For the forthcoming BoS meeting, Raul (cc'ed) and myself would like to request the following updates to be made to the DPT for the course "Randomized Algorithms", which should run in the *** FALL SEMESTER *** (Semester 1) of 2022,for the 2022/2023 year. (Note that this is a change because it is currently scheduled to run in Semester 2. Sharon has already said it is fine to change it to Semester 1.)
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New DPT content for "Randomized Algorithms" (INFR11201):

Summary
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This course is about randomness as a resource in algorithms and computation. The course introduces basic mathematical models and techniques and applies them to the design and analysis of various randomized algorithms. We will also cover a variety of applications of probabilistic ideas and randomization in several areas of computer science.

Course description
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1) Introduction, review of discrete probability,
and elementary examples including randomized algorithms for checking identities, matrix multiplication verification, minimum cut in graphs.
2) Discrete Random Variables, Moments, Deviations and Tail Inequalities; applications, including the coupon collector problem.
3) Chernoff bounds and applications: random sampling and estimation of discrete distributions. The birthday paradox and applications.
4) The Probabilistic Method: random graphs and threshold phenomena. Max-cut approximation. Lovasz Local Lemma and application to boolean satisfiability.
5) Random Walks and Markov Chains: hitting and cover times; stationary distributions, random walks on undirected graphs.
6) The Monte Carlo Method; applications including sampling and approximate counting, the markov chain monte carlo method, the Metropolis algorithm.
7)Coupling of Markov Chains, mixing time, and applications, including card shuffling and sampling of graph colourings and independent sets.

Pre-requisites
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It is RECOMMENDED that students have passed “Algorithms and Data Structures” (INFR10052).

Other requirements
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This course is open to all Informatics students including those on joint degrees.
For external students where this course is not listed in your DPT, please seek permission from the course organizer.

This is a theoretical and mathematically oriented course.

Some mathematical maturity is required, and concretely some basic background in:
- Linear Algebra
- Discrete Mathematics
- Probability

at least at the same level as the required prehonours undergraduate courses for Informatics students in these topics (INFR08031, MATH08057).

Secondly, some background in algorithms is required, roughly at the level of Informatics 2- Introduction to Algorithms and Data Structures (INFR08026), and preferably at the level of the 3rd year course, Algorithms and Data Structures (INFR10052). Some exposure to computational complexity theory (NP - completeness, etc.) would be desirable but is not required.

Learning Outcomes
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On completion of this course, the student will be able to:

Understand and apply fundamental tools in discrete probability (e.g. expectation, concentration inequalities, the probabilistic method, random walks) toward the design and analysis of randomized algorithms.

Understand randomized algorithms for selected combinatorial and graph problems.

Be able to analyze expected running time and error probabilities of randomized algorithms.

Understand the fundamentals of Markov chains and their algorithmic applications.
Apply Monte Carlo methods such as MCMC to some discrete algorithmic problems.

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