

## Problem Set 9

**Problem 1.**

Place  $N$  spheres with variable radii  $r_i$  on a line. When all spheres are in contact, the length of the string of spheres is  $2 \sum_{i=1}^N r_i$ . Use the simplex algorithm to show this numerically. (The problem is of course trivial — the point is to be able to formulate it as a linear programming problem.)

**Problem 2.**

Here is a hamiltonian that describes proteins:

$$H = - \sum_{k=1}^N a_k \prod_{j=1}^k \phi_j \quad (1)$$

where

$$0 \leq \phi_j \leq 1 \quad (2)$$

and  $a_k$  are  $-1$  or  $1$  with equal probability. Use *linear programming* to find the minimum energy  $E_{\min}$  for this system. How does  $E_{\min}$  scale with  $N$ ?