# CSC2423 FINITE MODEL THEORY AND DESCRIPTIVE COMPLEXITY

Fall 2003

http://www.cs.toronto.edu/~libkin/csc2423/f03

**General**:
Class meets on Wednesdays
BA 2135, 3–6pm

**Instructor**:
Leonid Libkin
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Office hours: PT398a, Wed 2–3pm or by appointment

**Prerequisites**:
being familiar with the basic notions of first-order propositional and predicate logic (if you took an undergrad logic course, you should probably be fine);

basic knowledge of complexity theory (classes P, NP, PSPACE, LOGSPACE);

basic knowledge of language theory (regular languages, automata)

**Topics**

Examples from database theory, language theory, complexity

First-order logic (FO), expressiveness, failure of classical techniques in the finite

Ehrenfeucht-Fraïssé games, winning strategies, locality

Ordered vs unordered settings, Gurevich's and Grohe-Schwentick theorems

Complexity of FO

Extensions of FP: adding counting, locality; Adding second-order quantification, monadic second-order (MSO), connection with regular languages and automata

Coding Turing machines: Trakhtenbrot's theorem (failure of completeness in the finite), and Fagin's theorem (logical chcracterization of NP)

Fixed point logics, Immerman-Vardi theorem (capturing PTIME); other complexity classes (logspace, pspace)

Finite variable logic, pebble games

0-1 law for FO and finite variable logic, the random graph; randomness phenomena over finite structures

Finite structures embedded into infinite ones; connection with constraint databases; new techniques for expressive power

New directions, connections with formal methods and constraint satisfaction

**Text**

L. Libkin, *Elements of Finite Model Theory*, 1st draft.

**Requirements**

Assignment 1 (50%)
Assignment 2 (50%)

Each assignment consists of three sections: exercises, problems, and challenges. The first two are compulsory.

Collaboration & sit-in policy:

| section | collaboration | sit-in |
|---|---|---|
| exercises | not allowed | do not submit |
| problems | allowed but not encouraged | feel free to submit |
| challenges | encouraged | please do submit |

**Late Assignments** No late submission for exercises. The grading standards will be different for problems submitted late. No deadline for challenges.