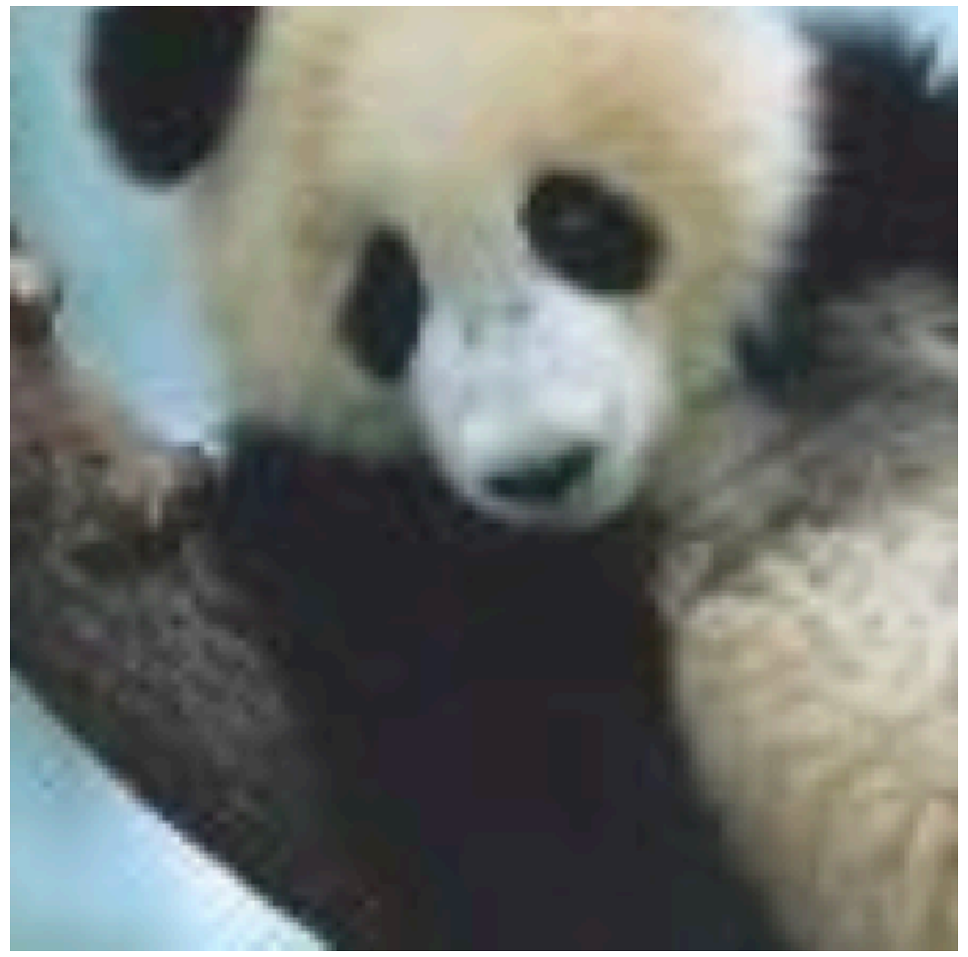
Hacking Computer Brains

🔥 Nobody panic! 🔥

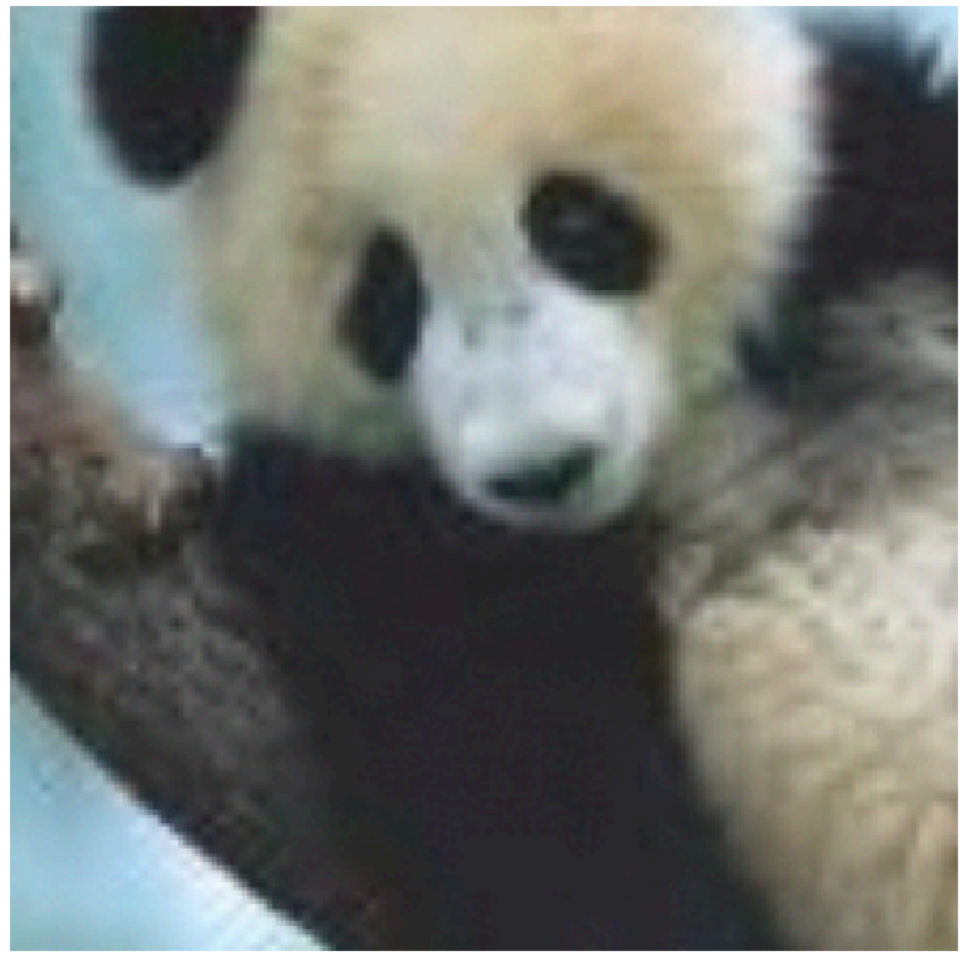
By Dan

Some problems

- Deep Neural Networks (DNNs) are great — they’re pretty useful things
- But they can be exploited in trivial ways with surprising consequences



Panda



Gibbon

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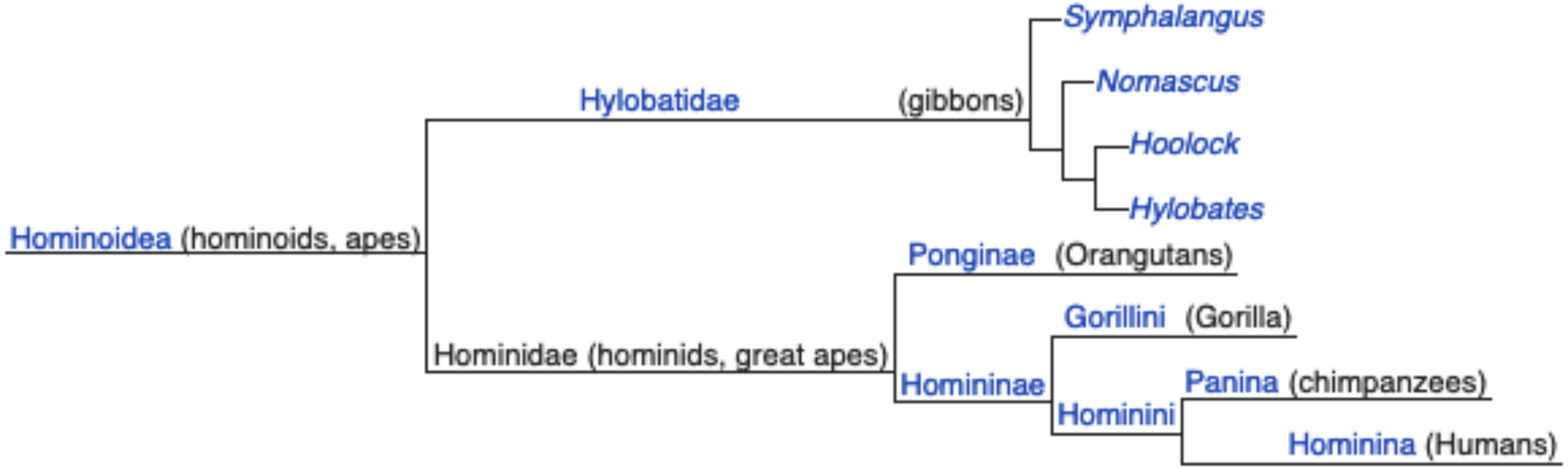

[1]

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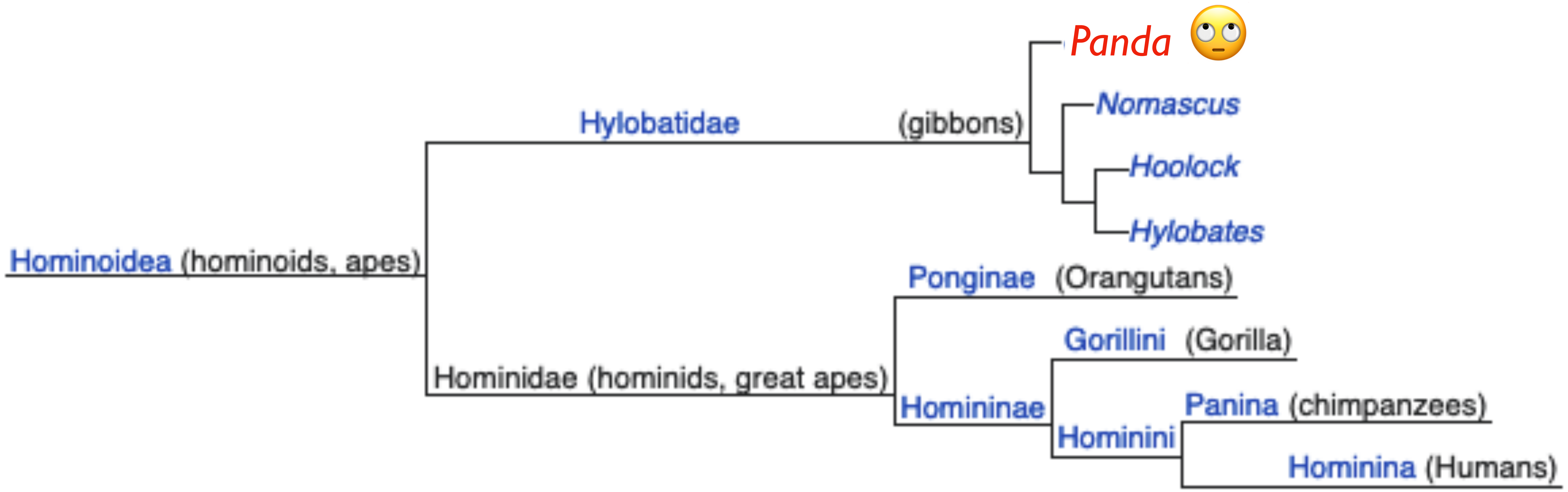
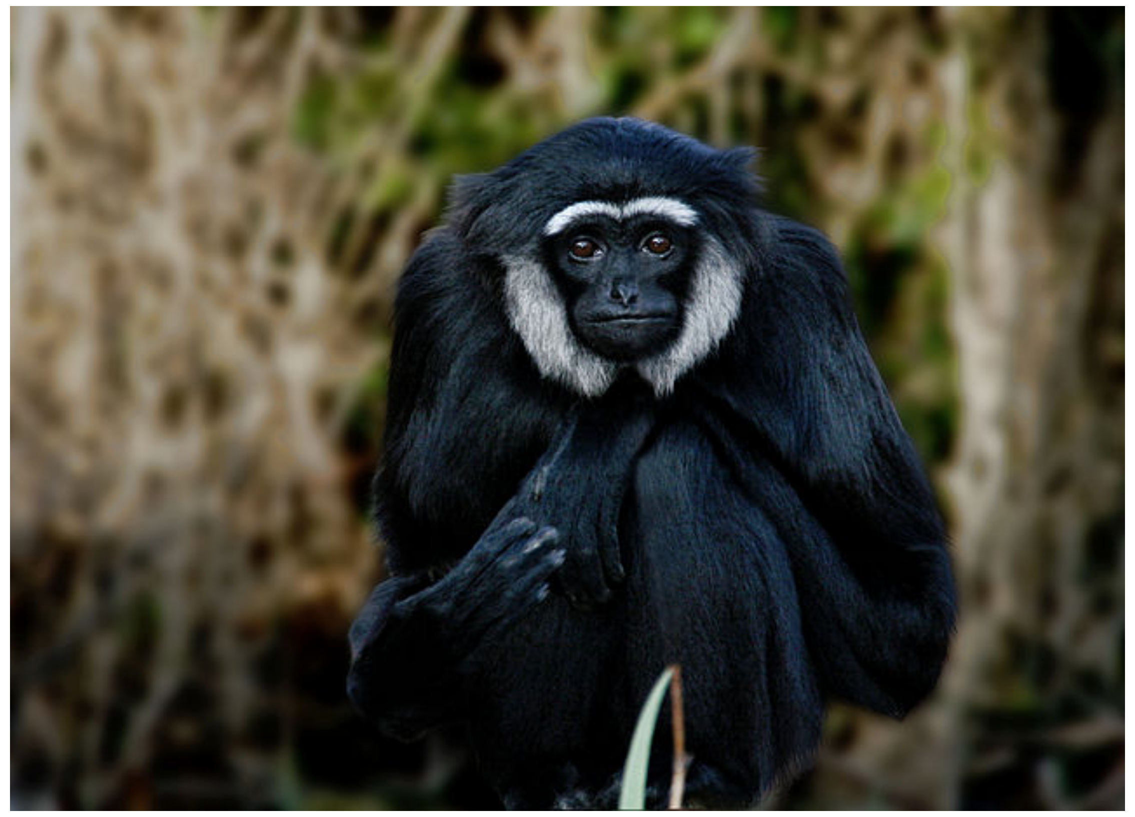
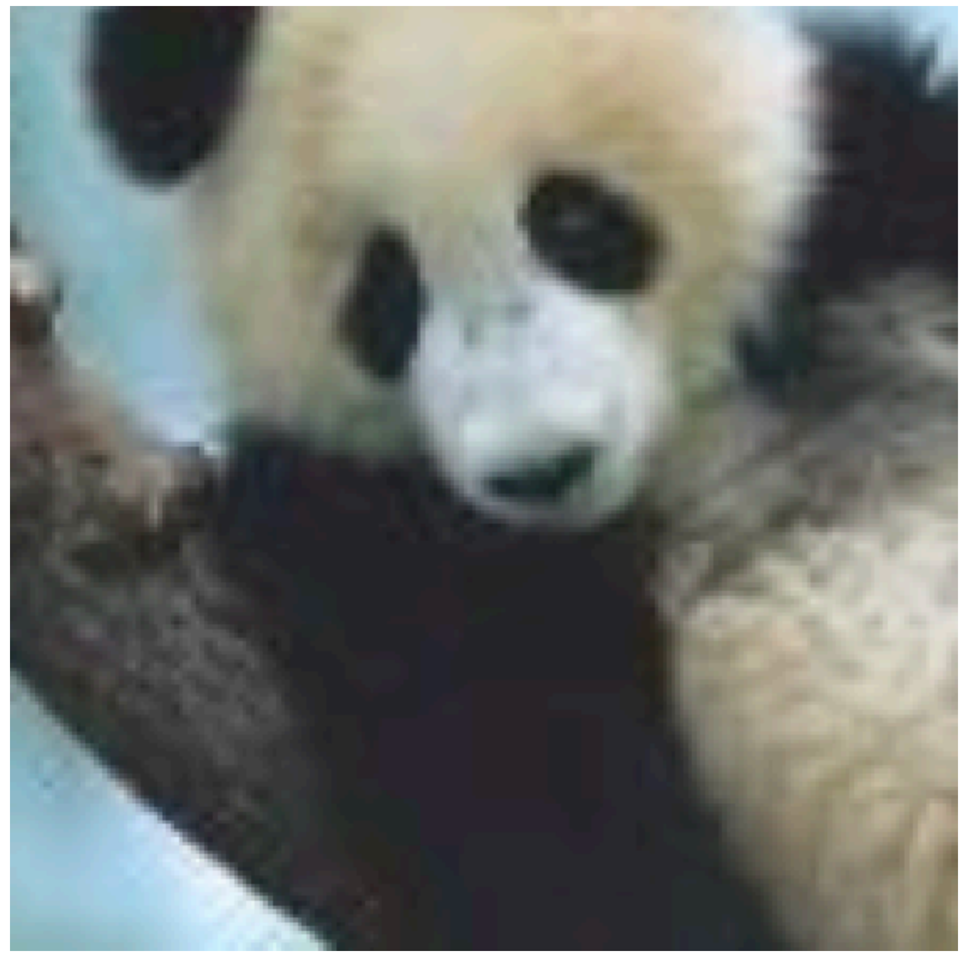




[1]

The difference

An adversarial perturbation has been applied



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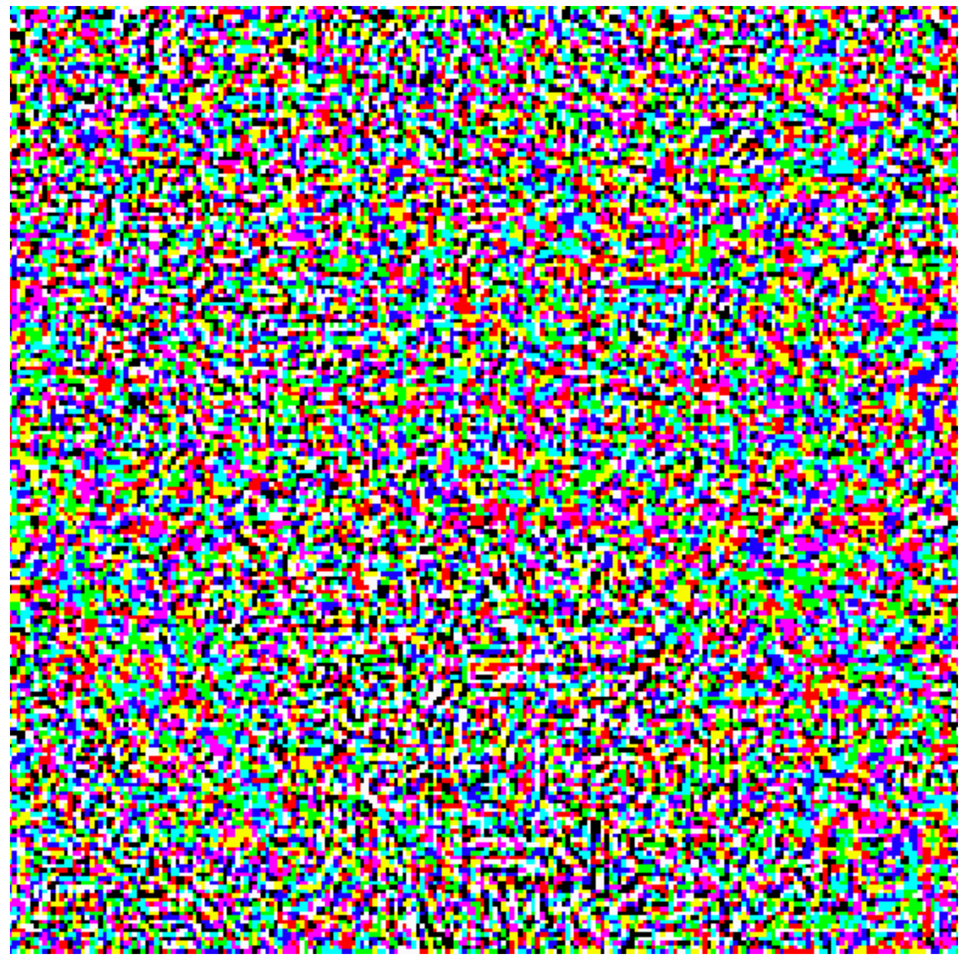
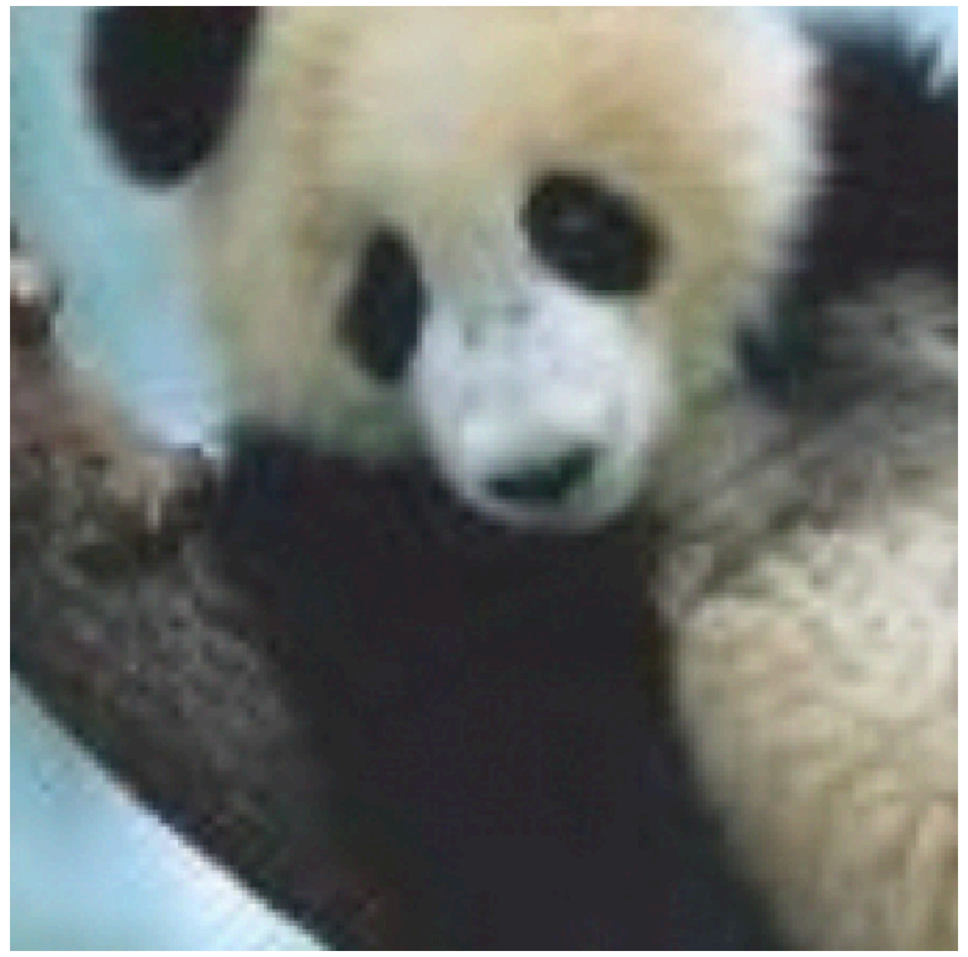
+



Nematode

=



Gibbon [2]

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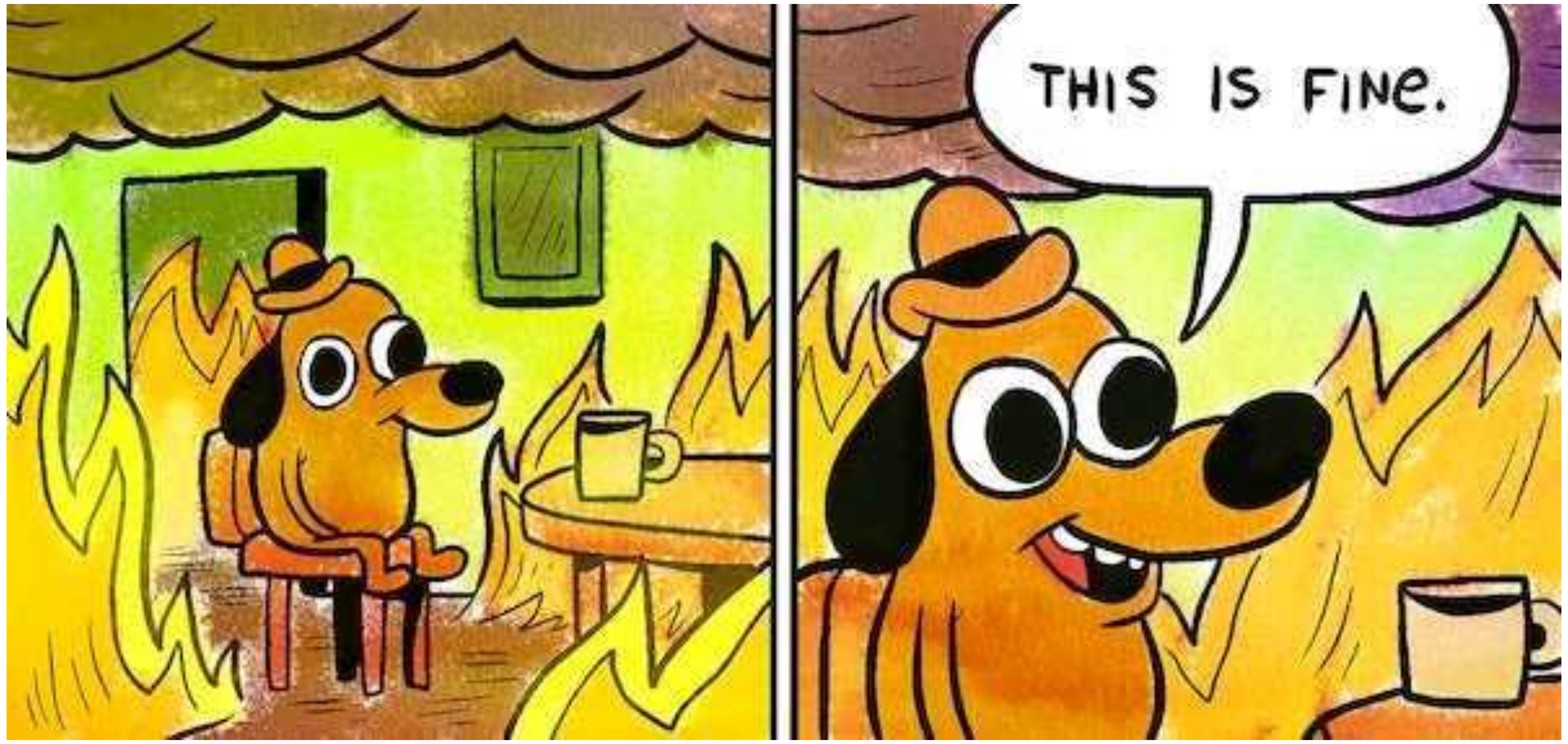
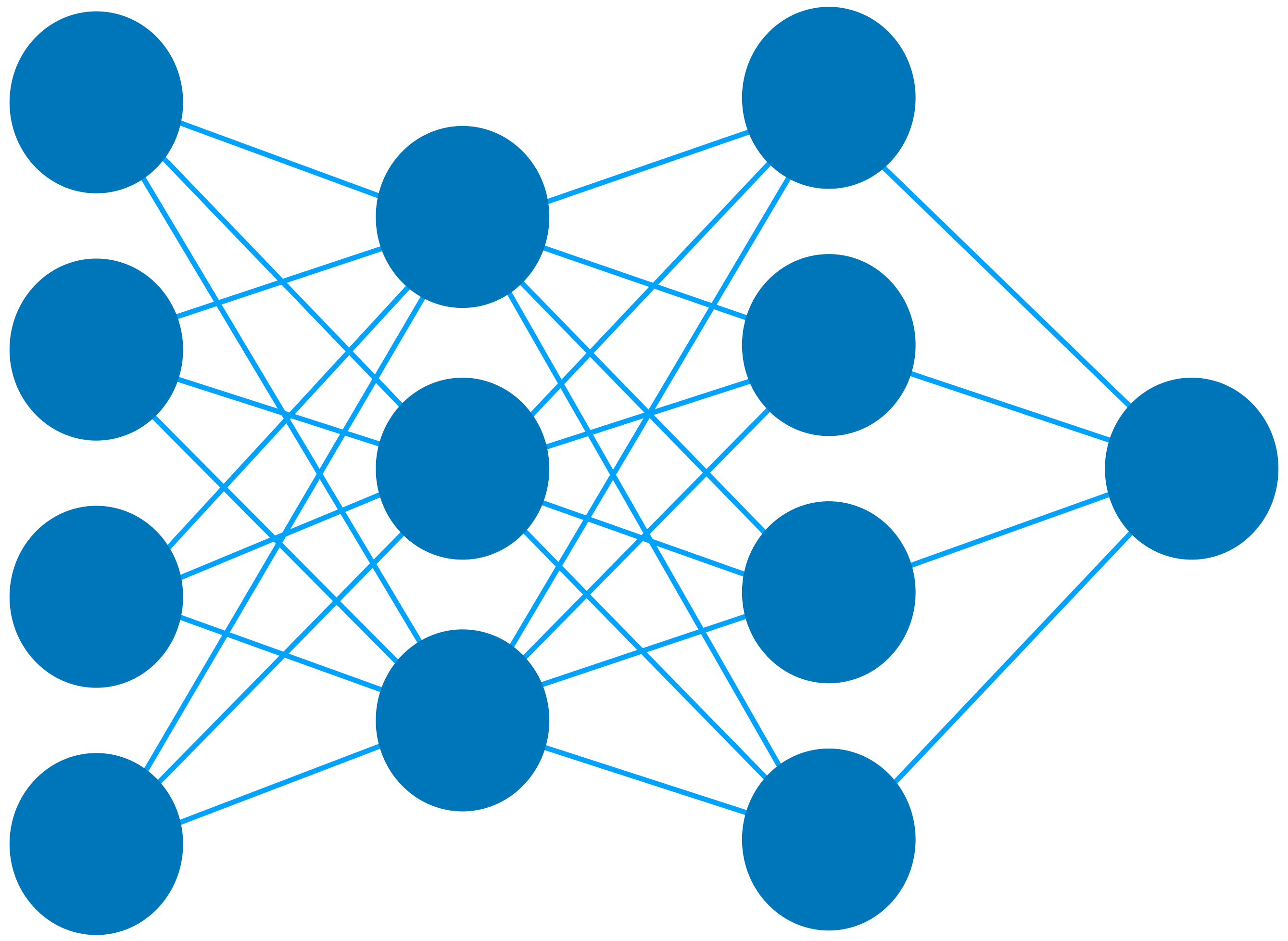


Think again

We can create these attacks by using backpropagation



A simple DNN

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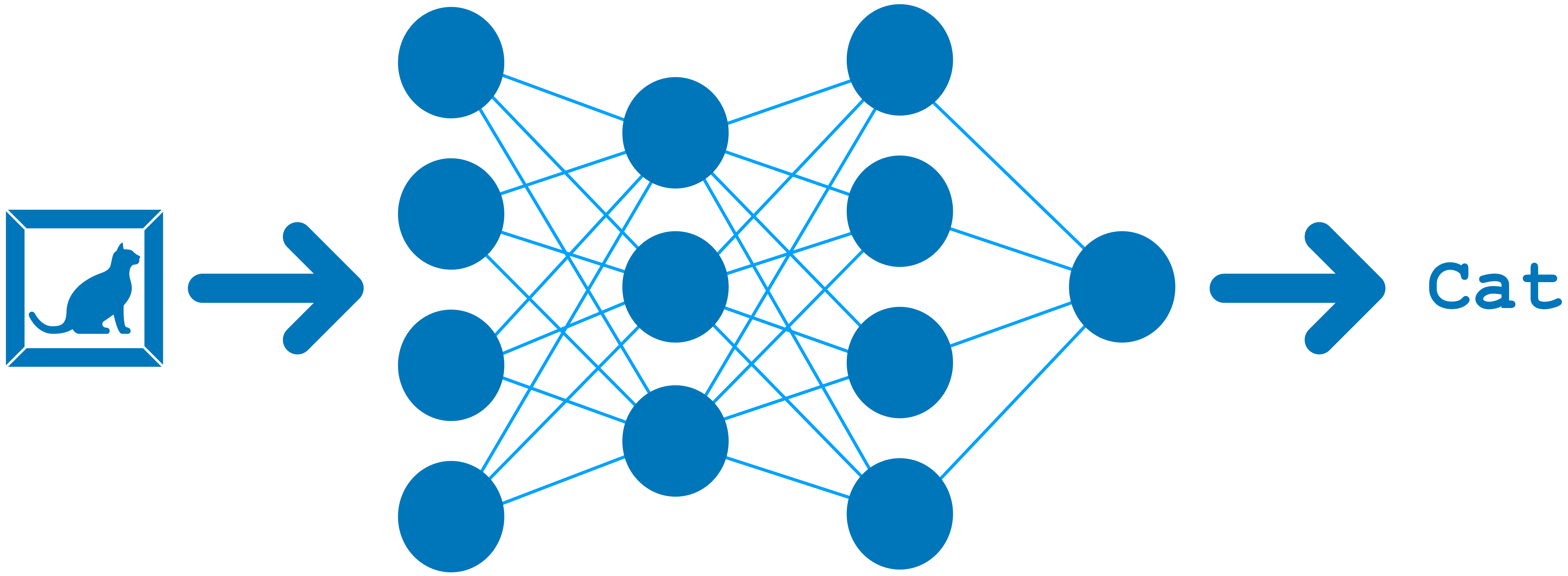

We provide some input and the DNN gives us an output

Think again

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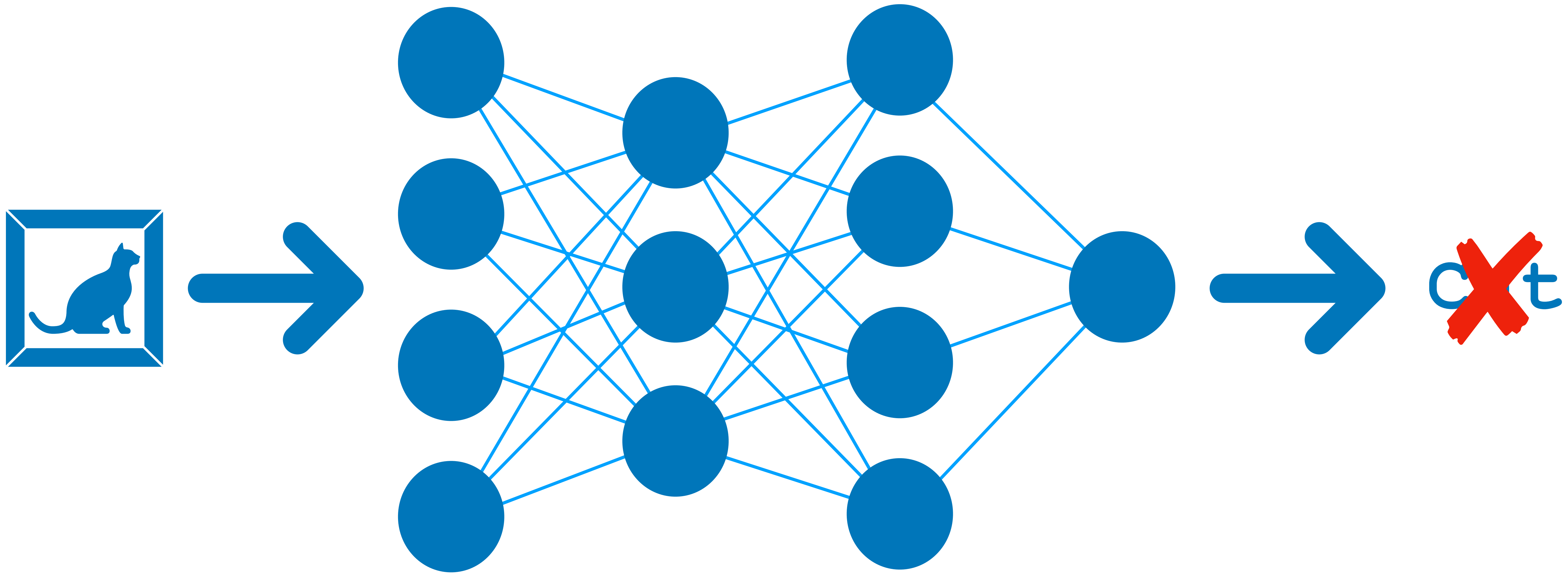

What if we want to encourage a misclassification?

Think again

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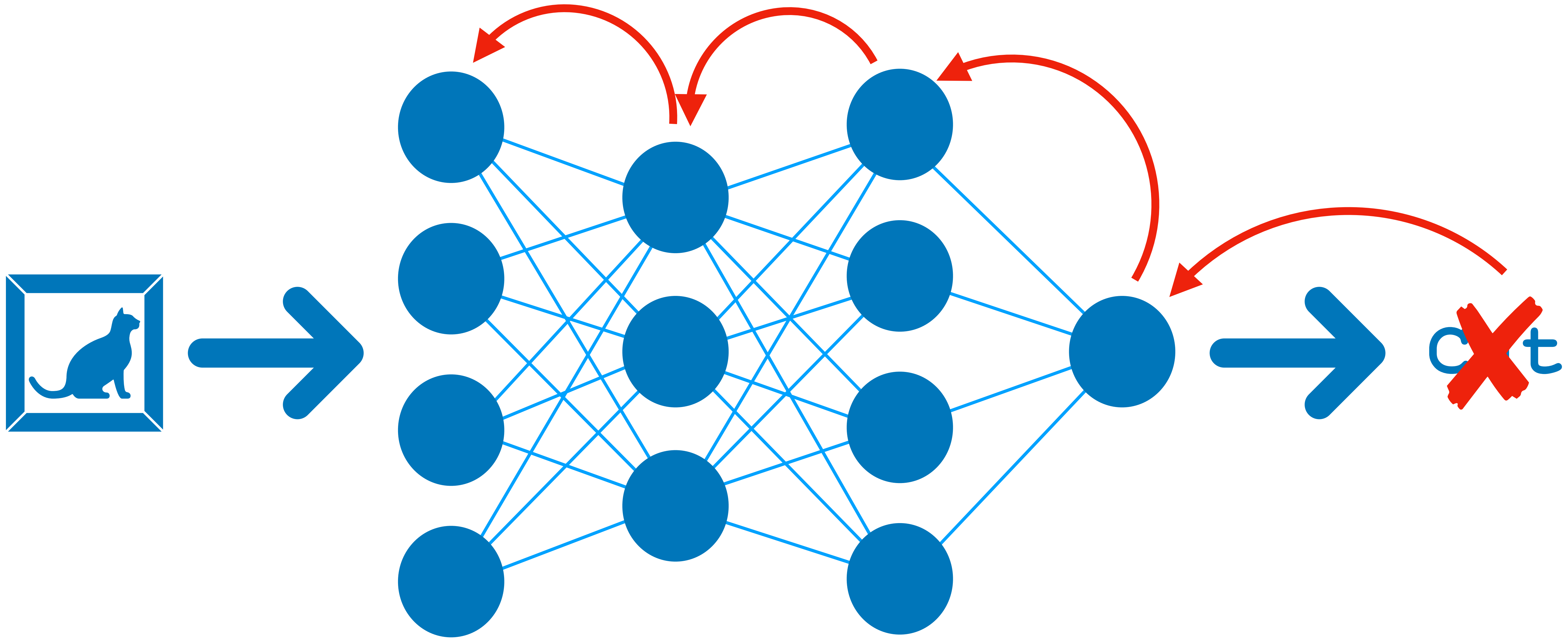

We backpropagate the maximised cost function

Think again

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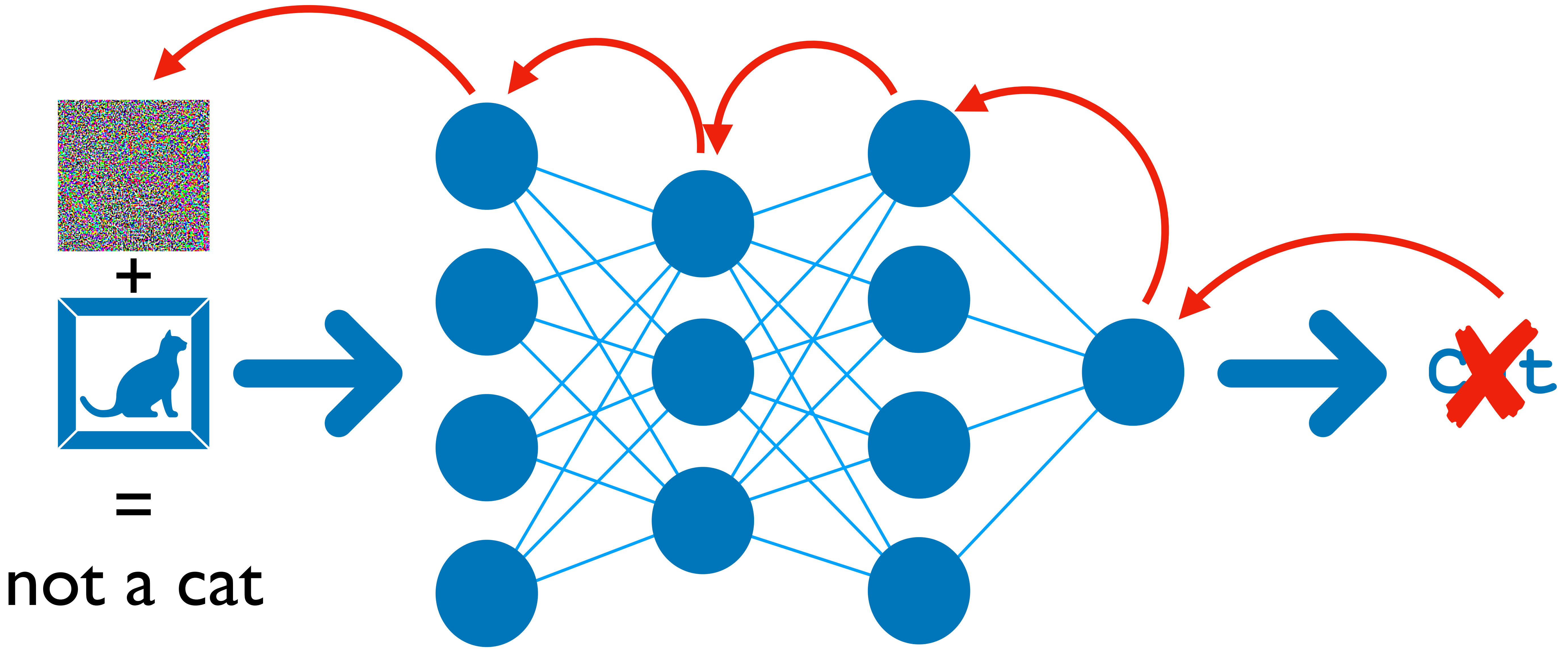

To create an adversarial perturbation

But why? 🤔

There could be a whole presentation on this…

Essentially DNNs are *“function approximators”*

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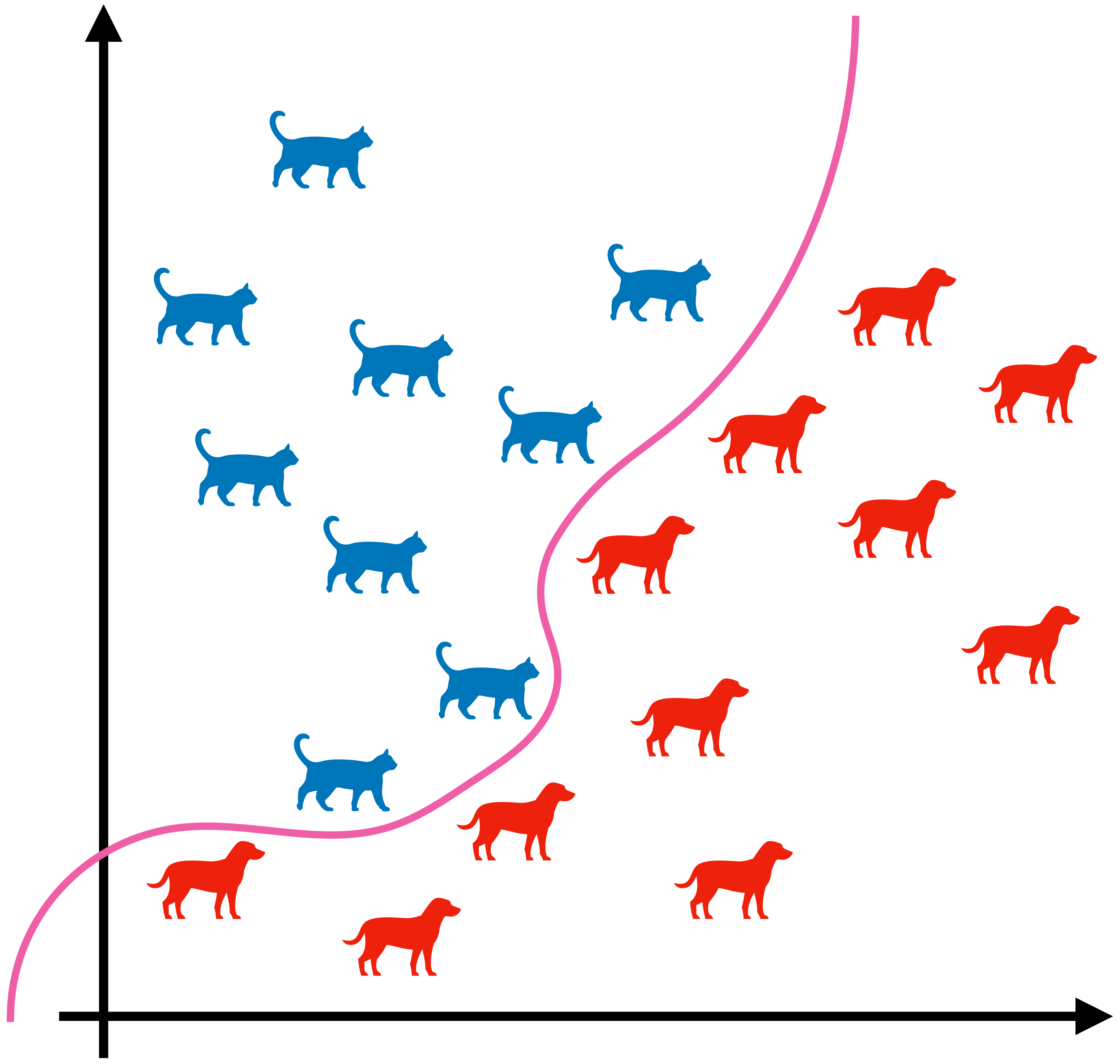

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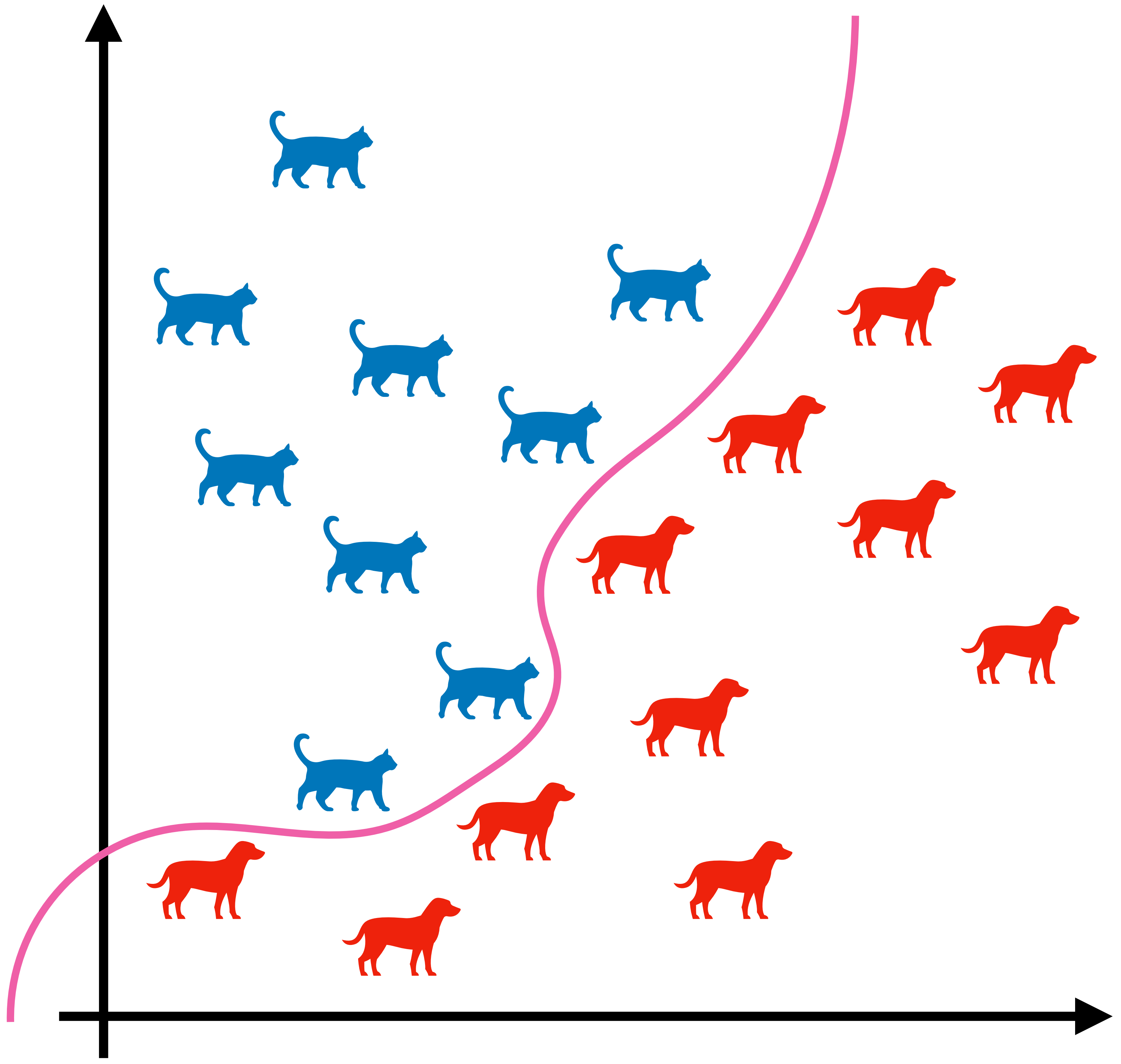

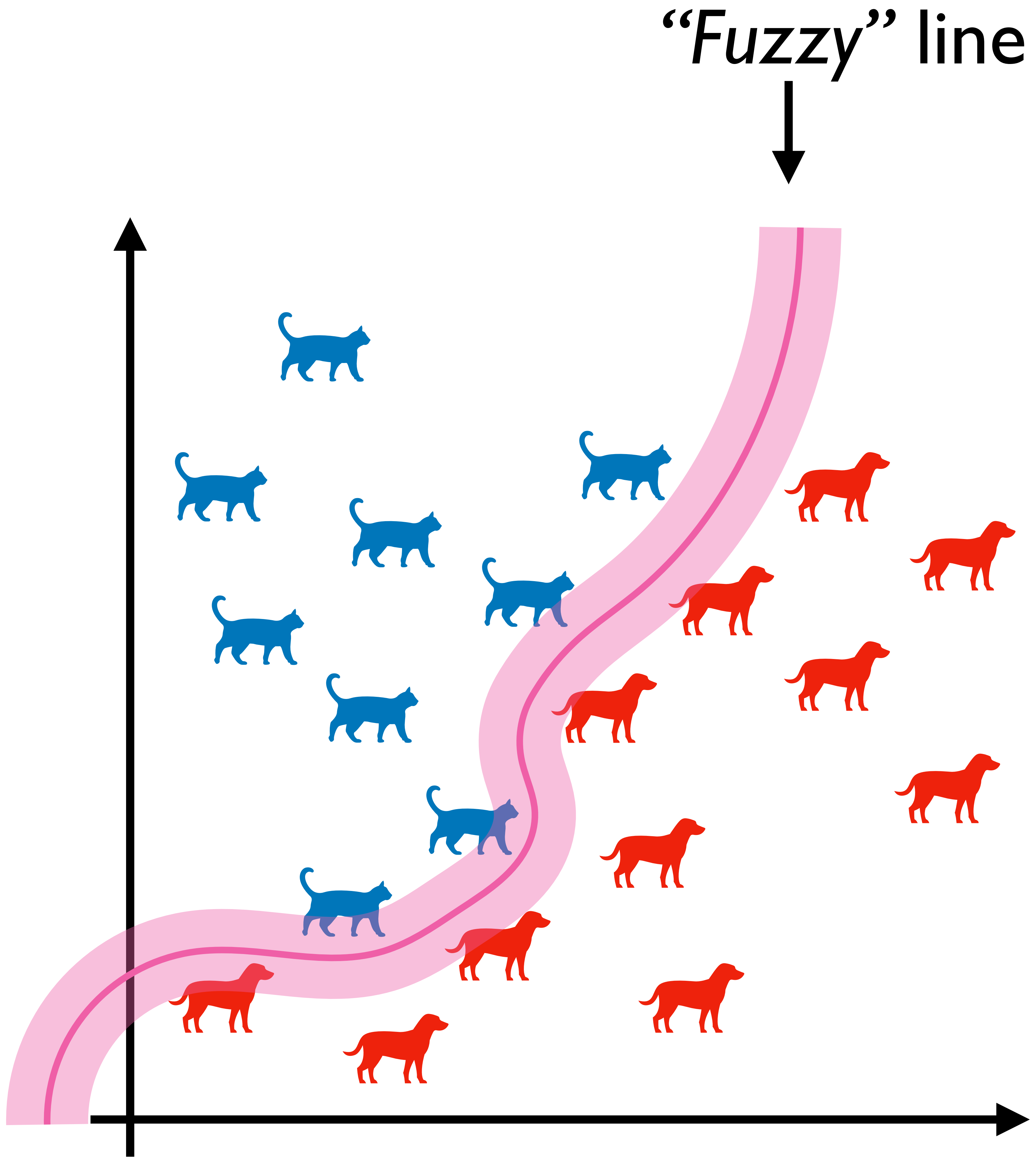

So what?

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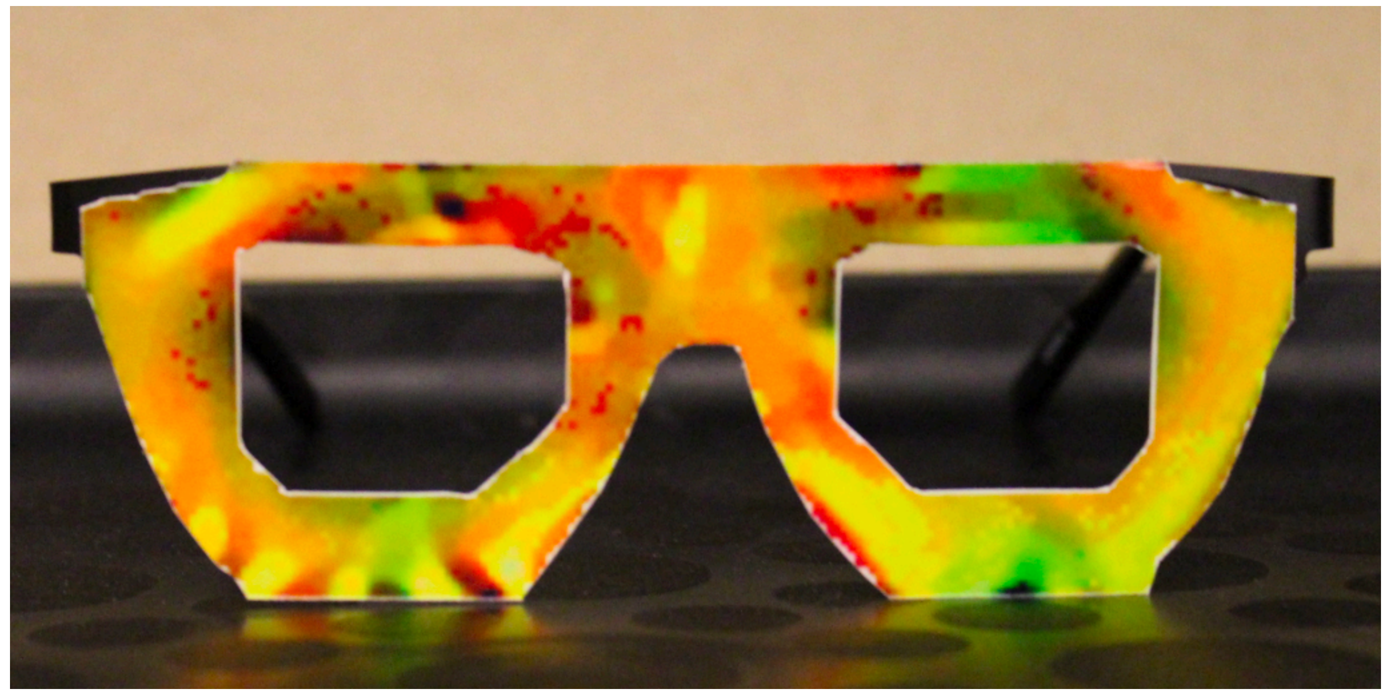
- Facial recognition systems



[3]

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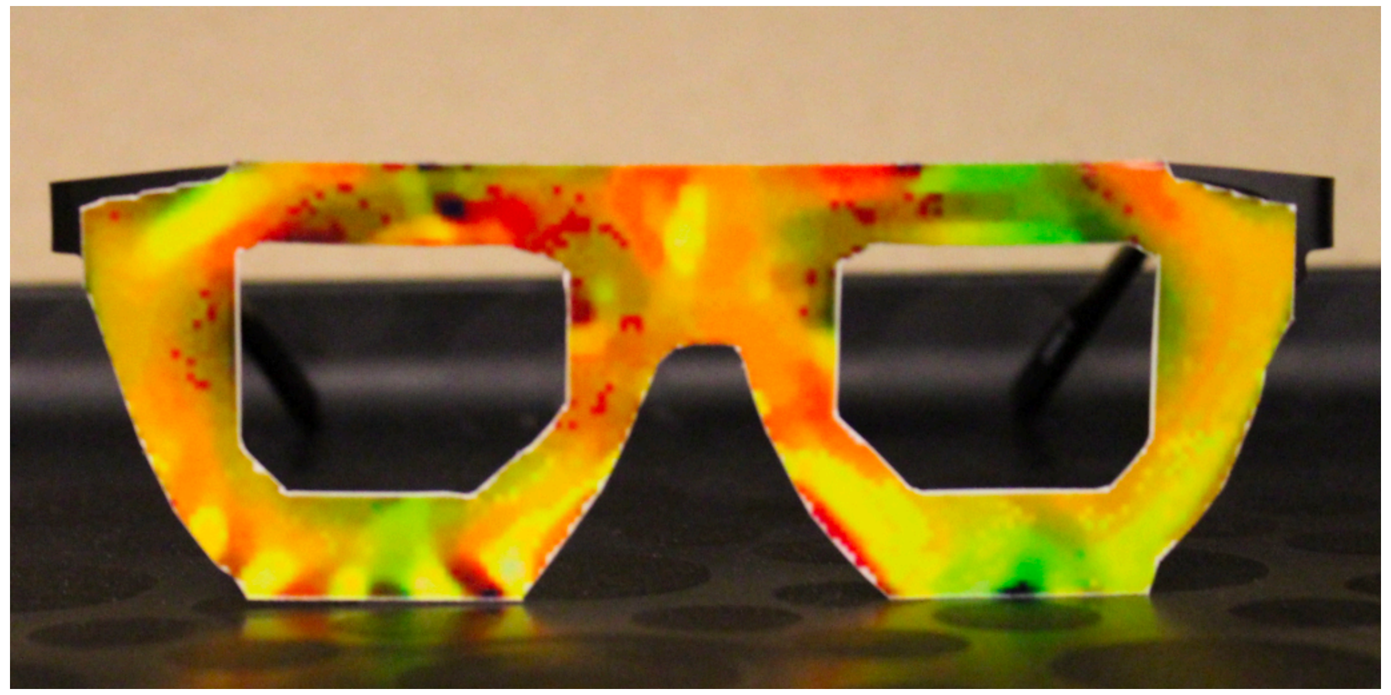

[3]

- Autonomous vehicles

[4]

So what?

These attacks can be performed on any DNN

Provided the input space has a high enough dimension, they can be invisible

We'll leave it there…

Thanks for listening
Feel free to ask any questions!

dxf209@cs.bham.ac.uk

Discord: dxf

References

[1] https://en.wikipedia.org/wiki/Gibbon

[2] Goodfellow, I. J., Shlens, J., & Szegedy, C. (2015, December 19). Explaining and harnessing adversarial examples. *3rd International Conference on Learning Representations, ICLR 2015 - Conference Track Proceedings*. http://arxiv.org/abs/1412.6572

[3] Sharif, M., Bhagavatula, S., Bauer, L., & Reiter, M. K. (2016). Accessorize to a crime: Real and stealthy attacks on state-of-the-art face recognition. Proceedings of the ACM Conference on Computer and Communications Security, 24-28-Octo, 1528–1540. https://doi.org/10.1145/2976749.2978392

[4] Povolny, Steve, and Shivangee Trivedi. 2020. "Model Hacking Adas to Pave Safer Roads for Autonomous Vehicles." McAfee Advanced Threat Research; https://www.mcafee.com/blogs/other-blogs/mcafee-labs/model-hacking-adas-to-pave-safer-roads-for-autonomous-vehicles/

Resources

A good place to start is the original paper by Szegedy *et al.* — https://arxiv.org/abs/1312.6199

For the more practically minded TensorFlow and PyTorch both have tutorials on basic adversarial attacks:
- TensorFlow — https://www.tensorflow.org/tutorials/generative/adversarial_fgsm
- PyTorch — https://pytorch.org/tutorials/beginner/fgsm_tutorial.html?highlight=fgsm

A whole suite of adversarial attacks can be found in the CleverHans python library (does NOT support TF 2.x) — https://github.com/tensorflow/cleverhans

For understanding of Neural Network fundamentals see 3B1B — https://www.youtube.com/watch?v=aircAruvnKk&list=PLZHQObOWTQDNU6R1_67000Dx_ZCJB-3pi

For a deeper understanding of Neural Networks see Deep Learning — https://www.deeplearningbook.org/