On the Use of the `ubcdiss` Template

by

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Abstract

This document provides brief instructions for using the `ubcdiss` class to write a University of British Columbias (UBCS)-conformant dissertation in LaTeX. This document is itself written using the `ubcdiss` class and is intended to serve as an example of writing a dissertation in LaTeX. This document has embedded Unique Resource Locators (URLS) and is intended to be viewed using a computer-based Portable Document Format (PDF) reader.

Note: Abstracts should generally try to avoid using acronyms.

Note: at UBC, both the Graduate and Postdoctoral Studies (GPS) Ph.D. defence programme and the Library's online submission system restricts abstracts to 350 words.

Preface

At UBC, a preface may be required. Be sure to check the GPS guidelines as they may have specific content to be included.

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Glossary

This glossary uses the handy `acroynym` package to automatically maintain the glossary. It uses the package's `printonlyused` option to include only those acronyms explicitly referenced in the LaTeX source.

GPS Graduate and Postdoctoral Studies

PDF Portable Document Format

URL Unique Resource Locator, used to describe a means for obtaining some resource on the world wide web

MOF Model Objective Function

Acknowledgments

Thank those people who helped you.

Don’t forget your parents or loved ones.

You may wish to acknowledge your funding sources.

Chapter 1

Introduction

If I have seen farther it is by standing on the shoulders of Giants.
— Sir Isaac Newton (1855)

In all cases these are first guesses at what needs to be in each section more or less detail need to be added.

1.1 What problems

Geophysical inversions, specifically potential fields include formulation of non-regularized inverse problem

1.2 Difficulties with said problems

The standard way to fit a set of parameters to a set of data (especially when they are related by a linear operator) is least squares optimization. This is rendered problematic since, in general, geo-physical inversions are ill-conditioned (define) and undetermined (define) ([1] other sources I'm sure). In specific potential fields are particularly under-determined due to the lack of any depth information in the data.

show some form of problems with forward operator matrix in PF inversion

1.3 Solutions to said difficulties

To mitigate the difficulties presented above an extra term is added to the optimization.

$$\phi = \phi_d + \beta \phi_m \tag{1.1}$$

where ϕ_m is called the Model Objective Function (MOF) or model norm. This ϕ_m can be defined in many ways, following [1]

$$\begin{aligned}
\phi_m(m) &= \alpha_s \int (m - m_{ref})^2 dx + \alpha_x \int \left(\frac{d}{dx}(m - m_{ref}) \right)^2 dx && (1.2)\\
&= \alpha_s \|\mathbf{W}_s(m - m_{ref})\|_2^2 + \alpha_x \|\mathbf{W}_x(m - m_{ref})\|_2^2 && (1.3)
\end{aligned}$$

in higher dimensions more smoothness terms can be added. The $\mathbf{W}$ terms contain both the operator (identity for $\mathbf{W}_s$ and derivative for $\mathbf{W}_x$ and other dimensions) and the relative weight each cell or face contributes to the MOF. This gives us several levers to add a-priori information into the inversion.

The MOF allows us to mathematically solve the problem by adding a priori information into the inversion. Namely we assume that the recovered model should be small and smooth. There are times when this is desired but often we have more specific information about the true model that needs to be inserted into the inversion. Luckily the various terms in the MOF allow us to add a significant amount of information is various ways to the inversion.

1.3.1 α coefficients

broad strokes weights the relative importance of the smallness and smoothness in the various directions. can also be thought of as length scales

1.3.2 Reference Models

we don't always want a model to be close to zero. Sometimes it should be close to another constant sometimes we have guesses of the property in some places and want the inversion result to be close to that value

1.3.3 Weighting matrices

much more precise. Can put interfaces in precise locations. Can also force a model towards the reference model where we are more sure

along with the terms in the MOF other parts of the optimization algorithm (may need more info in the optimization) can be used to add information into the inversion

1.3.4 Initial Model

In the optimization we assume that the initial guesse is near enough to the truth that the problem is locally convex. The initial model is important in that way. In an under determined system it also provides a way to push the invesion towards a given result. Often the initial model is simply the reference model, or the reference model shifted slightly to keep it within the bounds

1.3.5 Bounds

we can also set values that each cell of the final model must lie between. This allows for a hard setting of confidence intervals in the physical properties

1.3.6 L_pL_q weights

Finally we can generalize the MOF somewhat. In Equation 1.3 we used L_2 norms as this is a natural norm that promotes a smoothly varying model that is close to the reference model. We do not always want such a model and can change the norm used in the MOF. Lower norms promote more sparsity in whatever measure they are being applied to. This leads to models being more compact (should lowever norms be applied to the smallness term) or more blocky with greater discontinuities (should lower norms be applied to one or more smoothness terms). Non L_2 norms can be applied across the whole MOF or can be applied variably across the model. This allows for placing discontinuities in a given direction but not perfectly placing the location allowing the inversion algorithm more freedom to chose the location itself.

1.4 Forms of A Priori Information

1.4.1 Data

Chapter 2

Case Study #1 El Poma South

In all cases these are first guesses at what needs to be in each section more or less detail need to be added.

2.1 General Overview of El Poma

Two anomalies. North and South. This section discusses the southern anomaly. The next discusses the north.

Magnetic Anomaly. Clear remanent magnetization

2.2 Overview of Deposits

2.3 Discussion of the Geophysical Data Given

Magnetics. Missing a corner.

2.4 What Information is Available

Bore Hole -susceptibilities, much lower than the recovered model sue to remanent effects being present

Plan View Geological map -with susceptibility surface samples marked, in addition to surface samples and geological units, we also have a system of thrust faults over top of both anomalies.

Surface Samples -susceptibility, same as marked on map but includes many samples from outside map area as well -also have nine remanences measured with direction and K_n

2.5 Synthetic Model

TODO: Create Model show model discuss its creation - magnetization direction

show its fit to the field data

2.6 Blind Inversion of the Synthetic Model

Show results. Discuss how magnetization direction puts anomaly away from actual location

2.7 Determination of Magnetization Dirrection

Correlation of Vertical and Total Gradients of Half RTP field [**?**]

taking core direction from MVI result

apply recovered direction to the anomaly direction in MAG3D could apply anomalous dirrection locally to anomaly

2.8 Creation of Constraints

2.8.1 α coefficients

For El Españole (north south fault) we can lower the α_x to allow for greater discontinuity in general in that direction. Cannot account for other faults without rotation objective function.

(show result)

2.8.2 Reference Models

Most work to be done here.

Borehole: provides susceptibilities need to convert into effective susceptibilities. Assuming uniform magnetization direction this is not complicated. Choose a

K_n and multiply susceptibility by that (maybe with +1). For MVI I need to apply the dirrection of magnetization as well. Either from the truth of the synth model from direction of the nearest remanent sample or from the bulk rem mag direction.

Map: geological units have susceptibilities attached. Have to convert into effective susceptibilities.

Surface Samples: used to make susc values for geological unit s

2.8.3 Weighting matrices

much more precise. Can put interfaces in precise locations. Can also force a model towards the reference model where we are more sure

along with the terms in the MOF other parts of the optimization algorithm (may need more info in the optimization) can be used to add information into the inversion

2.8.4 Bounds

we can also set values that each cell of the final model must lie between. This allows for a hard setting of confidence intervals in the physical properties

2.8.5 L_pL_q weights

Bibliography

[1] D. W. Oldenburg and Y. Li. Inversion for applied geophysics: A tutorial. *Investigations in geophysics*, 13:89–150, 2005. → pages 1, 2

Appendix A

Supporting Materials

This would be any supporting material not central to the dissertation. For example:

- additional details of methodology and/or data;
- diagrams of specialized equipment developed.;
- copies of questionnaires and survey instruments.