Bayesian (Generalized) Linear Models

Outline

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0. Abstract
1. Introduction
    - Motivation of bayesian GLMs: uncertainty quantification, regularization, incorporation of domain knowledge, small data sets
    - Current research and related work
    - Structure of the paper
2. Bayesian Linear Regression

    2.1 Model definition

    - Regular linear model
    - Bayesian linear model

    2.2 Prior choice

    - Uninformative priors (for β and σ^2 or just for σ^2)
    - Prior distributions for regularization
        - Motivation of regularization
        - Ridge regularization $\iff$ Gaussian prior
        - Focus: Lasso regularization $\iff$ Laplace prior (and other methodes for real variable selection)
    - Other prior distributions and use-cases (i.e. heavy-tailed priors) (?)

    2.3 Bayesian inference with closed form priors

    - Posterior and marginal (parameter) distribution
    - Posterior predictive distribution

    2.5 Model evaluation (?)
3. Bayesian Generalised Linear Regression

    3.1 Extending linear regression *(alternative: last subchapter after logistic regression)*

    - Bayesian GLMs for any exponential family distribution

    3.2 (Binary) Logistic regression

    - Model definition
    - Parameter priors

    3.3. Inference methods

    - Laplace approximation
    - MCMC and Hamilton Monte Carlo

    3.4 Predictive posterior

    - Predictive posterior estimation
    - Model checking (?)

4. Simulation Study

   4.1. Linear Regression (= Regression): prior choice for bayesian linear regression with (Lasso) regularization

   4.2. Logistic Regression (= Classification)

5. Discussion

   - When would the use of Bayesian regression be preferred over regular regression?
   - Alternatives for more complex problems: Hierarchical GLMs and GLMMs
   - Are there Bayesian GAMs?

6. Conclusion and Outlook