

GDC 2014

AI Summit

Free-Range AI

Creating Compelling Characters
for Open World Games

Aaron Canary

AI Programmer



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Primary Topics

- Open World Response
- Scalability
- Environmental Interaction



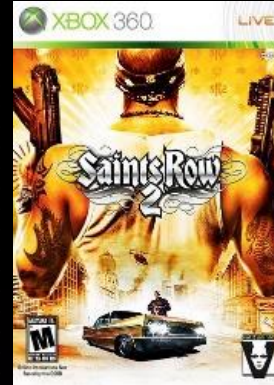
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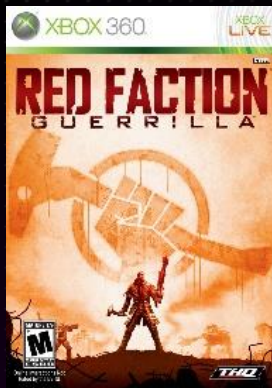
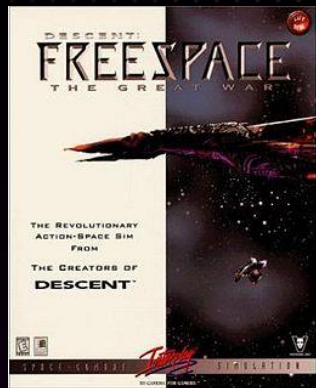
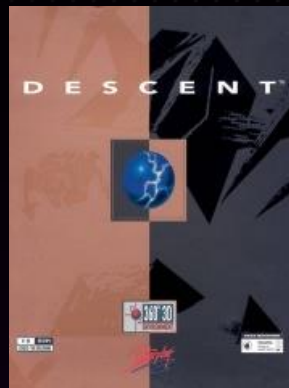
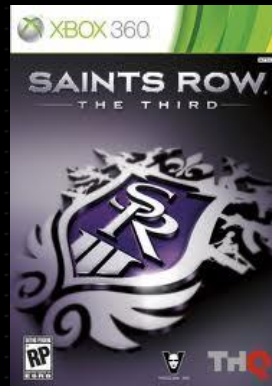
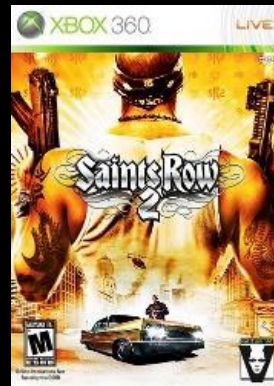
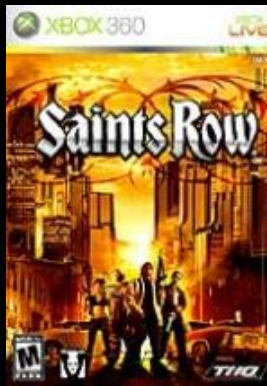
Slides available at
dsvolution.com/gdc/



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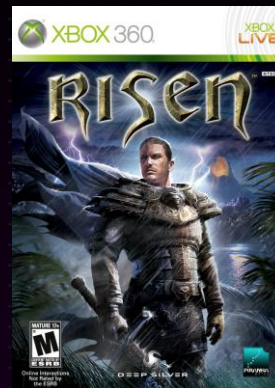




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KOCH MEDIA





SAINTS ROW

THE THIRD



Primary Topics

- Open World Response
- Scalability
- Environmental Interaction



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The world can respond in many interesting ways



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Open world combat system is called Notoriety



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Pacing is improved by varying player reaction



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Pacing is improved by varying player reaction



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Primary Topics

- Open World Response
 - Vary the players response
- Scalability
- Environmental Interaction

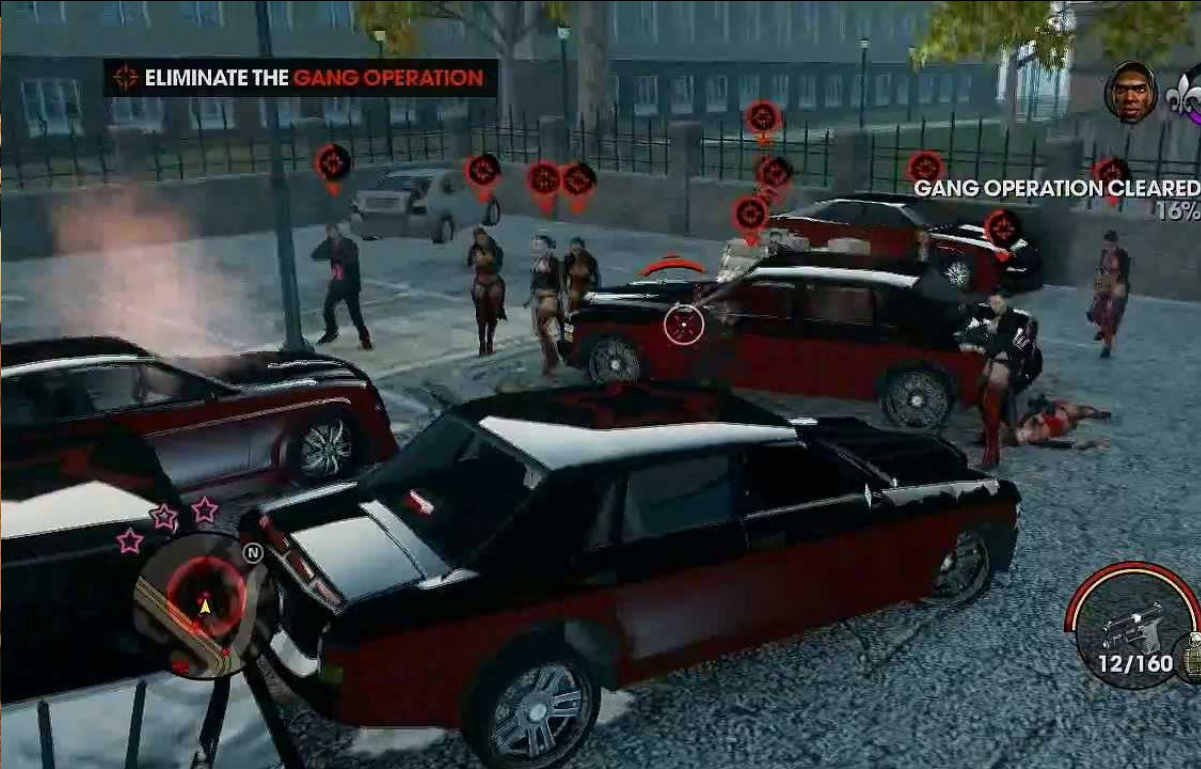


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Control combat pacing in open world



Avoid spawn redundancies





olution

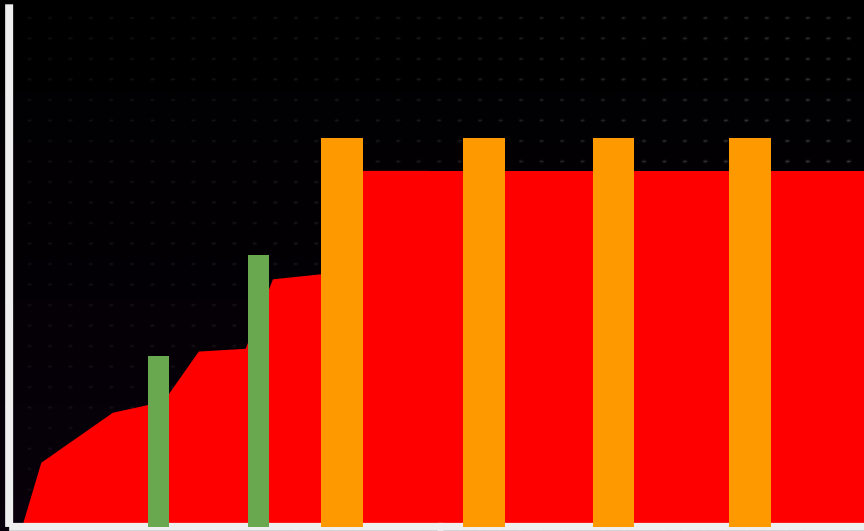
Primary Topics

- Open World Response
 - Vary the players response
 - Holistic spawning
- Scalability
- Environmental Interaction



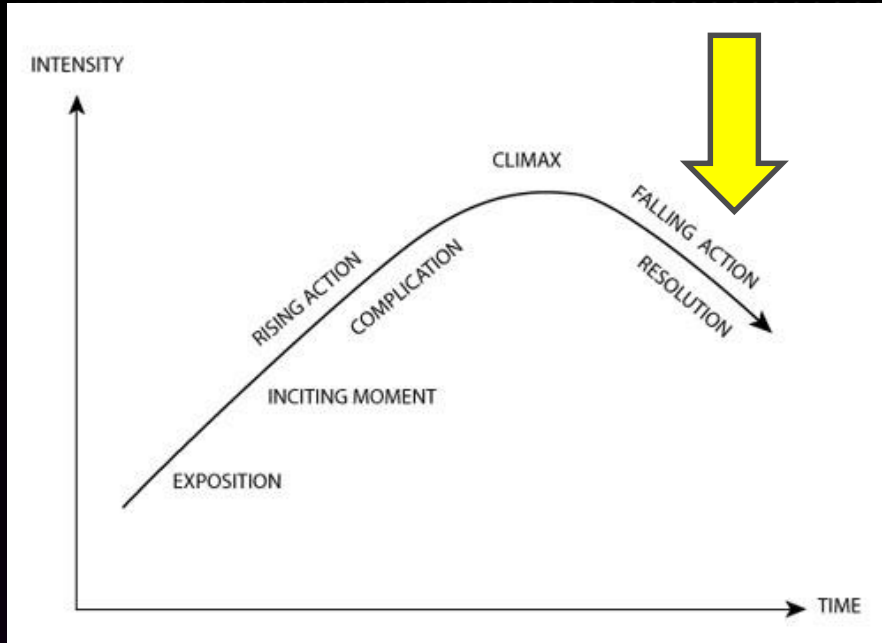
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SR3: After escalation, you need an endgame



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End with a reward and resolution



Allow Falling Action



NOT rewarded



Rewarded

We have Morals



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Primary Topics

- Open World Response
 - Vary the players response
 - Holistic spawning
- Scalability
- Environmental Interaction
- Rewarding experience



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SR4: Adapting to super powers



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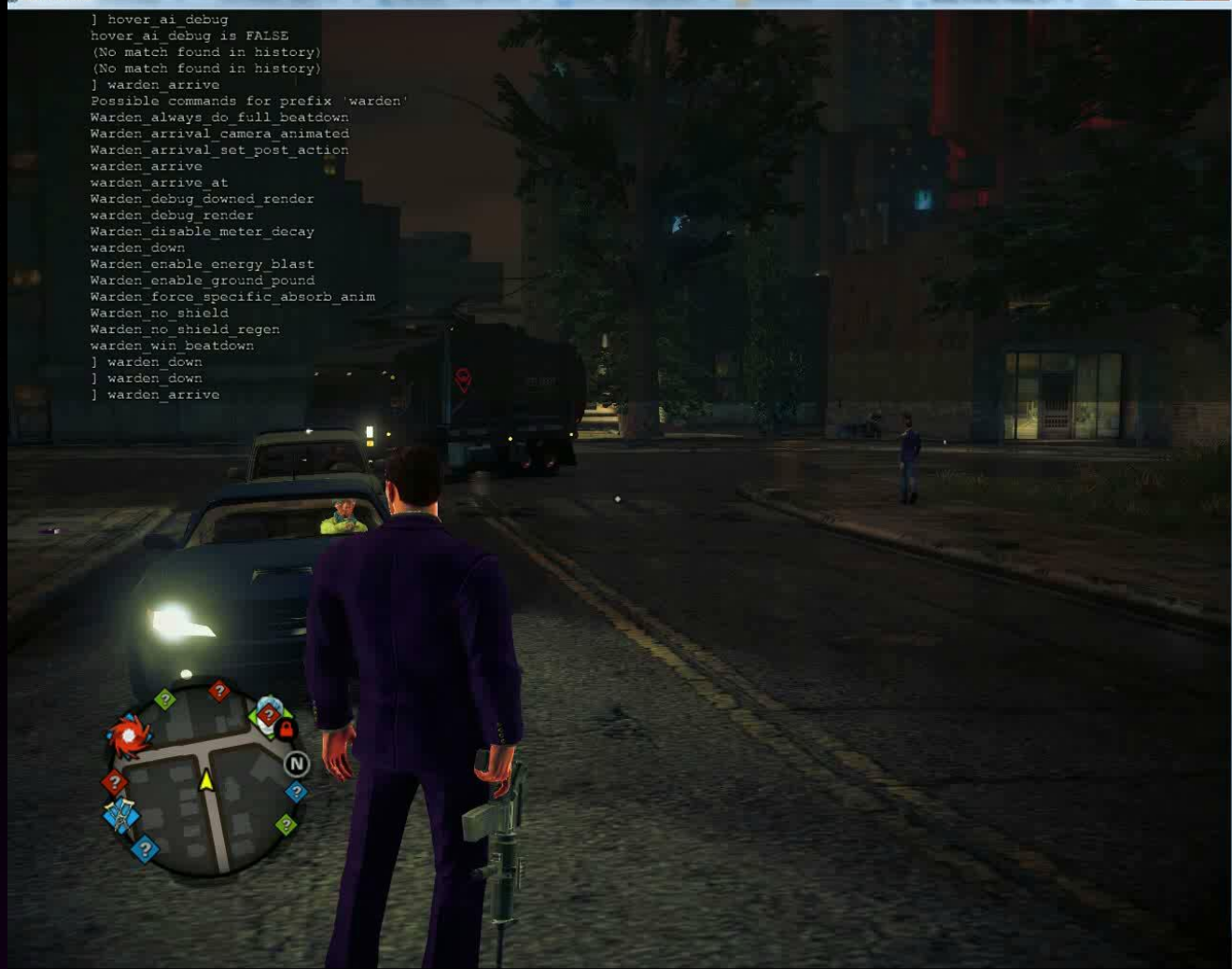


Camera Slow (paused)



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```
] hover_ai_debug  
hover_ai_debug is FALSE  
(No match found in history)  
(No match found in history)  
] warden_arrive  
Possible commands for prefix 'warden'  
Warden_always_do_full_beatdown  
Warden_arrival_camera_animated  
Warden_arrival_set_post_action  
warden_arrive  
warden_arrive_at  
Warden_debug_downed_render  
warden_debug_render  
Warden_disable_meter_decay  
warden_down  
Warden_enable_energy_blast  
Warden_enable_ground_pound  
Warden_force_specific_absorb_anim  
Warden_no_shield  
Warden_no_shield_regen  
warden_win_beatdown  
] warden_down  
] warden_down  
] warden_arrive
```



Primary Topics

- Open World Response
 - Vary the players response
 - Rewarding experience
 - Holistic spawning
 - Be creative
- Scalability
- Environmental Interaction



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Primary Topics

- Open World Response
 - Vary the players response
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Primary Topics

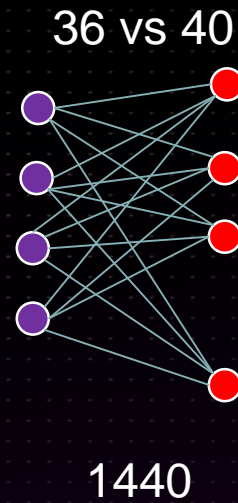
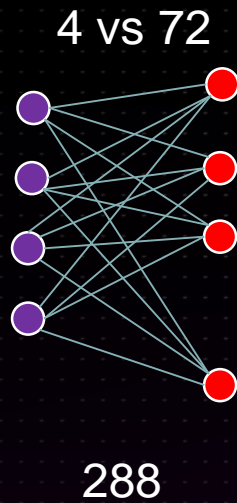
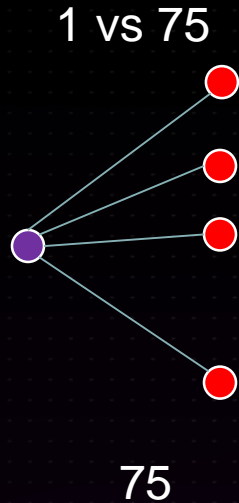
- Open World Response
 - Vary the players response
 - Holistic spawning
 - Rewarding experience
 - Be creative
- Scalability
- Environmental Interaction



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LOS checks are $O(?)$

Worse case 75 NPCs



1500 LOS @ 4 per frame = 12.5 seconds



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4 v 17



npc_cop 31.25 = 50 / 1.600
npc_cop 31.25 = 50 / 1.600
npc_cop 139.51 = 50 / 0.358
npc_cop 20.77 = 33 / 1.600
npc_cop 1.69 = 3 / 1.800
npc_cop 25.00 = 40 / 1.600
npc_cop 31.88 = 51 / 1.600

Num LOS requests = 96
Num LOS records = 34
Peak LOS process time = 153 us

Priority	#Queued	Delays: Avg	Peak	Ideal
0	0	0	0	1000ms
1	40	4301	4744	1600ms
2	41	7433	8242	3000ms
3	13	1315	11114	4000ms
4	2	118	159	10000ms
5	0	1176	1870	12000ms
6	0	0	0	14000ms

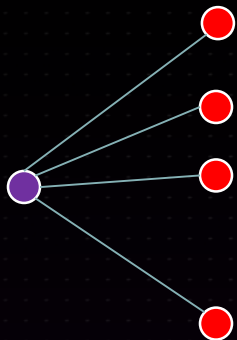
Render GPU ms: 21.5

Record checks: (nf) = 2% (req) = 66% (+) 32% (-) = 0%

LOS checks are O(?)

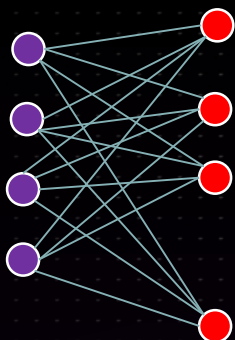
Worse case 75 NPCs

1 vs 75



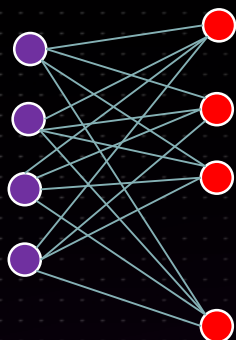
75
~35

4 vs 72



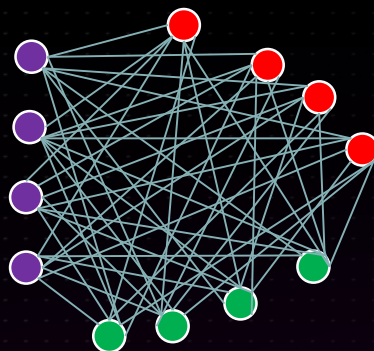
288
~90

36 vs 40



1440
~120

12 vs 32 vs 32

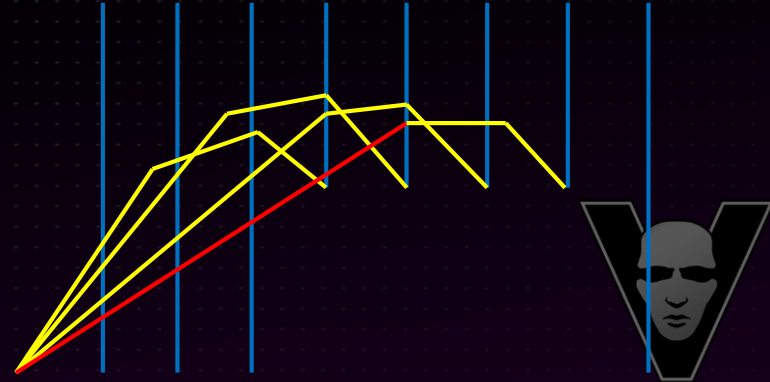
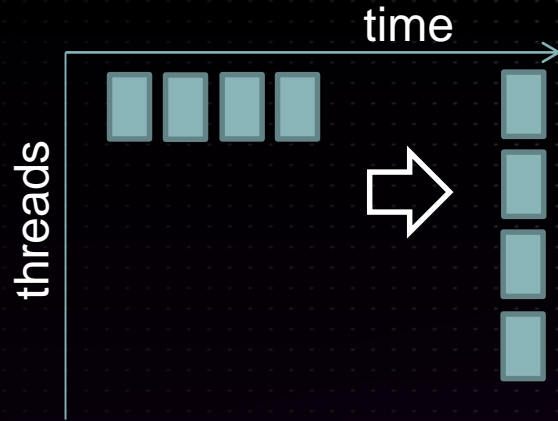


1792
~184

120 LOS @ 4 per frame = 1.0 second



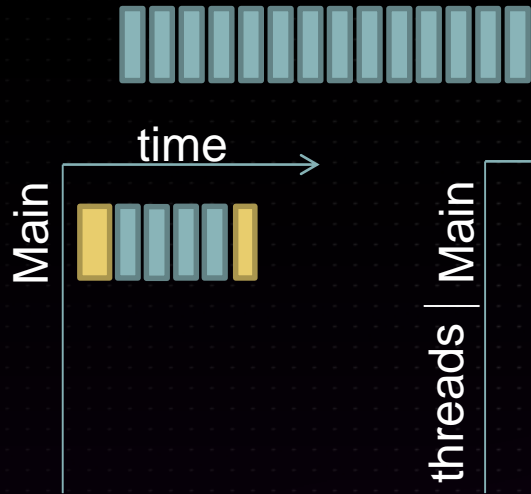
Multithread raycast has huge impacts



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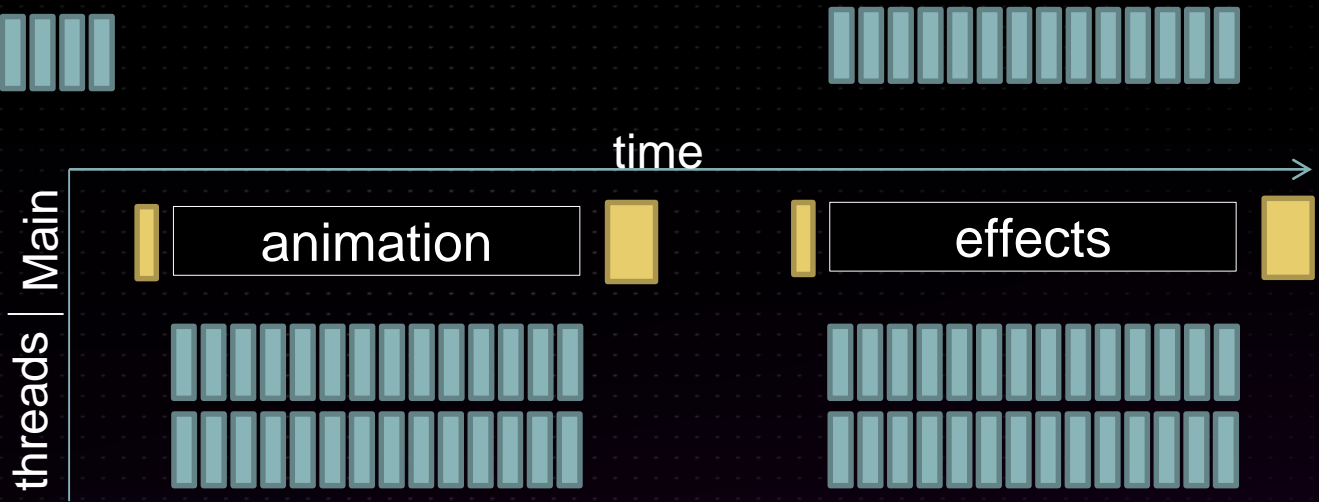
Make LOS a background thread.

SR3



4

SR4

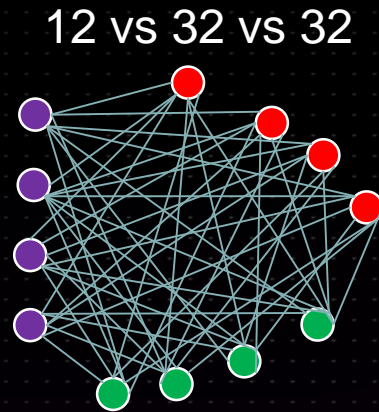


80



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Make LOS a background thread.



1800 LOS @ 4 per frame = 15 seconds

1800 LOS @ 80 per frame = .75 seconds

184 LOS @ 80 per frame = .10 seconds



Primary Topics

- Open World Response
- Scalability
 - Multithread AI
- Environmental Interaction



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Evolution of Saints Row AI Architecture

FSM



Overhead cost

Dependencies

Bigger it gets,
Harder it is to add.



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Support more behaviors

~~FSM~~



- Reduce Overhead
- Modular
- Performance (75 npcs)
- Volatile Environment
- Deterministic

~~Planner~~



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Behavior tree

- List of Goals
- Each Goal has list of actions
- Data driven
 - Programmer
 - Priority
 - Design
- Filter Goals and Actions
- Tweak parameters



Easy Reuse

```
If (is_burt_reynolds) {  
    // not good data driven
```



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Easy Reuse



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Primary Topics

- Open World Response
- Scalability
 - Multithread AI
 - Make your job easy
- Environmental Interaction



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Primary Topics

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Action Nodes



Primary Topics

- Open World Response
- Scalability
- Environmental Interaction
 - Over estimate amount of markup



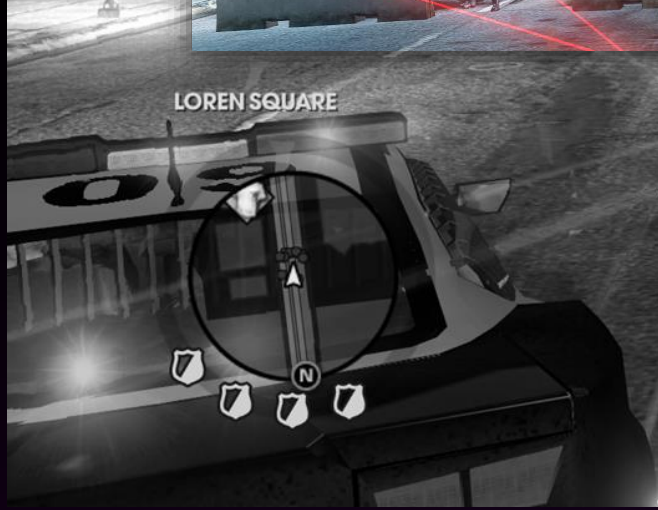
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\$3,906,322

Procedural Road Blocks



LOREN SQUARE



Primary Topics

- Open World Response
- Scalability
- Environmental Interaction
 - Over estimate amount of markup
 - Reuse markup



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Working without markup is risky

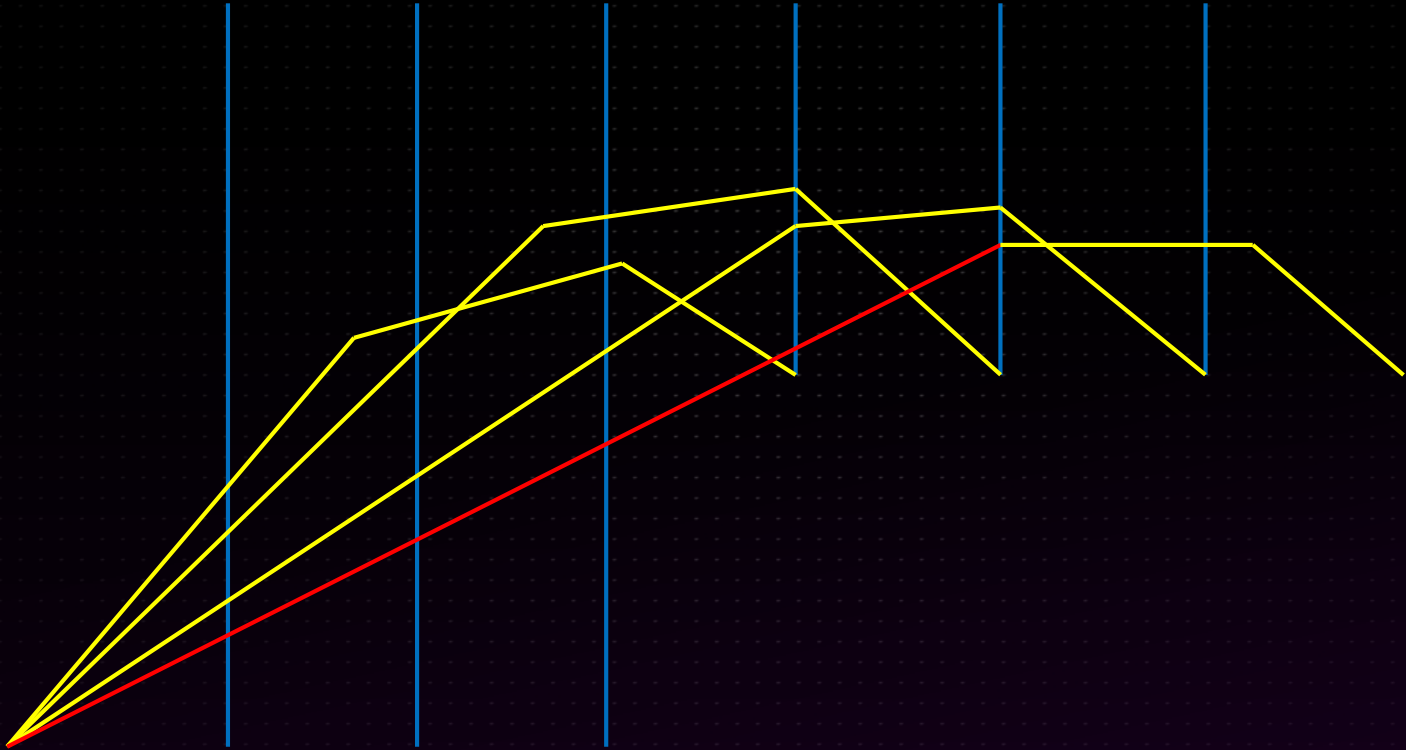


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Whole world needs more markup



Jump testing without markup

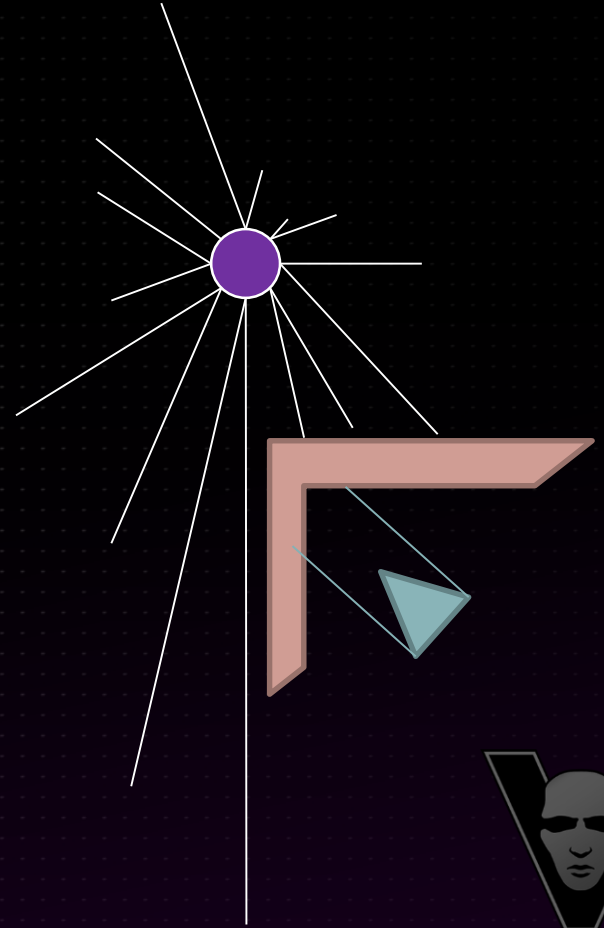
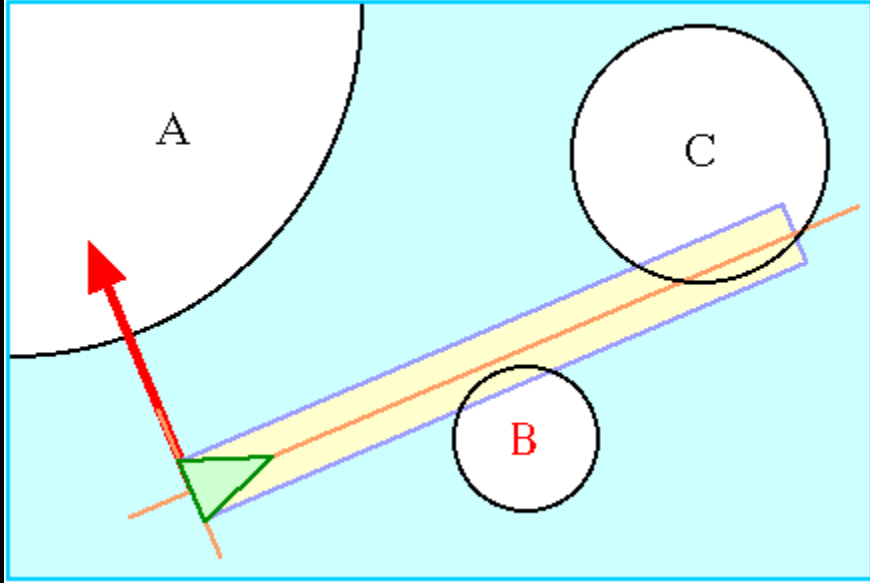


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Flying without markup



<http://www.red3d.com/cwr/steer/gdc99/>



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Primary Topics

- Open World Response
- Scalability
- Environmental Interaction
 - Over estimate amount of markup
 - Reuse markup
- Procedural is High Risk, High Reward



Primary Topics

- Open World Response
- Scalability
- Environmental Interaction



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Questions?



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Slides available at dsvolution.com/gdc/

More Volition @ GDC:

Animation Direction of
Saints Row IV's Super Jumping
Thursday 12pm
Rm 3016, West Hall

Defining Project Vision
Friday 10am
Rm 2010, West Hall

Vehicles of Saints Row
Friday 11:30am
Rm 2016, West Hall

Technical Artist Roundtable

Production Support Roundtables

Catastrophic User Experience Failures



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GANG KILL

2

NUT SHOT

1

NUT SHOTS

15/25

49/1786

8