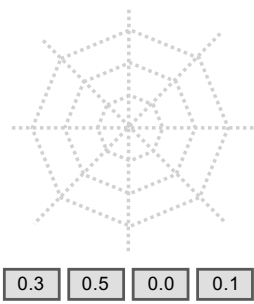


(a) Traditional

Single-Pass Prediction

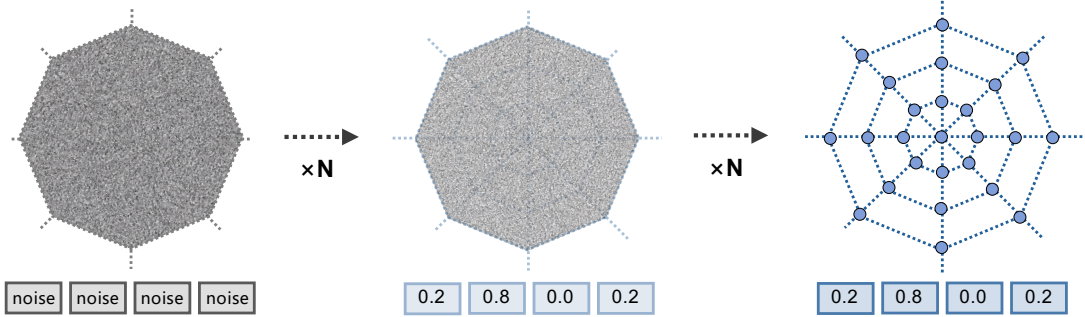
Progressive generation ✗ Gene-wise generation ✗ Regulatory guidance ✗



(b) DDPM

Global Denoising

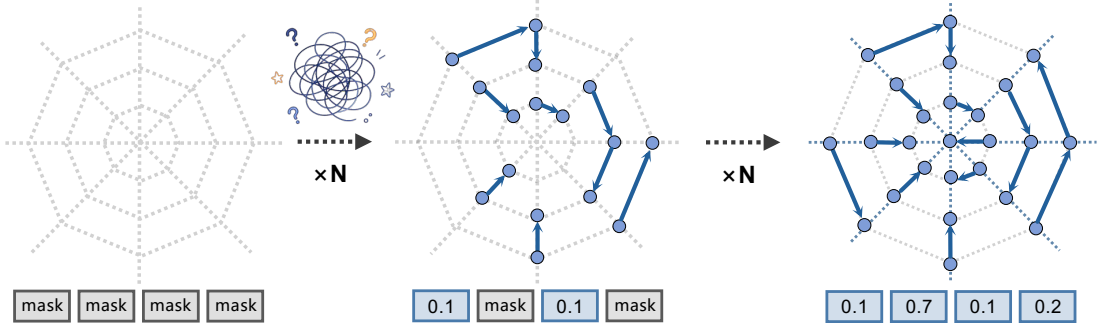
Progressive generation ✓ Gene-wise generation ✗ Regulatory guidance ✗



(c) MDDM

Random Unmasking

Progressive generation ✓ Gene-wise generation ✓ Regulatory guidance ✗



(d) D²R²

Guided Unmasking

Progressive generation ✓ Gene-wise generation ✓ Regulatory guidance ✓

