



Noninformative
Priors
1/8

D.E. Brown

Noninformative
Summary

Noninformative Prior Distributions

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Agenda

Noninformative
Priors
2/8

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Summary

- 1 Noninformative Priors
- 2 Summary of Approaches



Priors with No Information

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Priors
3/8

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- Bayesian approach is still appropriate with no information to inform the prior



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3/8

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- Suppose we are uncertain when an event will occur: prior should give $p = 0.5$



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- Uniform prior $[0, 1]$ will do this.



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3/8

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 - Improper



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3/8

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 - Not coherent



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3/8

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 - Improper
 - Not coherent
 - Not invariant under transformation



Improper Priors

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4/8

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- Suppose we have a parameter, $\theta \in \mathfrak{R}$. What noninformative prior will work?



Improper Priors

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Priors
4/8

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- Uniform? But $f(\theta) = c$ implies $\int_{-\infty}^{\infty} f(\theta) d\theta = \infty$, i.e., improper



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Priors
4/8

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4/8

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- An improper prior does not matter:
 - Suppose X_1, \dots, X_N sampled from $N(\mu, \sigma^2)$ with known σ^2



Improper Priors

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Priors
4/8

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- Suppose we have a parameter, $\theta \in \Re$. What noninformative prior will work?
- Uniform? But $f(\theta) = c$ implies $\int_{-\infty}^{\infty} f(\theta) d\theta = \infty$, i.e., improper
- An improper prior does not matter:
 - Suppose X_1, \dots, X_N sampled from $N(\mu, \sigma^2)$ with known σ^2
 - If $f(\mu) = 1, -\infty < \mu < \infty$, then from Bayes rule:

$$f(\mu|x_1, \dots, x_N) \propto \exp \left[\frac{-N}{2\sigma^2} (\theta - \bar{x})^2 \right]$$

The M.L. solution



Improper Priors

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Priors
4/8

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The M.L. solution

- Can also use a proper prior and let $\sigma^2 \rightarrow \infty$



Incoherent

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- Solutions with uniform or noninformative prior do not make sense



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- Solutions with uniform or noninformative prior do not make sense
- Example: Does life in the universe exist outside of the earth?



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5/8

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 - Uniform prior would suggest $p = 0.5$.



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Priors
5/8

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- Solutions with uniform or noninformative prior do not make sense
- Example: Does life in the universe exist outside of the earth?
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 - Need to correctly define the sample space from two events to many possible planetary events



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Priors
5/8

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- Example: Does life in the universe exist outside of the earth?
 - Uniform prior would suggest $p = 0.5$.
 - Need to correctly define the sample space from two events to many possible planetary events
- When well defined, noninformative priors are coherent



Not Invariant under Transformation

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6/8

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- Technical issue, of only modest practical importance



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- Solutions



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- Technical issue, of only modest practical importance
- Solutions
 - Jeffrey's prior



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6/8

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- Technical issue, of only modest practical importance
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 - Reference prior



Agenda

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Priors
7/8

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Summary

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Priors
8/8

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- Prior information is not the same as a prior distribution



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- Prior information is not the same as prior distribution
- Approaches to prior distributions



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- Prior information is not the same as prior distribution
- Approaches to prior distributions
 - Base rate - always use, but may modify



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- Prior information is not the same as prior distribution
- Approaches to prior distributions
 - Base rate - always use, but may modify
 - Subjective - use only when you have very good experts



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8/8

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- Prior information is not the same as prior distribution
- Approaches to prior distributions
 - Base rate - always use, but may modify
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 - Maximum entropy - use when you need to justify your work



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8/8

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- Prior information is not the same as prior distribution
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 - Base rate - always use, but may modify
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 - Maximum entropy - use when you need to justify your work
 - Conjugate - general purpose approach that can deliver fast results



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8/8

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- Prior information is not the same as prior distribution
- Approaches to prior distributions
 - Base rate - always use, but may modify
 - Subjective - use only when you have very good experts
 - Maximum entropy - use when you need to justify your work
 - Conjugate - general purpose approach that can deliver fast results
 - Noninformative - good starting point