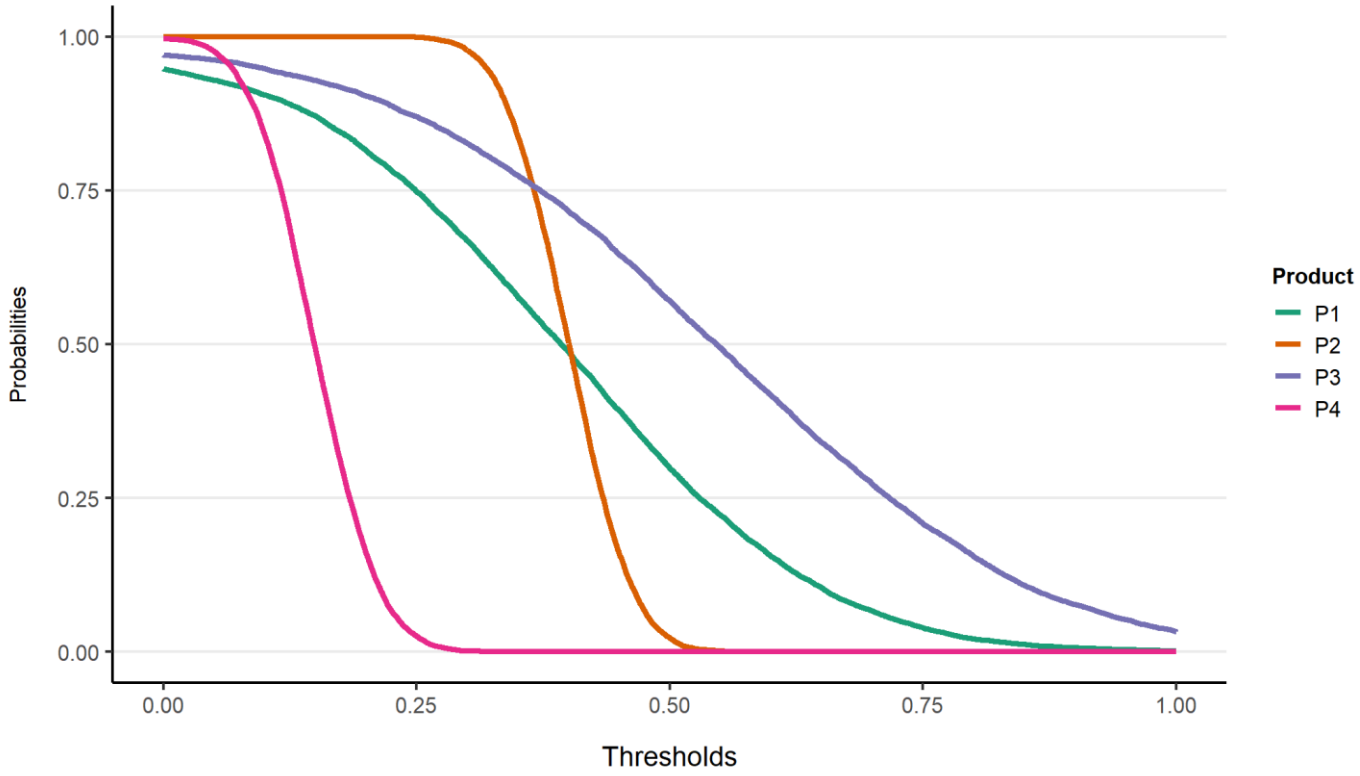
Step 3: Penalization of probabilities in step 2

- Penalized products that have a non-negligible probability to underperform the negative reference
  - They represent higher risk
- For each product, the penalization factor is multiplied by the probabilities derived in step 2



Step 4: Metric calculation

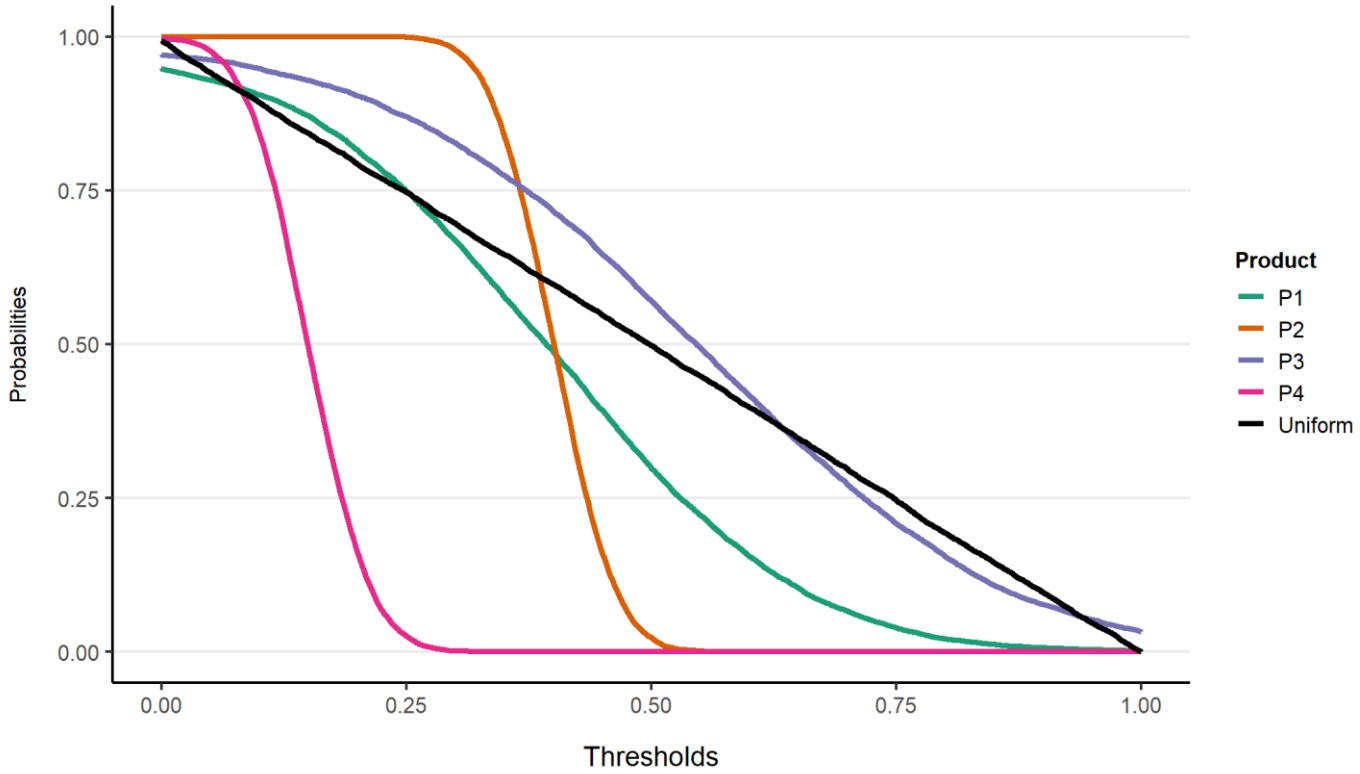
- AUC ?



Product	M	SD	P2	AUC
P3	-12.03	4.04	98.480	0.539
P2	-12.00	1.00	100.000	0.400
P1	-9.01	5.00	97.320	0.390
P4	-17.00	1.00	99.760	0.150

Step 4: Metric calculation

- AUC considering the hypothetical case of no knowledge as represented by a uniform distribution



Product	M	SD	P2	Metric	AUC
P2	-12.00	1.00	100.000	0.127	0.400
P3	-12.03	4.04	98.480	0.103	0.539
P1	-9.01	5.00	97.320	0.007	0.390
P4	-17.00	1.00	99.760	0.004	0.150

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