Neural Networks can learn periodic data

https://arxiv.org/abs/2006.08195

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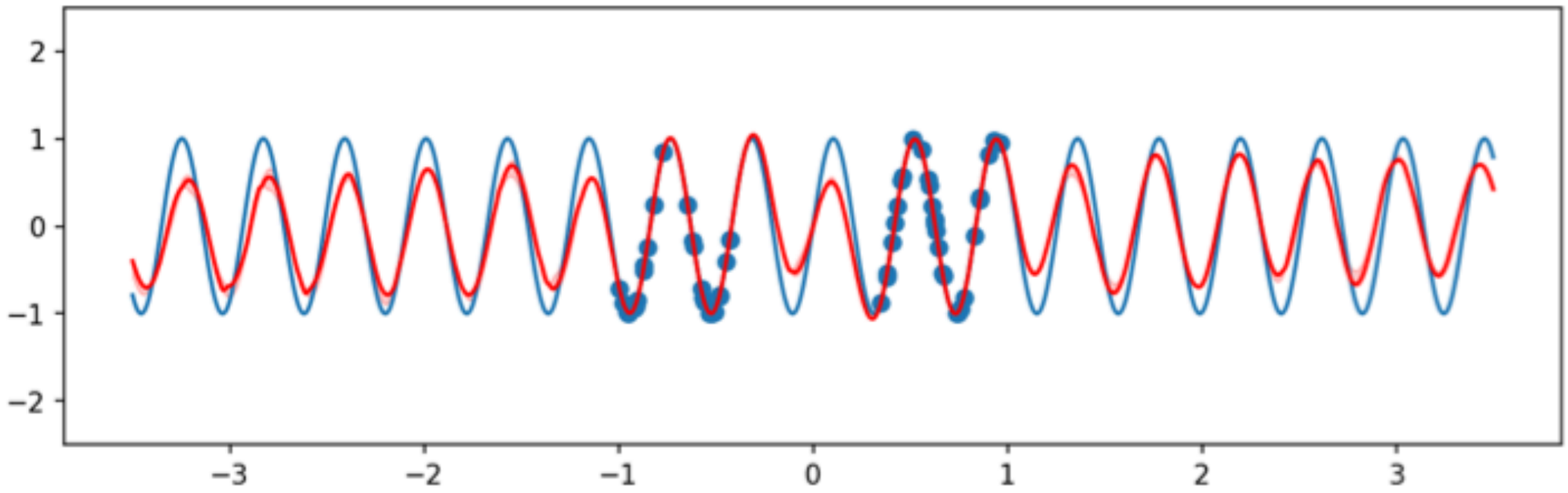

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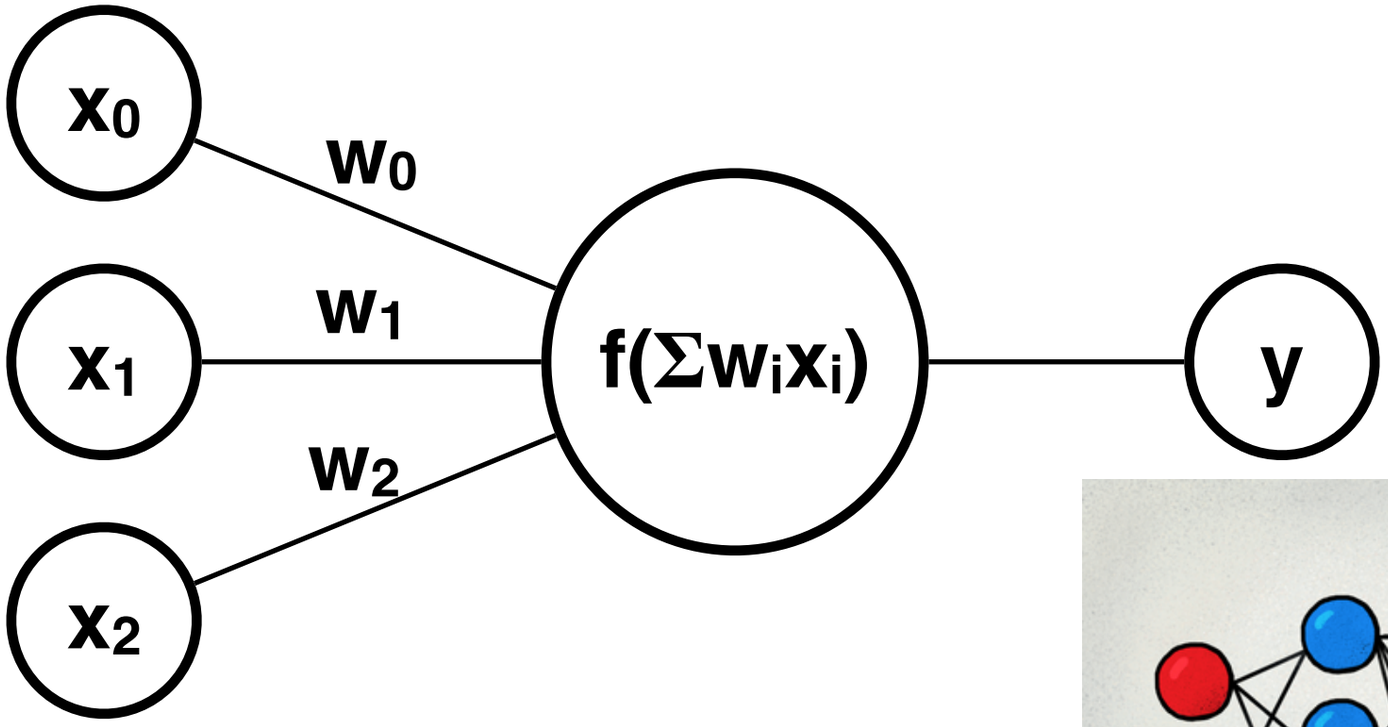
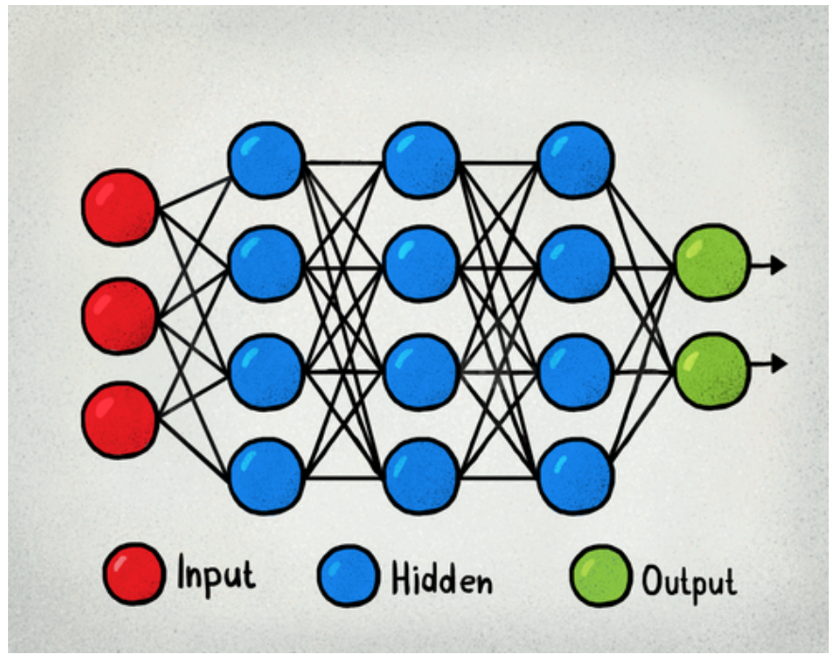
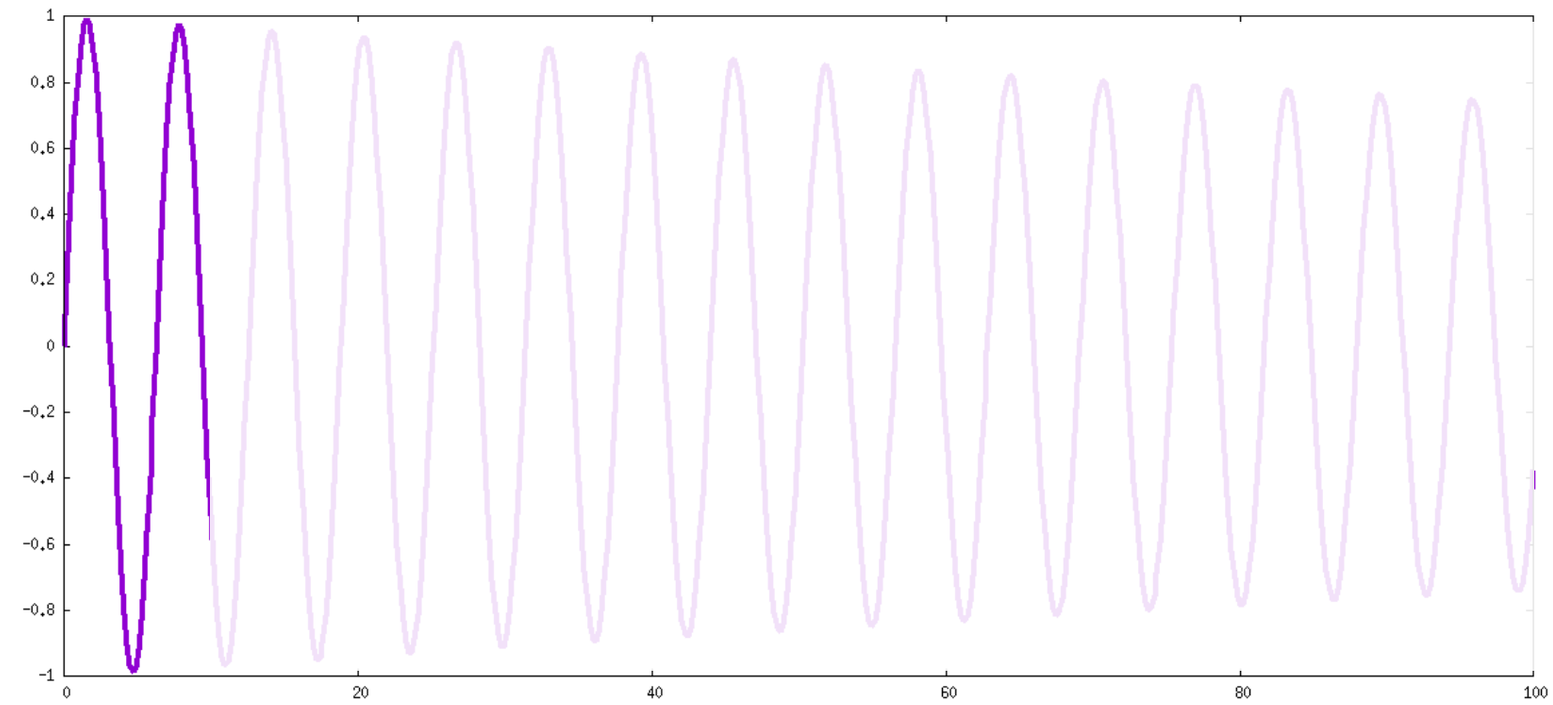
Artificial Neural Network



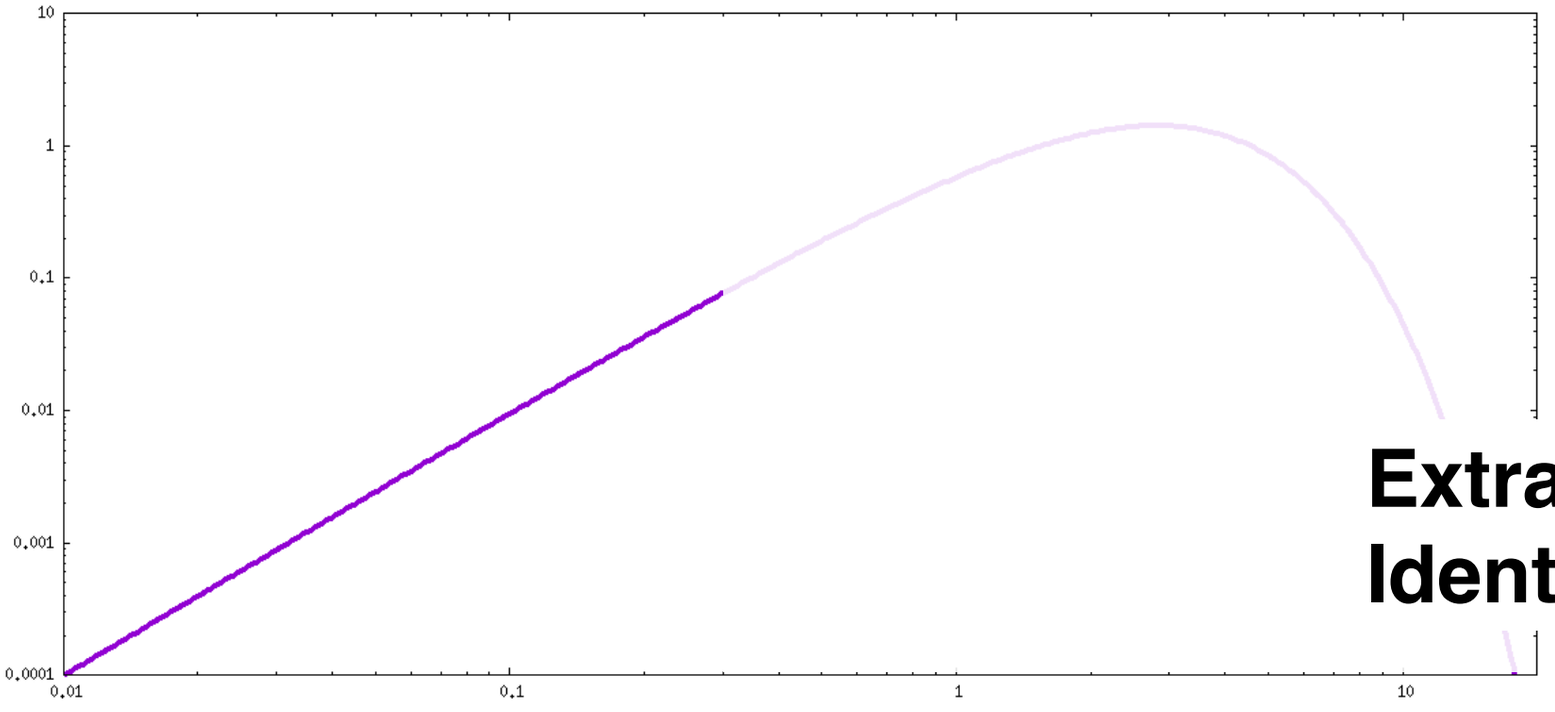


Input data: x_i (e.g. pixel values)
Learning: finding optimal weights w_i
Output: $y = f(w_0x_0+w_1x_1+w_2x_2)$ (e.g. cat/dog)
Activation Function f(x): sigmoid, ReLU, step-function,...

Extrapolate ("View Options" -> "Annotate")



Damped Oscillator

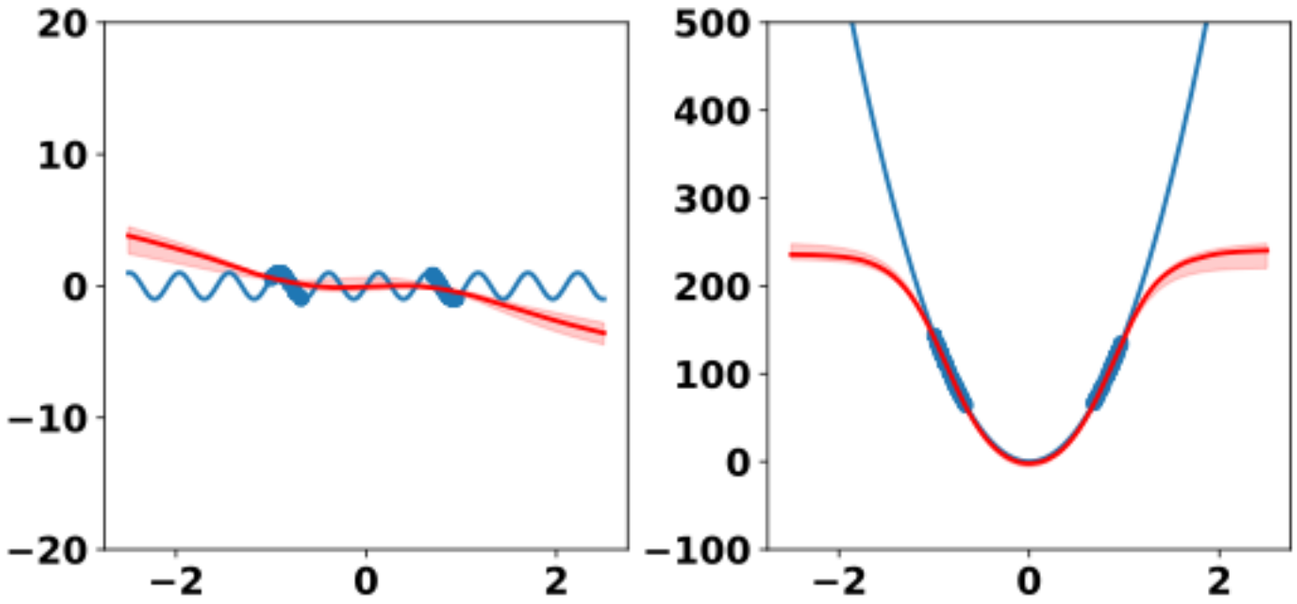


Blackbody

Extrapolation is ill-defined.
Identifying periodicity helps

Existing Activation Functions

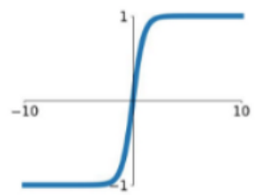
Tanh



- Ground Truth
· Sampled Input
- NN prediction

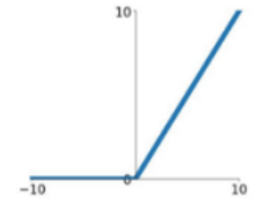
tanh

$\tanh(x)$

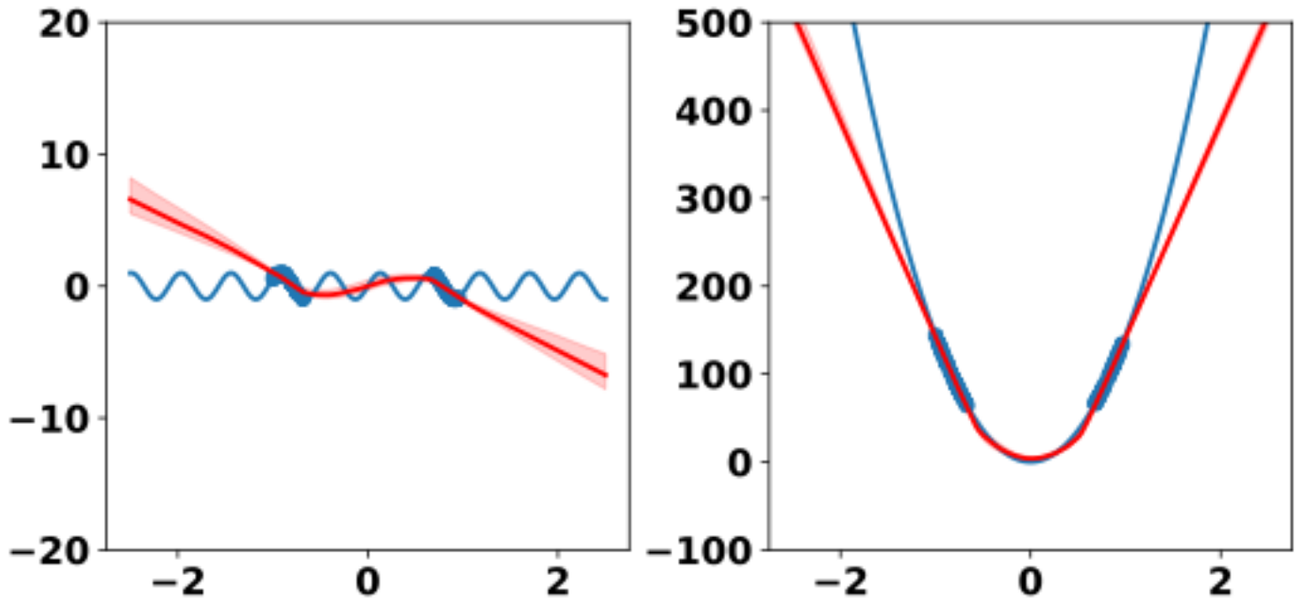


ReLU

$\max(0, x)$



ReLU



Neural Network adopts extrapolation properties of activation function.

We propose: Snake

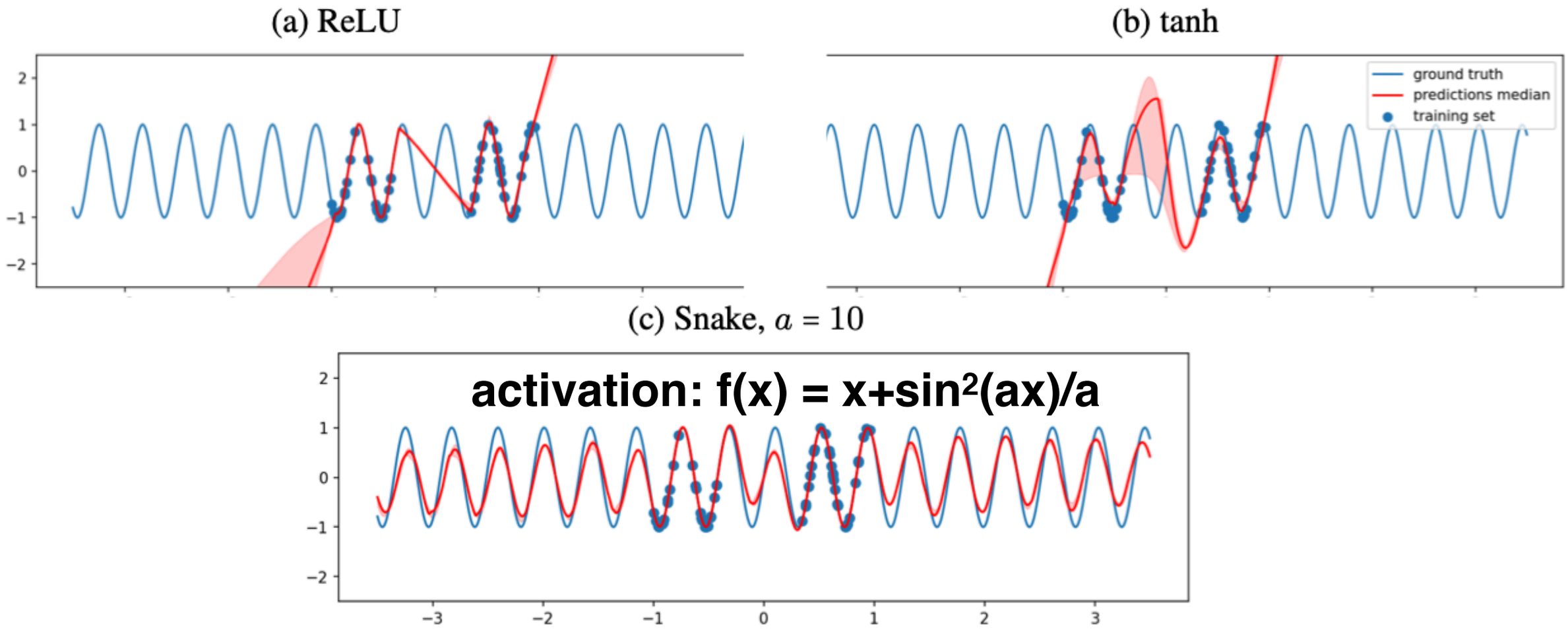


Figure 4: Regressing a simple sin function with tanh, ReLU, and Snake as activation functions.

Snake can capture and therefore extrapolate the periodic data.

Applications: Body Temperature

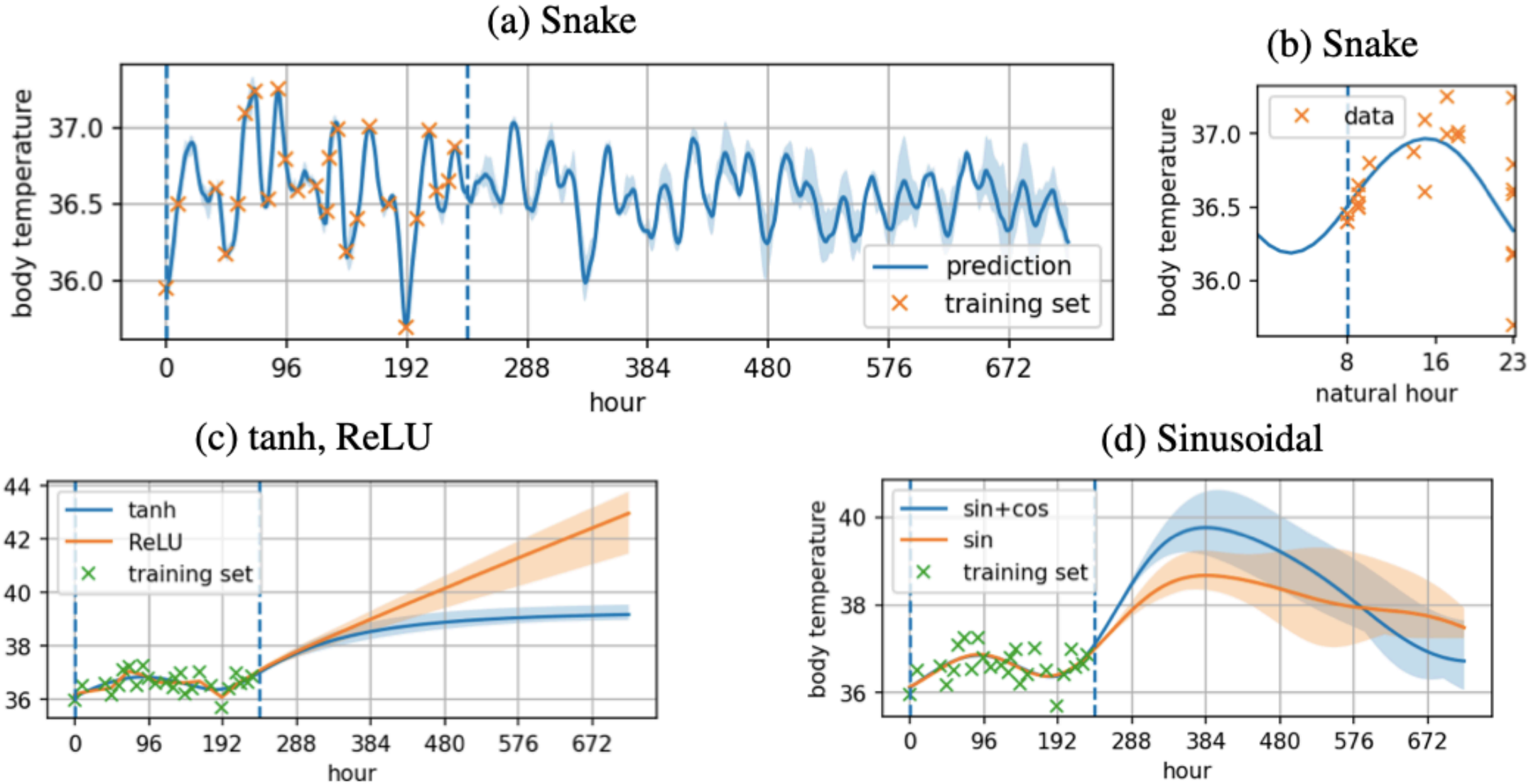
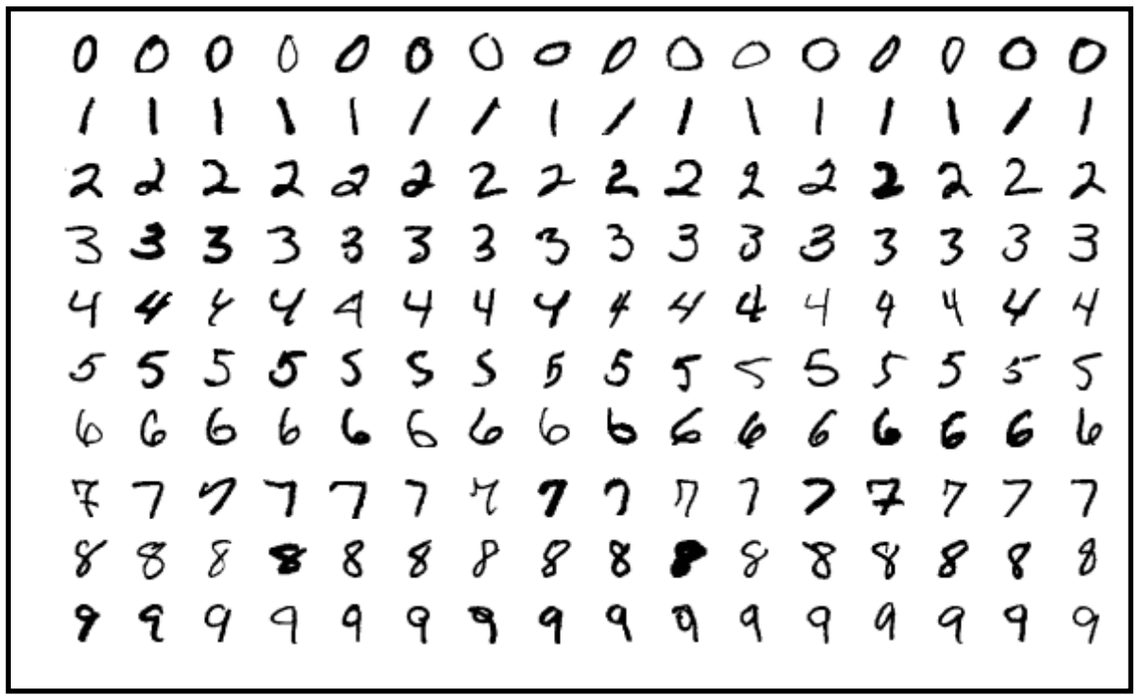
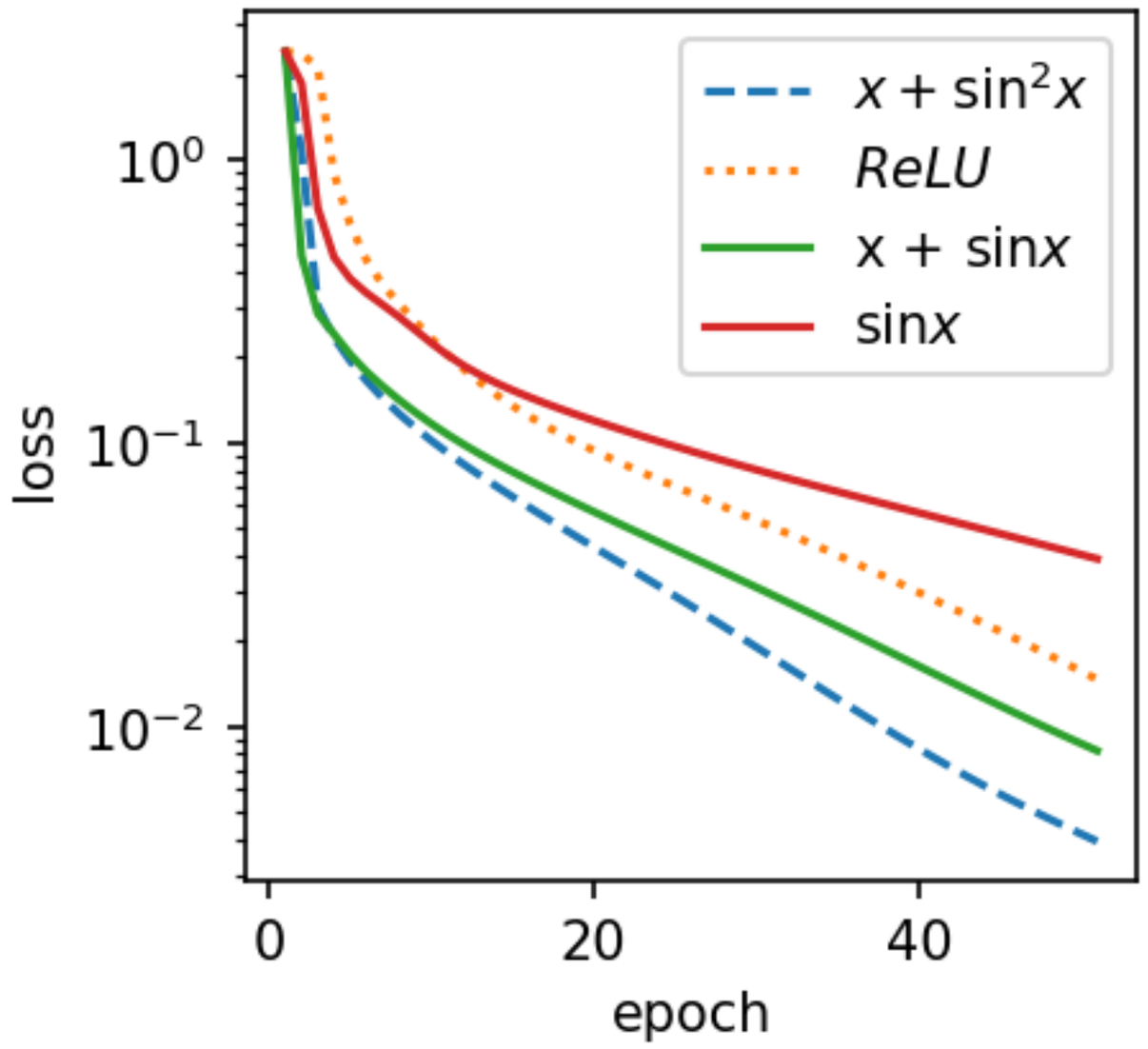


Figure 8: Prediction of human body temperature. (a) Snake; (b) Averaged temperature prediction in a circadian cycle (i.e. as a function of the natural hours in a day); (c) tanh and ReLU; (d) sinusoidal activations.

Applications: MNIST





Snake can also be used on "classical" computer vision tasks.

Conclusion & Summary

- We propose a **new activation function** to model and extrapolate periodic data: $x+\sin^2(x)$ ("Snake").
- Minimises **inductive bias.**
- Can be applied to all kind of **semi-periodic data** and image classification tasks.