

Grid-Functioned Neural Networks

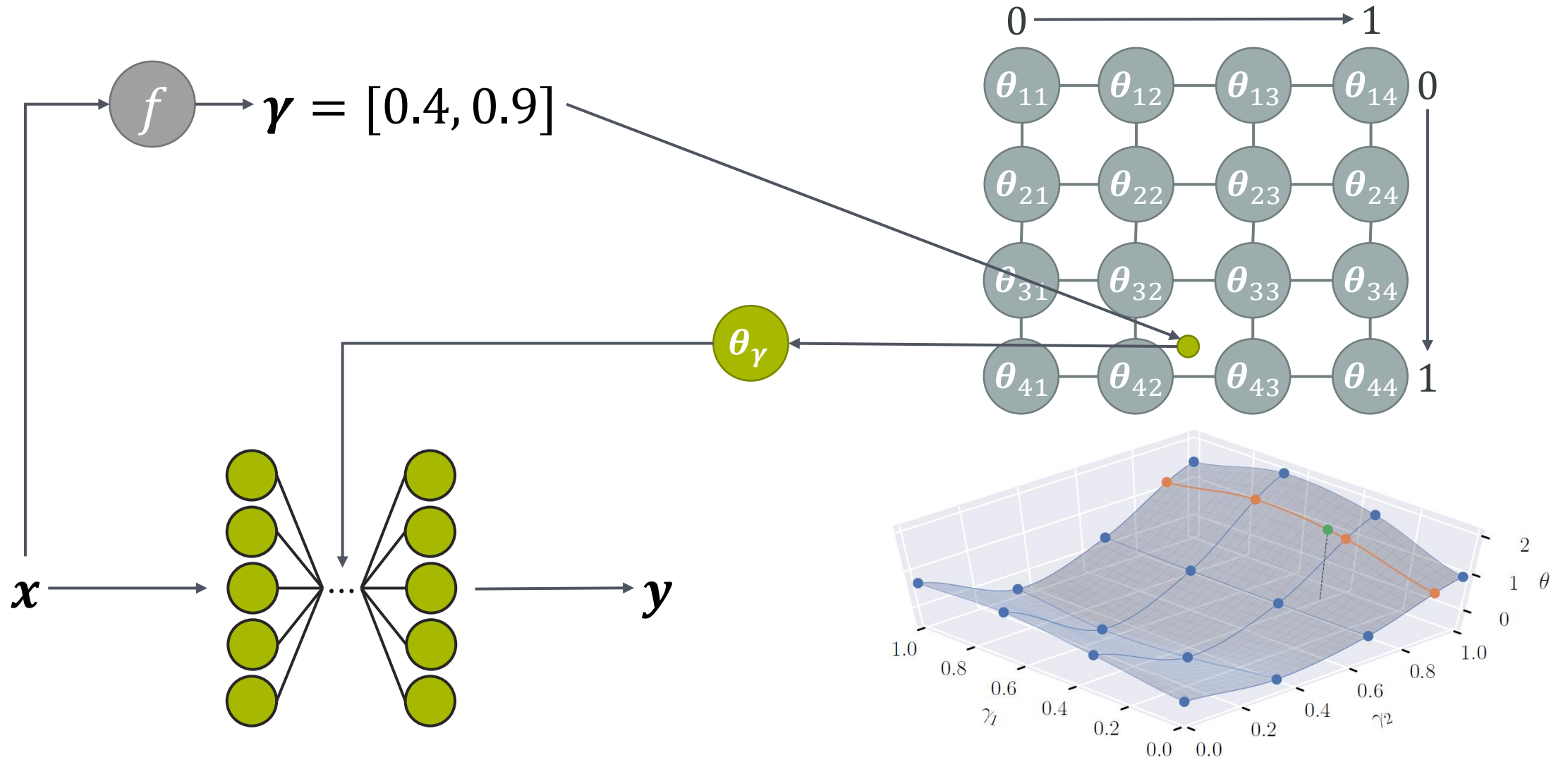
Javier Dehesa, Andrew Vidler, Julian Padget & Christof Lutteroth

ICML | 2021

Introduction

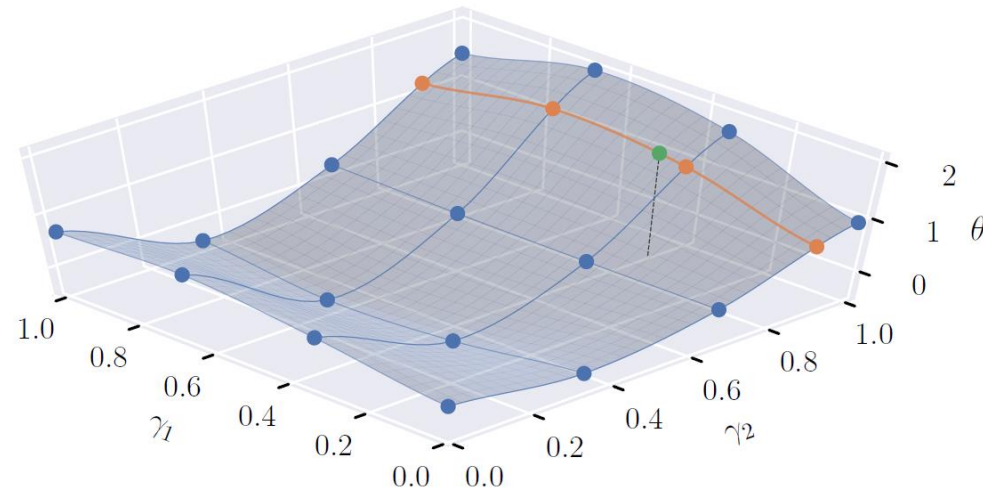
- Regular neural network models learn **a single set of weights** for the whole problem.
- For highly nonlinear problems, this makes it difficult to **learn local details**.
- Previous authors have proposed methods to use **multiple sets of weights**.
 - Specialised across one dimension (PFNN, Holden et al., 2016).
 - With no explicit structure (MANN, Zhang et al., 2018).
- Grid-functioned neural networks (GFNN) uses a **multidimensional grid** of expert weights that explicitly breaks down the problem domain.

Grid-Functioned Neural Networks



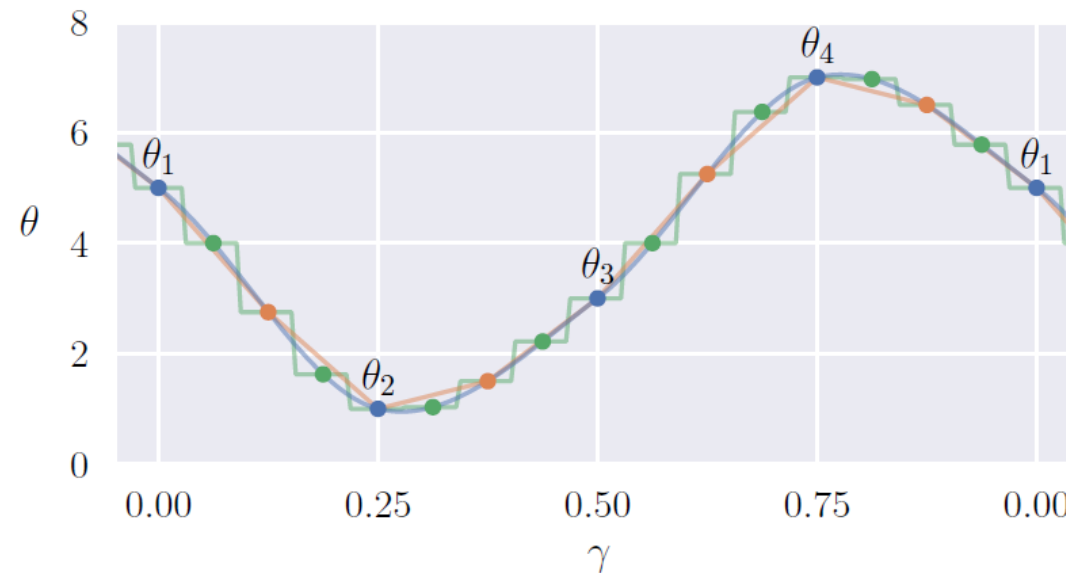
Interpolation Cost & Approximations

- The spline interpolation guarantees **smooth behaviour**, desirable in many cases, but has an impact on the computational cost.



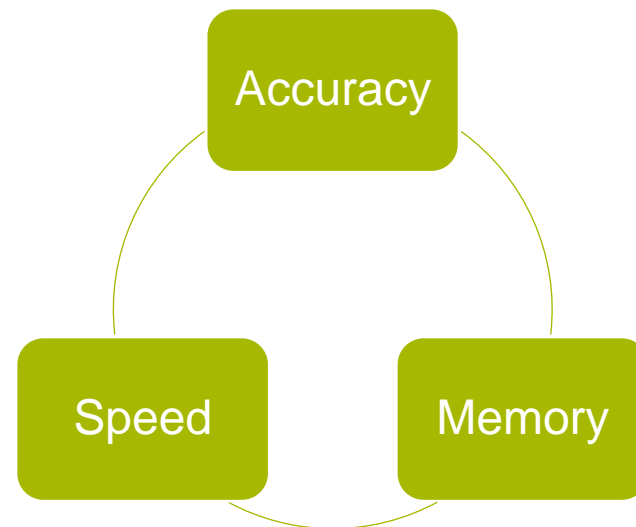
Interpolation Cost & Approximations

- The spline interpolation guarantees **smooth behaviour**, desirable in many cases, but has an impact on the computational cost.
- To reduce this cost, the **cubic spline interpolation** can be **approximated** through **linear** or **constant** interpolation using precomputed values.

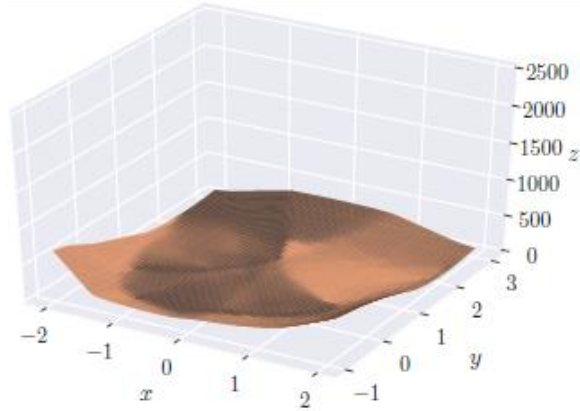


Interpolation Cost & Approximations

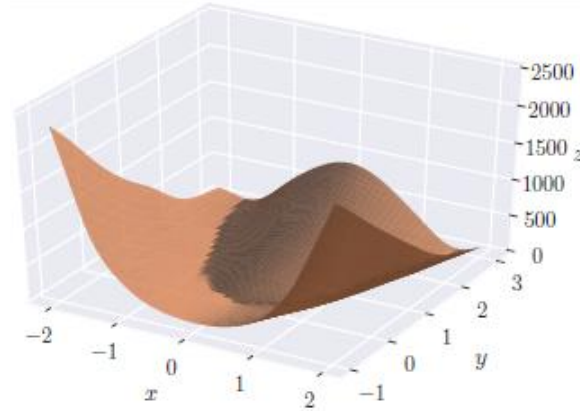
- The spline interpolation guarantees **smooth behaviour**, desirable in many cases, but has an impact on the computational cost.
- To reduce this cost, the **cubic spline interpolation** can be **approximated** through **linear** or **constant** interpolation using precomputed values.
- This offers a versatile **trade-off** between accuracy, speed and memory.



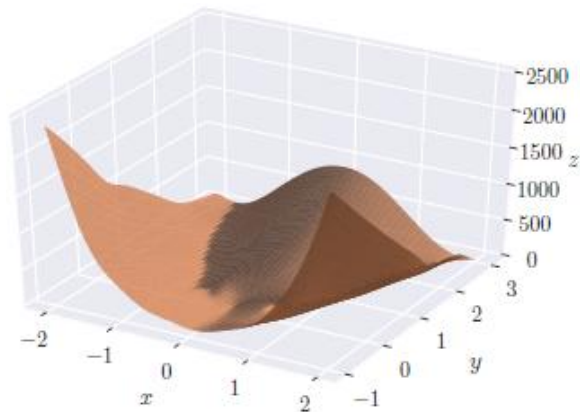
Evaluation



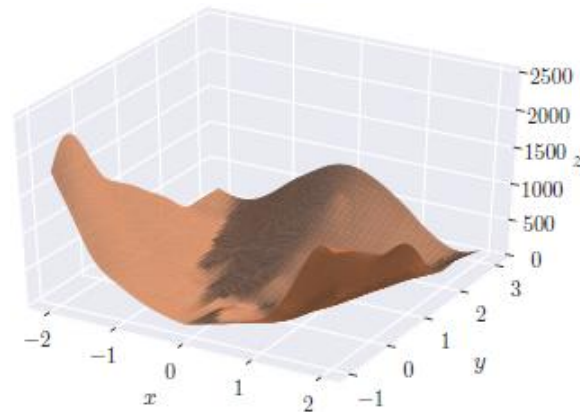
MLP



3×3

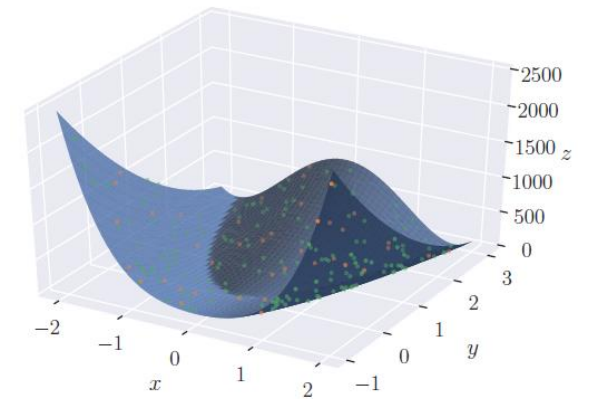


5×5



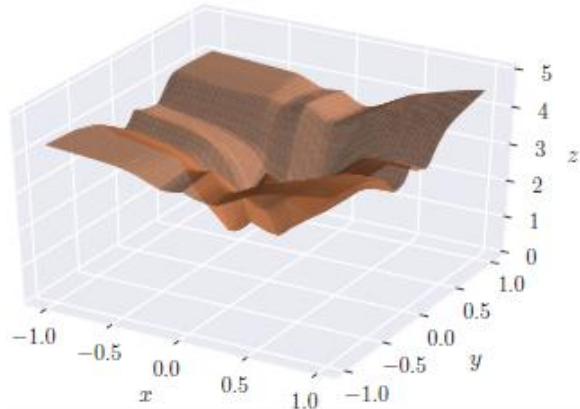
7×7

Parameters:
 ~10,000

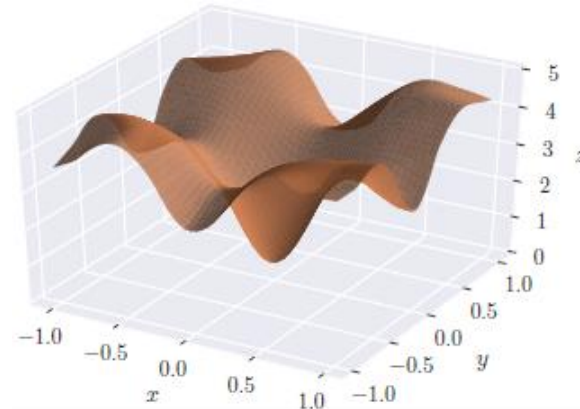


Rosenbrock

Evaluation

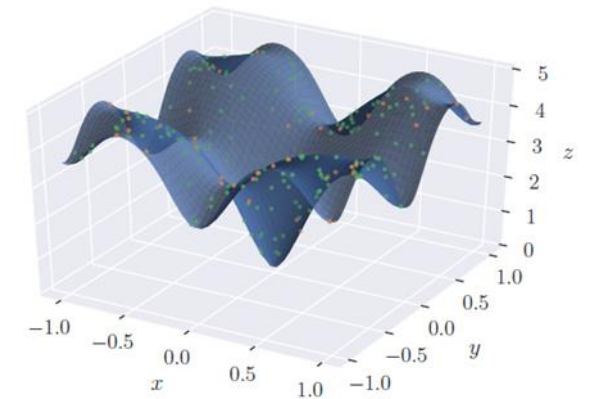


MLP

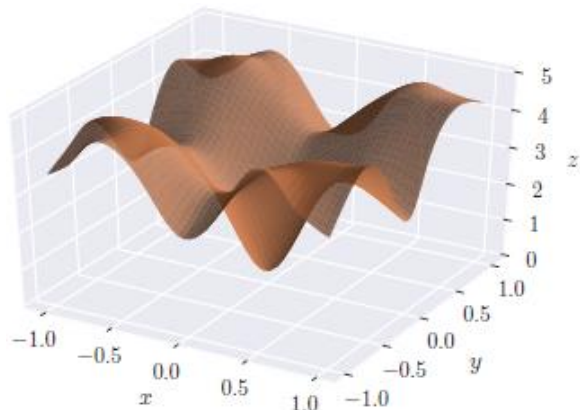


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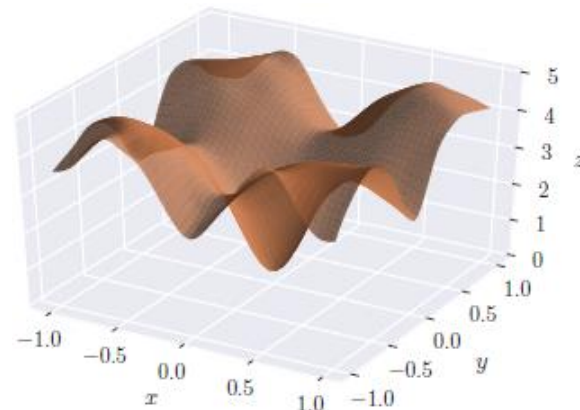
Parameters:
 ~10,000



Ackley (small region)

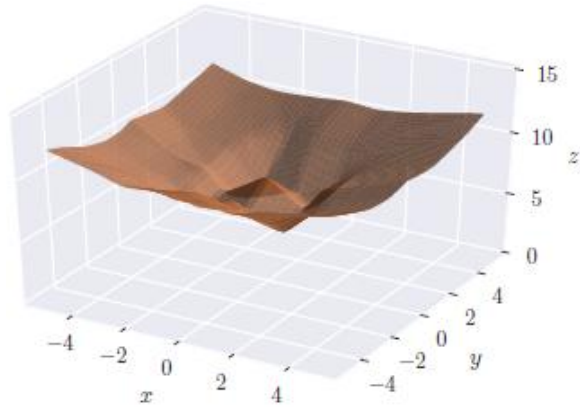


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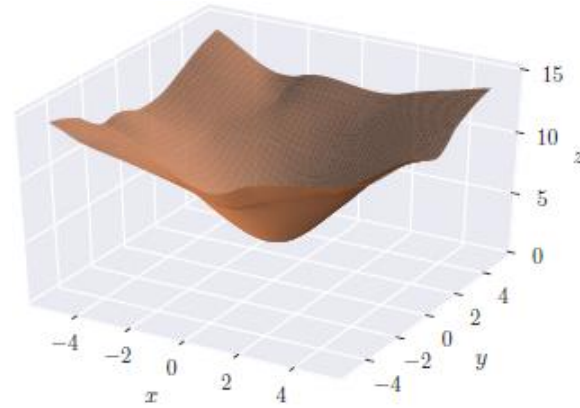


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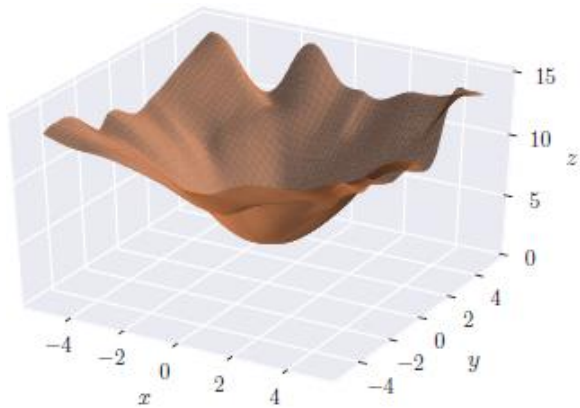
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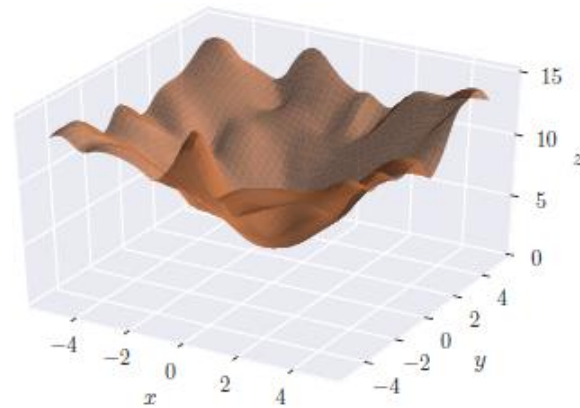
MLP



3×3

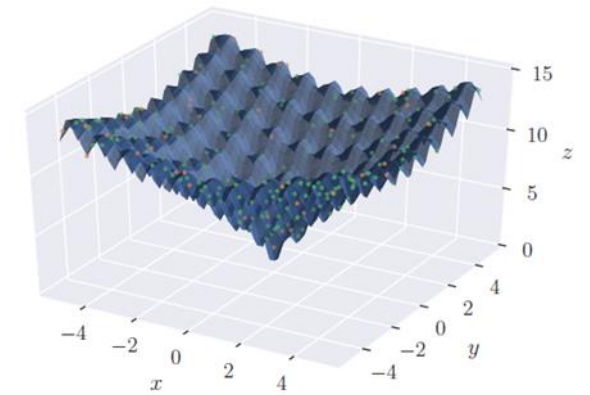


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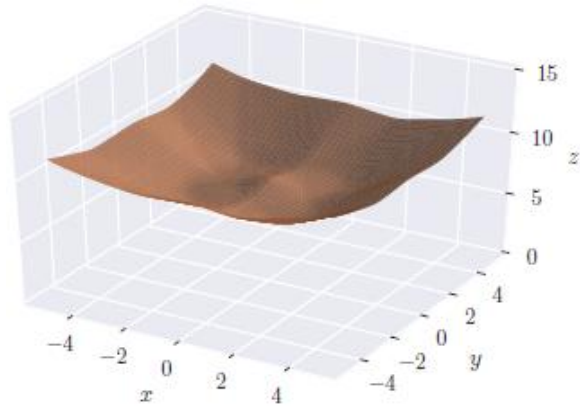
7×7

Parameters:
 ~10,000

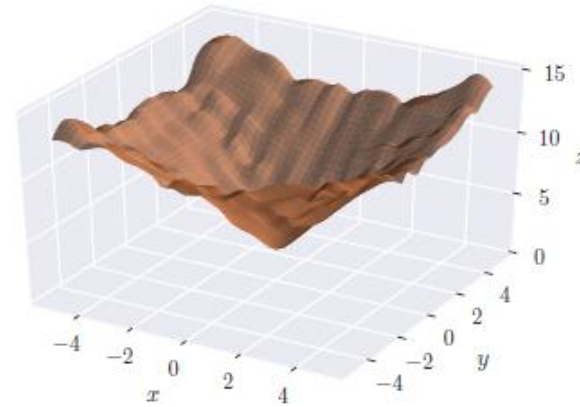


Ackley

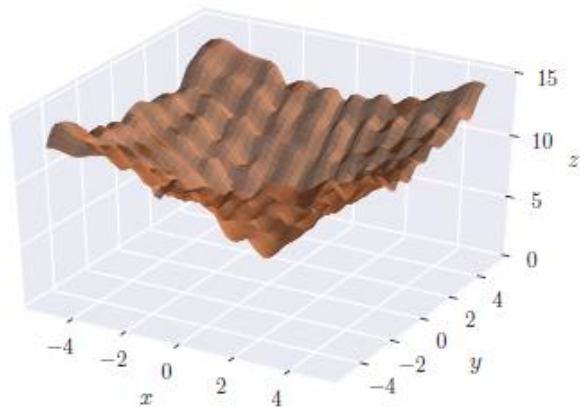
Evaluation



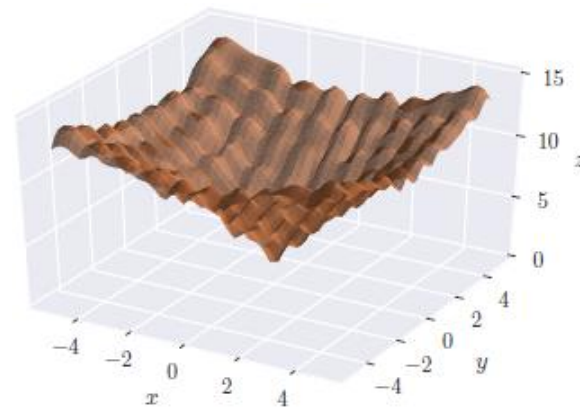
MLP



7×7

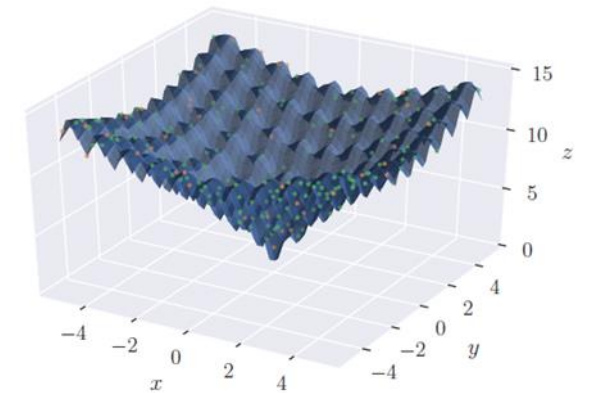


10×10



14×14

Parameters:
 ~60,000



Ackley

Case Study: Quadruped Locomotion



Thank you