

# Procedural Content Generation for Computer Games

## What is Procedural Content Generation?

- ▶ Procedural Content Generation (PCG) is a broad field with no agreed definition:
  - ▷ “the application of computers to generate game content, distinguish interesting instances among the ones generated, and select entertaining instances on behalf of the players.” - Hendrikx et al. [1].
  - ▷ “the algorithmical creation of game content with limited or indirect user input.” - Togelius et al. [2].
- ▶ Applications of PCG techniques often make use of approaches from the fields of dynamic difficulty adjustment, particle systems, evolutionary algorithms, cellular automata and AI.

## Online vs Offline

- ▶ "Offline" PCG
  - ▷ Performed at development or load time
- ▶ "Online" PCG
  - ▷ Performed during game execution
  - ▷ Can use runtime information

	Traditional	Offline	Online
Reduced Workload	✓	✓	
Reduced Storage	✓	✓	
More Variety	✓	✓	
Responsive		✓	

## PCG for Artists

Artists use PCG techniques to make the production of multiple content types more efficient & varied:

- ▶ Textures
  - ▷ Perlin noise and PRNGs
  - ▷ Image Filtering techniques
- ▶ Models
  - ▷ Component-Assembly method using generative grammars
- ▶ Music
  - ▷ Responsive generated music
- ▶ Animations
  - ▷ Offline automatic completion
  - ▷ Online reactive generation
- ▶ Effects
  - ▷ Procedural particle systems
  - ▷ Procedural rendering effects (see fig. 1)

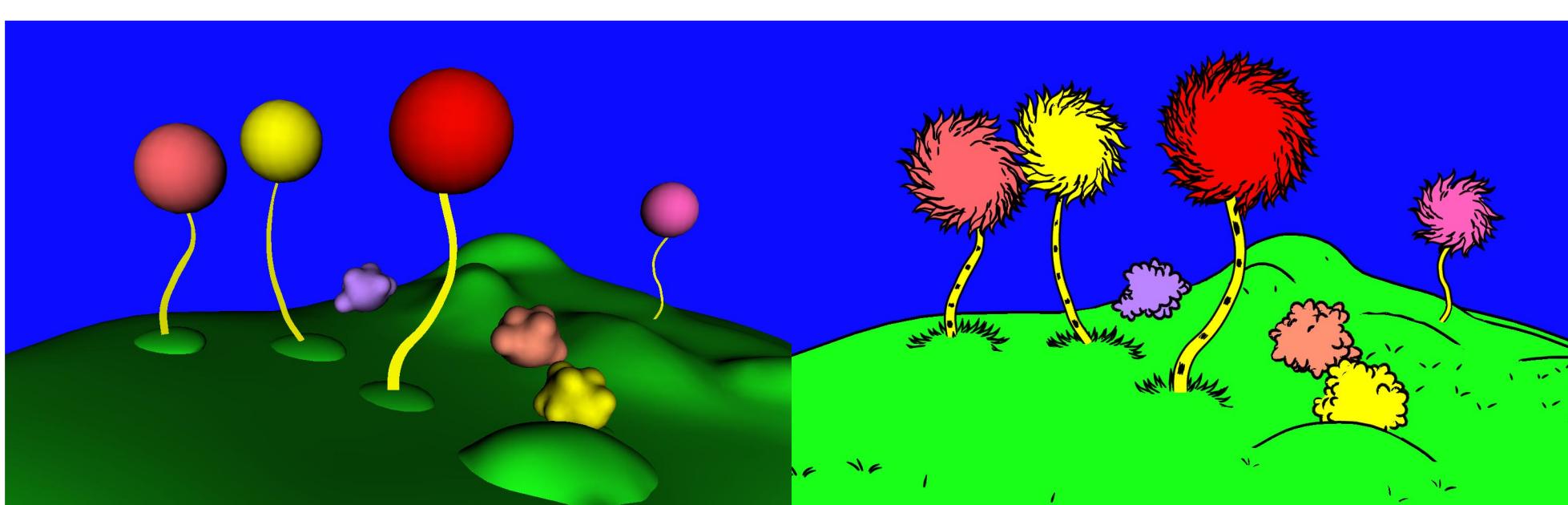


Figure 1: Procedural rendering of grass and trees, from [1].

## PCG for Designers

- ▶ Enclosed Environments
- ▶ Open Environments
- ▶ Entity Behaviours
- ▶ Search-Based PCG
- ▶ Mixed-Initiative Creation
- ▶ Content Scale
- ▶ Replay Value
- ▶ Challenge Adjustment

## PCG for Users

Some games use information about the player to tailor content at runtime, improving:

- ▶ Experience
  - ▷ Valve's AI Director – maintains emotional intensity
  - ▷ Bethesda's Radiant Story – encourages exploration
- ▶ Agency
  - ▷ Weapons Lab in Galactic Arms Race – custom weapons
  - ▷ Creature Creator in Spore – procedural creatures

