# Escaping Local Optima



Key insights: Using global moves works very well. In the case of guiding information, warm restarts are also very useful.

### **Basins of Attraction**

An area so attractive that local exploration ( >> ) always leads to the same (local) optima.



**Problem:** If the basin of attraction is large but suboptimal, it is hard to escape.

### Results













Key insights: Restarts are beneficial and better than larger search distances if the basin of attraction of the global optimum is large.

### Conclusion

**Any** modification to basic local exploration is useful.

Each modification has advantages and disadvantages.

For our settings, using larger search distances proves typically more useful than using restarts.







### A Theory-Driven Discussion



Target



### As adventurer, you have *two possibilities* of advancing your search

explore at a set distance, never going to worse places



Variants

*Always* do one of these:

... explore only in your direct neighborhood

explore in increasing neighborhoods

explore anywhere, with a distribution centered around your position, then continue locally

Maybe do one of these from time to time:

restart

call the helicopter



go anywhere randomly (cold restart)

go anywhere locallly, even worse places (*warm restart*)

We only consider restarts in combination with  $\mathcal{P}$ .







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## **Iterated Optima**

We consider a sequence of optima that is improving in the distance to the starting position. In between these optima, there are worse positions but with guiding information.

**Problem:** Reaching one optimum can be costly. Doing so multiple times can become more challenging.

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**Results** (starting from a local optimum)











Key insights: Using larger search distances helps. However, restarting does not, as each restart only has a decent chance to be successful so that iterated optima pose a problem.

### **Deceptive vs. Guiding** Information

Information about a slope is *deceptive* if local exploration ( *p* ) leads to a local optimum. It is *guiding* if P leads to a global optimum.

**Problem:** If deceptive regions are large, they are hard to overcome. If guiding information is close to a local optimum, one can still land in the local optimum if the search distance is too large.

**Results** (starting from a local optimum)



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Key insights: Larger search distances are useful. Warm restarts only work for guiding information, but they do so very well.





#### **Information for Nerds**

1] P. Hansen, N. Mladenović, J. Brimberg, and J.A. Moreno Pérez. Variable neighborhood search. In: *Handbook of Heuristics*. Springer, 2019, 57–97. [2] P.T.H. Nguyen and D. Sudholt. Memetic algorithms outperform evolutionary algorithms in multimodal optimisation. *Artificial Intelligence* 287 (2020), 103345.

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#### The math was set via the plugin LaTeX2AI.

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