Image generation using a diffusion process

How image-generating AI learns patterns and produces new images

Image-generating artificial intelligence systems such as Midjourney, DALL-E and Stable Diffusion use diffusion processes in artificial neural networks to generate images.

1	The AI system learns to identify relevant features in the training data. Put simply, it analyses different arrangements of pixels in digital images and associates them with increasingly complex concepts.
2	Patterns, textures, corners and edges can thus be combined into complex objects, such as a dog.
3	In a final step, labels are assigned to these concepts—that is, the words or categories we use to describe images.
4	This initially enables images to be recognised and classified.
5	The process can then be reversed: an image is generated step by step from randomised pixels, also known as noise.

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From noise to image

The diffusion process reverses gradual image degradation

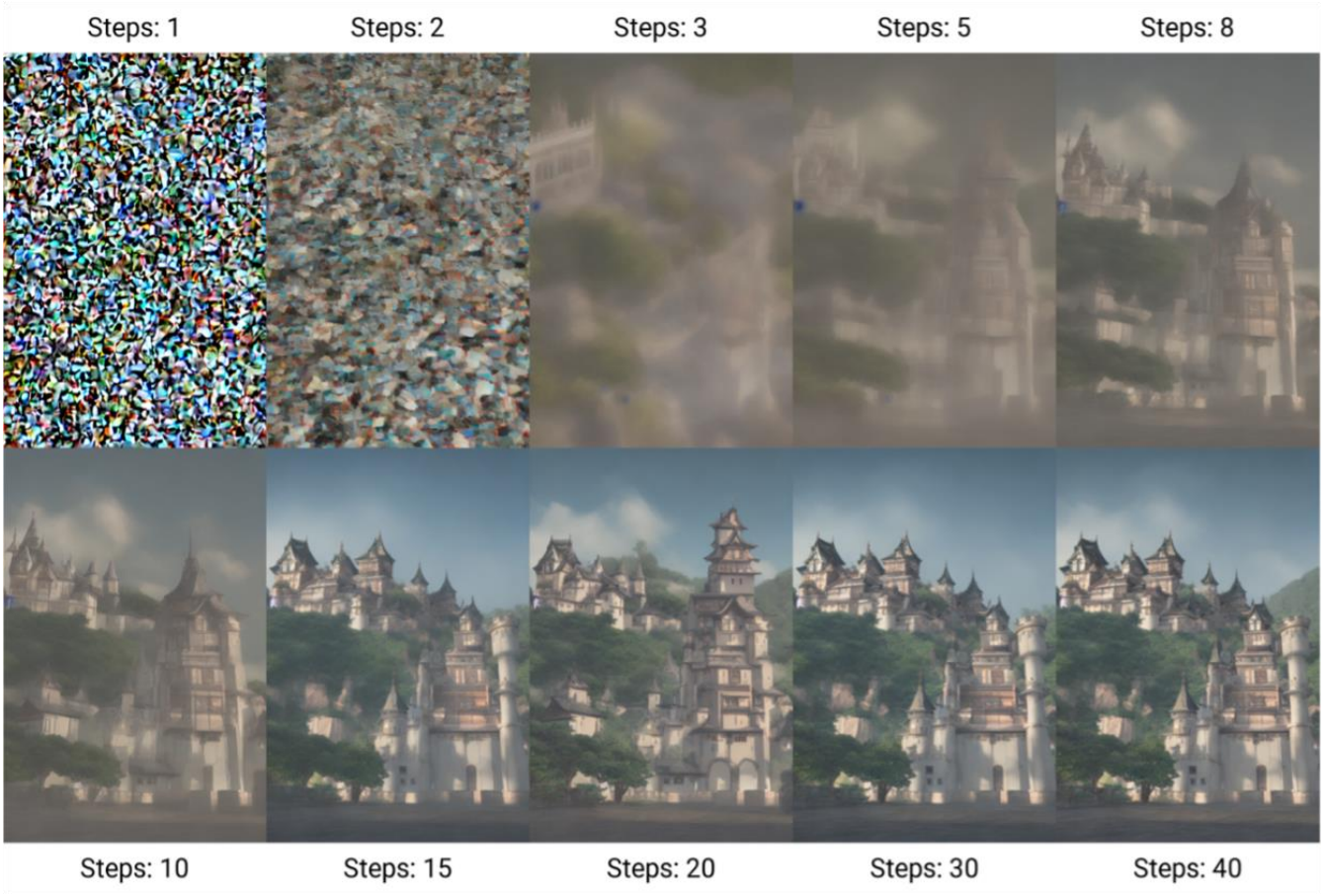


Figure 1: Visual representation of the diffusion process used in image generation, available at: https://en.wikipedia.org/wiki/Stable_Diffusion#/media/File:X-Y_plot_of_algorithmically-generated_AI_art_of_European-style_castle_in_Japan_demonstrating_DDIM_diffusion_steps.png1

Why bias matters

A significant problem with image-generating AI systems is that they can reproduce distortions, commonly referred to as biases, contained in their training data. These may appear in different ways, for example through the disproportionate representation of particular ethnic groups, genders or age groups.

The composition of the training dataset is the underlying cause: if the training data contain a bias, the AI model will learn these patterns and reproduce them in its outputs. It is therefore necessary either to select training data without such biases—which is difficult because of the large volume of data required—or to counteract existing biases during fine-tuning.

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