



September 23,
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Parameter Uncertainty in Weather and Climate Forecasts

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**Presentation given at the
European Meteorological
Society Conference in Reading**

Parameter Estimation in Mathematical models

- Old style: fixed, best-estimate parameters
- New style: distributions around parameters
 - Allows the propagation of parameter uncertainty into predictions

Objective Bayesian Statistics

Models



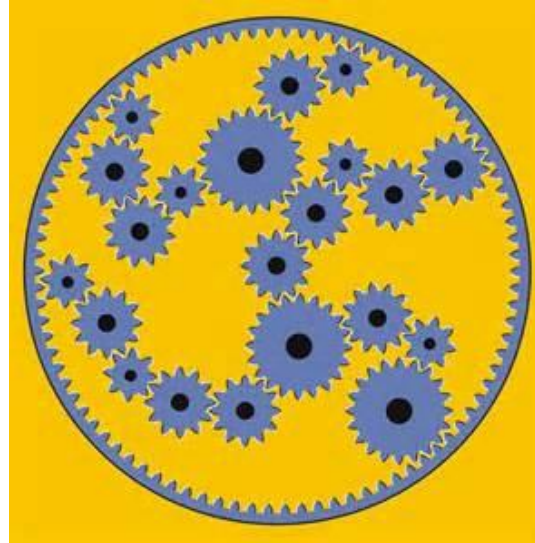
Data



Independent

Objective

Prior Information



Probabilistic
Prediction
inc. param. unc.

Objective Bayesian Statistics

Models



Data

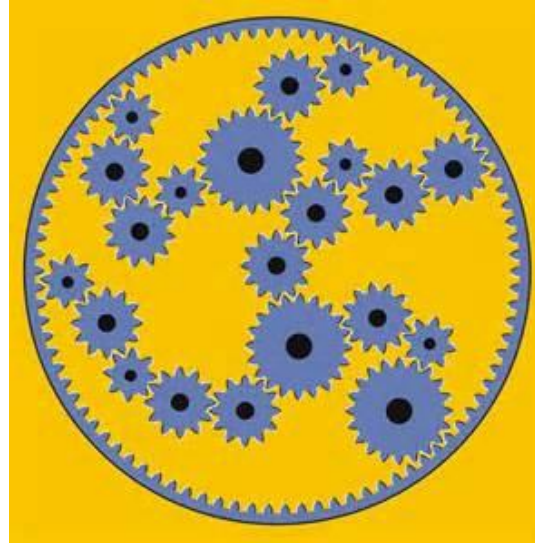


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- Incorporates the idea of 'reliability' i.e. that if you predict something with a probability of 10% then it would occur 10% of the time in repeated experiments

Objective Bayesian Statistics

Models



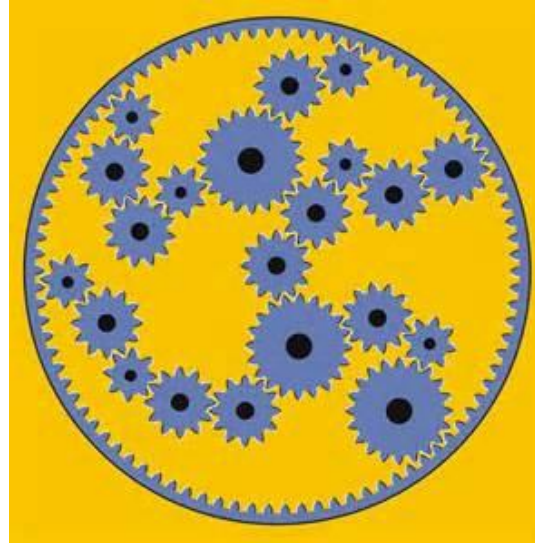
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- Transparent
- Evidence-based
- Testable
- Science as we know it

Objective Bayesian Statistics

Models



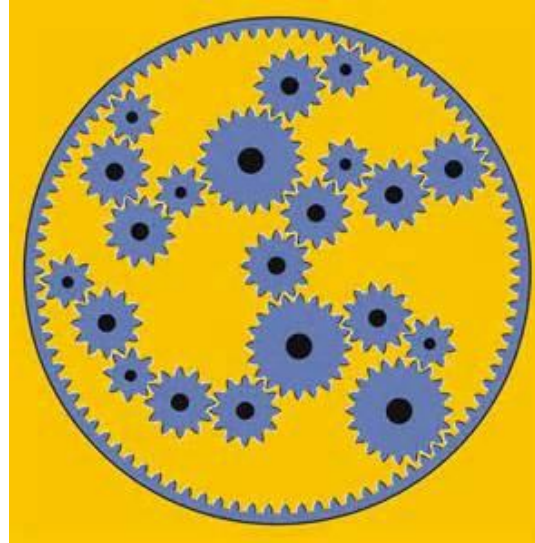
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- Not entirely trivial for all types of mathematical model
 - And hence some statisticians don't like it
- But for climate models, actually pretty easy
 - no major challenges

~~Objective~~ Subjective Bayesian Statistics

Models



Data



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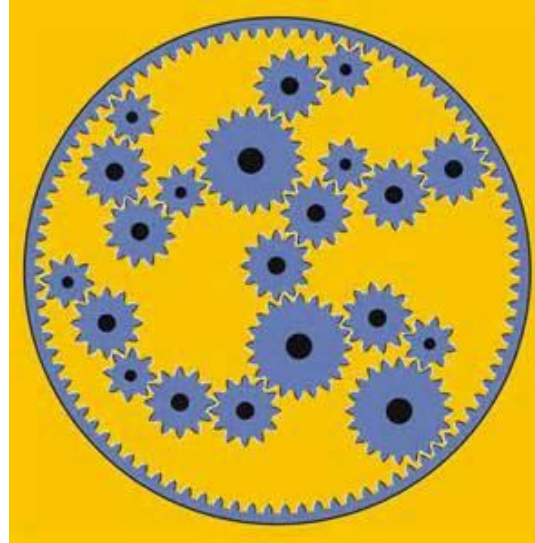
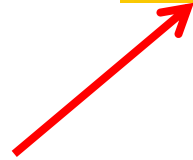
Objective

Prior Information



Subjective prior
information

(you know more or
better...hunches,
feelings, belief)



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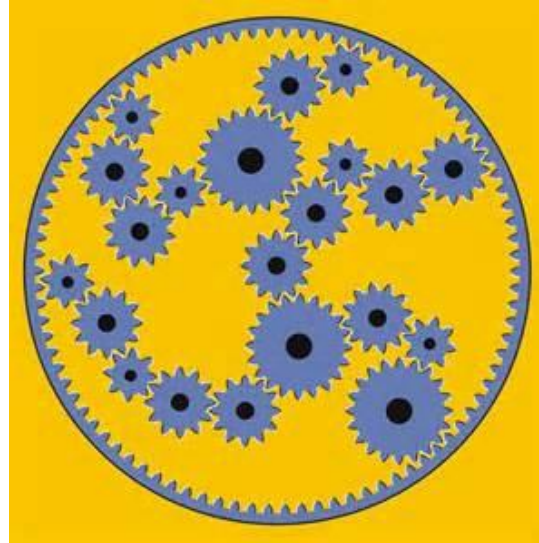
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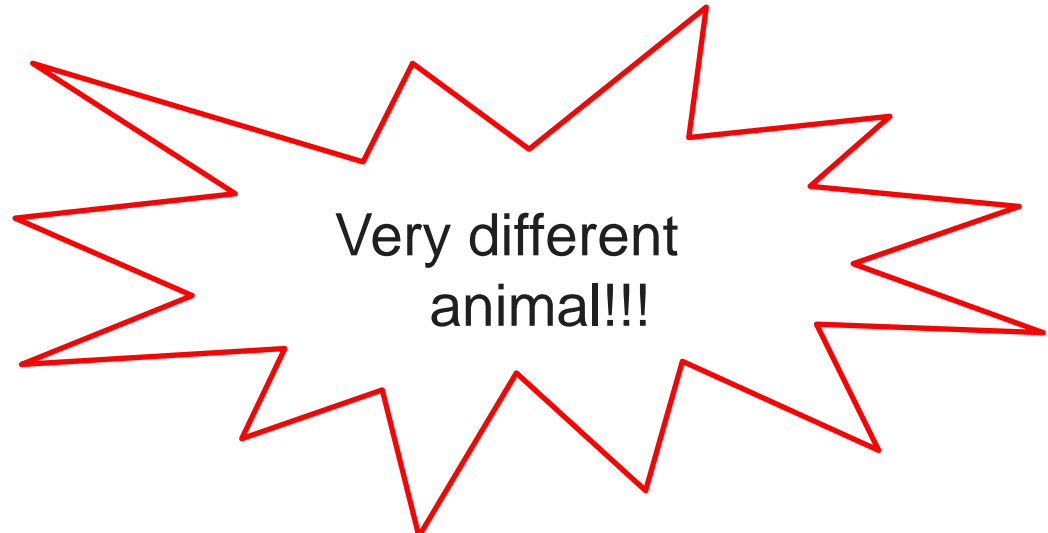
Prior Information



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Very different
animal!!!

~~Objective~~ Subjective Bayesian Statistics

Models



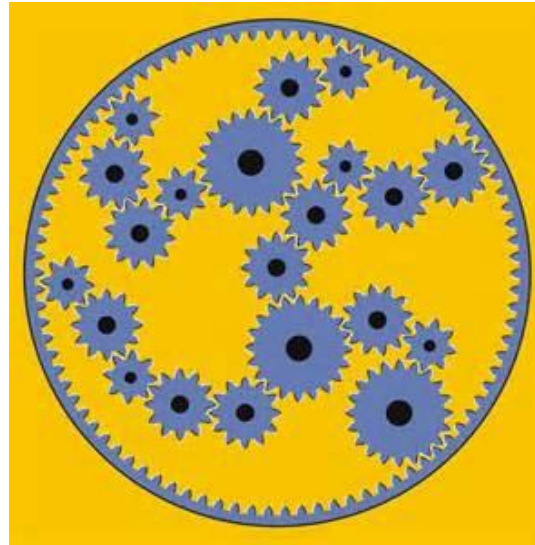
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- ~~Transparent~~
- ~~Evidence-based~~
- ~~Testable~~
- ~~Science~~

~~Objective~~ Subjective Bayesian Statistics

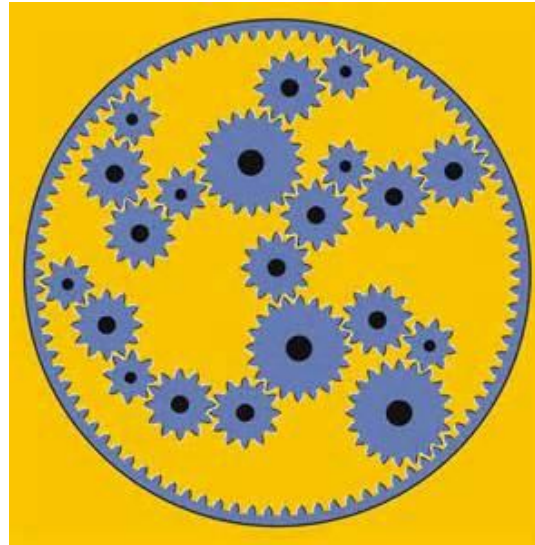
Models



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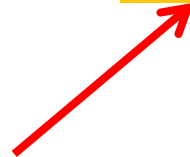
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Subjective prior
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- ~~Transparent~~
- ~~Evidence based~~
- ~~Testable~~
- ~~Science~~

- Personal Opinion
- Moral hazard
- Not 'reliable'

Examples in Climate Science

- Objective (deliberate)
 - Routinely used in weather risk and catastrophe risk modelling
 - Lewis (2013)
 - Otto et al (2013)

- Objective (accidental)
 - Gregory (2002)
 - Forster and Gregory (2006)

- Subjective
 - UKCP
 - Rougier
 - Annan and Hargreaves

UKCP

- Unashamedly uses subjective methods (see their papers)
- Includes subjective beliefs that go beyond the models and the data

- Nic Lewis has analysed the impact of these additional subjective factors:
 - And it seems that they push the rate of climate change higher than that suggested by the evidence
 - If true, then UKCP predictions of future temperatures would be higher than their own models and data would suggest
 - And should not be expected to be ‘reliable’

- Is UKCP output suitable for climate applications?

Don't Use Flat Priors

- Flat priors can almost never be justified in either objective or subjective priors

- Forest et al (2002)
Knutti et al (2002)
Frame et al (2005)
Forest et al (2006)
Hegerl et al (2006)
Forest et al (2008)
Sanso, Forest and Zantedeschi (2008)
Libardoni and Forest (2011)
Olson et al (2012)
Aldrin et al (2012) (list courtesy of Nic Lewis)

- None of these studies would give reliable estimates
- And they'd all give higher rates of climate change than objective approaches

My Contribution

- Practical methods for applying Objective Bayesian Methods:
 - 3 papers in 2009/2010 (search for 'Jewson' on arxiv.org)
 - Bridging the gap between what you can read in a statistics textbook about Objective Bayesian Methods, and what you need for a climate model
 - Briefly: to use objective Bayesian methods, you will need to include factors based on calculating gradients of the output of your climate model versus the parameters in the model
 - Now working on adding some bells and whistles to this basic theory

- UKMO could very easily strip out the subjectivity from UKCP, and produce a prediction based solely on the evidence, using these methods