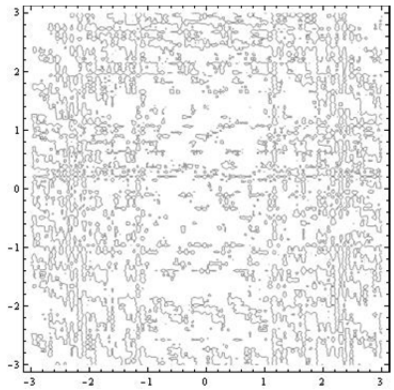
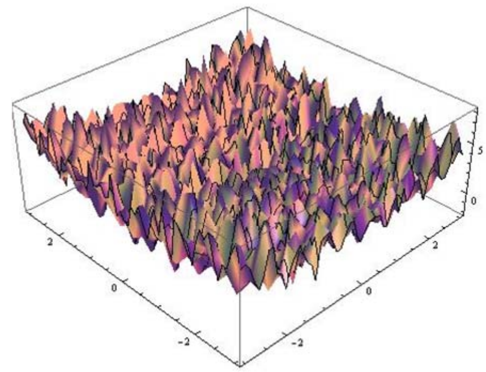
Homework: Simulated Annealing

1. Minimize the function

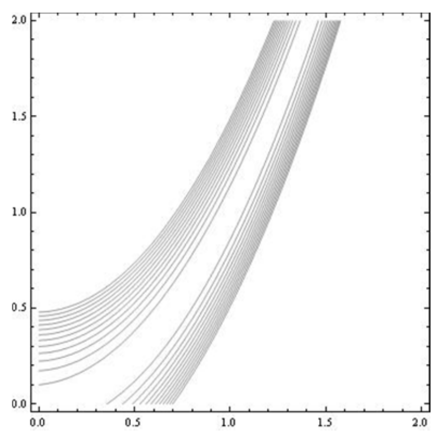
$$\exp(\sin(50x))+\sin(60e^{y})+\sin(70\sin x)+\sin(\sin(80y))-\sin(10(x+y))+1/4\left(x^2+y^2\right)$$

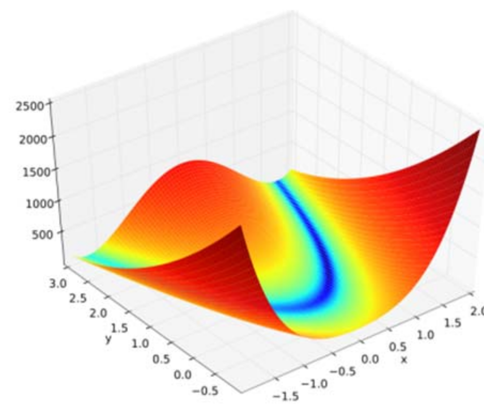
See http://en.wikipedia.org/wiki/Hundred-dollar,_Hundred-digit_Challenge_problems (Problem #4). The best known solution to this problem is −3.306868647.



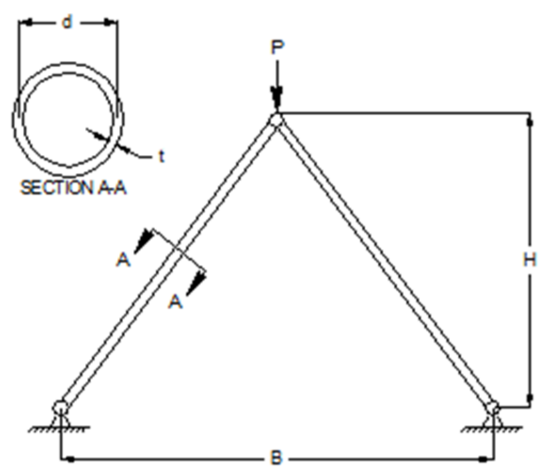


2. Minimize the Rosenbrock function $f=(x_1-1)^2+100(x_1^2-x_2)^2$ using simulated annealing, as applied to a continuous problem. Start at the point x = [-3 2]^T. Take N = 100, P_s = 0.7, P_f = 0.0001 and Δ= 0.4. Before temperature is reduced, perturb the design (both variables) 10 times. The parameter Δ is the maximum perturbation of a design.





3. We are revisiting the two-bar truss problem with simulated annealing. Recall that we are interested in designing a truss that has a minimum weight, will not yield, will not buckle, and does not deflect "excessively". We created a model that calculates weight, stress, buckling stress and deflection. The model of the truss using explicit mathematical equations is shown below:



$$Weight = \rho \cdot 2 \cdot \pi \cdot d \cdot t \sqrt{\left(\frac{B}{2}\right)^2 + H^2}$$

$$Stress = \frac{P \cdot \sqrt{\left(\frac{B}{2}\right)^2 + H^2}}{2 \cdot t \cdot \pi \cdot d \cdot H}$$

$$Deflection = \frac{P \cdot \left[\left(\frac{B}{2}\right)^2 + H^2\right]^{(3/2)}}{2 \cdot t \cdot \pi \cdot d \cdot H^2 \cdot E}$$

$$Buckling\ Stress = \frac{\pi^2 E(d^2 + t^2)}{8[\left(\frac{B}{2}\right)^2 + H^2]}$$

Optimize the values of height, diameter, and thickness to minimize the weight of the two bar truss. The deflection must remain less than 0.25 in, the stress less than 90 ksi, and the stress minus buckling stress less than zero (i.e. no buckling).

Use simulated annealing to obtain an optimal solution. Compare the optimal objective, computational time, and program complexity with that of exhaustive search and branch and bound from the prior homework.

Summary of Parameters and Variables

Variables (Design Variables)	**Lower**	**Allowable Values**	**Upper**
Diameter, d (in)	1.0	1.0, 1.5, 2.0, 2.5, 3.0	3.0
Height, H (in)	10	Continuous	50
Thickness, t (in)	0.05	0.05, 0.10, 0.15, 0.20	0.20
Parameters (Analysis Variables)		**Value**	
Width of separation at base, B (inches)		60.0	
Modulus of elasticity, E (1000 lbs/in^2)		30,000	
Density, ρ (lbs/in^3)		0.3	
Load (1000 lbs)		66	