Fri, Mar. 22, 2024

Scientific Computing

Topic 9 - Introduction to Metaheuristics

Previously: focused on algorithms guaranteed to find optimal solution (brute force, D+C, backtracking)

These can be difficult, sometimes slow, and sometimes difficult to apply

Ex: Traveling Salesman

A method called "dynamic programming" can find optimal solutions in $O(n^2 \cdot 2^n)$ time. Still too slow for real world applications

Metaheuristics:

- General problem solving paradigms that are easy to adapt to any real-world

problem
- Look for really good solutions, not nec. optimal.
- Pretty fast

Similar setup:

* Search space of candidates / solutions
* Every candidate has a score / fitness / quality
* Goal: Find a candidate with a good score [maximizing or minimizing]

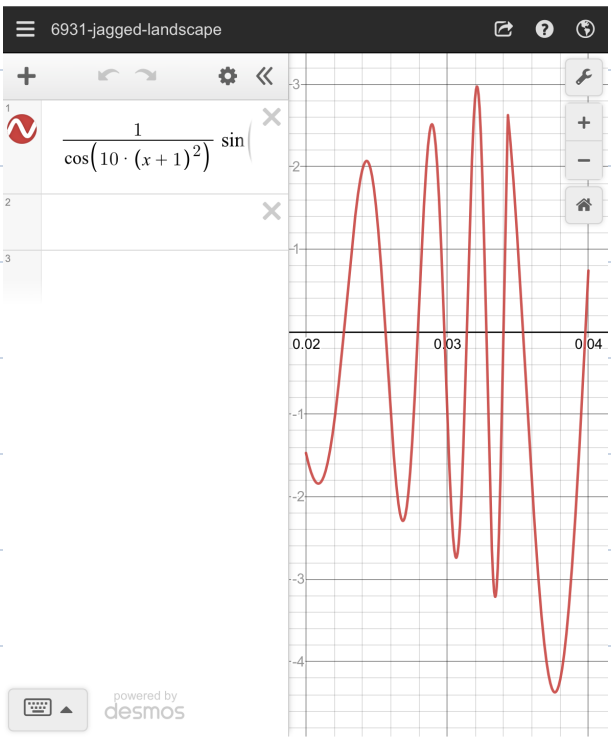
In the abtract: maximizing

Work for both discrete and continuous problems
- discrete → finite search space
- continuous → infinite search space

Ex: Find the maximum value of

$$f(x) = \frac{1}{\cos(10(x+1)^2)} \cdot \sin\left(\min\left((x+1)^{100}, \frac{1}{x}\right)\right)$$

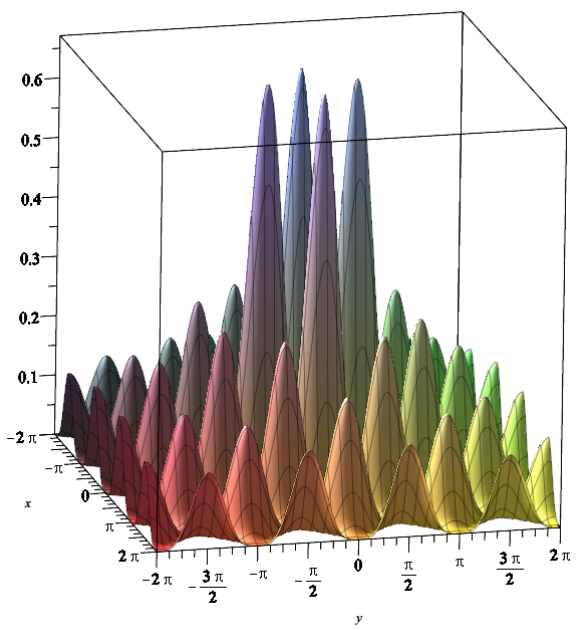
on the interval $0.02 \leq x \leq 0.04$



Probably could be done with calculus, but would be annoying.

What if the function was implicit, like a solution to an ODE?

Most of the continuous spaces will not be 1D.



$$f(x,y) = \frac{\sin^2(x-y)\sin^2(x+y)}{\sqrt{x^2+y^2}}$$

"landscape pictures"
"terrain"