



## SIGMM Education Column

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By Wei Tsang Ooi

Welcome to the first SIGMM Education Column. The SIGMM Education Column is a new regular column in the SIGMM Record, featuring multimedia-related education activities among the SIGMM communities.

In this first column, we want to highlight the course CS5240 offered at the National University of Singapore, entitled "Theoretical Foundations in Multimedia," designed and taught by Assistant Professor Terence Sim.

The course is aimed at first year Ph.D. students in the Department of Computer Science, preparing them for research in multimedia. As its title suggests, the course covers many fundamental mathematical techniques commonly used to analyze and solve multimedia research problems.

The course was proposed for two reasons. First, fresh Ph.D. students come from a variety of disciplines from various undergraduate institutions, with most lacking the basic concepts required for multimedia research. For example, students with traditional CS training typically have not learned the Fast Fourier Transform (FFT). On the other hand, those hailing from an engineering background would know the FFT, but are weak in algorithmic analysis. Students therefore need to "level up" to a common body of knowledge suitable for multimedia work. Second, prior to the introduction of this course, many of these fundamental concepts used to be taught in several advanced multimedia courses, in order to address the knowledge gap of new graduate students. This not only duplicated effort, but also took away precious semester time from teaching advanced topics. The need for such a "foundational" course was thus clear.

To meet its goals, CS5240 was carefully designed to cover a selected list of fundamental concepts that are important for multimedia research. Faculty members teaching multimedia courses were consulted to identify a common core to go into CS5240. This initial list was still deemed too ambitious for a one-semester workload, and was further pruned to its current syllabus (see below), covering the main topics of Linear Algebra, Signal Processing, and Statistical Estimation.

Every week, a three-hour lecture covers one concept in depth, after which students read and discuss one or two research papers that apply the said concept to solve a real research problem, ranging from computer vision, image rendering, music retrieval and text classification. Unfortunately, no single textbook covers the whole range of topics in the course, so lecture notes and research papers form the main teaching material. Homework exercises further reinforce the theoretical concepts covered in class, and occasionally include computational assignments (e.g., face recognition using eigenfaces).

The topics covered in the course include the Singular Value Decomposition, Matrix Derivatives, the Discrete and Discrete Time Fourier Transforms, Wavelets, Maximum Likelihood Estimation, Expectation Maximization, and Robust Methods. The syllabus of the most recent version (Fall 2010) of the course can be found at the <http://www.comp.nus.edu.sg/~cs5240> [<http://www.comp.nus.edu.sg/~cs5240>].

The course has been popular since its inception, and is playing an important role in the multimedia research program in the Department of Computer Science, ensuring that all Ph.D. students with intention of pursuing a research in multimedia receive a solid theoretical background in the field. While designed for Ph.D. students in the Department of Computer Science, the course has also attracted students from the Master of Computing program and students from other departments, such as Electrical and Computer Engineering. Students generally find the course tough: the rigor is not what they are used to. But regardless of what grade they eventually get, student invariably feedback, in their later years, how immensely useful the course has been in their research, or in bootstrapping their learning of more advanced topics. In this regard, CS5240 has fulfilled its objectives.

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