Bayesian Inference Without Tears

E.-J. Wagenmakers
What is Bayesian Inference?
What is Bayesian Inference?

“Common sense expressed in numbers”
What is Bayesian Inference?

“Common sense expressed in numbers”

“The only good statistics”
What is Bayesian Inference?

“The outcome of a learning process that is governed by relative predictive success”
BAYESIAN LEARNING CYCLE

Prior Knowledge

Prediction

Prediction Error

Data

Knowledge Update

Induction

Deduction

Artwork by Viktor Beekman • instagram.com/viktordepictor
THE PRINCIPLES OF SCIENCE

A TREATISE ON LOGIC
AND
SCIENTIFIC METHOD

BY

W. STANLEY JEVONS

LL.D. (EDINB.), M.A. (LOND.), F.R.S.
Bayes’ Rule

\[
p(\theta \mid \text{data}) = p(\theta) \times \frac{p(\text{data} \mid \theta)}{p(\text{data})}
\]

- Posterior beliefs about parameters
- Prior beliefs about parameters
- Predictive updating factor
Bayes’ Rule

\[
\frac{p(\theta \mid \text{data})}{p(\theta)} = \frac{p(\text{data} \mid \theta)}{p(\text{data})}
\]

Support

Predictive success
The Two Faces of Bayes' Rule

Posterior Belief About $\theta$

\[
\frac{p(\theta | \text{data})}{p(\theta)}
\]

Prior Belief About $\theta$

Predictive Adequacy of $\theta$

\[
\frac{p(\text{data} | \theta)}{p(\text{data})}
\]

Change in Belief About $\theta$

Average Predictive Adequacy

Relative Predictive Adequacy of $\theta$
THE TWO FACES OF BAYES' RULE

POSTERIOR BELIEF ABOUT $\theta$

\[
\frac{p(\theta | \text{data})}{p(\theta)}
\]

CHANGE IN BELIEF ABOUT $\theta$

PREDICTIVE ADEQUACY OF $\theta$

\[
\frac{p(\text{data} | \theta)}{p(\text{data})}
\]

What about $\theta = 0.5$ for $k = 5$ successes out of $n = 10$ attempts?

Knowledge update = 2.71

Predictions from prior distribution

Predictions from $\theta = 0.5$

Prediction ratio = 2.71
\[
\frac{p(\theta \mid y)}{p(\theta)} = \frac{p(y \mid \theta)}{p(y)}
\]

**BF_{1A}** = 244.4

**BF_{1B}** = 2.1

**BF_{C1}** = 3.2
Bayes Factors for Those Who Hate Bayes Factors

POSTED ON NOV 3RD, 2017

This post is inspired by Morey et al. (2016), Rouder and Morey (in press), and Wagenmakers et al. (2016a).

The Misconception

Bayes factors may be relevant for model selection, but are irrelevant for parameter estimation.

The Correction
Pragmatic Bayesian Advantages

- Attach probabilities to parameters and hypotheses;
- Quantify evidence, for any hypothesis you care to specify;
- Learn;
- Monitor the evidential flow as the data come in.
How Do We Best Spread the Faith?

- Mathematicians: teach practitioners mathematical statistics, so they can derive posterior distributions!
How Do We Best Spread the Faith?

- Mathematicians: teach practitioners mathematical statistics, so they can derive posterior distributions!
- Programmers: teach practitioners R, Python, Stan, and/or JAGS, or even how to design their own MCMC routines!
How Do We Best Spread the Faith?

- Mathematicians: teach practitioners mathematical statistics, so they can derive posterior distributions!
- Programmers: teach practitioners R, Python, Stan, and/or JAGS, or even how to design their own MCMC routines!
- Bayesian statisticians: have practitioners collaborate with Bayesian statisticians!
How Do We Best Spread the Faith?

- Mathematicians: teach practitioners mathematical statistics, so they can derive posterior distributions!
- Programmers: teach practitioners R, Python, Stan, and/or how to design their own MCMC routines!
- Bayesian statisticians: have practitioners collaborate with Bayesian statisticians!
A Fresh Way to Do Statistics

Download

More information at jasp-stats.org
A Fresh Way to Do Statistics

Download

0.8.3.1
NEW RELEASE
Hierarchical regression, logistic regression, & more

More information at jasp-stats.org
Encouragement

- Let me know if you have suggestions for improvement, or if you would like to contribute in some way.
- Follow JASP on twitter/Facebook and read our weekly blog posts to be up to speed with the latest developments.
A Fresh Way to Learn Bayesian Statistics

August ?? & ??, 2019
University of Amsterdam
Ninth Annual JAGS and WinBUGS Workshop
Bayesian Modeling for Cognitive Science
http://bayescourse.socsci.uva.nl/

August ??-??, 2019
University of Amsterdam
Three JASP Demos

- Adam Sandler (correlation)
- Rating Cartoons (t-test)
- World Happiness (linear regression)
JASP
A Fresh Way to Do Statistics

Download

More information at jasp-stats.org