Navigating detailed worlds with a complex, physically driven locomotion: NPC Skateboarder AI in EA's:

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What is *skate?*

- It's a skateboarding game…
- A brand new franchise from EA Black Box, launched in September 2007 on Xbox 360 and PS3.
- Lots of fun

So what about the AI?

The Game Design called for:

- AI competitors in challenges (Races / Best Trick Contests / etc.)
- Ambient “Living World” AI skaters for atmosphere.
- (Note: There are also AI controlled pedestrians and vehicles, but that’s a separate topic.)

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So where's the problem?

- Detailed Collision Environment
- Skaters are fully physics driven (i.e. we can't cheat)
- Fully physics driven skateboarding is quite a complex form of locomotion to steer.
- No ability to walk (until skate 2)
- Dynamic world (vehicles, pedestrians, other skaters, etc.)

Launch a trick incorrectly

(wrong place / direction / speed / time / …)

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… then you'll bail

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Even curbs are hard…

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Our Solution – AI Paths

- Record people playing the game
  - Records the “what and where”, not the “how”.
- Attach metadata to the path
- Save out as an XML file
- Process the paths into something usable in game.

Path Recording

- Store nodes at varying intervals whilst skating.
- Path Nodes consist primarily of:
  - Position
  - Velocity
  - Orientation
  - Width (calculated by terrain analysis)

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Runtime Path Format

- Node elements are stored compressed, quantized and packed.
- Path is interpolated from nodes.
  - Position and velocity use a Hermite curve.
  - Orientations use slerped quaternions.
  - Nodes are stored whenever the interpolated data would differ from the original by more than a given threshold.

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Recording A Path

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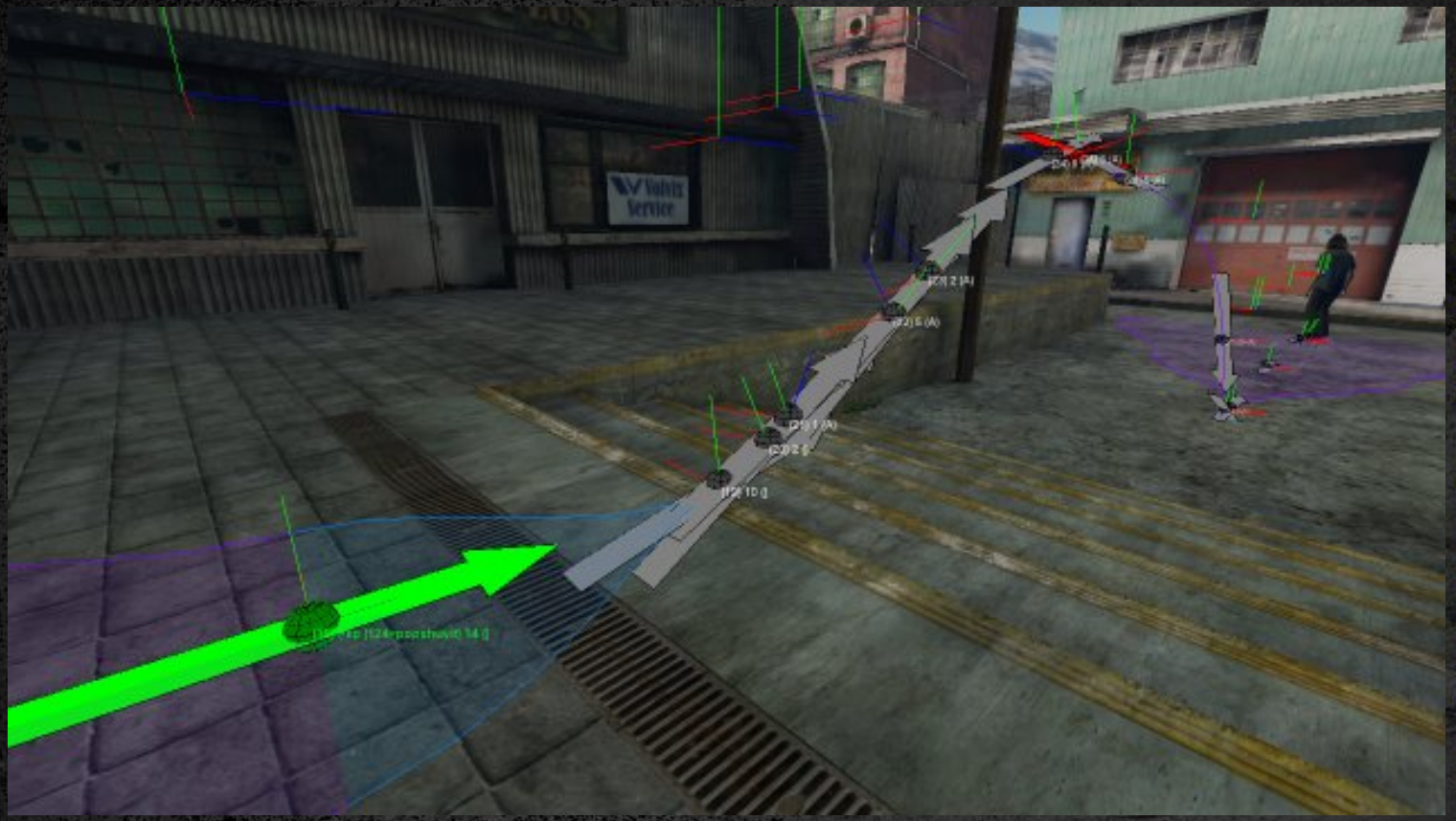
Path Editor

- All in game, allows designers to:
  - View and select paths in the world
  - Trim, tweak and delete paths
  - Edit metadata (effectively allowing them to script who can use the paths and when)
  - Quickly iterate, test and debug.

Viewing A Path



Path Pre-Processing

- Detects branches etc.
- Available in-game for rapid WYSIWYG iteration by designers
- Also done offline to generate efficient binary data for the rest of the team (and the finished product)

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Path Following

- Any skater can optionally have an AI Controller attached
- Looks at the skater's current path
- Evaluates dynamic obstacles
- Looks at branches and other paths
- Tries to pick the best route
- Drives the skater with controller intents

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AI Profiles

- Tunable by designers
- Influence ability, tricks performed and style of skating for each character
- AI skaters dynamically swap tricks when possible for variety.

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It’s easy if there’s nothing in the way…

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Dynamic Avoidance

- Evaluate all dynamic obstacles around the skater.
- No static analysis of the world (all we need is already in the path)
- Cut obstacles out of the paths
- Look for possible speeds that would allow skater to pass in front or behind of other moving entities

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Dynamic Avoidance: Ex 1

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Dynamic Avoidance: Ex 1

Dynamic Avoidance: Ex 2

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Dynamic Avoidance: Ex 2

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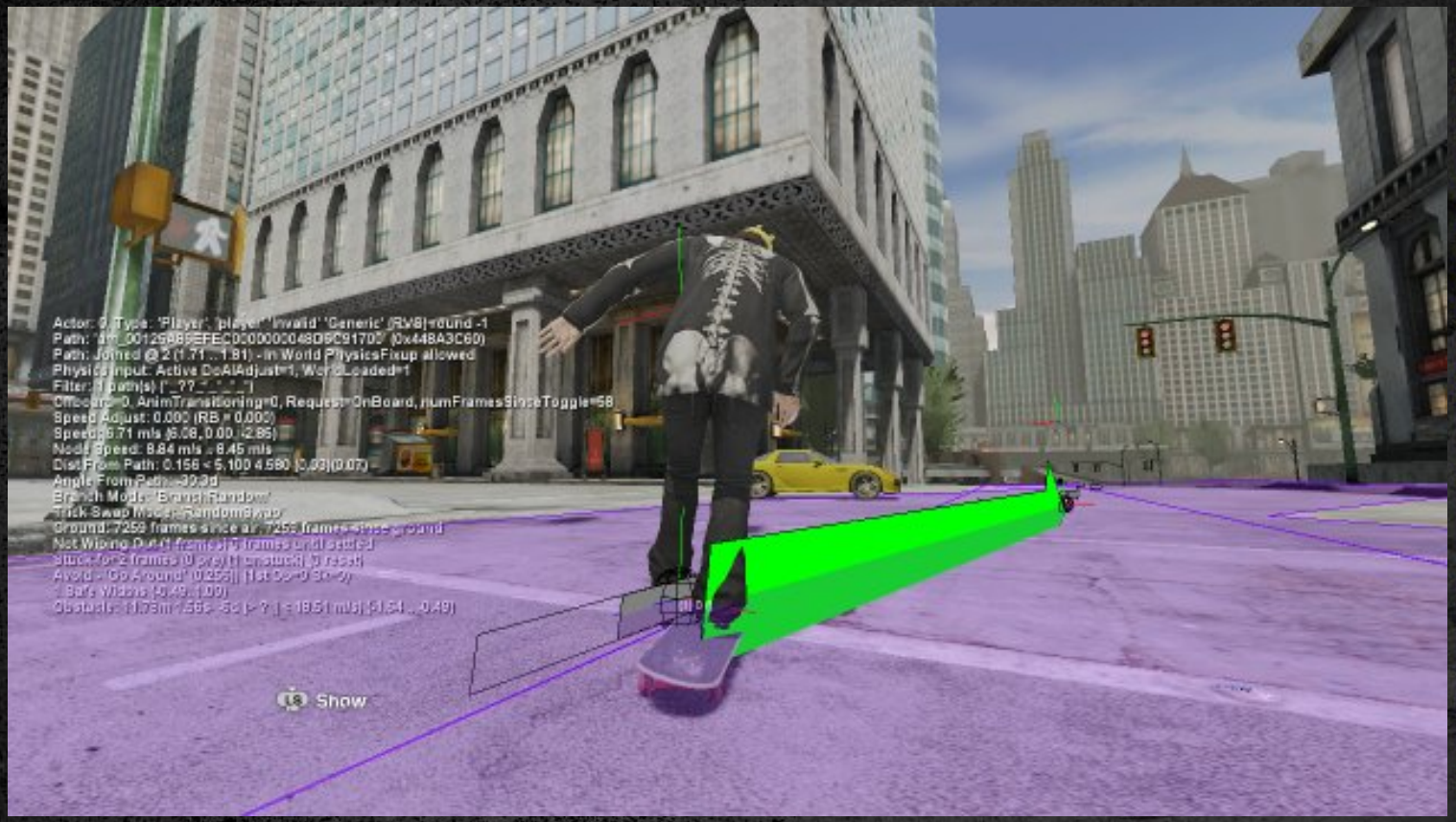
Dynamic Avoidance: Ex 3

Added Bonus - Skitching



A Skitchable Obstacle

Within Path, Correct Direction

So Skitch It…

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And Steer As Necessary

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Skitching – Exit

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Paths Diverge

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Detatch from Vehicle

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Narrow Path, Wide Object…

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If Short Enough…

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Run / Jump Over It

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If Completely Blocked…

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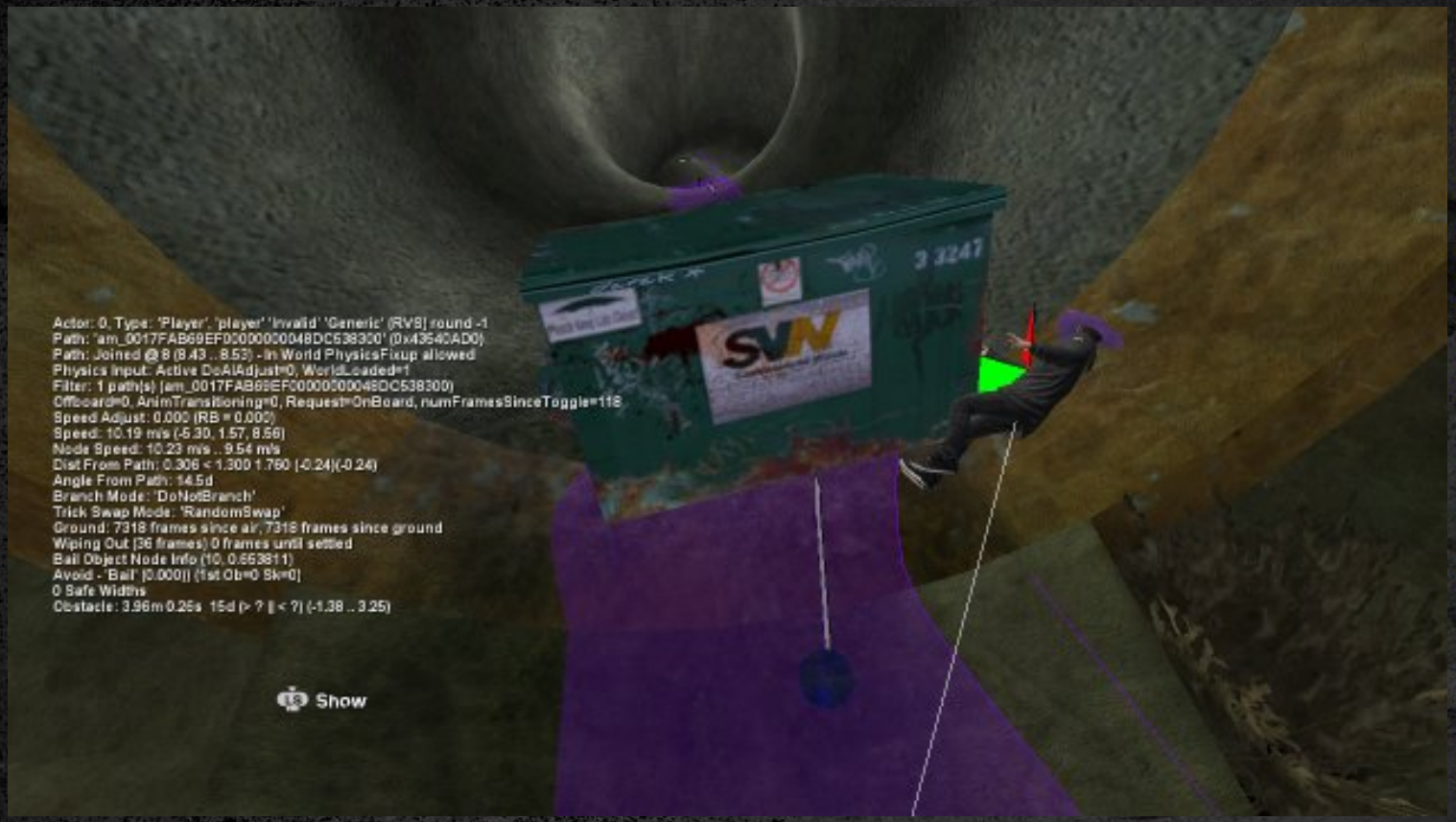
Give up and bail…



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Respawn Just Past It...

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Quick Tangent…

- All the above shots are from skate's replay editor.
- All debug + diagnostics drawing goes through our replay system.
- Insanely helpful for debugging (for SEs and designers)

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Automated Testing

- AI Controller could be attached to any skater.
- Therefore easy to make the game play itself.
- Useful for overnight soak tests etc.

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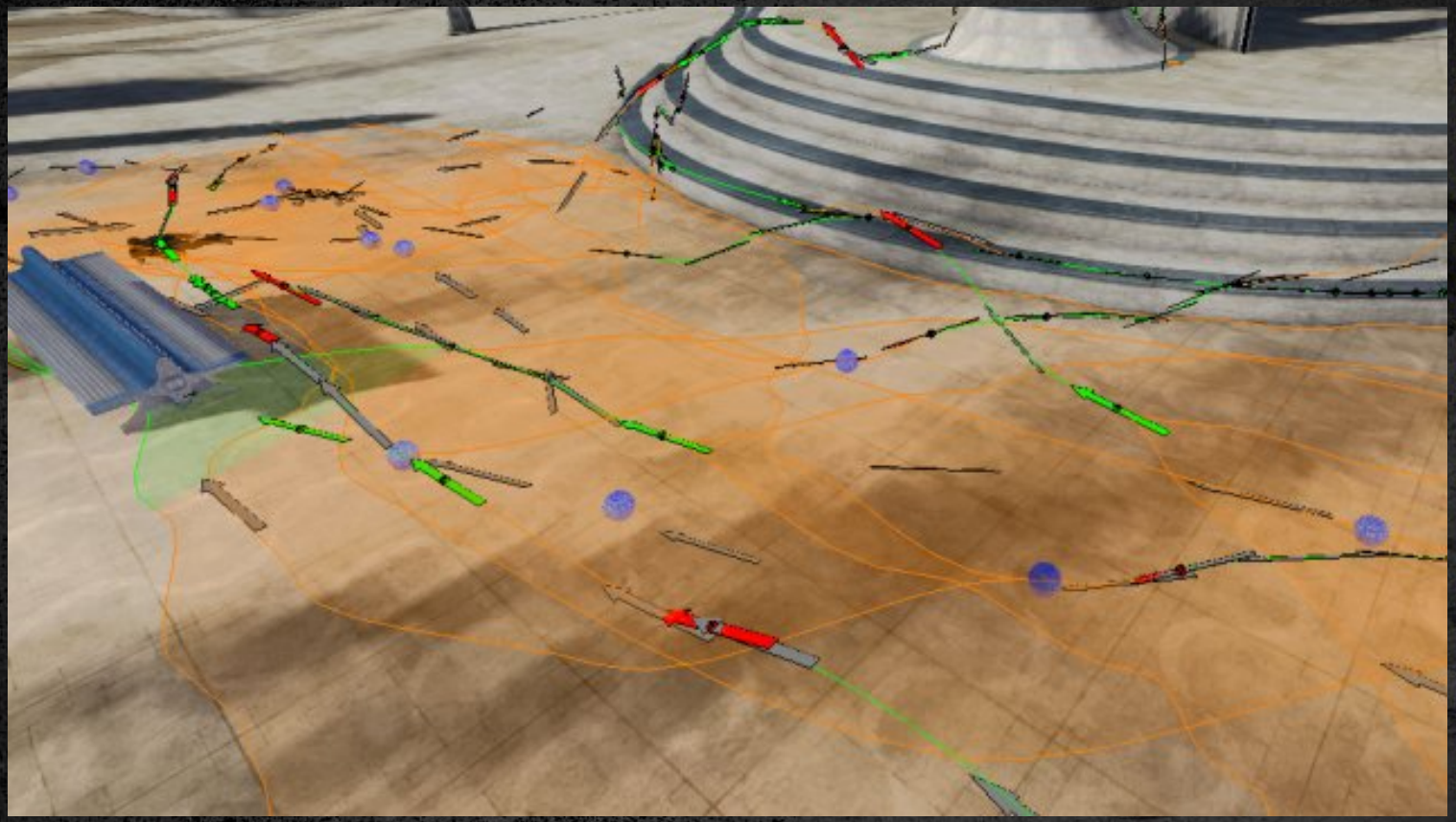
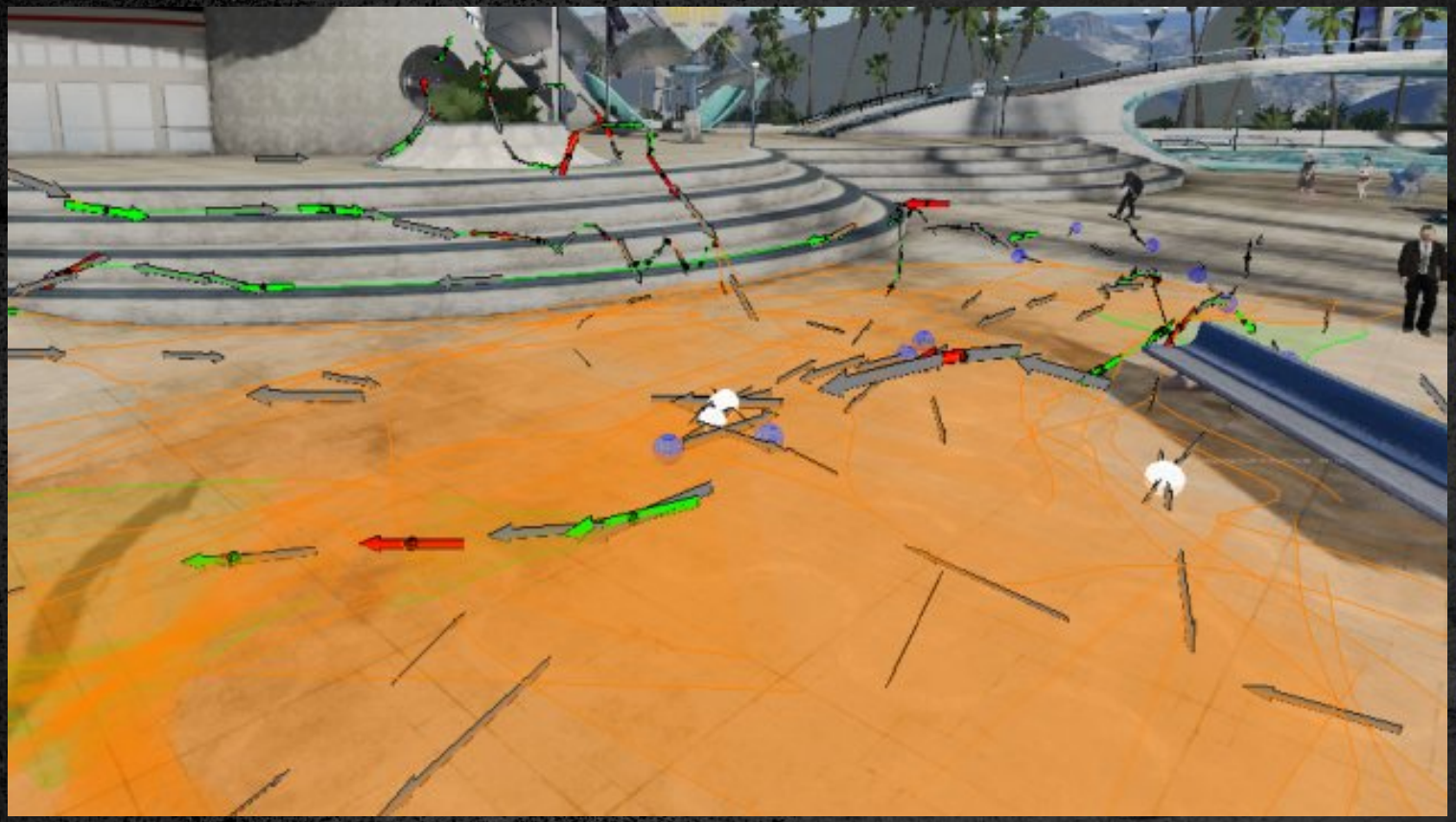
Some Paths



Do we need many Paths?

- Large Open World
- Needed lots of good path data
- Our QA department helped out by generating a large amount of it for us.

Lots of Paths



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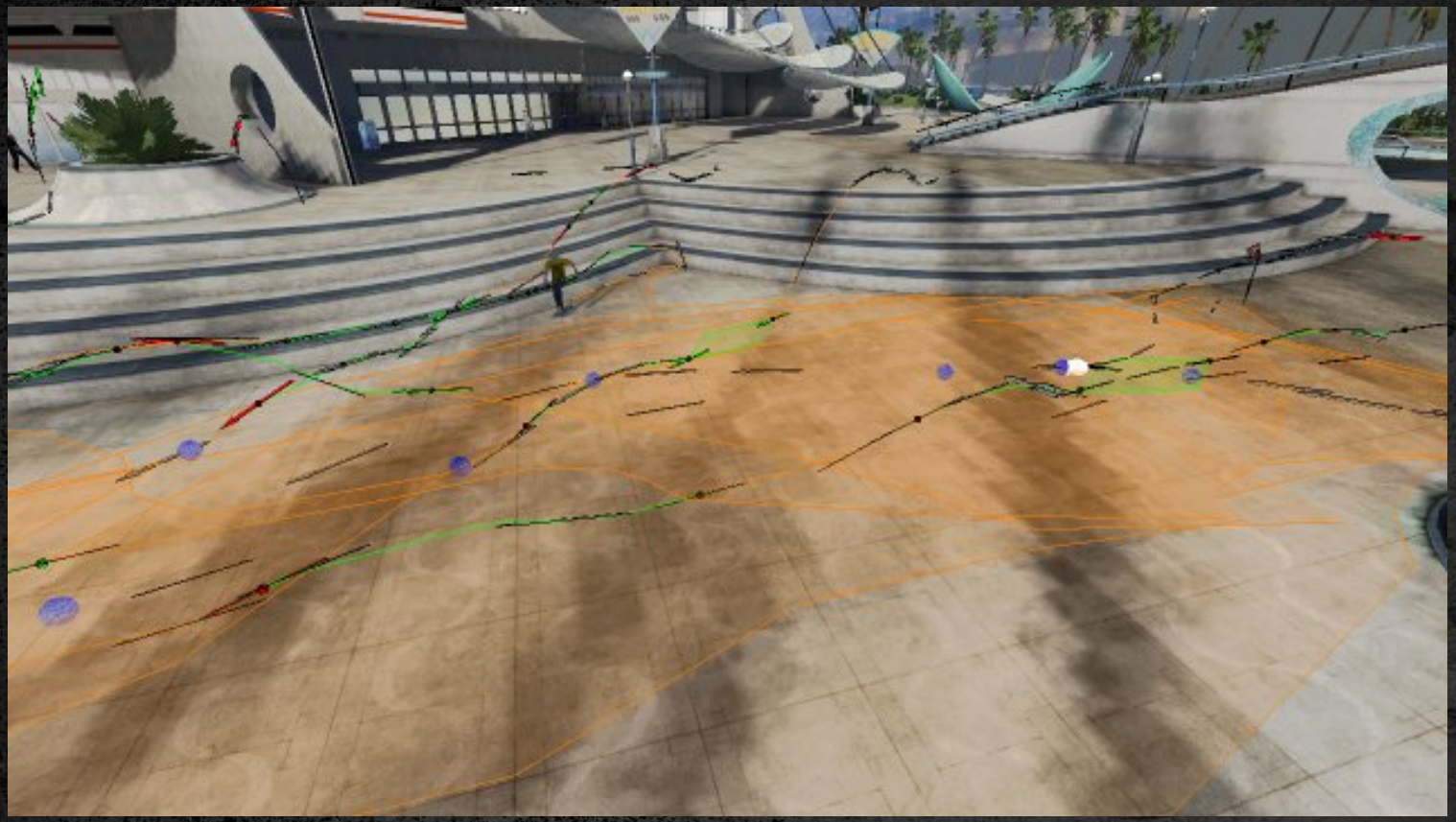
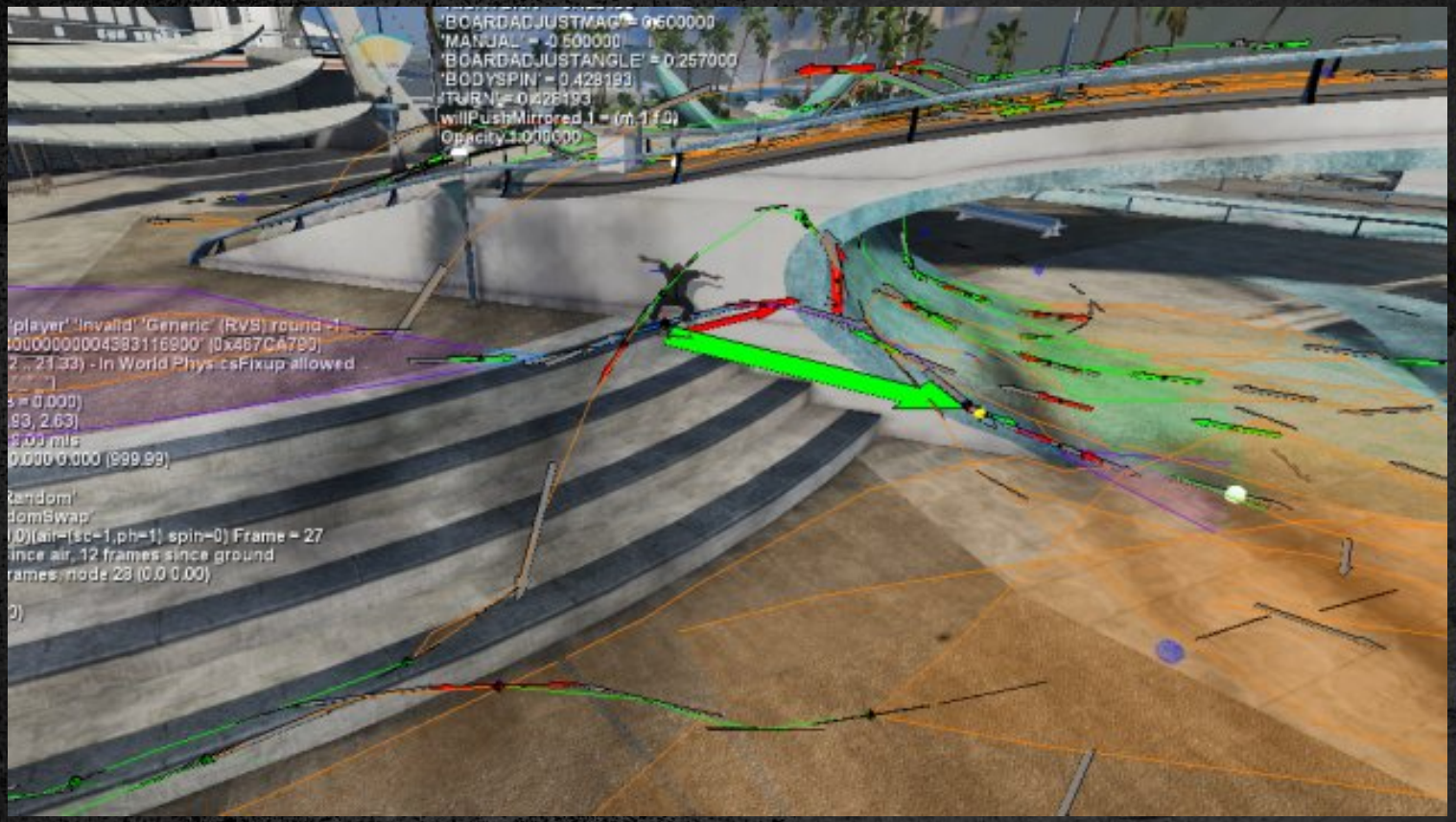
Lots and Lots of Paths



Paths, paths, everywhere



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Some Stats from *skate*

Total number of Paths	4,825
Total number of Nodes	250,747
Total number of Tricks	20,515
Total number of Branches	48,500
Total length of paths	465 Km
Total duration of paths	17.5 Hours
Total memory (if all paths were loaded simultaneously)	12.68 MB

- Note: 465 Km (290 Miles) is the is equivalent of skating from Vancouver to Seattle and back, followed by 11 runs down Mount Everest.

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Conclusion
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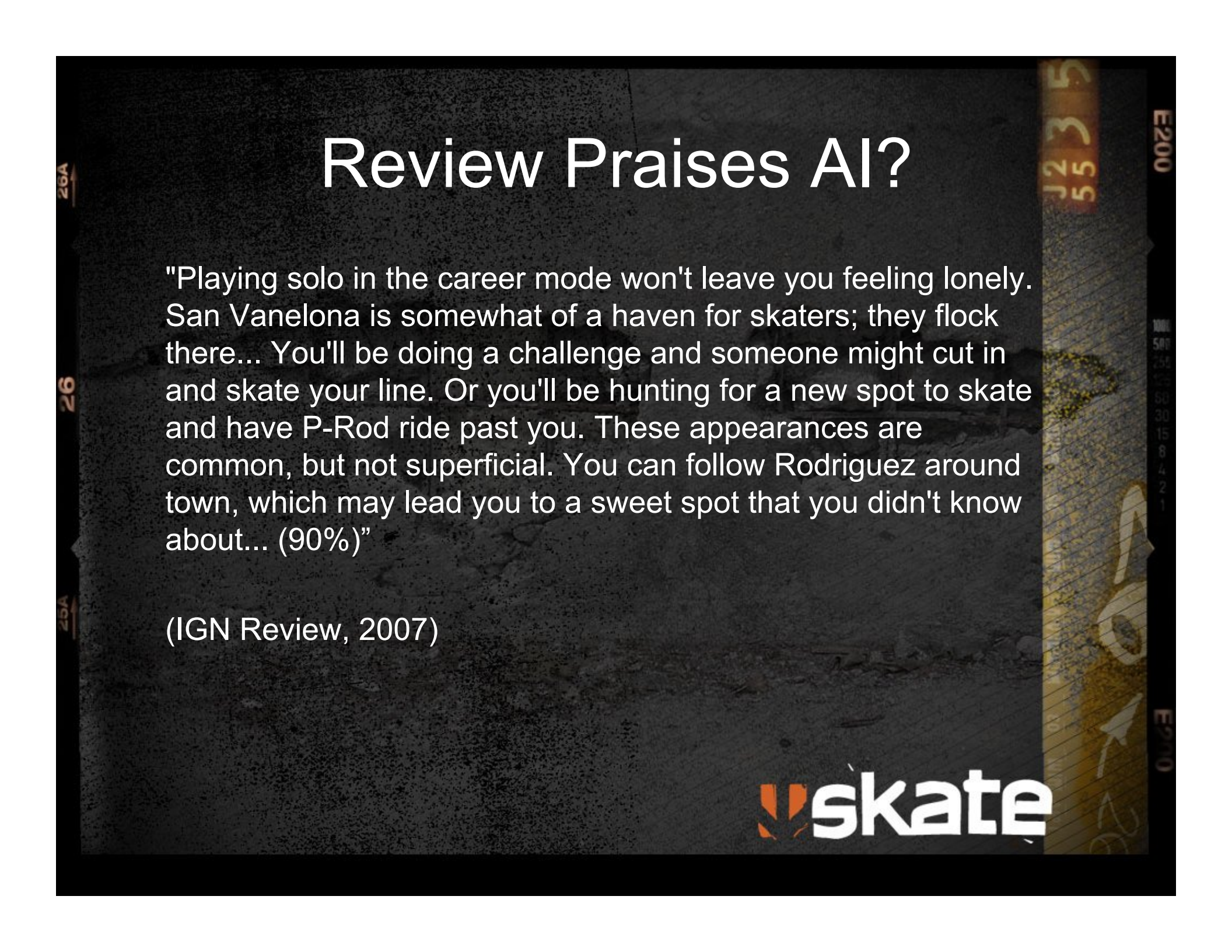
Pros

- It worked
- Game Designers seem to like it
- Allows some scripting “for free” by simply constraining the paths used at a particular point
- A large path set combined with more random path constraints gives a nice emergent behavior

Review Praises AI?

"Playing solo in the career mode won't leave you feeling lonely. San Vanelona is somewhat of a haven for skaters; they flock there... You'll be doing a challenge and someone might cut in and skate your line. Or you'll be hunting for a new spot to skate and have P-Rod ride past you. These appearances are common, but not superficial. You can follow Rodriguez around town, which may lead you to a sweet spot that you didn't know about... (90%)"

(IGN Review, 2007)



Cons

- Skaters are constrained by the path network
- Requires a lot of data to be recorded
- Paths are invalidated if the underlying world moves.


Possible Extensions
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Paths on Dynamic Objects

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Paths on Dynamic Objects

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Record the End User

- Record paths constantly, upload, process and share the data.
- Easy to generate an AI profile from already captured telemetry data.
- Asynchronous Online – AI equivalents of your friends appear around you!

Better use of NavMesh

- There's Navmesh in the world already (for the pedestrians).
- Didn't use it for skaters in Skate 1 (you couldn't walk after all…)
- Originally planned to use it as a fallback in many cases in skate 2…

Smarter Path Usage

- Background process to weight paths based on object obstruction etc.
- Thinking multiple steps ahead (we don't do any "path-finding", because we've never actually needed to).


Questions?