AN INTRODUCTION TO GENETIC ALGORITHMS
FOR NUMERICAL OPTIMIZATION

Solutions for Exercises of Section 3

Exercise 1:

Aha, you're on your own with this one... Gotta keep on your toes...

Exercise 2:

For a start, here's s a listing of a general P1-type fitness function:

```
      real function fp1(n,x)
      implicit none
      integer n,i
      real x(n),fp1,pi,ff,sum
      parameter (pi=3.1415926536)
c----------
      sum=0.
      do i=1,n
         sum=sum+(0.5-x(i))**2
      enddo
      ff=cos(sqrt(sum)*9.*pi)
      fp1=exp(-sum/0.15)*ff**2
      return
      end
```

where the input parameter n automatically sets the dimensionality of the problem. We give it to PIKAIA in its GA2 version for $N_g = 2500$ generations, working with the default population size $N_p = 50$. The Table below summarizes global performance, based on 1000 independent runs.

Table 3.1

Global Performance on n-dimensional P1's

P1 version:	3D	4D	5D	6D	7D	8D
p_G	0.906	0.289	0.060	0.020	0.002	0.001

The following Figure is a plot of this data (solid dots), together with a power Law relationship of the form

$$p_G \propto n^{-K}, \qquad \text{[GA2]}$$

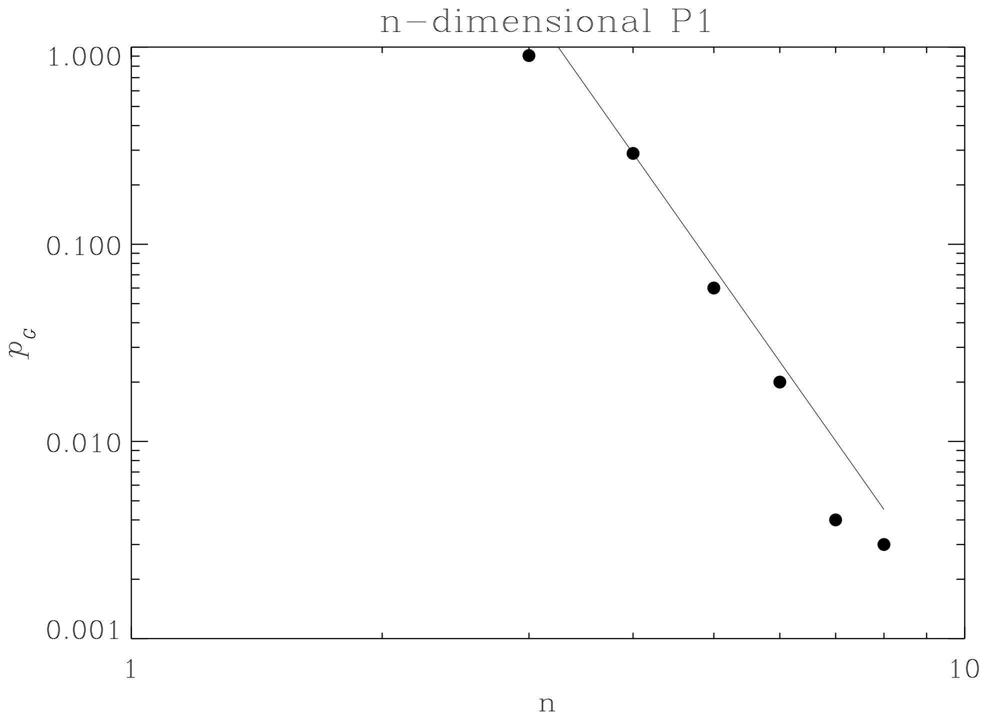

Figure 3.1: Probability of global convergence p_G vs parameter space dimension `n` for a set of P1-like test problems. In all cases p_G is estimated on the basis of 1000 independent runs. The solid line is a power law with exponent -6. The last few data (`n`= 7 and 8) only got a few succesfull global maximum detection over the 1000 trials, so that the inferred p_G is "noisy".

with exponent $K = 6$ and with the proportionality constant adjusted to pass exactly through the `n`= 4 datum (solid line). This is just an "eyeball" fit meant to illustrate that over this range of `n`, $p_G(\mathtt{n})$ is well described by a power law relationship. The significance of this comee from the fact that, following the argument laid out in §1.5 of the tutorial, the performance of Iterated Simplex can be expected to scale as

$$p_G \propto a^{-\mathtt{n}}, \qquad \text{[Iterated Simplex]}$$

where $a > 1$, the exact value being problem dependent. Comparing the P1 and P3 results in Table 1 one would infer $a \simeq 12$ (by rescaling the Iterated Simplex result for P3 to 100 trials using eq. [1.10], and with no consideration given to the number of required function evaluations, which seems to increases more or less linearly with `n` although I did not bother to check this carefully).

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