School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 03/31/2023

TO: Faculty and Students

FROM: Professor(s) Rosemary Renaut
Chair/Co-Chairs of Michael Byrne
Defense for the PhD in Applied Mathematics
Committee Members
Douglas Cochran
Malena Espanol
Rodrigo Platte
Zdzislaw Jackiewicz

DEFENSE ANNOUNCEMENT

Candidate: Michael Byrne

Defense Date: Friday, April 14, 2023

Defense Time: 10:15 AM

Virtual Meeting Link: https://asu.zoom.us/j/82042470274

Title: Learning-based estimation of parameters for spectral windowed regularization using multiple data sets

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40 minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. But, guests are primarily invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
-See next page-

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ABSTRACT

During the inversion of discrete linear systems, noise in data can be amplified and result in meaningless solutions. To combat this effect, characteristics of solutions that are considered desirable are mathematically implemented during inversion. This is a process called regularization. The influence of the provided prior information is controlled by the introduction of non-negative regularization parameter(s). Many methods are available for both the selection of appropriate regularization parameters and the inversion of the discrete linear system. Generally, for a single problem there is just one regularization parameter. Here, we consider a learning approach to identify a single regularization parameter based on the use of multiple data sets described by a linear system with a common model matrix. Further, we consider the situation with multiple regularization parameters that weight different spectral components of the solution. To obtain these multiple parameters we need to modify standard methods for identifying the optimal regularization parameters. Modifications of the unbiased predictive risk estimation, generalized cross validation, and the discrepancy principle are derived for finding spectral windowing regularization parameters. These estimators are extended for finding the regularization parameters when multiple data sets with common system matrices are available. Statistical analysis of these estimators is conducted for real and complex transformations of data. It is demonstrated that spectral windowing regularization parameters can be learned from these new estimators applied for multiple data and with multiple windows. Numerical experiments evaluating these new methods demonstrate that these modified methods, which do not require the use of true data for learning regularization parameters, are effective and efficient, and perform comparably to a supervised learning method based on estimating the parameters using true data. The theoretical developments are validated for one and two dimensional image deblurring. We verify that the obtained estimates

of spectral windowing regularization parameters can be used effectively on validation data sets that are separate from the training data, and do not require known data.