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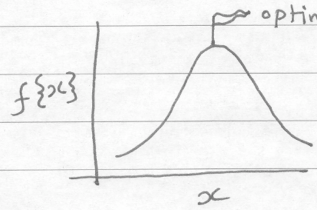
Genetic Algorithms - Lecture 1

We will be using biological terms to introduce the subject, focusing on fundamentals rather than applications.

Will use genetic algorithms for <u>optimisation</u> problems.

optimum which we need to locate.



Many optimisation techniques are gradient based. Make a guess, take derivatives, and hence find maximum when slope = 0

Genetic algorithm uses a non-calculus method instead, i.e., it is not necessary to take derivatives. Instead of just one guessed value, begin with many.

<u>Simple algorithm</u> Guessed value → several

Each guessed value is an "individual"

Set of guessed values is a "population"

$$f\{\vec{x}\} = f\{x_1, x_2, x_3 \dots\}$$

$\overbrace{100}^{x_4}\ \overbrace{100}^{x_3}\ \overbrace{100}^{x_2}\ \overbrace{110}^{x_1}$ ← individual guess

$\underbrace{110}_{x_4}\ \underbrace{101}_{x_3}\ \underbrace{111}_{x_2}\ \underbrace{001}_{x_1}$ ← another individual guess

⋮

Variables are mapped onto a binary number above

Where do we get the binary strings? To begin with at random, a random sequence of 1 and 0's.

How do the binaries represent real numbers? By linear mapping

Suppose we wish to decode 11001 $\equiv 1\times2^0 + 0\times2^1 + 0\times2^2 + 1\times2^3 + 1\times2^4$

↑ Begin here

$= \text{real number} = S_i$

However, linear mapping is different

Suppose the decoded integer value of ith string is S_i

S_i = decoded value

Suppose x_i^{upper}, maximum value of x_i, is provided by user.
Similarly x_i^{lower}, also given

Then provide another quantity l, the length of the binary string.

Once this is done, linear variable mapping is simple
If real value (say 32.1) is x_i, then

$$x_i = x_i^{lower} + \frac{x_i^{upper} - x_i^{lower}}{2^l - 1} (S_i) \quad \text{:- eqn. 1}$$

$(S_i)_{minimum} = 0\ 0\ 0\ 0\ 0$ for $l = 5$

$(S_i)_{maximum} = 1\ 1\ 1\ 1\ 1$ for $l = 5$

Equation 1 then provides a mapping between x_i and s_i

The choice of l is related to accuracy. A larger l will give greater accuracy, but too large a value increases the computing time.

In equation 1, $\dfrac{x_i^{upper} - x_i^{lower}}{2^l - 1}$ is known as "accuracy". To select l, we make this accuracy small.

In a multivariate problem, each variable is individually mapped.

So, what is genetic about all this? We talk of "individuals".

		height	Skin colour	eye colour
individual	$f(\vec{x})$	1 0 0	1 0 0	1 0 0
individual		0 1 1	1 0 0	0 0 0