

Homework 3 — Theory

Due: May 31, 2026

A 1-D stride-2 convolution layer is applied twice sequentially to an input 1-D tensor, with the same filter denoted k_2 . The input is padded with zeros only once before the two convolution layers are applied, so that the final output size is exactly $\frac{1}{4}$ of the input size. Find an equivalent filter k_4 that, when applied just once with a stride-4 convolution layer and the same padding, yields the exact same result.

Guidance: recall that a convolution layer (with appropriate padding) performs cross-correlation—discrete non-circular convolution with the **flipped** filter. Also note that a stride- s convolution is equivalent to a convolution followed by subsampling by s . Thus k_4 is defined by:

$$x * \tilde{k}_4 \downarrow_4 = (x * \tilde{k}_2 \downarrow_2) * \tilde{k}_2 \downarrow_2$$

where \tilde{k} is k flipped and \downarrow_s means subsampling by a factor of s .

Hint: use the notion of dilated convolution.