

Drivatar and Machine Learning Racing Skills in the Forza Series



JEFFREY SCHLIMMER, TURN 10 STUDIOS

Challenges with Robotic AI

- ▶ Single-player racing against a field of AI cars has some gameplay challenges
 - ▶ Monotonous gameplay: More of the same, race after race
 - ▶ Limited immersion: AI cars are moving traffic cones
 - ▶ Limited suspension of disbelief: Player knows AI drivers are artificial
 - ▶ Limited difficulty settings: Faster cars, more cars, starting farther back
 - ▶ Limited ability to contribute to gameplay mechanics

Ghosts

- Pre-recorded lap
- Limited immersion: Not interactive
- Limited difficulty setting: Lap time
- Limited gameplay: Single car, very predictable lap to lap
- Limited generalization: Need a lap for every car on every track ribbon



Drivatars

- ▶ Play your friends any time you want, in any car, on any track ribbon, in any weather, in any Forza game
- ▶ Drivatars have a real player's name, car, and livery, and drive as that player would
- ▶ Single-player races vary as they do in multiplayer
- ▶ Gameplay is immersive, engaging, and surprising
- ▶ Enabled by a connected world and power of the cloud

 19 sharp paws

PLACE
20 /24

00:42.827



CURRENT LAP
⚠ 00:41.624



LAPS
1 /2



SHAW

Drivatar Design

- ▶ When a player drives
 - ▶ Upload what the player does and how precisely they do it
 - ▶ Infer for similar behavior cars, track ribbons, weather, ...
- ▶ When their drivatar drives
 - ▶ Download the player's behavior for the current car, track ribbon, weather, ...
 - ▶ Use a robust physics sim to understand what the car is doing and predict what it can do
 - ▶ Utilize a percentage of that capability to emulate the player's behavior
- ▶ Modeling a rich set of player behaviors enables interesting, genuine drivatars

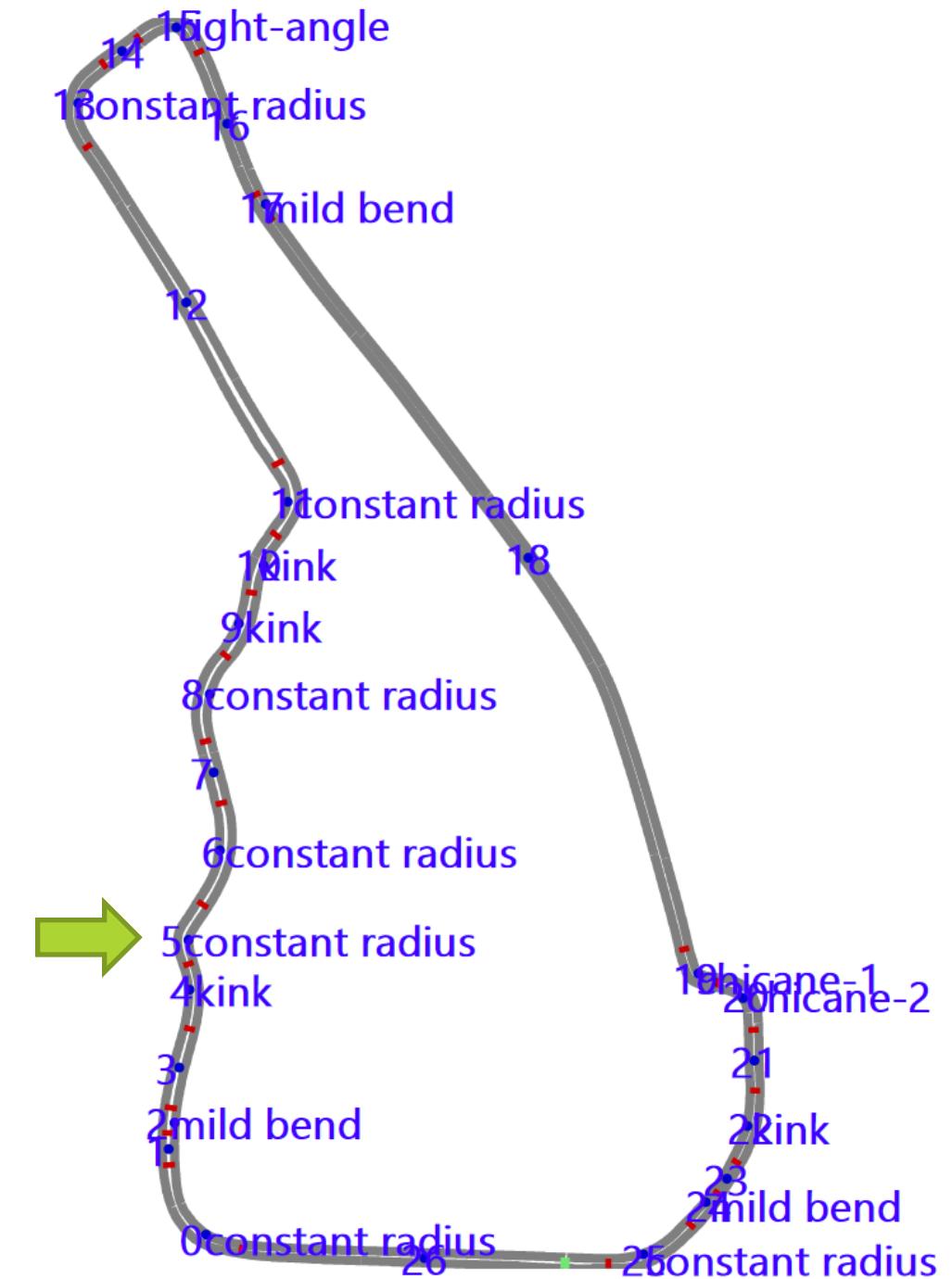
Player Speed

- ▶ When the player races a track ribbon
 - ▶ For each section of the track, upload how fast they drove and how consistent they were
 - ▶ Infer speeds (and variance) for similar track sections
- ▶ When their drivatar races another track ribbon
 - ▶ As the race is underway, use physics to compute current grip and predict future grip
 - ▶ Utilize a percentage of that grip to make the car drive as fast as the player would in this car here and now
- ▶ Taken with many other behavior models, a drivatar can drive in a convincing, recognizable way in cars, track ribbons, and weather – even those the player has never driven

Player Speed Details

- ▶ For each drivatar, we store
 - ▶ Average utilization and variance for each segment of each track ribbon
 - ▶ Road Atlanta Full Circuit segment 0 through 26
 - ▶ Average utilization and variance for each turn type
 - ▶ Kink, ConstantRadius, IncreasingRadius, DecreasingRadius, Hairpin, Sweeper, RightAngle, DualApex, Chicane1, Chicane2, MildBend, HardCorner
 - ▶ Overall average utilization and variance
- ▶ When player races, the update rule emphasizes segment then turn type then overall values
- ▶ When drivatar races, utilization emphasizes known over unknown values

Road Atlanta Turn 3



Gameplay Design

- ▶ Drivatar models allow designers to enhance gameplay
- ▶ Interesting options to set up starting grid
- ▶ Ensure players observe behaviors but don't get drawn into them
- ▶ Vary playback between player, friends, and other drivatars
- ▶ Manage behaviors that trigger player frustration
- ▶ Minimize value judgments about behavior tendencies: You drive like you do
- ▶ Detect player behaviors during rewind

Drivatar Payoffs

- ▶ Delight when you see people you know driving in a way you recognize
- ▶ Excitement by possibility of last-minute win: race isn't over until it's over
- ▶ Water cooler moments shared between friends
- ▶ Anecdote: The case of John's drivatar and his kids

Playtest Comments

- ▶ I was winning the first race and was passed by Alan. I thought I had everyone blocked out.
- ▶ Alan and I were almost neck and neck in race 2, but he pulled ahead and won. Like racing a friend.
- ▶ One of the drivers really enjoyed tailgating me.
- ▶ This time, Bill drove me off the track. What an *****.
- ▶ Alan drove me off the track.
- ▶ I was about to win, then Bill took first, right at the final turn.

Overdoing Humanity

- ▶ Turns out, there's such a thing as being too human, too authentic with drivatars
 - ▶ Community feedback that drivatars were hitting them too often, breaking immersion and triggering frustration
 - ▶ Root cause was accurately-aggressive car-to-car behavior models
- ▶ Responsible fiction
 - ▶ Design tuning of generalization and playback for car-to-car behaviors
 - ▶ Instrumentation to measure problem and improvement

Community Response

- ▶ They are MUCH better. Turn one is always gonna be tight. But it's no longer a crash derby where you have a 1 in 20 chance of coming out straight. The drivatars now act like clean, respectful, yet competitive racers. They will swerve to avoid running you off but they'll also push and rub with you if you don't mind it. Rubbing, is ok. Some say 'rubbing is racing'. And that's about as bad as it gets now.
- ▶ The drivatars are 100% better after the update. Great job T10! Makes the game much more fun.
- ▶ I have to say, the updated drivatars are much better than before, a lot more mellow, especially on Long Beach in turn 2 after the start. They give each other plenty of space, there's less wrecks except for the typical rubbing, and the track environments are much calmer, thanks T10 for this update! Horizon 2 is going to be great with these drivatars!
- ▶ Noticed the difference in the AI today when I came second on Sebring (worst track) Ran a few more races and its so much cleaner and more competitive, makes me want to finish off the career now.

Thank You

- ▶ Turn 10 Studios is dedicated to pushing the Forza franchise to new heights while delivering truly incredible experiences for car enthusiasts of all types. We would like to thank our community and fans, new and old, for their support in helping us achieve our goals.