TECHNISCHE HOCHSCHULE
OSTWESTFALEN-LIPPE
UNIVERSITY OF
APPLIED SCIENCES
AND ARTS

Welcome

to Advanced Topics in Algorithms

Results ATA - Exercises 1

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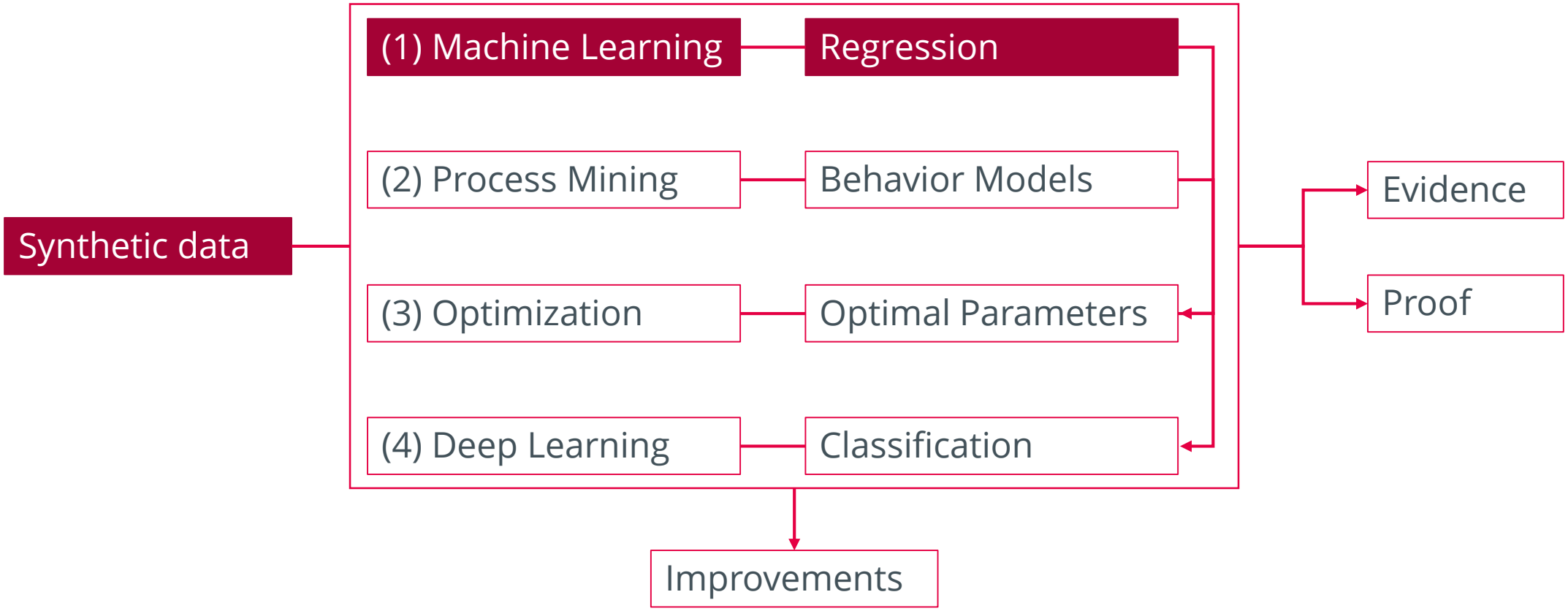
- **###: Baboucarr Jarbo**

Next deadline: 10/21/2022

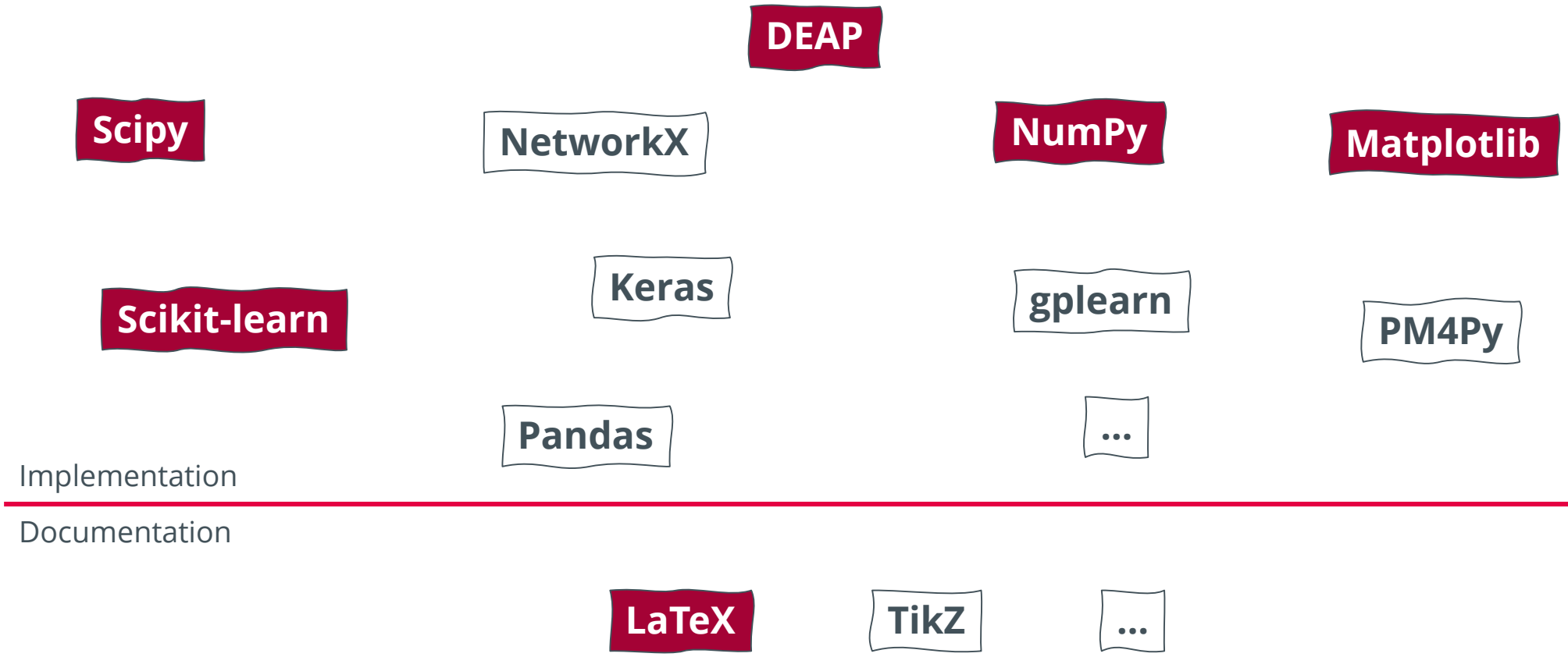
Subject: ATA E2 [TEAMNAME]

Only one PDF

Overview: Advanced Topics in Algorithms



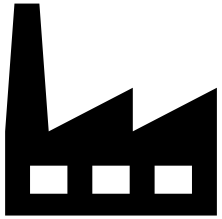
Overview: Practical Part



Background: Cyber-physical Systems (CPS)

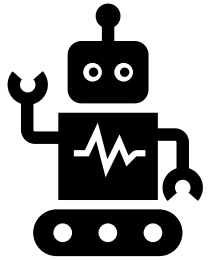
Cyber-physical Systems (CPS) are networks of software and hardware components controlling physical processes, i.e. time-dependent and concurrent processes.

Production Systems

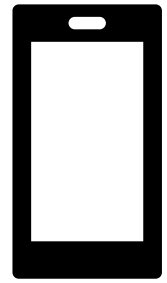


Self-driving car

Robotics

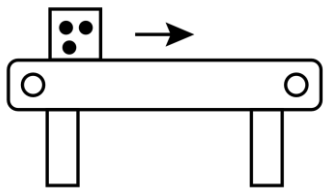


Smartphone



Use Case: Production Systems

Conveyor



Time	Motor	Energy
09:59	0	0
10:00	1	21.16
10:01	1	42.33
10:02	1	63.49
10:03	1	84.65
10:04	1	105.81
10:05	1	126.97
10:06	0	0
…		

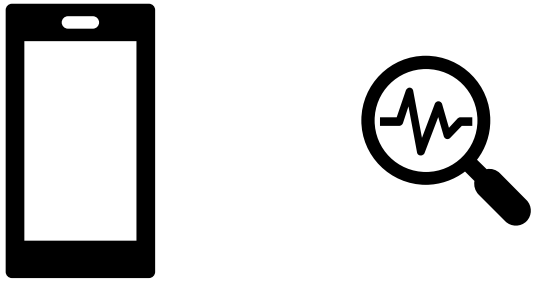
Time	Motor
09:59	0
10:00	1
…	
10:05	1
10:06	0
…	

Scope of today

Time	Energy
09:59	0
10:00	21.16
…	
10:05	126.97
10:06	0
…	

Use Case: Smartphone

Smartphone

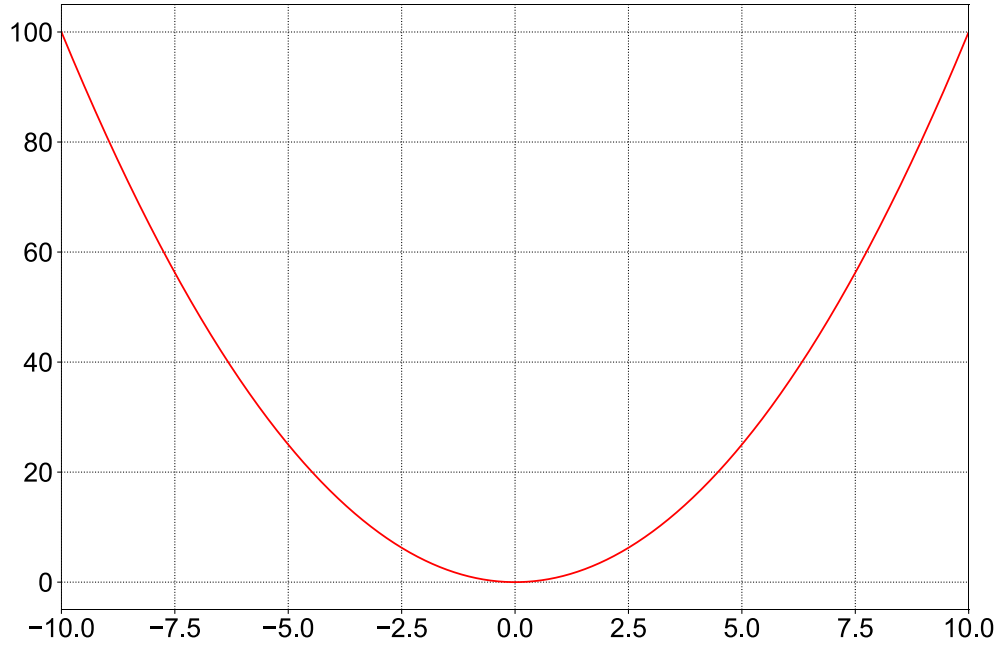


- **What sensors have a smartphone?**
- **What information can we extract?**

Synthetic Data 1/2

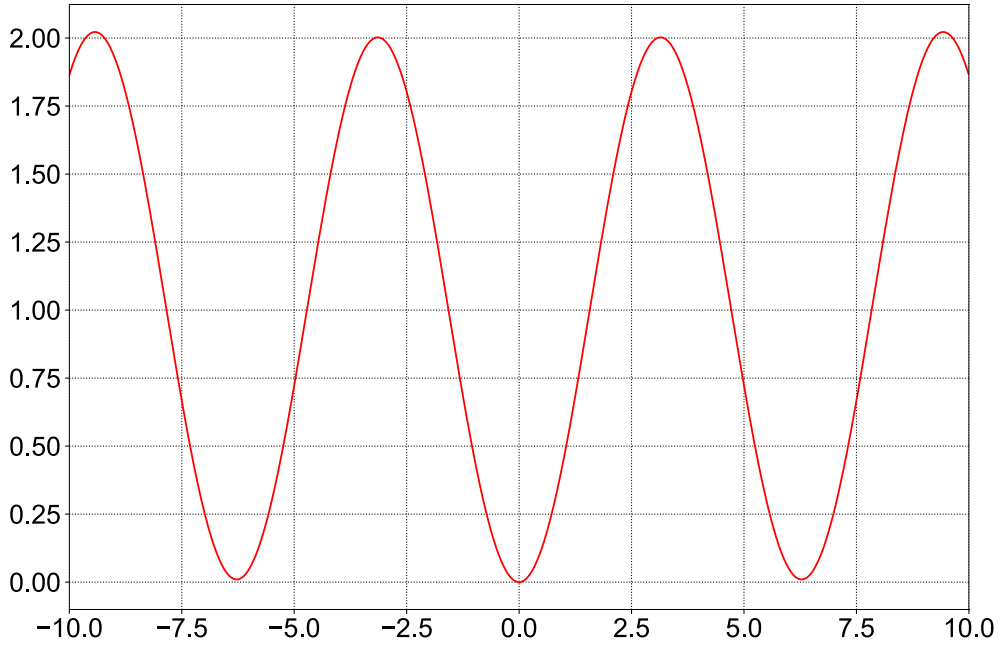
Sphere

$$f_s(x) = \sum_{i=1}^{n} x_i^2$$



Griewank

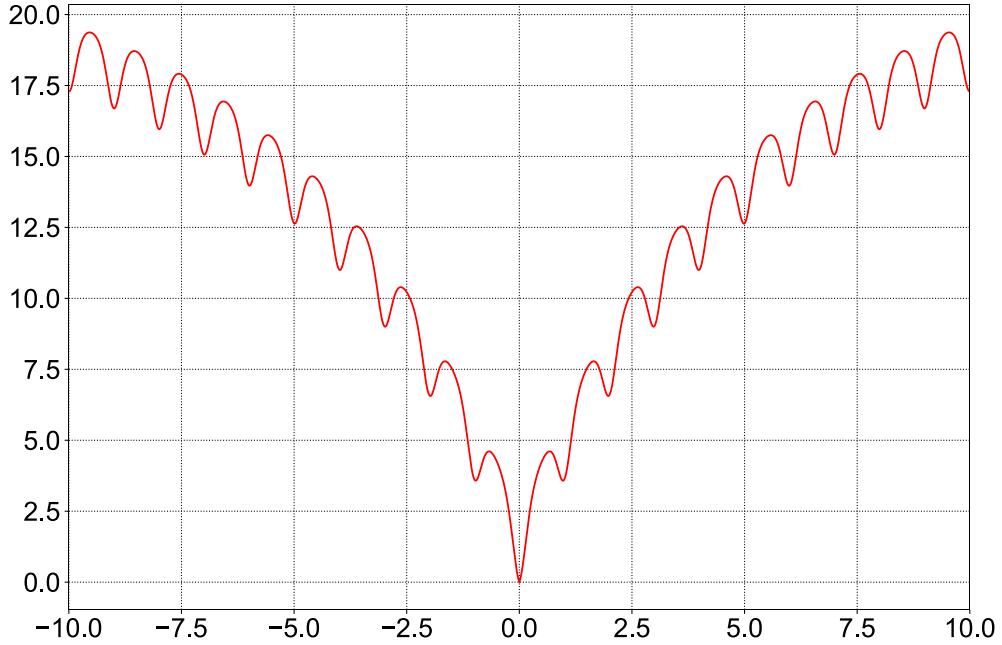
$$f_g(x) = 1 - \prod_{i=1}^{n} \cos\left(\frac{x_i}{\sqrt{(i)}}\right) + \sum_{i=1}^{n} \frac{x_i^2}{4000}$$



Synthetic Data 2/2

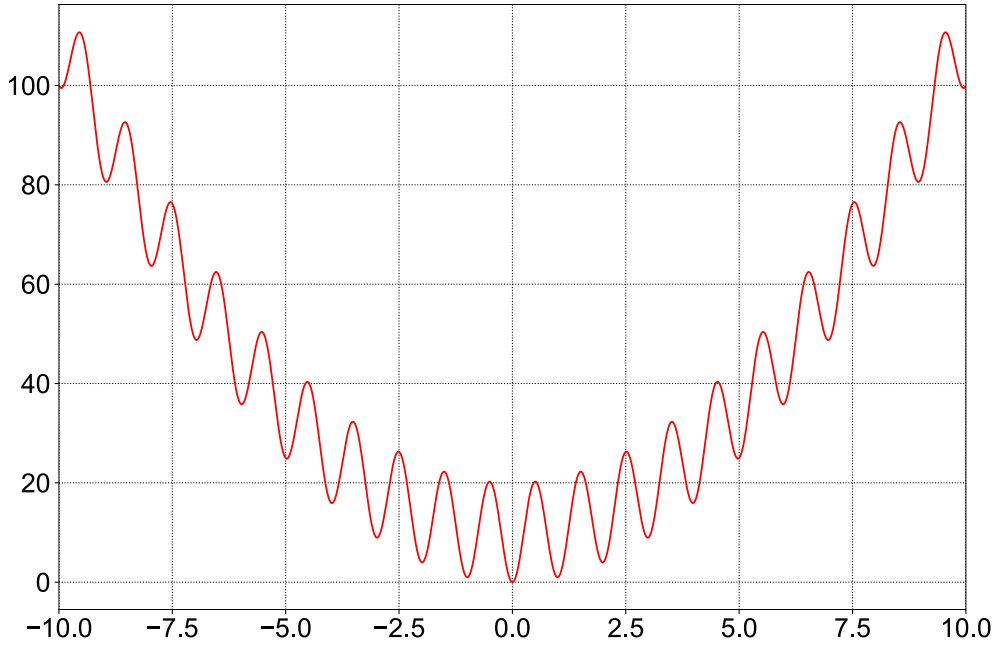
Ackley

$$f_{\mathrm{a}}(x) = 20 - 20 * \exp\left[-0.2\sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}}\right] + \exp(1) - \exp\left[\frac{\sum_{i=1}^{n}\cos(2\pi x_i)}{n}\right]$$



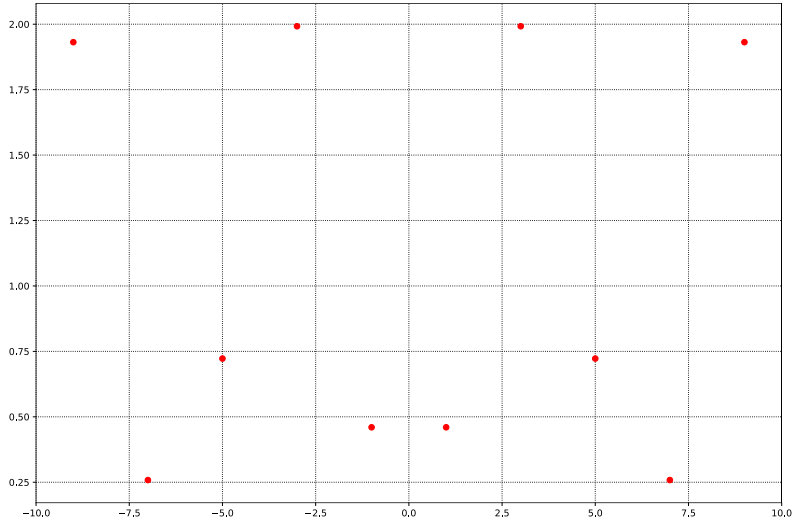
Rastrigin

$$f_{\mathrm{r}}(x) = 10 \cdot \left[n - \sum_{i=1}^{n}\cos(2\pi x_i)\right] + \sum_{i=1}^{n} x_i^2$$

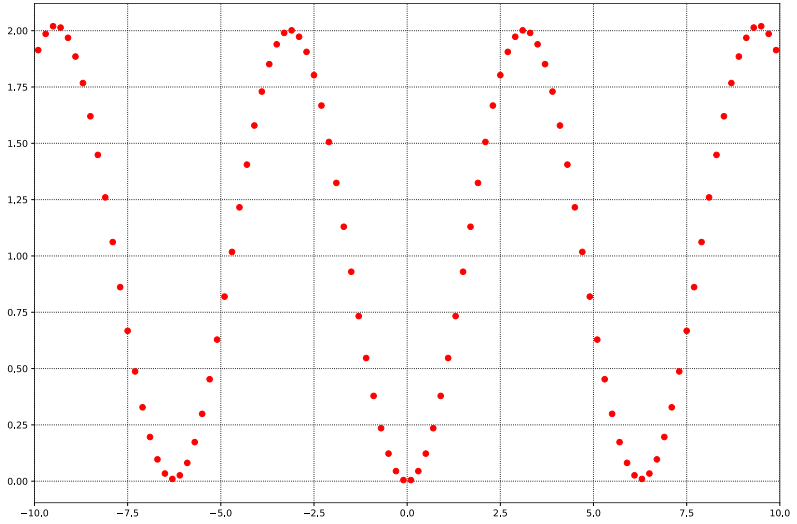


Latin Hypercube Sampling

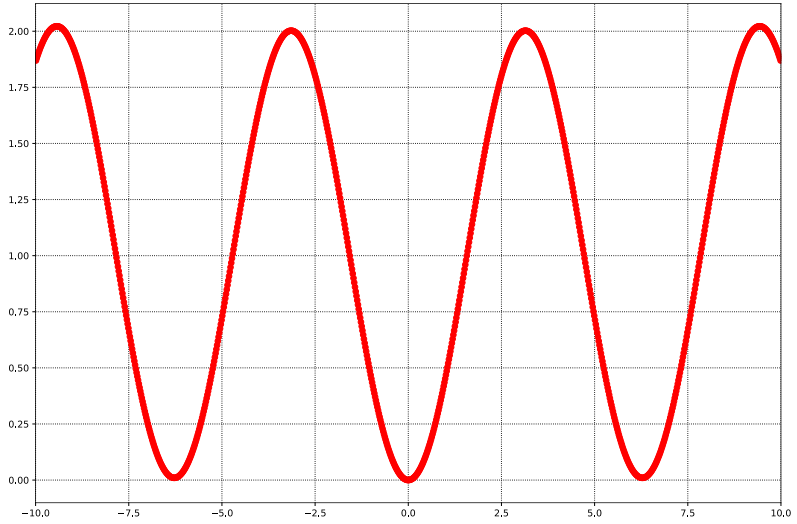
10



100



1000



It is among the most popular sampling techniques in computer experiments thanks to its simplicity and projection properties with high-dimensional problems.

Jin, R. and Chen, W. and Sudjianto, A. (2005), “An efficient algorithm for constructing optimal design of computer experiments.” Journal of Statistical Planning and Inference, 134:268-287.

https://smt.readthedocs.io/en/latest/_src_docs/sampling_methods/lhs.html

Symbolic Regression 1/3

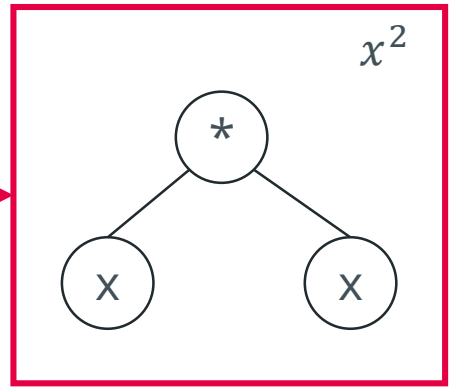
Input

Time	Energy
09:59	0
10:00	21.16
…	
10:05	126.97
10:06	0
…	

- mean squared error
- root mean squared error

Symbolic Regression

Output

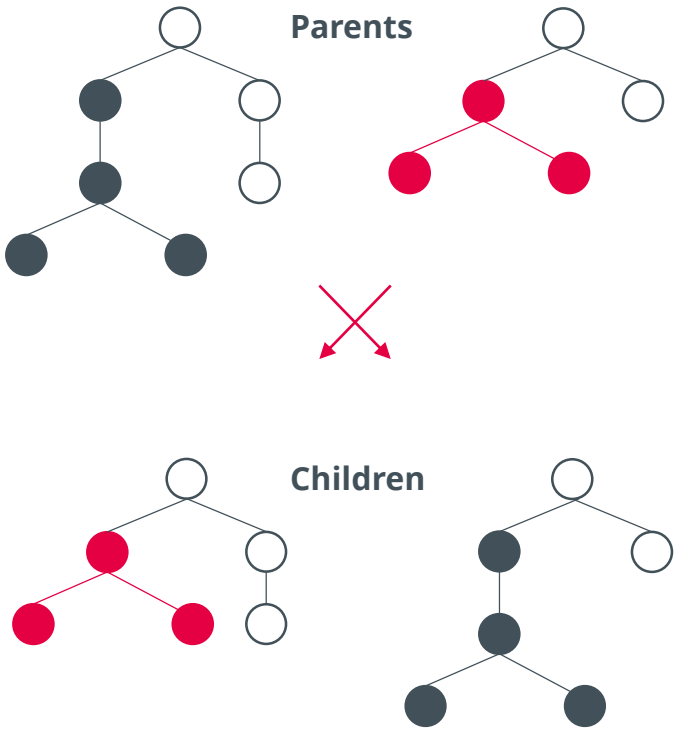


Primitives

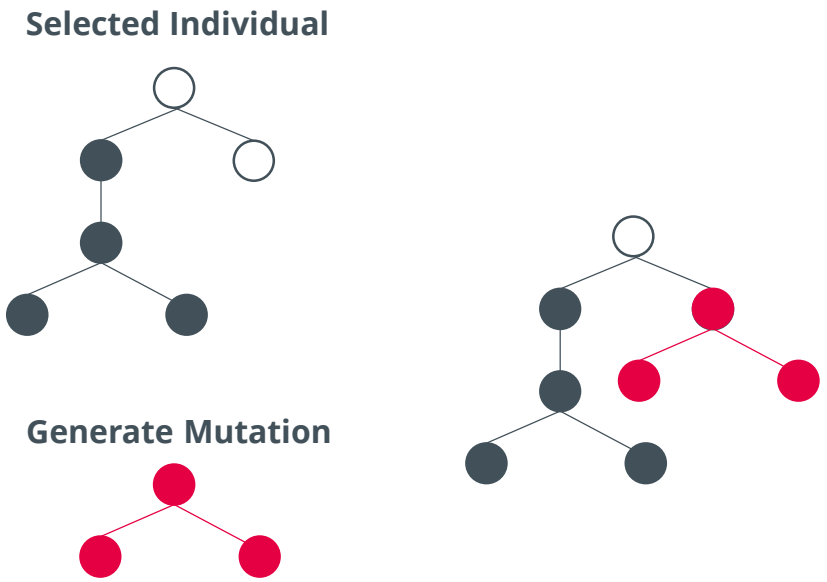
- add
- sub
- mult
- …

Symbolic Regression 2/3

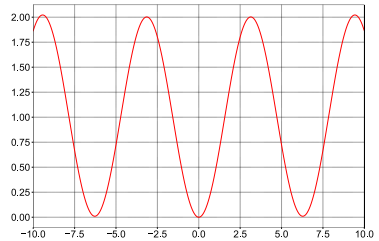
Crossover



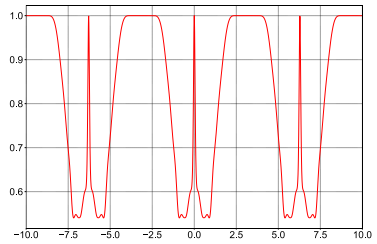
Mutation



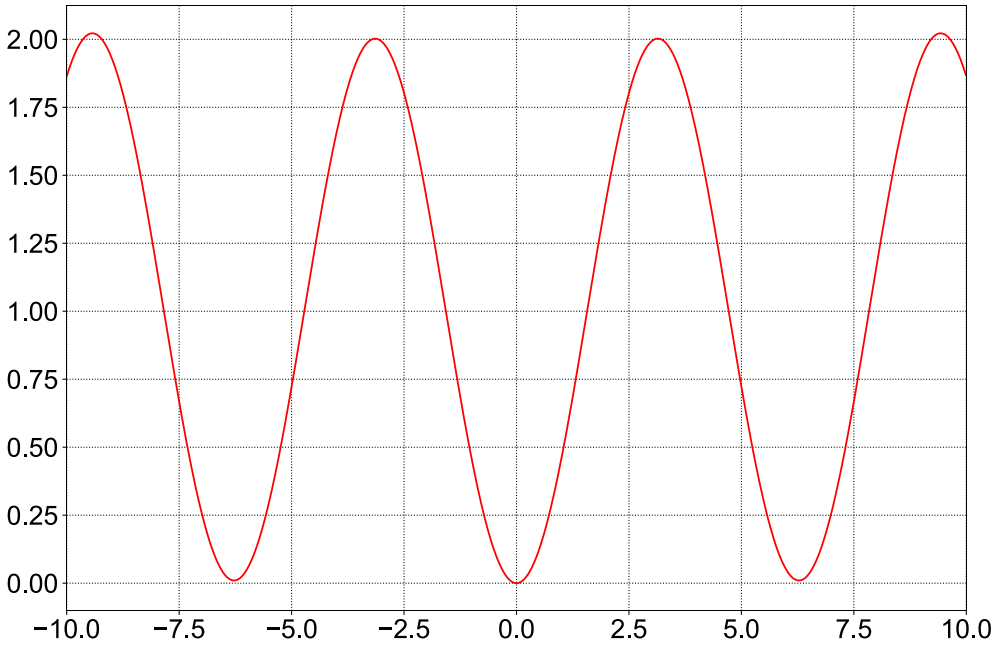
Evaluate

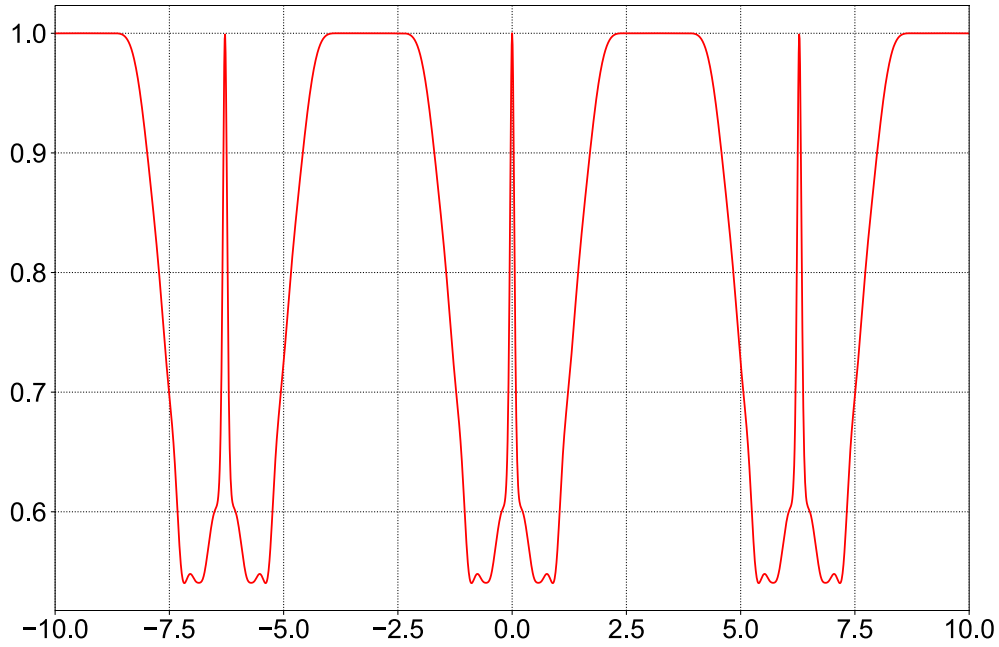


e.g. mean squared error

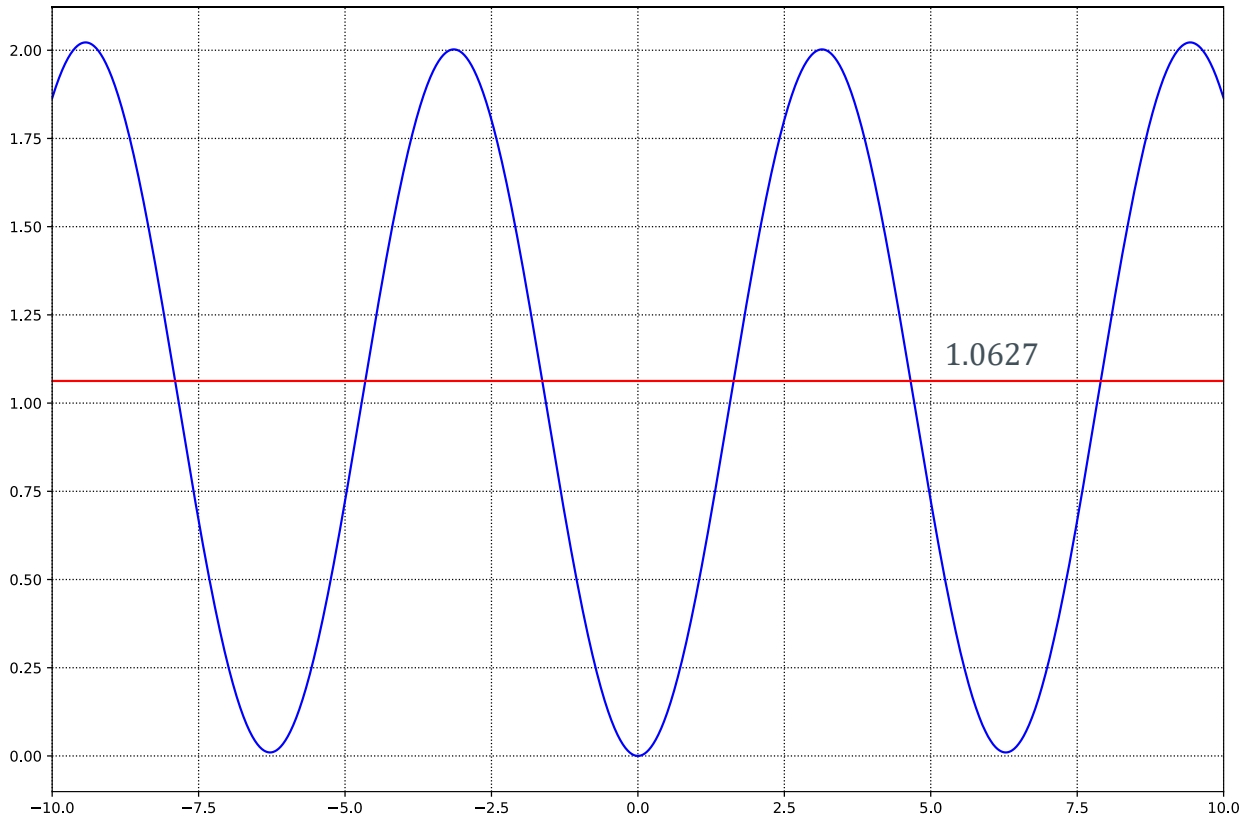


Symbolic Regression 3/3

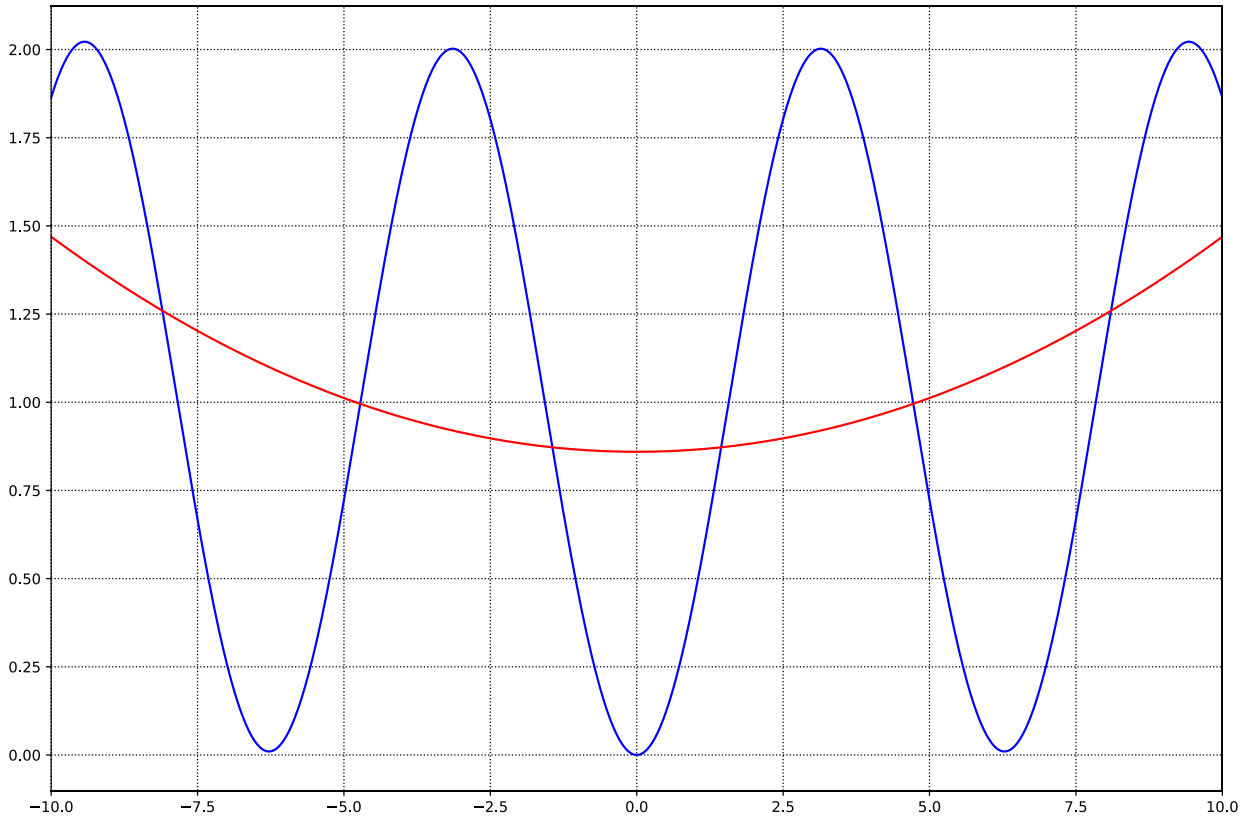




Regression with Polynomial Features: Step 1

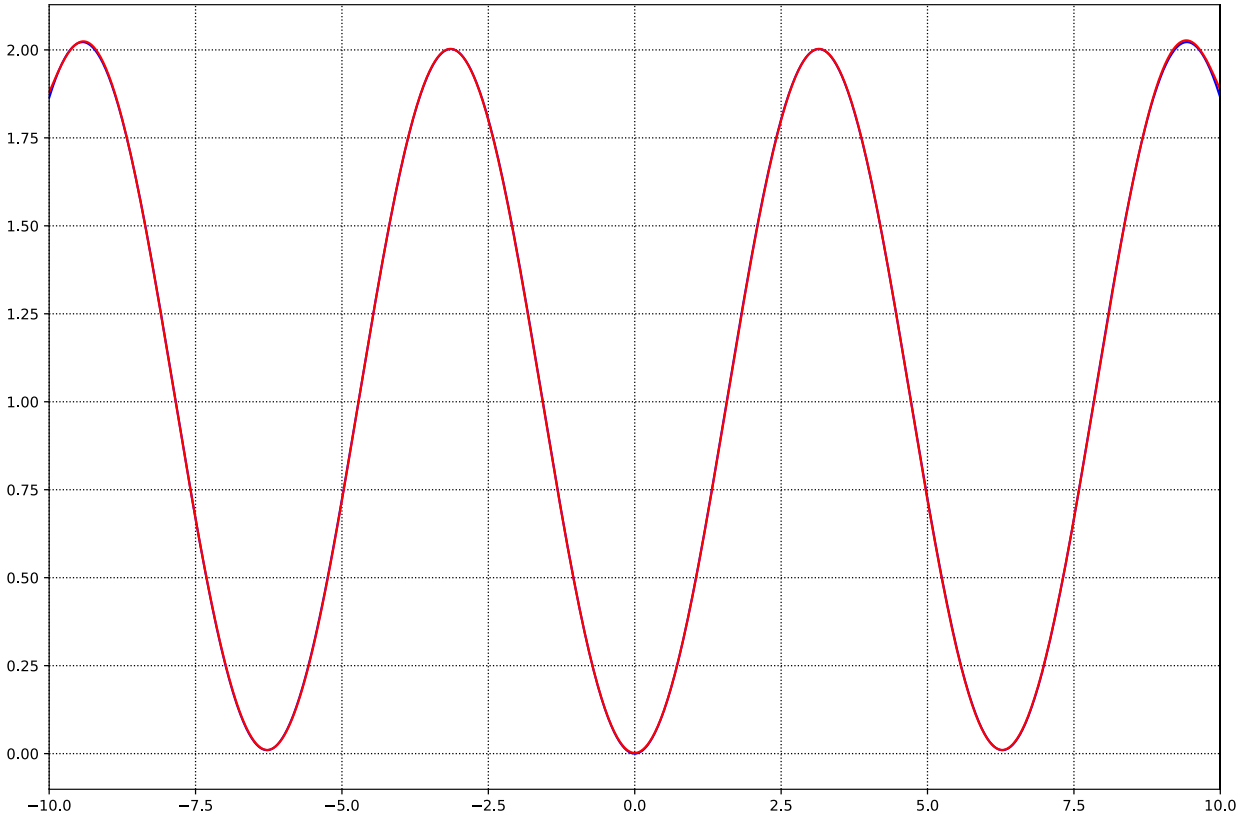


Regression with Polynomial Features: Step 2



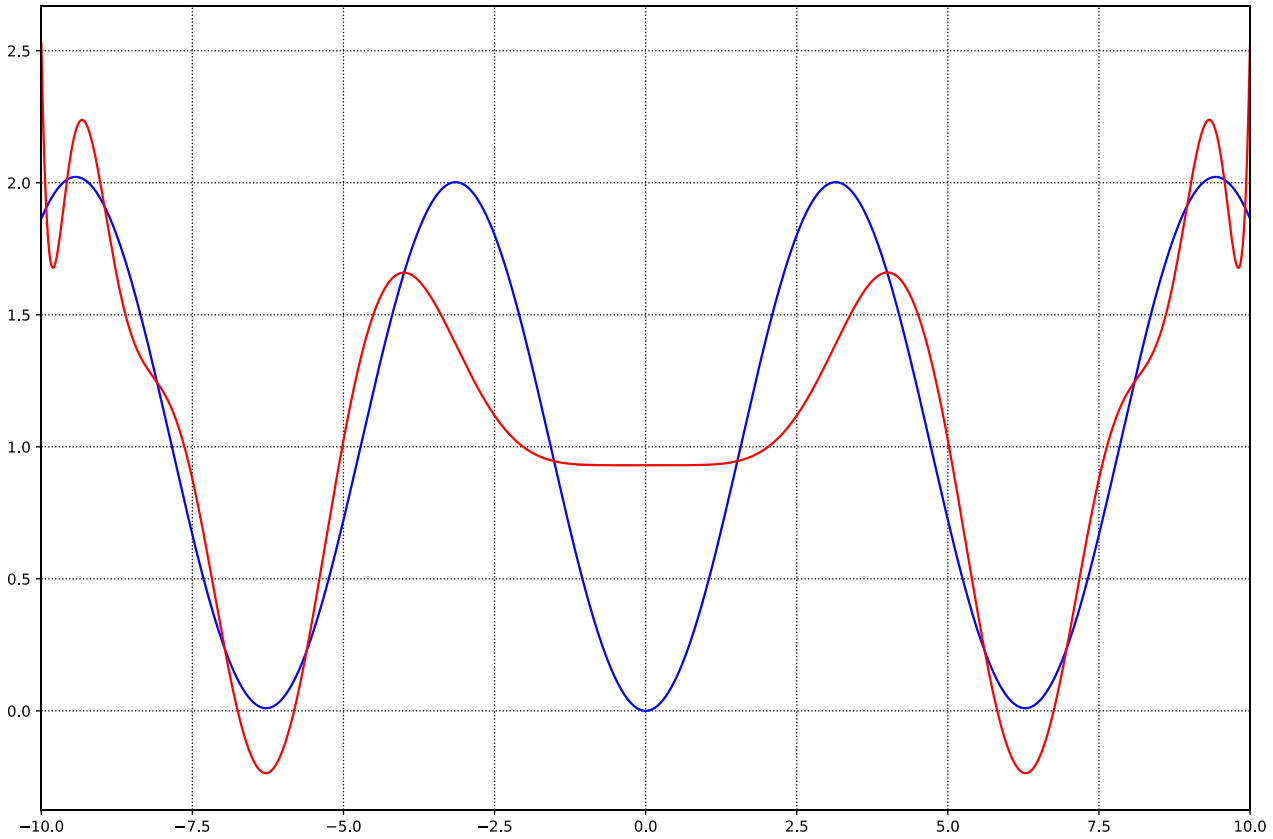
$$0.00609567x_0^2 + 0.8595$$

Regression with Polynomial Features: Step 14



$$2.0 \cdot 10^{-7} x_0^{10} - 2.167 \cdot 10^{-5} x_0^8 + 0.00131727 x_0^6 - 4.0 \cdot 10^{-8} x_0^5 - 0.04085166 x_0^4 + 1.78 \cdot 10^{-6} x_0^3 + 0.49669338 x_0^2 - 3.354 \cdot 10^{-5} x_0 + 0.0025$$

Regression with Polynomial Features: Step 18



$$-1.4 \cdot 10^{-7} x_0^{12} + 6.5 \cdot 10^{-6} x_0^{10} + 2.0 \cdot 10^{-8} x_0^9 - 0.0001587 x_0^8 - 4.2 \cdot 10^{-7} x_0^7 + 0.00150314 x_0^6 + 3.51 \cdot 10^{-6} x_0^5 + 0.00022478 x_0^4 + 6.6 \cdot 10^{-7} x_0^3 + 1.824 \cdot 10^{-5} x_0^2 + 1.589 \cdot 10^{-5} x_0 + 0.9302$$

TH OWL

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Thank you!