Geostatistical Techniques for

Practical Wireless Network Coverage Mapping

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Prof. Douglas Sicker

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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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Geostatistical Techniques for

Practical Wireless Network Coverage Mapping

Thesis directed by Prof. Douglas Sicker

The problem of mapping the extent of “usable” coverage of an existing wireless network is important in a large number of applications, including communicating the abilities of the network to users, identifying coverage gaps and planning expansion, discovering opportunities for spectrum reuse, and determining possible sources of interference with other networks. This thesis addresses fundamental but unsolved problems of measurement-based wireless coverage mapping: where should measurements be made, how many are necessary, and what can be said about the coverage at points that have not been measured. To address these problems, this thesis advocates a geostatistical approach using optimized spatial sampling and ordinary Kriging. A complete system for coverage mapping is developed that systematically adresses measurement, sampling, spatial modeling, interpolation, and visualization. This geostatistical method is able to produce more accurate and robust coverage maps than the current state of the art methods, and is able to discover coverage holes as effectively as dedicated heuristic methods using a small number of measurements. Several important practical extensions are investigated: applying these methods to drive-test measurements which have been resampled to alleviate effects from sampling bias, and crowd-sourced coverage mapping applications where volunteer-collected measurements may be sparse or infrequent. The resulting maps can then be refined iteratively, and updated systematically over time using an optimized iterative sampling scheme. An extensive validation is performed using measurements of production WiFi, WiMax, GSM, and LTE networks in representative urban and suburban outdoor environments.

Dedication

To my grandmother, Lila May Hiatt (Richards)

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