# Is Bayesian Inversion a Model for Searching the Truth?

Wolfgang Jacoby, Mainz
jacoby@uni-mainz.de

The philosophical approach to searching the truth is akin to geophysical Baysian inversion of potential fields. Karl Popper proposed that science approaches the infinitely distant truth by challenging and falsifying existing hypotheses and theories. The kinship between the two is that "truth" is as much hidden in both fields of human endeavour.

Bayesian inversion is built on the assumption that a "true" model exists which gives observable signals which are used to determine and to optimize the model parameters. For this we must know the "sensitivities" of the observations to changes of all the adjustable model parameters (i.e. the Jacobian). In geophysical potential fields as gravity and magnetics, inversion is infinitely ambiguous. An infinite set of mass models exist which generate the same external field; in other words, an infinite set of "difference models" generate no external field, the set is called the "null space". On the other hand, there is an even larger model set which generates different fields. Any of such models can be excluded by gravity inversion.

A reduction of the null space is possible by invoking a priori knowledge. It is an indispensable precondition for any meaningful inversion to be obtained. The Bayesian approach is to regard the a priori information as having the same categorical status as the observations to be "explained" or "fitted". Both are treated in the same way. A priori model parameters are "optimized" within their error limits, as the model effects are fitted to the observations within their error limits. Solutions are as reliable, as the errors or uncertainties allow. It is therefore essential to estimate the errors and model uncertainties as "carefully" as possible.

A few examples are presented to make the point.

So, I think that philosophy is an inversion procedure.

Philosophically, we attempt to understand complex and multiple observations and confront our pre-existing ideas, hypotheses, theories with them. We are in the same situation as the geophysicist. We build a models and "calculate" or predict their effects or consequences which can be checked by observations. From Bayesian inversion we can learn that we must be most concerned about the uncertainties of any of the complex model features and predictions. We must also be fully aware of the fact that agreement between prediction and observations is only a necessary condition, not a sufficient one. As in gravity, probably an infinite set of hypotheses exist that may predict the same or similar observations or experiences. As in gravity, this problem may be minimized with a maximum of additional information. For philosophy it suggests that complex "interdisciplinary" sets of ideas, models and observations must be combined. But do we generally know the uncertainties of our data, hypotheses, ideas? And can we claim to approach the truth in any quantifiable way? Do we know the sensitivities of our theory parameters to observable phenomena?