How to break Apple's NeuralHash

Introduction to adversarial preimage attacks

Apple's PSI protocol

- Used to detect CSAM on iCloud
- Verification is on-device only
- Privacy-preserving crypto

Apple's PSI protocol

- Detection is based on a watchlist of known hashes
- Standard hashing is inefficient (easy to avoid detection by flipping any bit)

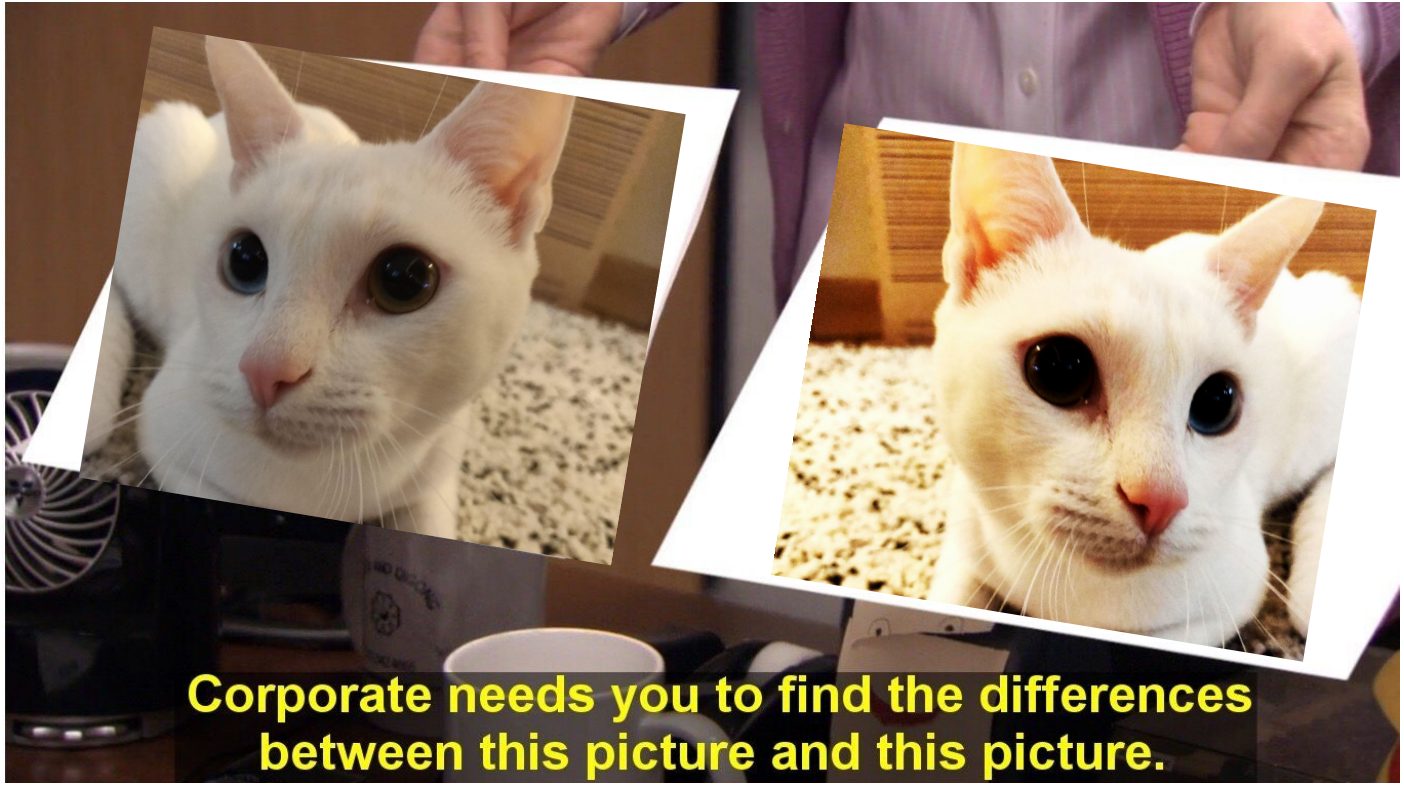
  → use Neural Networks!

NeuralHash

Neural network trained to give the same hash to similar images

Very similar to FADA's FaceNet!

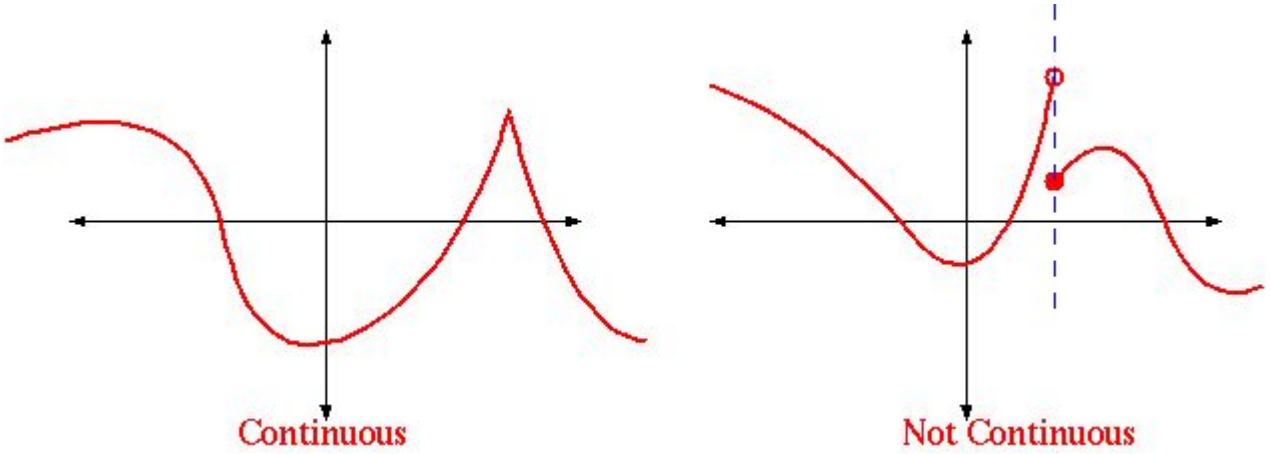
How it's trained



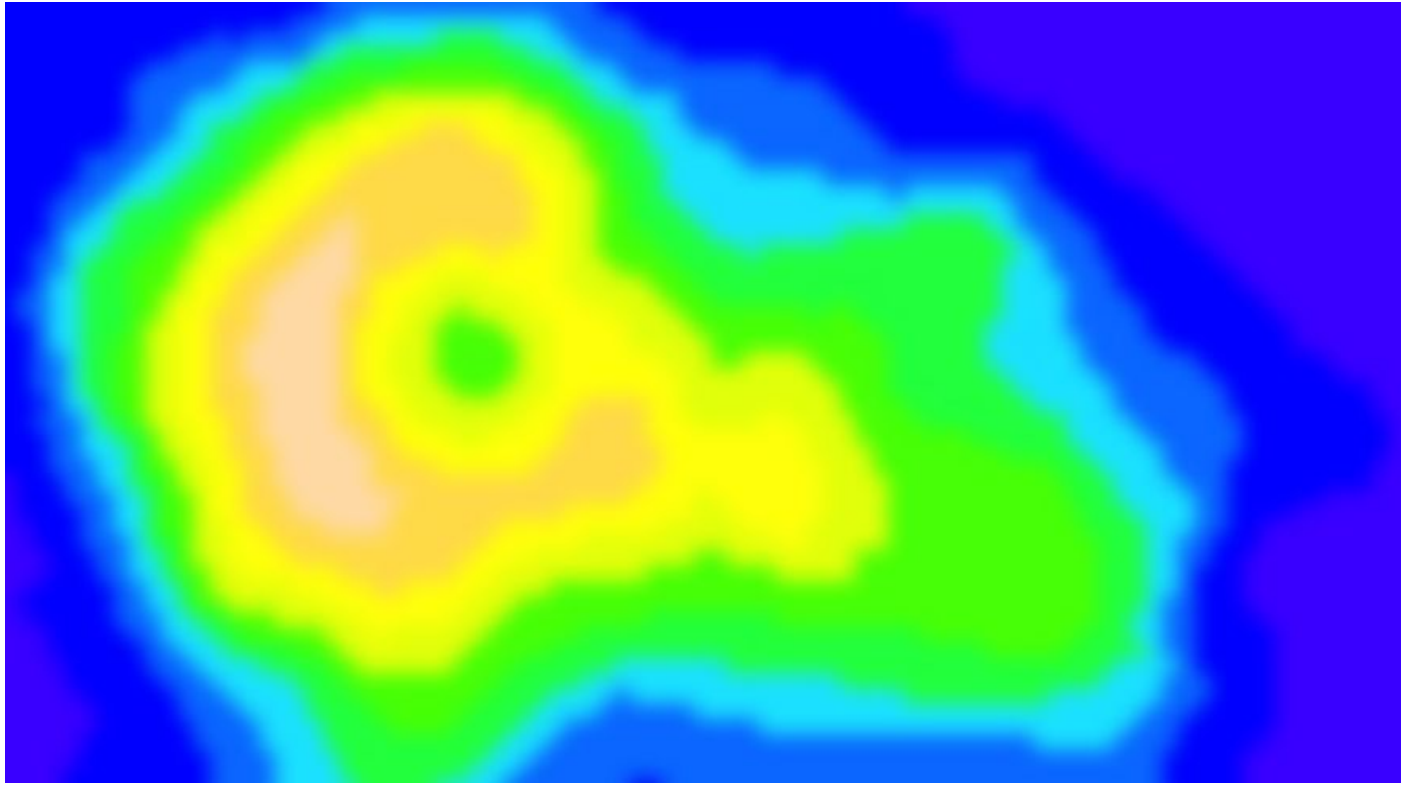
Adversarial attacks

Neural networks are <u>continuous</u> functions

Small input change = small output change



Adversarial attacks

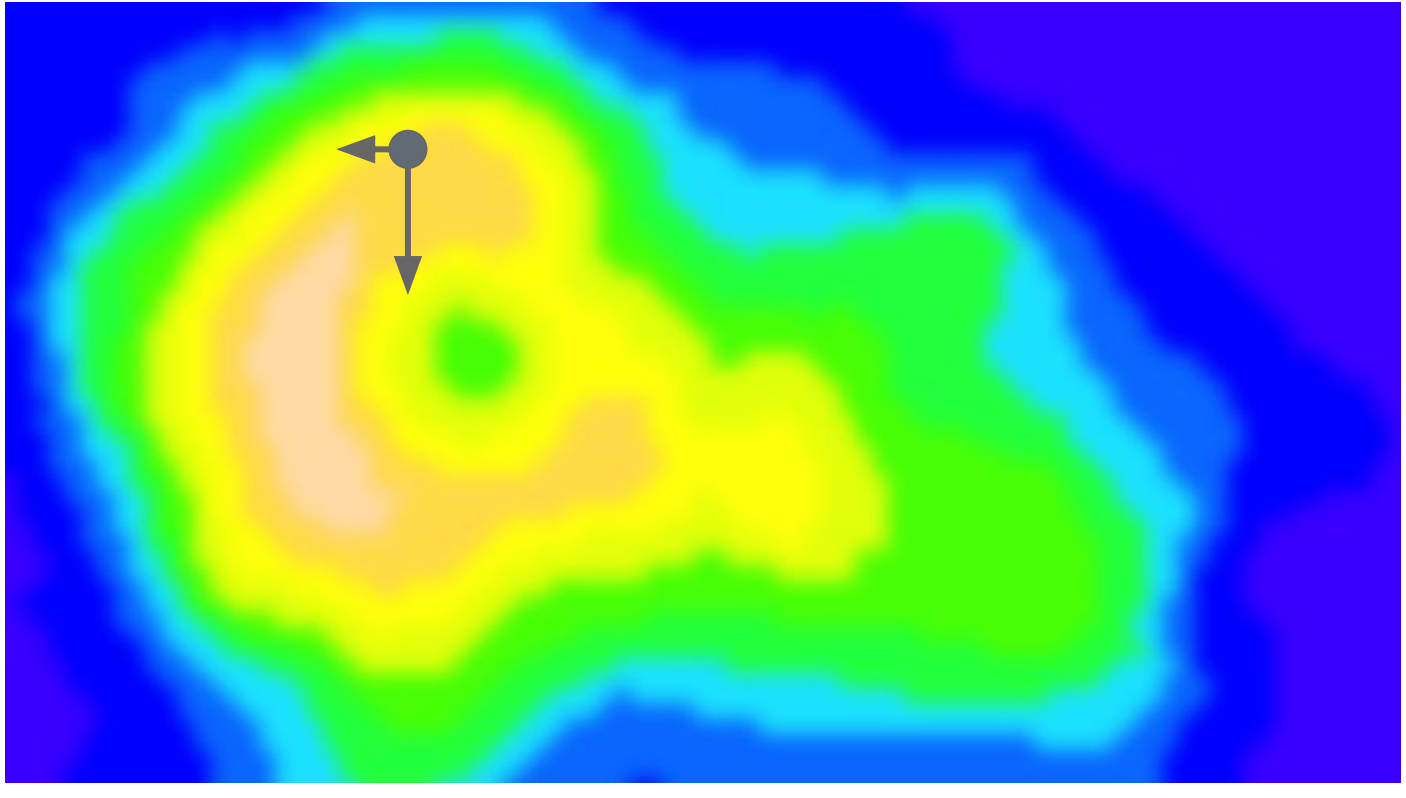


Adversarial attacks

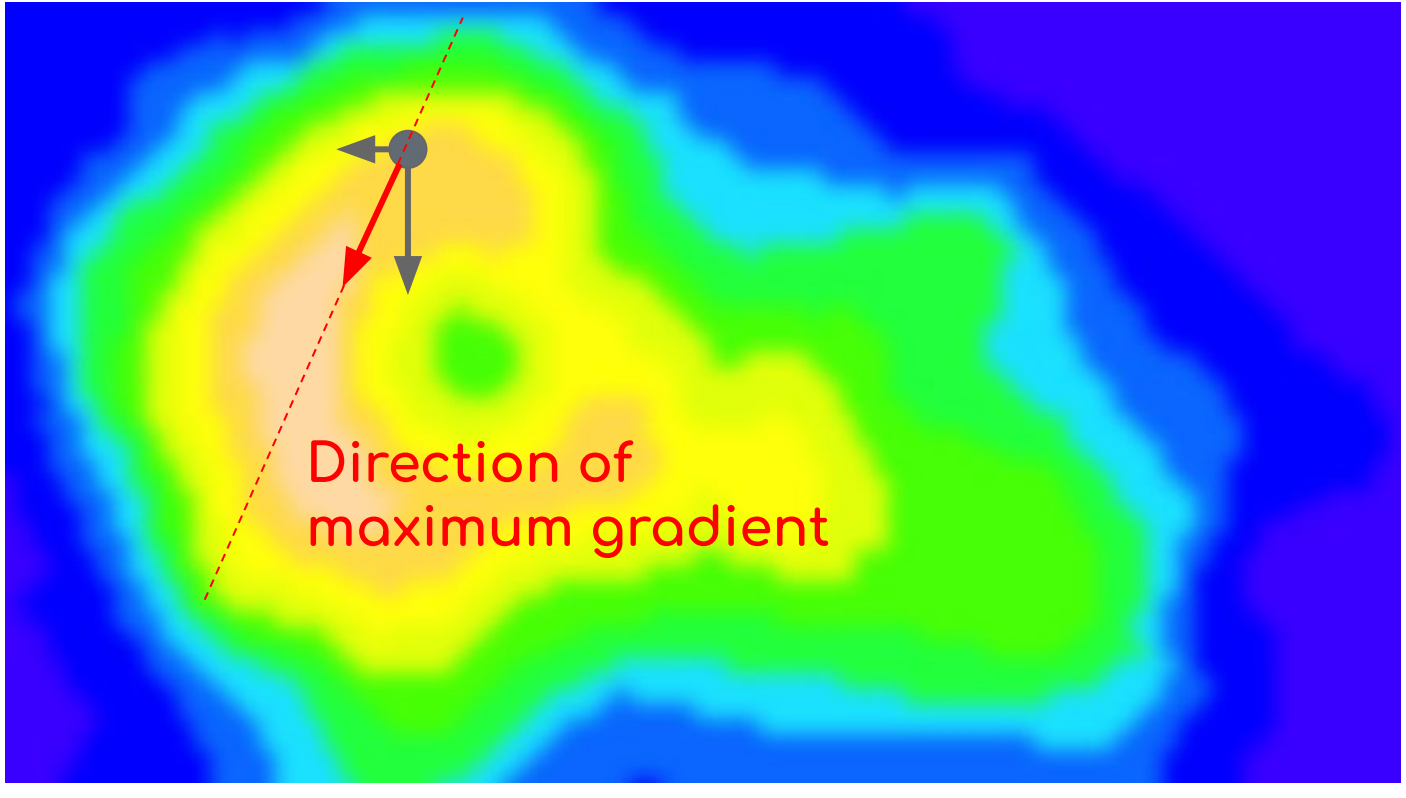
Differentiability

is a crucial property of neural networks

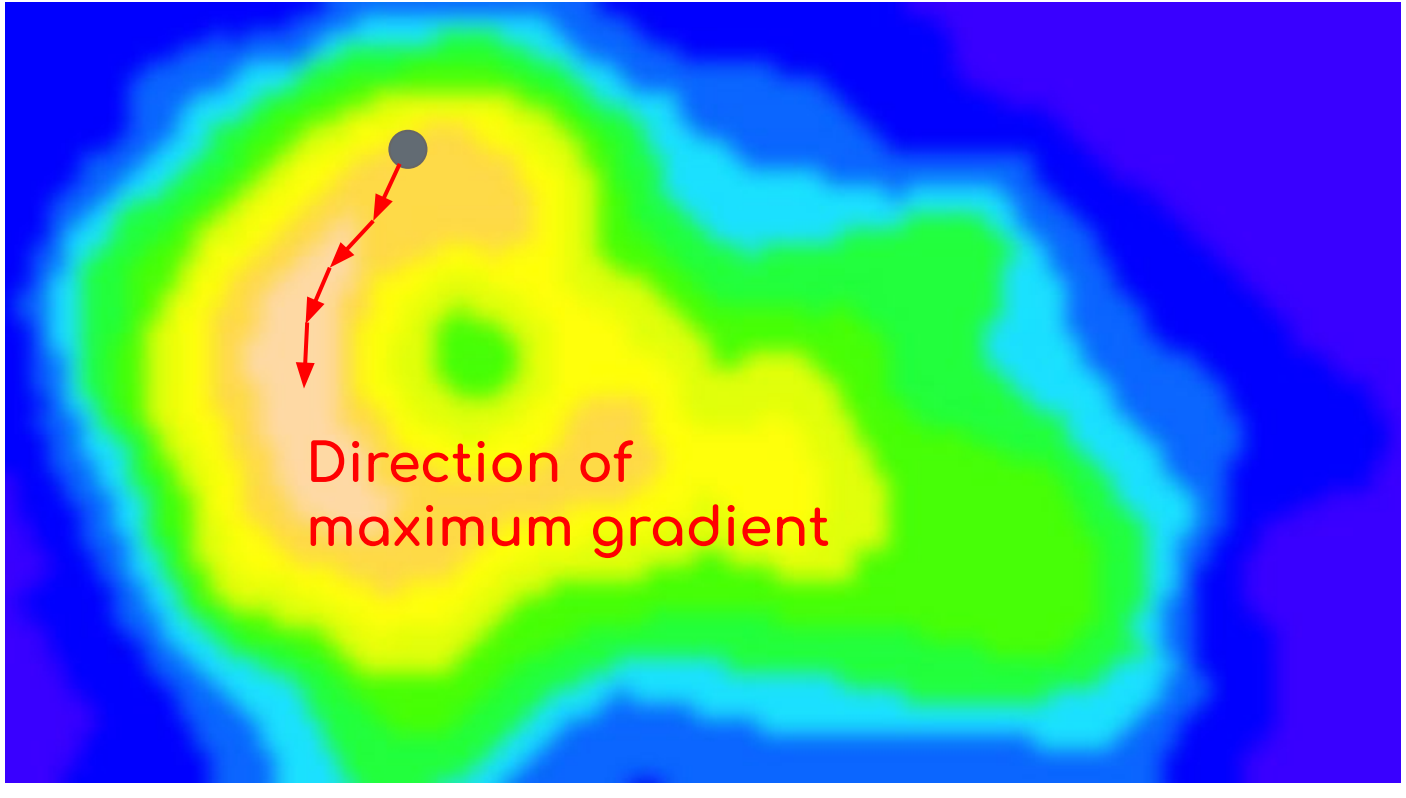
Adversarial attacks



Adversarial attacks



Adversarial attacks



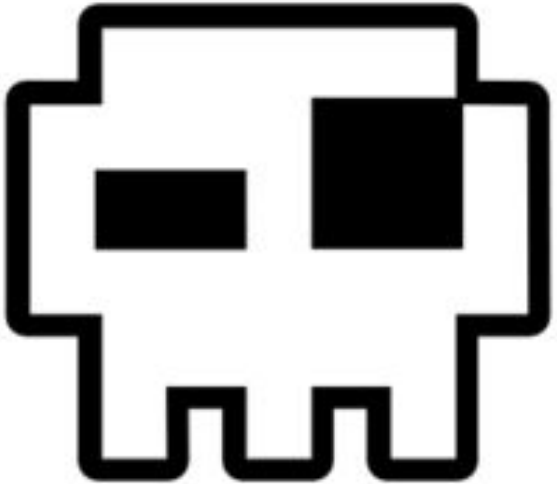
Adversarial attacks

Much more complex in practice (1080p image is more than 6M dimensions)

But the principle is the same : small changes towards target using gradient

Let’s hack NeuralHash!

Result



b8c8cd71e551101f54c3874b

Conclusion

- All neural networks have this vulnerability by definition
- Some mitigations exist
- Do not use NNs for critical tasks in adversarial environments

Bonus


NeuralHash self-image !
c7ef b04a f72a
893f e963 f6a1
@MathisHammel

Bonus

= c7ef b04a f72a...

Bonus

= c7ef b04a f72a...

Bonus

= c7ef b04a f72a...

= c7ef b04a f72a...

Q&A

Thanks!


@MathisHammel / @h25io


discord.h25.io


twitch.h25.io