

Circuit Lower Bounds Syllabus

List of topics:

1. Bounded depth circuits:
 - (a) Håstad's Switching Lemma (The survey of Beame [Beame]).
 - (b) Razborov-Smolenski bounds for MOD_p in $ACC^0[q]$ circuits. (Lecture notes online, for example [Aro] . See also the survey [Viola, Sec 2.1])
 - (c) The average sensitivity of bounded-depth circuits ([LMN]/[Boppana]).
 - (d) Poly-logarithmic independence fools AC^0 circuits ([Bra]).
2. Monotone circuits:
 - (a) Lower bound for cliques (Razborov/Alon-Boppana. The paper is [AB]. See also notes [Arv] and the exposition by Gowers [Gow]).
 - (b) Karchmer-Wigderson lower bound for Connectivity. ([KW]. see also notes by [Sr])
 - (c) Counting bottlenecks to show monotone P/NP (Haken).
 - (d) Constructing a poly-size log-depth monotone circuit for Majority (Valiant. See note [Zw] or [Sin]).
3. Additional topics:
 - (a) Average-Case Complexity of Detecting Cliques (Rossman).
 - (b) Matrix rigidity (Valiant).
 - (c) Time-space trade-off lower bounds for randomized computation of decision problems (Beame, Saks, Sun, Vee).
 - (d) Improving Exhaustive Search Implies Superpolynomial Lower Bounds (Williams).
 - (e) Non-Uniform ACC Circuit Lower Bounds (Williams).

More useful sources:

1. The book of Arora and Barak [AroBa] (Chapter 14).
2. The survey of Boppana and Sipser [BS].
3. The book "Boolean Function Complexity" of Jukna [Juk].
4. The book of Alon and Spencer [AS] (Chapter 7).

Please, feel free to add to suggest more topics/sources.

References

- [AB] N. Alon and R.B. Boppana. The Monotone Circuit Complexity Of Boolean Functions.
- [AS] N. Alon and J.H. Spencer. The Probabilistic Method.
- [Aro] S. Arora. Lecture 5 from "A Theorist toolkit" course.
<http://www.cs.princeton.edu/courses/archive/fall02/cs597D/lec5.ps>
- [AroBa] S. Arora and B. Barak. Computational Complexity: A Modern Approach. <http://www.cs.princeton.edu/theory/index.php/Compbook/Draft>
- [Arv] V. Arvind. Lecture notes Computational Complexity II
<http://www.cmi.ac.in/~ramprasad/lecturenotes/raz.clique.pdf>
- [Beame] P. Beame. A Switching Lemma Primer.
- [Boppana] R.B. Boppana. The average sensitivity of bounded-depth circuits.
- [BS] R.B. Boppana and M. Sipser The Complexity of Finite Functions.
- [Bra] M. Braverman. Poly-logarithmic independence fools AC0 circuits.
- [Gow] T. Gowers. Razborov's method of approximations.
- [Juk] S. Jukna. Boolean Function Complexity.
- [KW] M. Karchmer and A. Wigderson. Monotone circuits for connectivity require superlogarithmic depth.
- [LMN] N. Linial Y. Mansour and N. Nisan. Constant-depth circuits, Fourier transform and learnability,
- [Sin] U. Sinclair. Lectures 11,12 from Randomness & Computation course
<http://www.cs.berkeley.edu/~sinclair/cs271/n6.pdf>

- [Sr] K. Sreenivasaiah Lecture 18 from Computational Complexity course
<http://www.tcs.tifr.res.in/~prahladh/teaching/2011-12/comm/>
- [Viola] E. Viola. Correlation bounds for polynomials over $\{0, 1\}$.
- [Zw] U. Zwick. Lectures 11,12 from Concrete Complexity course
www.cs.tau.ac.il/~zwick/circ-comp-new/six.ps