10. Diagnosing convergence

At the end of the rainbow is a pot of gold.

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When will we get there?

• Like the kid in the back seat, on the way to the beach. Never sure when the journey will be over (or at least within a short walk to the waves).

• Up front, Dad will tell you lies, just to keep you quiet. Maybe you will jump out at the next set of traffic lights.

• When the car finally stops you are at the waves. Or as close as makes little difference.
When will we get there?

• For most practical problems, we never *know* that we have arrived.

• It could be a local optimum (a river with some sand, perhaps). But surfing around the solution space can help detect that situation (ever tried surfing at the river?)

• Find a *satisficing* solution
Criteria for stopping

- Many possible criteria
- Stop when an appropriate mix of criteria have been met (see last 2 columns of checkboxes …)
- Do not take this as the only strategy available!
Criteria for stopping

1. Predicted percent converged

- Fit a non linear function

- One point for each jump in fitness + plus last generation.

- I use the red dots: $1 + 8$.

$$S_g = S_{max} \times \left(1 - e^{-k \cdot g^b}\right) + \text{error}$$

[$S_g$ is the best fitness solution at generation $g$]
Criteria for stopping
1. Predicted percent converged

\[ S_g = S_{max} \times \left(1 - e^{-k.g^b}\right) + \text{error} \]

- Find \( S_{max} \) and \( k \) that minimise:
  \[ \sum (S_g - \hat{S}_g)^2 \]

- Could use an EA! But there is an easier way.
Criteria for stopping
1. Predicted percent converged

\[ S_g = S_{max} \times \left( 1 - e^{-k \cdot g^b} \right) + \text{error} \]

\[ \hat{S}_{max} = \frac{S_g}{(1 - e^{-k \cdot g^b})} \]

- Given \( k \) and \( b \), we have \( \hat{S}_{max} \)
- So, only need to optimise \( k \) (if \( b \) is constant)
- “Exocet”
Criteria for stopping

2. No improvement over the last $p_{nc}$ percent of $n_{last}$ generations

- $150 > 1.40 \times 100$, so ...
- Current generation passes this test
Criteria for stopping

2. No improvement over the last $p_{nc}$ percent of $n_{last}$ generations

\[ p_{nc} \text{(corrected)} = p_{nc} \times \sqrt{\frac{MaxGens}{n_{last}}} \]

- Eg. \textit{MaxGens} = 20,000 ...

<table>
<thead>
<tr>
<th>$p_{nc}$ (%)</th>
<th>MaxGens</th>
<th>$n_{last}$</th>
<th>$p_{nc}$ (Corrected)</th>
<th>Stop at generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>20,000</td>
<td>10</td>
<td>894</td>
<td>99.4</td>
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<tr>
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<td>20,000</td>
<td>20,000</td>
<td>20</td>
<td>24,000</td>
</tr>
<tr>
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<td>20,000</td>
<td>100,000</td>
<td>8.9</td>
<td>108,944</td>
</tr>
</tbody>
</table>
Criteria for stopping

2. No improvement over the last $p_{nc}$ percent of $n_{last}$ generations

- $p_{nc}$
- $p_{nc}$ (Corrected)
Criteria for stopping

3. No improvement for a specified fixed number of generations.

- $150 > 40 + 100$, so ...

- Current generation passes this test
Criteria for stopping

4. No fewer than $n_{min}$ generations in total.

- $150 > 100$, so ...
- Current generation passes this test
Criteria for stopping

5. No more than $n_{\text{max}}$ generations in total.

- $150 = 150$, so ...
- Current generation passes this test
Criteria for stopping

- Many possible criteria
- Stop when an appropriate mix of criteria have been met (see last 2 columns of checkboxes …)
- Do not take this as the only strategy available!
No Guarantee!

- There is no guarantee that convergence has been truly met …
  - … unless you already *know* the true maximum

- Observe the best solution achieved, and realize (if true) that it has all the properties that you think it should have …
  - That it is a “Satisficing Solution”.