

15.081 Fall 2009
Recitation
for Lectures {18-19}
Ellipsoid Method

1 Separation and Feasibility

Ellipsoid method was the first polynomial time algorithm developed for LP. The Ellipsoid algorithm requires a convex set described by a separation oracle, and determines whether the set is empty.

Separation Oracle

A separation oracle associated with a convex body, when given a point as an input determines whether the point is in the convex set. If the point is not in the convex body, it provides a separating hyperplane that separates the point from the body. An oracle which only determines the inclusion or exclusion of a point from a set is called a membership oracle.

Separation Problem

The problem of determining whether a point $x \in C$ where C is called a membership problem. The separation problem also asks one to come up with a separating hyperplane.

Ellipsoid method shows that, for nice sets, if given a separation oracle, the feasibility problem can be solved in polynomial time.

And since feasibility and optimization are equivalent, this shows that, when given a separation oracle, the optimization problem is polynomial.

Hence,

$$\mathbf{Separation} \in \mathbf{P} \iff \mathbf{Optimization} \in \mathbf{P}$$

Example - Probability consistency problem

The problem can be found in the book. The book shows that the problem of determining whether a set of beliefs about some events is consistent with theory of probability is an easy problem. This is shown by showing that the problem is equivalent to the problem of finding a min-cut in an appropriate graph. The mincut problem is known to be easy and so is the original problem.

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