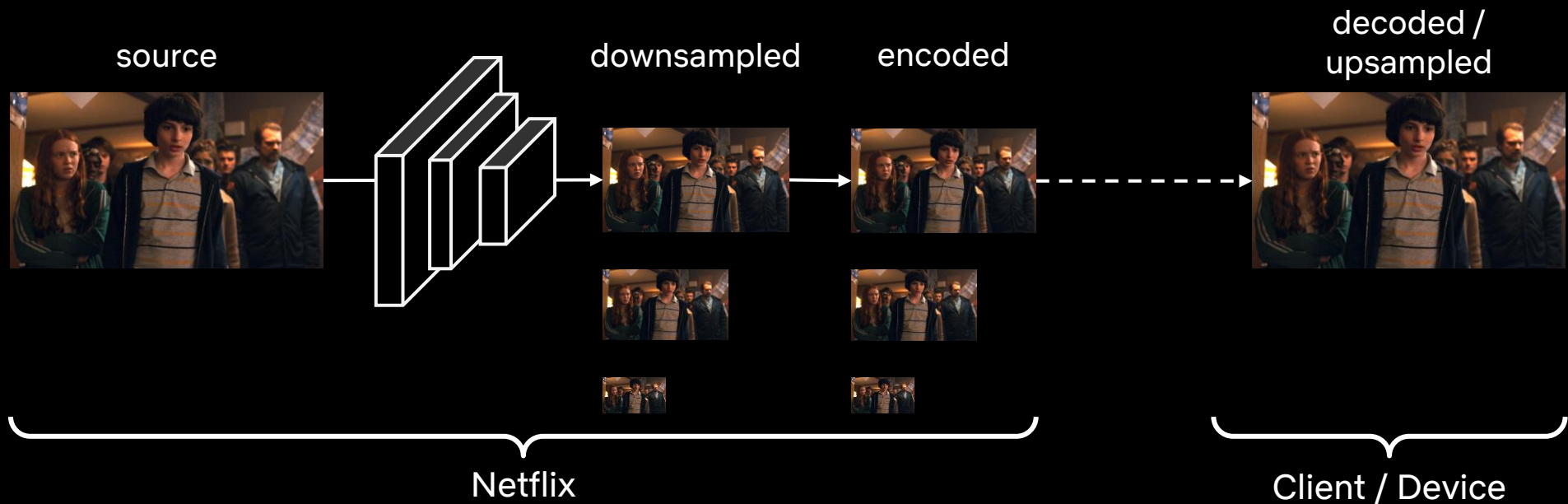# Improving Netflix Video Quality with Neural Networks

Christos Bampis, Li-Heng Chen, Zhi Li
Netflix Encoding Technologies

MHV 2023

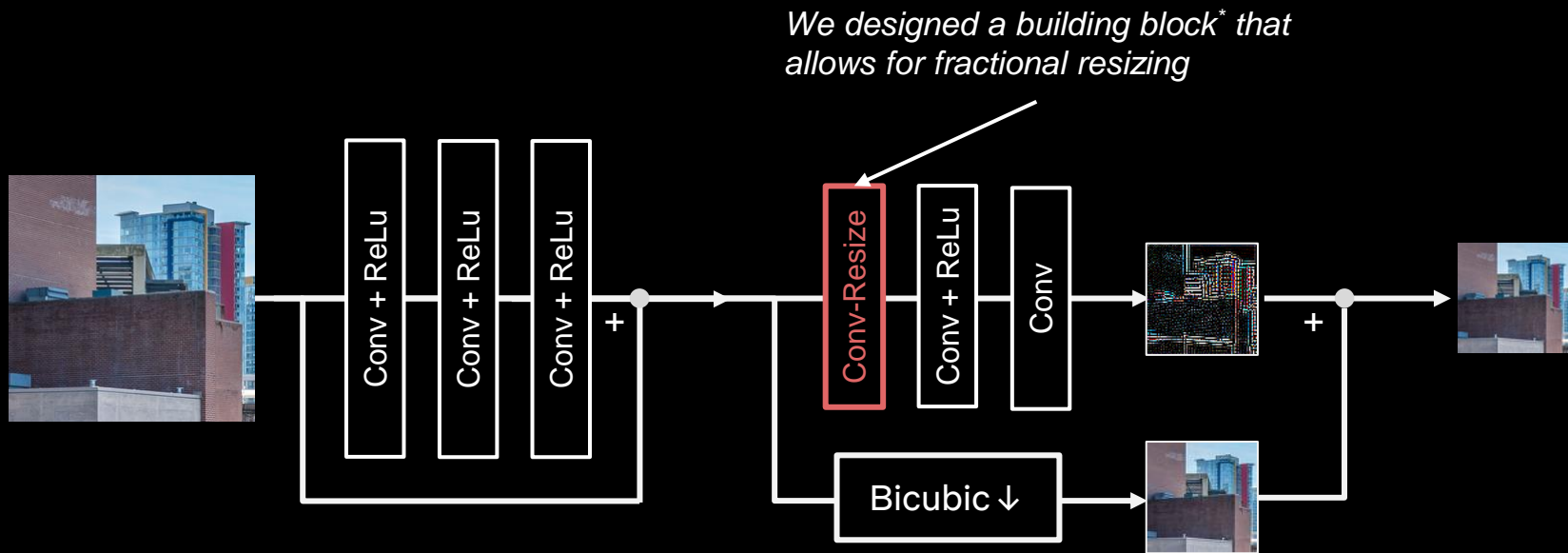# We developed neural networks to improve downscaling done during cloud-based encoding.

source

downsampled

encoded

decoded / upsampled

Netflix

Client / Device

Our networks, aka deep downscaler, are trained to produce the best downsampled representation.

Training: minimize the reconstruction error

Not differentiable!

Deep ↓

Encode

bicubic↑

Input

Output
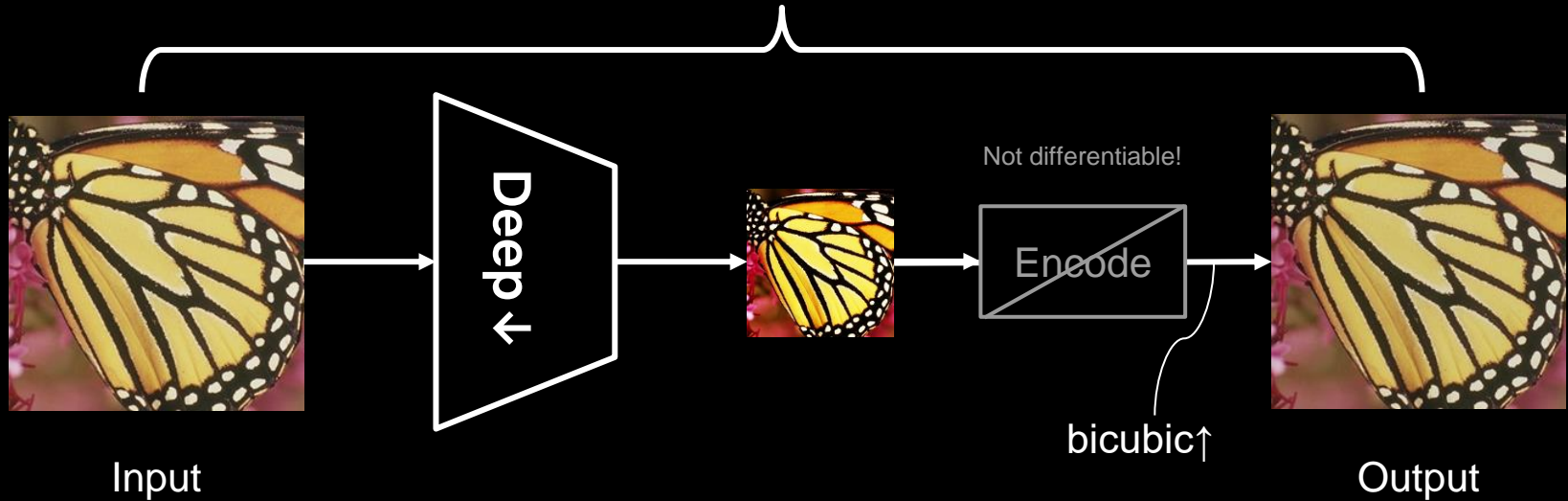
We use only a few custom-made convolutional layers.

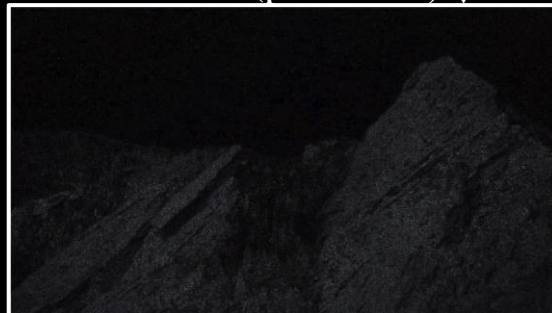We designed a building block* that allows for fractional resizing

| *Chen *et al.*, "Convolutional Block Design for Learned Fractional Downsampling," 56th Asilomar Conference, 2022

The network compensates for frequencies lost by downscaling for edges or regions with rich texture.

Source video

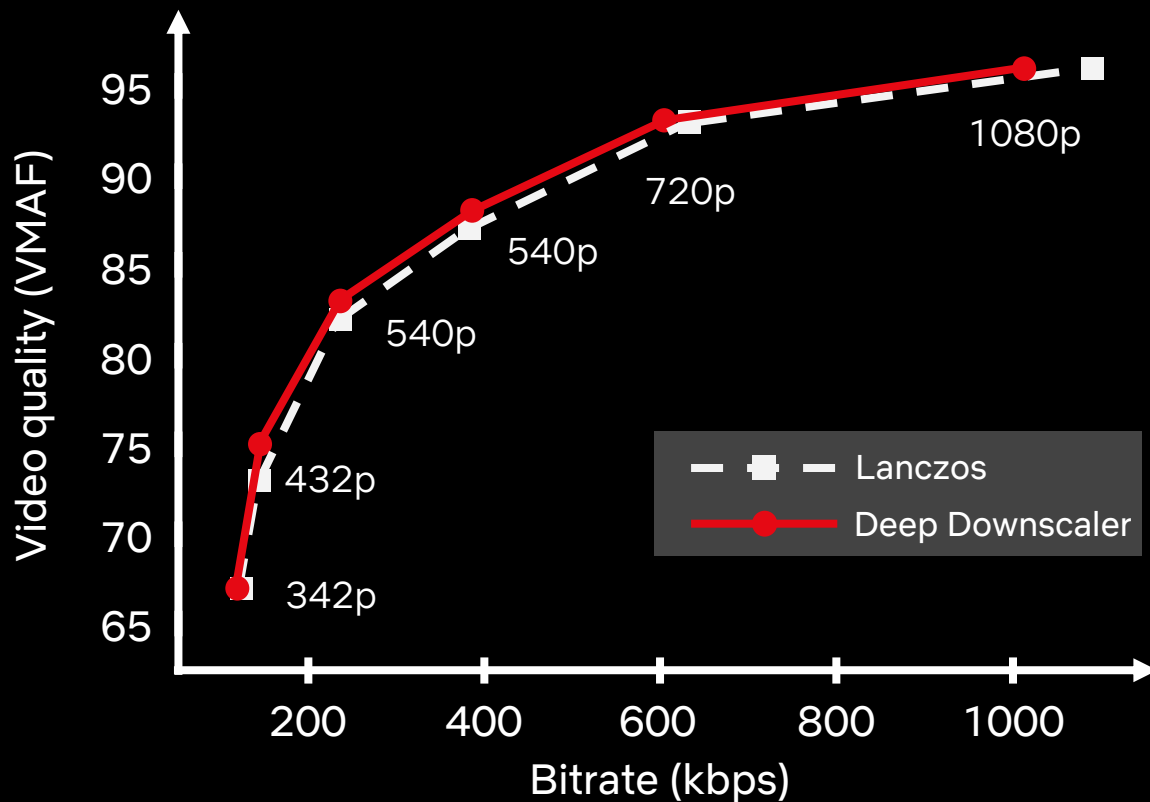Residuals (pre-down) ↓2

Residuals (post-down) ↓2

Lanczos

Deep downscaler

We measured 5% encoding gains on average. Put simply, we use 5% less bits for the same VMAF.

# We validated the visual quality improvements with rigorous subjective studies using paired-comparison.

76%
subjects preferred the "deep downscaler" version

82%
of these visual preferences were statistically significant

We deployed our neural networks as part of our encoding microservices in Cosmos*.

Encoding microservice

| downscaling using ffmpeg filter | encoding |
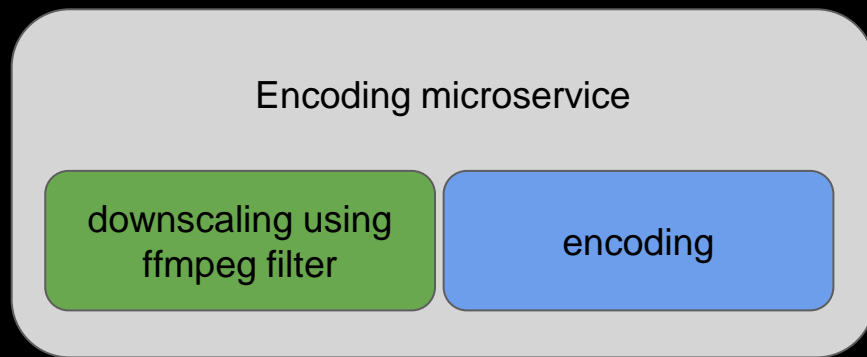
Through iterative development, we arrived at a viable product, ~10x faster compared to our prototype.

- A luma-only model

- Model complexity reduction

- Ffmpeg filter integration

- Leverage Intel® one-DNN library

- And more …

This effort paves our ML journey for Netflix video encoding at scale. But we are only getting started.

- More efficient solutions to neural network applications

- Video denoising

- NN-based coding tools

- And more …

The End