GDO

'Genshin Impact': Building a Scalable **AI System**

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GAME DEVELOPERS CONFERENCE | July 19-23, 2021

Genshin Impact



- Anime-style
- Open-world adventure
- Expanding
- Multi-platforms











Road Map

Architecture design

- Concerns
- **Pipeline and productivity** •

NavMesh for open world

- Size and complexity ۲
- **Dynamic scene objects**

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Performance optimization

- LOD
- **Ticking Strategy**
- Multithreading



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Expectation

- Multiple types of AI lacksquare
 - Civilians •
 - Wildlife •
 - **Combat NPCs**
- **Entropies** \bullet
 - **200+** archetypes \bullet
 - Various positioning tactics \bullet
 - Various sensing strategies •
 - ...
- **Diversity**
 - **Customize specific AI behaviors** lacksquare



Architecture design

NavMesh for open world

Performance optimization

Pipeline and State Machine

VS

Behavior Trees





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Animation

Params



Architecture design **Performance optimization** NavMesh for open world







Performance optimization

Key State Manager

- **Finite state machine**
- A key state could be \bullet
 - **Combat phase**
 - **Buff status**
 - Alertness



Characteristics







example of fire slime





Performance optimization

Open-world Constraint

- Large map
- **70+ km²**













Architecture design

NavMesh for open world

Performance optimization

NavMesh

- Precision
- 128 tile size
- 0.125m voxel size
- ~6GB data







Performance optimization

Dynamic Obstacles

Dynamic Obstacles

Dynamic Obstacles

Dynamic Obstacles

Performance

- **Mobiles**
 - **Targeting 60 FPS**
 - **30+ simultaneously running NPCs**
 - AI takes 2~3ms budget before optimization
 - **Overall bottleneck on CPU**
 - **Thermal management**

LOD for AI

- **Importance of ticking**
- 3 tiers
- Decide on
 - **Player distance** ullet
 - **Combat status**

Performance optimization

LOD for AI

Asynchronous Module Ticks

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- High (30Hz)

Low (5Hz)

Even more

- Pause animations
- Hide skinned meshes

Performance optimization

Combined

Multithreading

- **Best practice**
- Modules
 - Sensing
 - **Threat**
 - Ability scoring \bullet
 - **Decision Tree**
 - **Positioning Tactics** \bullet

locomotion & animations

Multithreading

🔻 Unity Job System					
[5] Worker Thread	Idle (18.39ms)	≥ (0.44)	Idle (1.02ms) Idle (0.86ms)≥ (0.45r	e (0.52m (0.45i (0.33) (0.2(0.2)	ddar Idle (1.13ms) e (0.51m (0.37 Idle (0.99ms) e (0.64m
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[23] Worker Thread	Idle (18.39ms)	≘ (0,44r	Idle (1.02ms) Idle (0.86ms)≅ (0.45r	e (0.52m (0.45r (0.33 (0.280.2	Idle (1.14ms) e (0.52m (0.38 Idle (0.98ms) e (0.64m
[24] Worker Thread	Idle (18.39ms)	t (0.45t	Idle (1.01ms) Idle (0.86ms)e (0.48r	e (0.52m (0.45i (0.33) (0.2(0.2)	Idle (1.14ms) e (0.52m (0.37 Idle (0.99ms) e (0.64m
▶ Loading				•	

Architecture design

NavMesh for open world

Performance optimization

0.5ms frame budget for AI

Tested on Apple A12 chip

Recap

- An AI pipeline
- Remote NavMesh and pathfinding service
- Ticking strategy and multithreading

Thank you

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