

GDC

**MAKING THE BELIEVABLE HORSES
OF
'RED DEAD REDEMPTION II'**

**TOBIAS KLEANTHOUS
LEAD AI/GAMEPLAY PROGRAMMER
ROCKSTAR GAMES**



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LEAD AI/GAMEPLAY PROGRAMMER



OVERVIEW

1. STARTING OUT
2. FREEDOM OF MOVEMENT
3. GAITS, SPEED & RESPONSIVENESS
4. RIDERS & SYNC
5. ENVIRONMENTAL AWARENESS
6. PERSONALITY
7. BREEDS
8. WRAP UP





STARTING OUT

GOALS

Live up to the memories of **RED DEAD REDEMPTION**

“Best Supporting” role to Arthur Morgan’s lead

Huge variation in terrain, ground characters in the world

Encourage player bond with the horse



STARTING OUT

BIG revamp of systems from GTAV

Unify disparate movement systems for humans, animals & **HORSES**

RDRII a very different world to GTAV

Focused on early first pass horses with our new tech...



RDRII FIRST PASS

Functional

Discrete speeds, no range, nor variation

Limited range of movement

Stiff turns, C-shape posing

Lumpy and inconsistent transitions



WHAT'S DIFFERENT ABOUT A HORSE AND A VEHICLE?

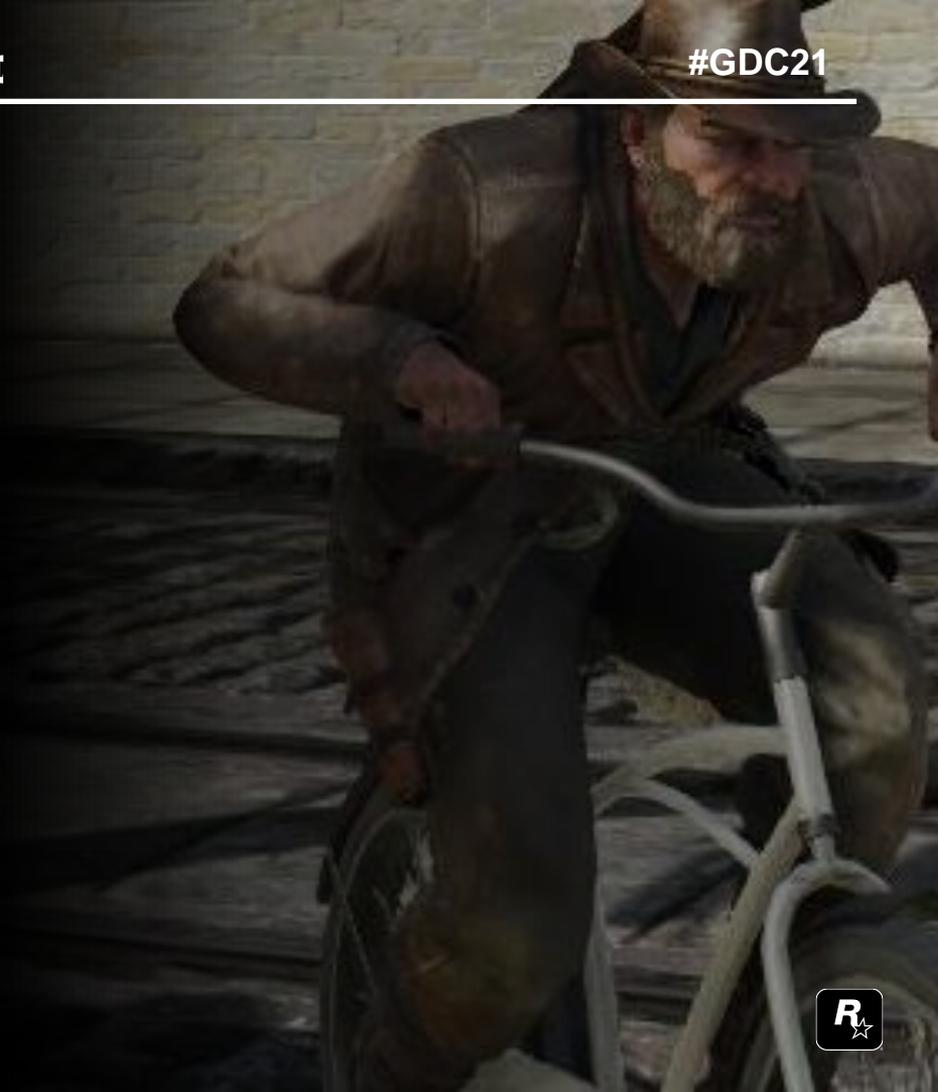
Functional... missing... SOMETHING

Not a car, not a bike

How to get livelier performance?

Behavioural implications and personality from movement?

How to introduce believability?





FREEDOM OF MOVEMENT



LATERAL MOVEMENT

Lateral movement to assist in ability to change movement direction

Deliver a movement required by horses for tight turning

One of the most **DIFFICULT** and integral features of the horse that defined much of what followed



PROBLEMS WITH BLEND TREES?

Scaled badly with further assets and dimensions

EXPLICIT parameterization, mapping input to blend weights

Notable performance issues as we made increasingly complicated animation trees



AUTOMATED EXTRACTION OF ANIMATION FEATURES

Improve accuracy of movement-to-animation

Derive features from the asset or annotation

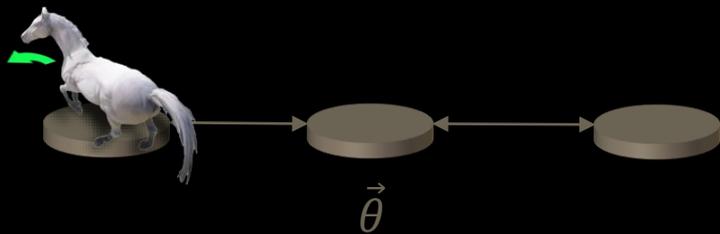
Remove strict structure mapping animation in blend

Automate association between animations

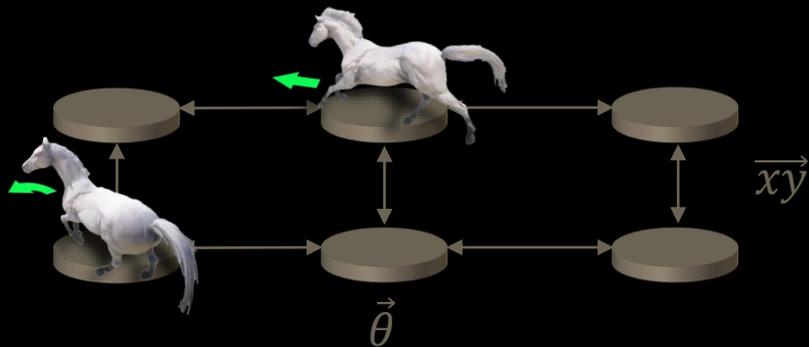
Stop wasting programmer and animator time



DIMENSIONALITY: 1D, E.G. $f(\vec{\theta})$



DIMENSIONALITY: 2D E.G. $f(\vec{xy}, \vec{\theta})$



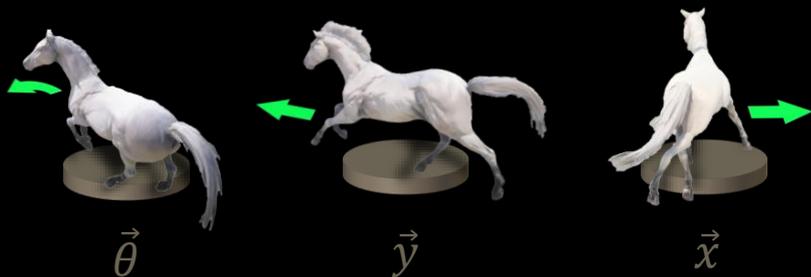
DIMENSIONALITY: 3D, E.G. $f(\vec{x}, \vec{y}, \vec{\theta})$

Critical 3rd dimension for “DRIFT”

Split \overline{xy} to \vec{x}, \vec{y}

Single lookup in memory:

$$f(\vec{x}, \vec{y}, \vec{\theta}) = [\text{weight}_0, \dots, \text{weight}_n]$$





1. Pivot, roughly about front feet/under chest
2. Turn assisted via lateral adjustment

"DRIFT"

Lateral movement assists mobility smoothly

Animation at zero makes it easier to control movement as we decelerate and turn

NOTION of indirect control but consistent responsiveness

Loose look, accurate relationship between assets and movement



RACE TO (0.0, 0.0, 0.0)



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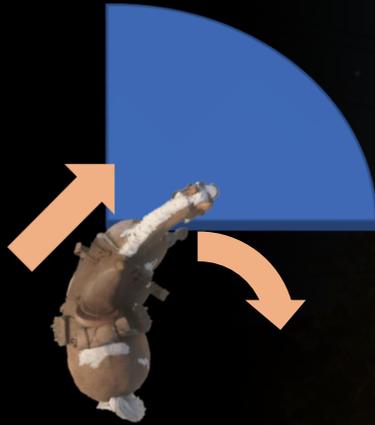
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ANATOMY OF "DRIFT"



1. Loose lateral movement range, little orientation change



2. Movement direction breaks threshold, wider range of lateral, angular velocity increases



3. Angular velocity exceeds sustained threshold, horse "overturns" beyond direction of movement



GAITS, SPEED & RESPONSIVENESS



WALK



TROT



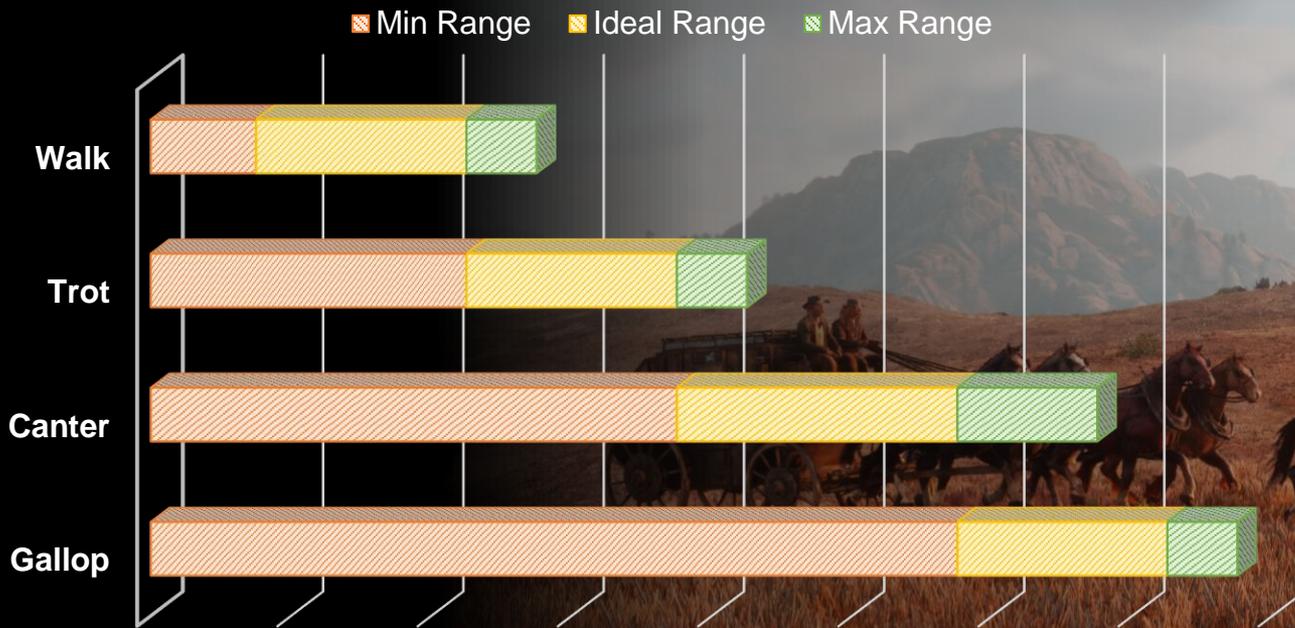
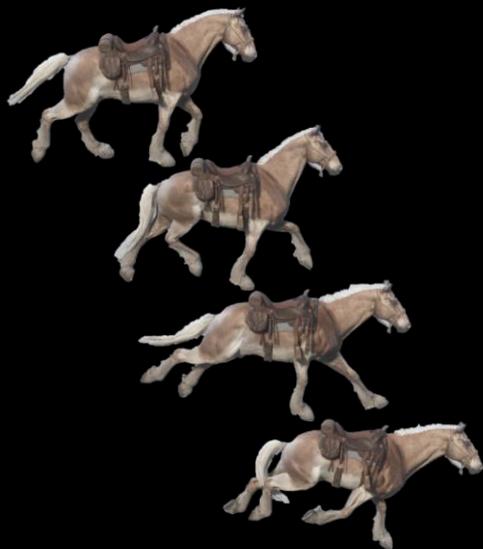
CANTER



GALLOP



GAIT VERSUS SPEED



Remove idea of tight coupling of gait to speed, exploit gaits for representing “effort”

Each gait has an ideal range and a full range for overlap (and *scale, more later*)

Transitions, however, presented a problem...



IMPROVING TRANSITIONS

One shot transitions appealing in isolation

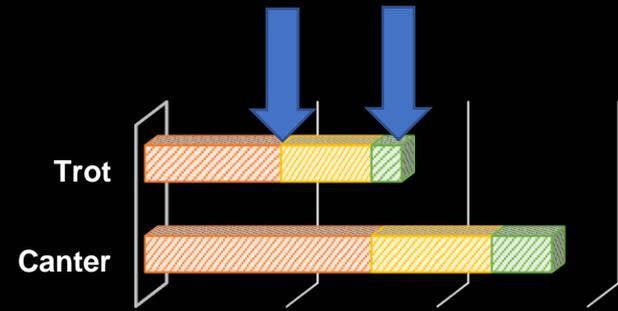
Problems:

- Difficult to control speeds
- Foot cycle defines transition
- Unpredictable

Attempted tech to “unroll” transitions:

- Volume of assets
- Undesirable slow-mo/superspeed
- Unpredictable, still





CONTINUOUS ACCELERATION & DECELERATION

Parameterise same way as cycles

Speed change independent of gait change

Vary duration of “transition” independent of asset

Change pose when best suited

Deterministic duration



ACCELERATION & DECELERATION CYCLES



Overlapping parametric blends of animation for each gait, same capabilities

Capture key features of transitions in the cycles for acceleration and deceleration

Canter example:

- Deceleration, more “collected”, compressed legs and body, head up
- Acceleration, extended legs and body, head down



DON'T. STOP. MOVING.

“Loop” based approach to start/stopping

Procedurally composite layers to deliver performance of bespoke assets

Retain AI and Player control at all times

Support indecision and indirect control





RIDERS & SYNC

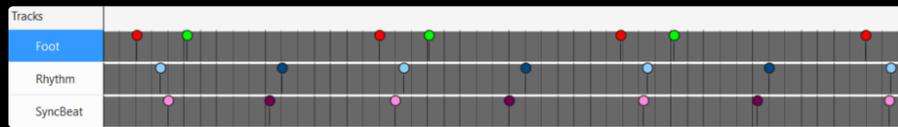
...ON SYNC POINTS

Canter & Gallop are three-beat gaits, intervals between front foot strikes are irregular

Sync on phase?

Variations in number of synced cycles, on transition to new motion, ...?

Multiple tag tracks became important for more regular spaced sync points





Tracks	
Foot	
SyncBeat	



HORSE DRIVING THE RIDER

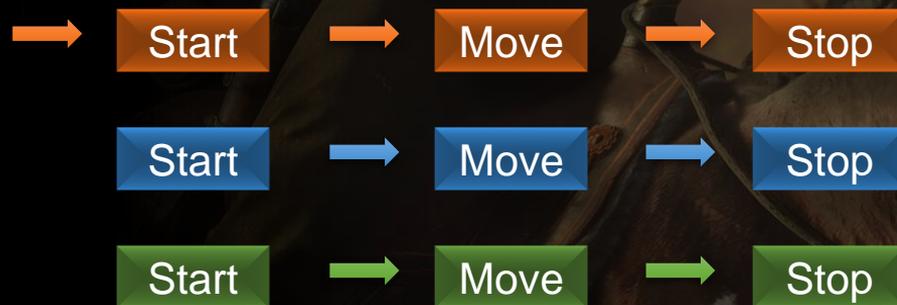
Additional dedicated code and animation staff

Rider and passenger provided from 2 layers of horse's locomotion data

Appropriate data to compliment horse's style

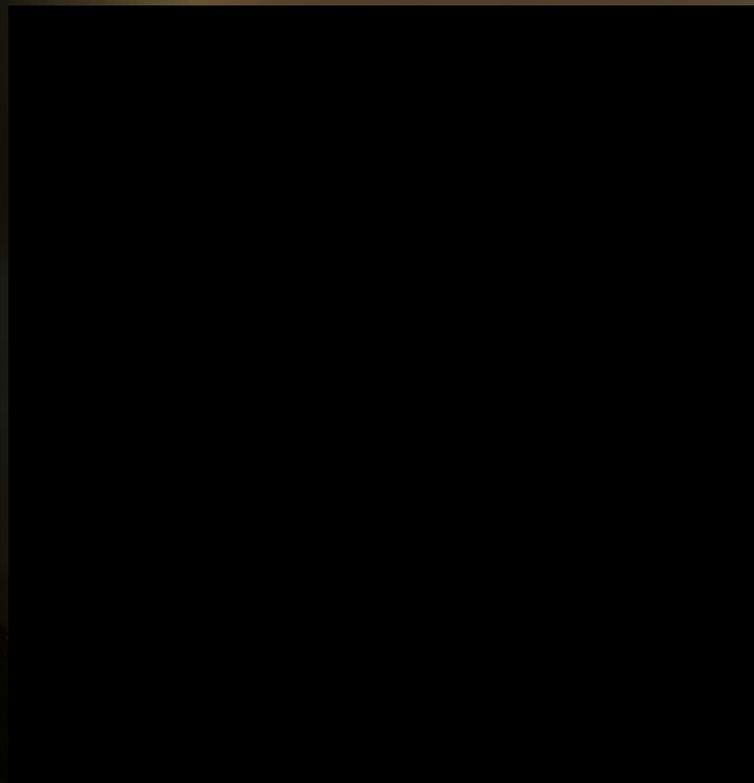
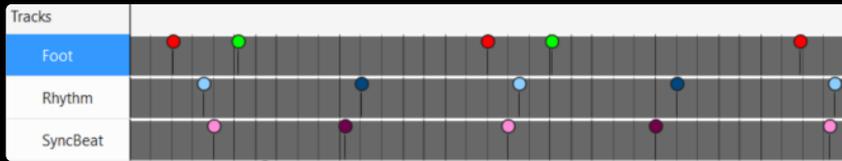
Interpolate rider parameters independently to locomotion controller

No 1-1 requirement for horse and rider



SYNC

Synchronise transitions and cycles to dominant fullbody horse assets

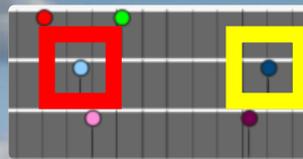


SYNC

Shared rhythm sync tags for general movement or “phase” for fully synced motions

Extract target phases, tags and dominant assets from horse’s animation tree





A screenshot from the video game Red Dead Redemption II. A cowboy in a tan jacket and hat is leading a brown horse on a rocky path. The background shows a vast, mountainous landscape under a cloudy sky. The text 'ENVIRONMENTAL AWARENESS' is overlaid in large, white, bold letters across the center of the image.

ENVIRONMENTAL AWARENESS

A BELIEVEABLE HORSE, IN A BELIEVABLE WORLD

Difficult terrain ought to take its toll

Sell with visual, “feel” and speed changes

Fastest horses almost 18m/s (40 mph), potential for mistakes

Independent AI character in-game, instinctive self-preservation, make decisions to assist (and **HINDER**) the player



DIMENSIONALITY: SURFACES

A lumpy world

IK alone didn't deliver what we wanted

Introduce MORE dimensions?!



DIMENSIONALITY: 4D-ISH, BLEND OF 3D SPACES

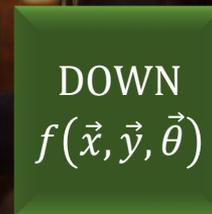
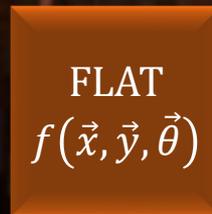
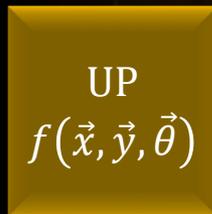
Bin assets on 4th dimension w

Simple or less accurate feature, e.g. pitch

N 3D spaces, each with similar w

Overloading features, repeat some assets with *different* w

$(\vec{x}, \vec{y}, \vec{\theta}, 0.25\pi)$ $(\vec{x}, \vec{y}, \vec{\theta}, 0.0)$ $(\vec{x}, \vec{y}, \vec{\theta}, -0.25\pi)$



$$f(\vec{x}, \vec{y}, \vec{\theta}, 0.125\pi) =$$

DIMENSIONALITY: 5D-ISH, 2D BLEND OF 3D SPACES

Bin on 4th and additional 5th dimensions

Simple or uniform features (leading foot)

*k*NN clustering process where number of groups not user specified

UP, L
 $f(\vec{x}, \vec{y}, \vec{\theta})$

FLAT, L
 $f(\vec{x}, \vec{y}, \vec{\theta})$

DOWN, L
 $f(\vec{x}, \vec{y}, \vec{\theta})$

UP
 $f(\vec{x}, \vec{y}, \vec{\theta})$

FLAT
 $f(\vec{x}, \vec{y}, \vec{\theta})$

DOWN
 $f(\vec{x}, \vec{y}, \vec{\theta})$

UP, R
 $f(\vec{x}, \vec{y}, \vec{\theta})$

FLAT, R
 $f(\vec{x}, \vec{y}, \vec{\theta})$

DOWN, R
 $f(\vec{x}, \vec{y}, \vec{\theta})$

STYLE AND VARIED LOCOMOTION

“**MOTIONS**” atomic moves, fullbody or layered

“**MOTION TYPES**” collective styles of “**MOTIONS**”

Inherit, combine and replace motions

Data-driven selection of “**MOTION TYPE**”

“**BLACKBOARD**” for condition-able data

~210 locomotion “**ARCHETYPES**”

~2500 unique “**MOTION TYPES**”

~6300 unique “**MOTIONS**”

~1800 data-driven “**CONDITIONS**”



TERRAIN ANALYSIS

Global and local data pushed to “blackboard”

Forward integration of controller to produce path

Navmesh and physics casts to validate

Surface data cached: normal, positions, etc.

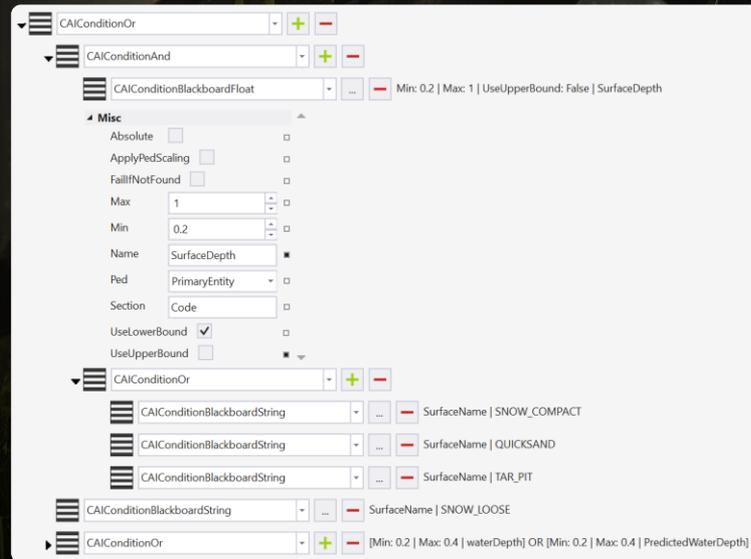
“Deep” surface depths detected (snow, water, mud)

Environmental features, bug swarms, wind velocities



STYLE AND VARIED LOCOMOTION

```
blackboard.Set<float>(SurfaceDepth, 0.4f);
blackboard.Set<hashstring>(SurfaceName, SNOW_LOOSE);
blackboard.PushEvent(ShakeTail);
```



AVOIDANCE

Mobility could enable more self preservation

We implemented unique solutions for player and AI

Scan everything? Calculate all the surfaces?

Too many false positives, markup all the things?

Elaborate VOs for AI, casting solution for Players



Your Dead Eye ability has improved.
You will now remain in Dead Eye
when you fire your weapon if you
have not tagged a target.

OUCH!



SPEED AND EFFORT

Support more fluidity in control without dependencies on specific assets

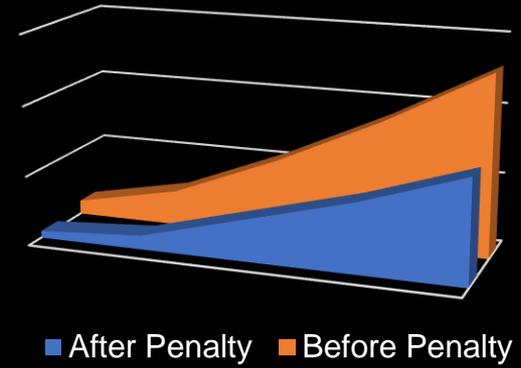
Precise control over impact of terrain, weight, etc on movement via “speed penalties”

Procedurally drive acceleration & deceleration cycles, layered head and tail shakes, stamina and “agitation”



NO PENALTIES

PENALTIES APPLIED





CLIFF STOPPING

TRANSLATION TO GOAL

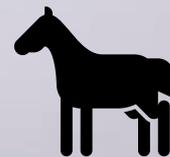
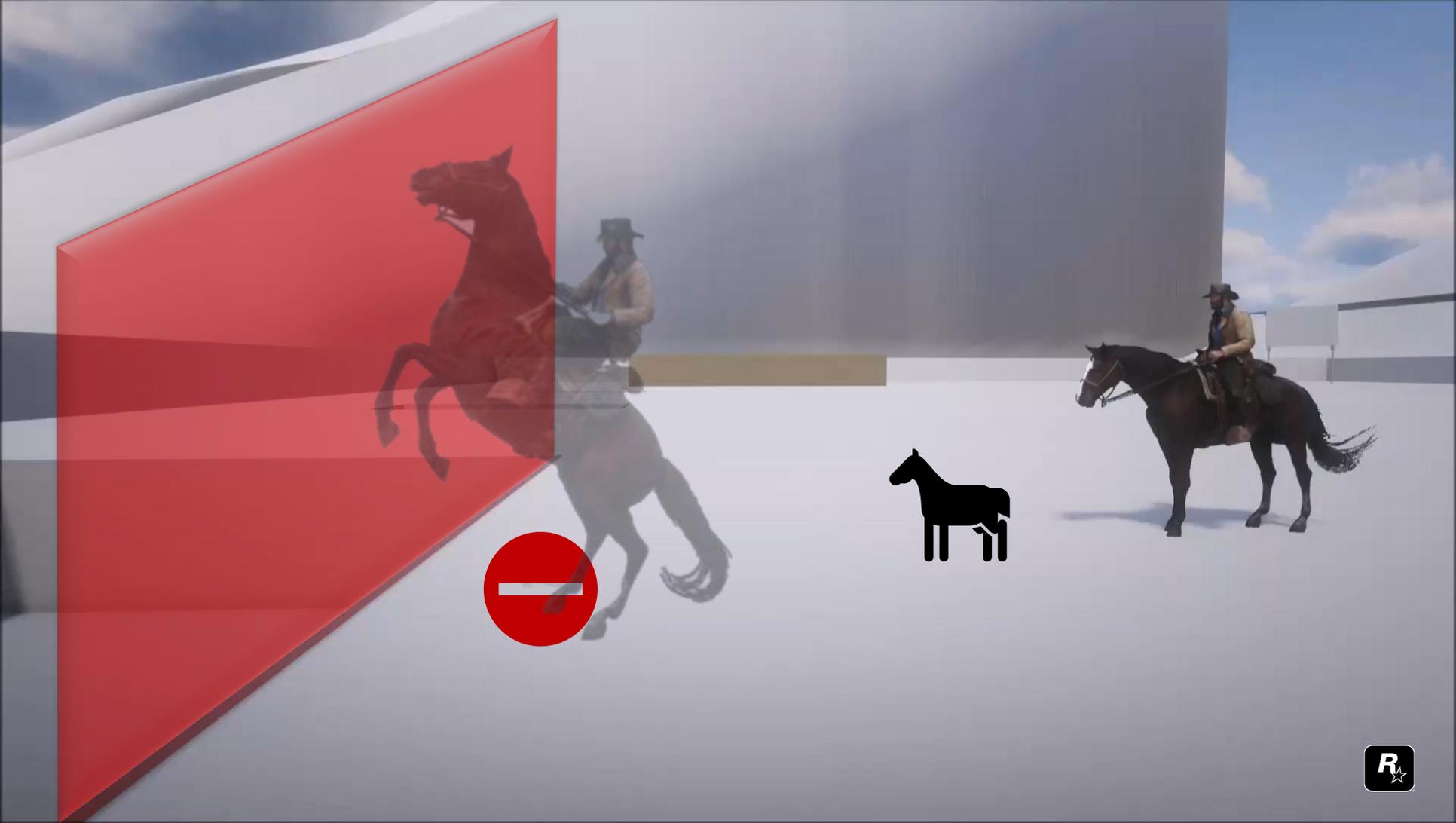
FOOT OR 'BEAT' CYCLE

ORIENTATION TO GOAL

++ MARKUP!

No Pupups

Parameterised Tracks







PERSONALITY

With the Radar turned off you can press  to briefly display it again.

HORSE WEAPONS 

HORSE CARGO 

 KENTUCKY SADDLER 



AGITATION & UNRULINESS

Trigger negative and increasingly uncontrolled behaviour to certain stimuli

- Predators
- Guns
- Rider Handling
- ...

Baseline responses, differentiator between breeds

Communicate via character, not UI

Simple utility system: **"MOTIVATIONS"**

ANGRY_STATE: 0.000 Modify: 1.000
AGITATION_STATE: 0.657 Modify: 1.000



15:26:18:15



WELLBEING

Feedback to encourage response to states of neglect

Performance impaired

Sad horse :(

LOW HEALTH

LOW STAMINA





BREEDS

BREEDS

~3k animations across 23 unique movement styles

Already a big runtime budget

19 Different breeds at launch split in four categories:

- **Work/Standard,**
- **Heavy/War/Draft,**
- **Race**
- **Elite**



BREEDS

Controller variations

- Acceleration and deceleration
- Angular responsiveness
- Preferred speed ranges per gait

Strength impacts speed penalties across different forms of terrain, what the horse is carrying, so on

Equipment variations for further differentiation on subtler stats

Stat trade offs, no “one true horse to rule them all”



STANDARD



You must increase your bond with a new horse before it is able to perform credit for you. For more information, visit the help page.

HEAVY



RACE



ELITE



FUTURE

Runtime compositional approaches

Large-scale data driven systems, lower the barrier for entry

An even wider variety of movement

Similar detail for other animals



FUTURE

Improve responsiveness and quality of humans and animals with lower production costs

Machine learning approaches

Better parity between AI and player-controlled characters





is Hiring





THANKS FOR LISTENING!

