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Summary Report of Computer Science Graduate Seminar Presentations

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*Abstract*—This report summarizes three presentations of the Computer Science Graduate Seminars series. The topics covered include material perception modeling, oblivious computation and probabilistic soft logic.

*Index Terms*—material perception modeling, oblivious computation, translucency, phase functions, multi-dimensional scaling

# INTRODUCTION

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HIS report summarizes three presentations delivered as part of the Graduate Seminar series in fall 2013. The presentations concern material perception modeling (Dr. Bei Xiao, American University), oblivious computation (Dr. Elaine Shi, University of Maryland) and probabilistic soft logic (Dr. Bert Huang, Virginia Tech) and were delivered on 10/31, 10/17 and 10/3 respectively.

# Material perception modeling

Dr. Bei Xiao’s work addresses the characterization of human perception of physical materials. Human perceptual representation of physical properties such as the relative size, hue, saturation, brightness, lucidity, malleability etc. of an object is quite limited compared to that of models developed in computer graphics. An understanding of this representation should help in graphical simulation of novel materials by reducing their computational complexity and retaining their explanatory power in predicting contextual effects.

Material perception is critical to inferring a plan of action. Any action such as picking up a piece of cloth is preceded by inferences about its relative size, weight and texture. These inferences directly affect how we perceive and execute this action. These inferences are enabled by a non-trivial combination of senses.

One of the problems in this area is understanding translucence in physical objects, brought about by sub-surface scattering of incident light. The incident light undergoes a number of refractions inside the material in question. The process is understood in terms of the overall density and absorption coefficient for the material and the phase function describing the spread of scattered light. Human establish a lower-dimensional perceptual embedding of the phase function space which is established using perceptual similarity experiments.

Another related application is the estimation of fabric properties from videos. Human estimation of mechanical properties of fabrics (mass, bending stiffness etc.) is surveyed on to understand the perceptual dimensions of parameters that describe behavior of moving fabrics in virtual scenes. The conceptual foundations of this research methodology are in the theory of affordances which emphasizes the functionality of a physical object as critical for its identification.

# Oblivious Computation

Computation on an Oblivious RAM is provably protected, that is, its execution behavior is provably obfuscated. The research following the original proposition of the cryptographic primitive by Goldreich and Ostrovsky [1] concerns itself, among other things, with the practicality of ORAM and the tightness of the logarithmic bound (log(n)) on number of steps needed to mask a memory block – the Goldreich-Orstrovky bound.

Dr. Elaine Shi’s work addresses a new tree based paradigm for construction of ORAMs, the primary objective being to prevent statistical inference attacks on execution of a certain program. Existing constructions are computationally expensive and require complete memory reshuffling after a specified period for meeting mentioned criterion. The tree-based method organizes memory as a tree of packets with a position map containing the position of each packet. Eviction is defined as percolating blocks up towards leaf nodes subject to invariant. Randomized dummy evictions for each memory operation are employed to prevent information leakage and render the execution oblivious.

ObliVM, a programming framework for oblivious computation, is also introduced in the presentation. It is a user-friendly set of programming abstractions that compile programs into concise circuits – the operational model behind ideas such as secure computation and program obfuscation [2].

# Probabilistic Soft Logic

# Probabilistic soft logic (PSL) is a logic-based language for probabilistic modeling of complex phenomena. PSL allows for hinge losses and linear constraints. Hinge loss Markov Random Fields (HL-MRFs) are extremely scalable models because they are log concave densities that can be solved using consensus optimization via ADMM [3]. The presentation also invoked structured perceptron learning such that the highest scoring candidate should score at most the true label with respect to some loss function; inference is simply finding such a candidate; large margin learning was also invoked as a viable learning method.

# PSL generalizes various principles for continuous logical relaxation and on the cost-complexity axis stands to fight cost more than complexity.

# Questions and Discussion

**Question**: What is the relationship of aesthetic judgment to the theory of affordances in the context of material perception?

**Discussion**: Aesthetic judgment is a complex inference that has been tested in perception studies to some extent with survey questions asking respondents to rank how ‘pleasant’ a particular material is. Theory of affordances does not necessarily account for aesthetic judgment as it does not extend beyond the sheer functionality of an object for its definition.

**Question**: How do random evictions enable secure computation?

**Discussion**: Random evictions perform a percolation of random memory blocks for each memory block read or written so as to obfuscate the memory access patterns of a particular program and hence enable secure computation.

References

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