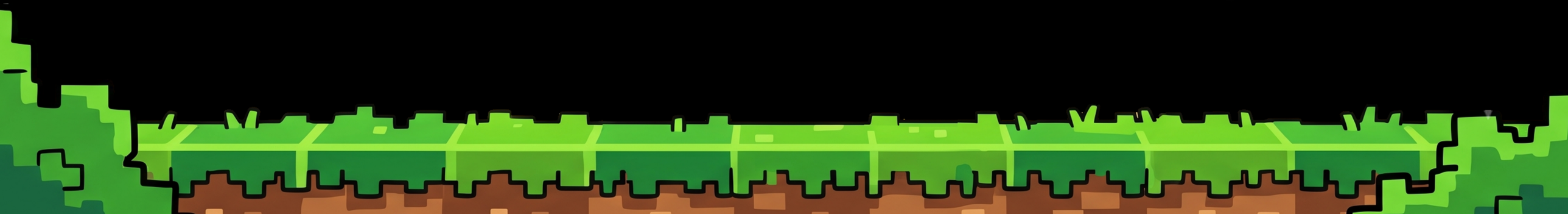


WARP PIPES AND PREFETCHING

Navigating the Web at Mario Speed



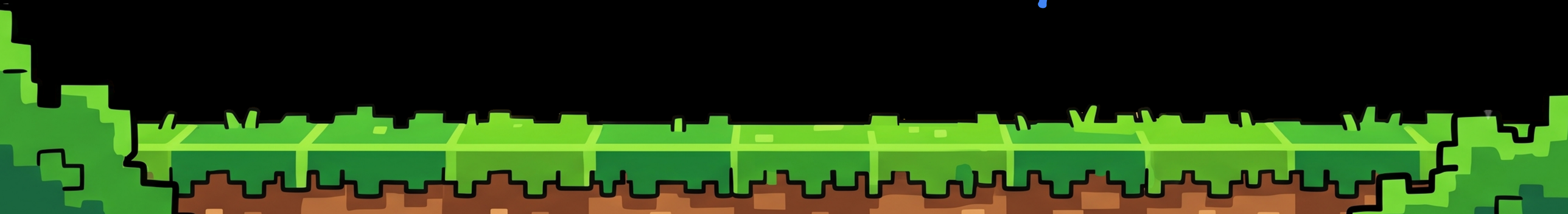


Core Web Vitals

Largest Contentful Paint

Interaction to Next Paint

Cumulative Layout Shift



Largest Contentful Paint

How fast does a website's main image or largest block of text actually appear on the screen ?



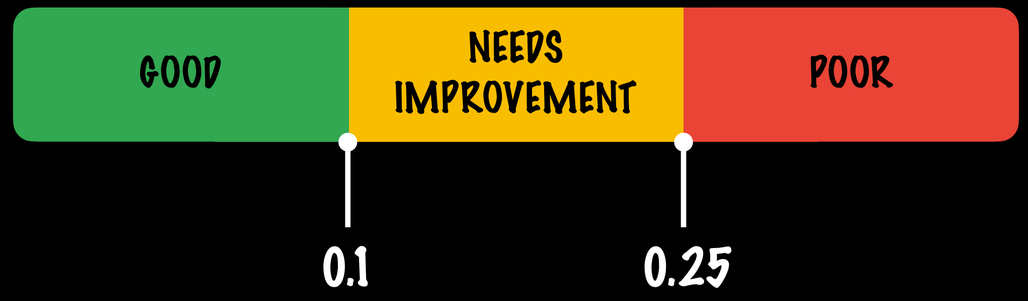
Interaction to Next Paint

How long does it take for a website to visually react after you click, tap, or type something ?



Cumulative Layout Shift

How much does the content of a website unexpectedly shift around while loading?




24
6
WORLD
1-1
HIGH SCORE: 255

Speculation Rules API

A cheat code to tell a browser to secretly prefetch or preload a page before a user clicks the link, making it appear instantly the moment they do.

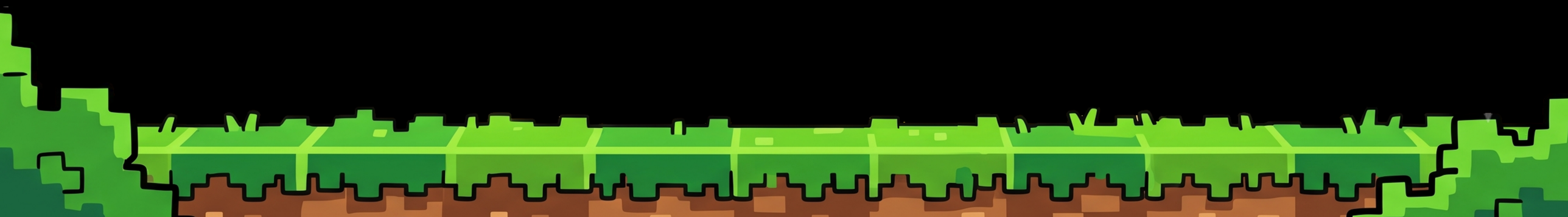


Prefetch

The browser proactively performs DNS lookups, establishes TCP connections, and downloads and caches specific web resources in memory to significantly reduce network latency for anticipated future requests.

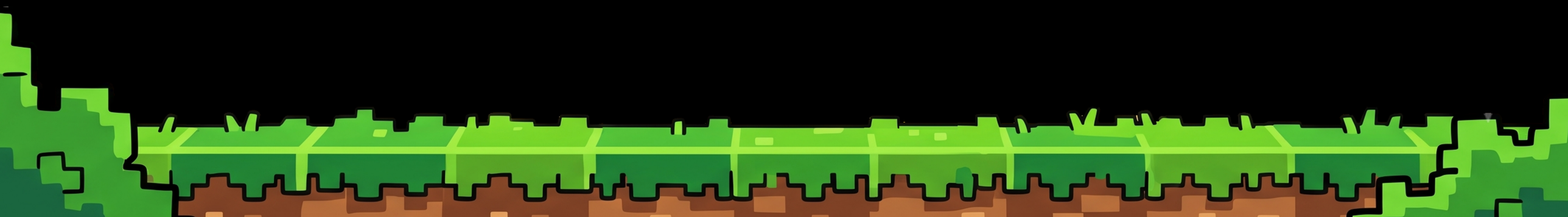


```
<link rel="prefetch" href="/mario.html" />
<link rel="prefetch" href="/luigi.html" />
```

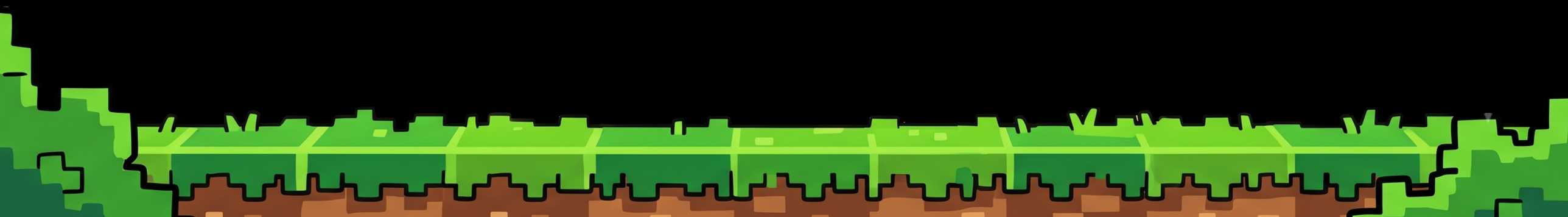




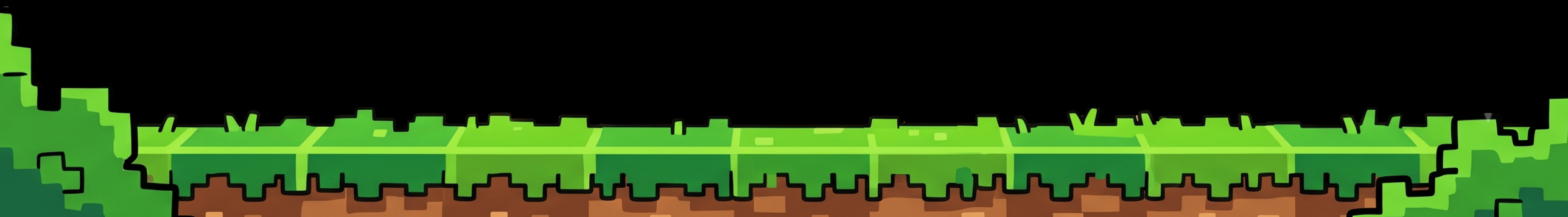
```
<script type="speculationrules">
{
  "prefetch": [
    {
      "urls": ["mario.html", "luigi.html"]
    }
  ]
}
</script>
```



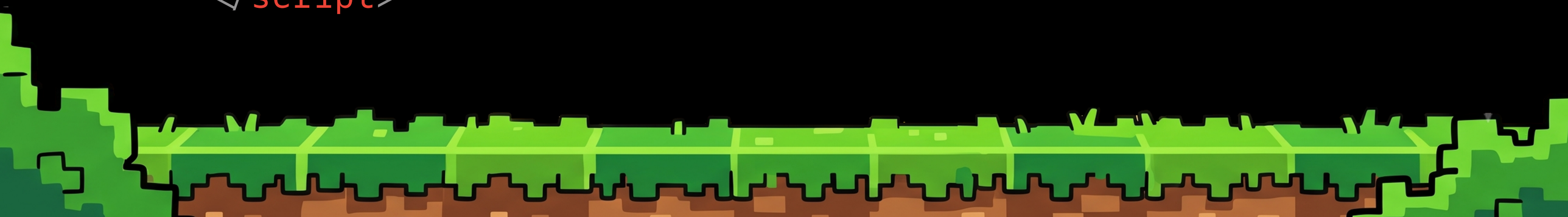
```
<script type="speculationrules">
{
  "prefetch": [
    {
      "where": { "href_matches": "/*" }
    }
  ]
}
</script>
```



```
<script type="speculationrules">
{
  "prefetch": [{
    "where": {
      "and": [
        { "href_matches": "/*" },
        { "not": {"href_matches": "/logout"}},
        { "not": {"selector_matches": ".no-prefetch"}},
      ]
    }
  }]
}
</script>
```



```
<script type="speculationrules">
{
  "prefetch": [{
    "where": {
      "and": [
        { "href_matches": "/*" },
        { "not": {"href_matches": "/logout"}},
        { "not": {"selector_matches": ".no-prefetch"}},
      ]
    },
    "eagerness": "eager"
  }]
}
</script>
```



Eagerness

immediate - as soon as the page loads

eager - on hover for 10 ms

moderate - on hover for 200 ms

conservative - on mousedown

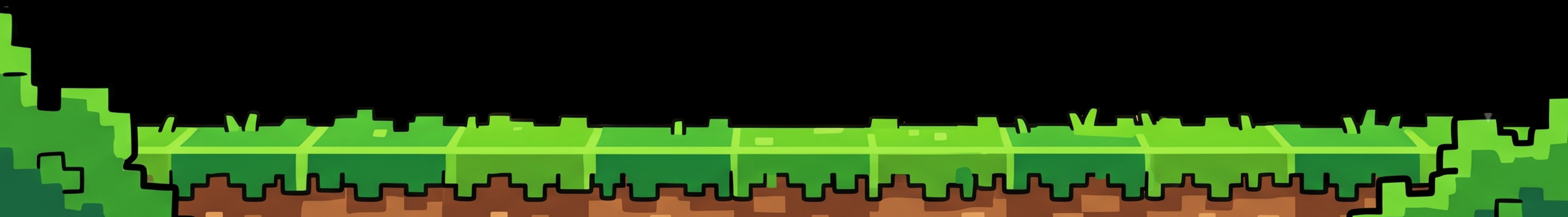


Prerender

The browser proactively fetches a designated URL and executes its entire critical rendering path, including DOM construction, layout, and JavaScript execution, in a hidden background context.

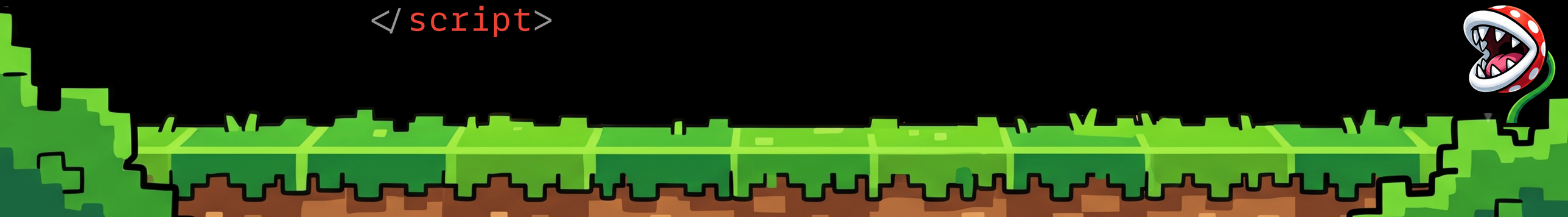


```
<script type="speculationrules">
{
  "prerender": [
    {
      "where": { "href_matches": "/*" },
      "eagerness": "moderate"
    }
  ]
}
</script>
```




M
L

```
<script type="speculationrules">
{
  "prefetch": [
    {
      "where": { "href_matches": "/*" },
      "eagerness": "eager"
    }
  ],
  "prerender": [
    {
      "where": { "href_matches": "/*" },
      "eagerness": "moderate"
    }
  ]
}
</script>
```





Elements | Console | Application | Main

Storage
- Local storage
- Session storage
- Extension storage
- IndexedDB
- Cookies
- Private state tokens
- Shared storage
- Cache storage
- Storage buckets

Background services
- Back/forward cache
- Background fetch
- Background sync
- Bounce tracking mi...
- Notifications
- Payment handler
- Periodic backgroun...
- Speculative loads
  - Rules
  - Speculations
- Push messaging
- Reporting API
- Device bound sessi...

Frames

Rule set	Status
index.html	2 not triggered





Mario



Luigi



Elements | Console | Application | Main

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  - Speculations
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- Reporting API
- Device bound sessi...

Frames

Rule set	Status
index.html	2 not triggered

http://127.0.0.1:8080/index.html

```
{
    "prefetch": [
        {
            "urls": [
                "luigi.html"
            ],
            "eagerness": "eager"
        }
    ],
    "prerender": [
        {
            "urls": [
                "luigi.html"
            ],
            "eagerness": "moderate"
        }
    ]
}
```



Elements Console Performance

Live metrics

Screenshots Memory Dim 3rd parties

Local metrics

Largest Contentful Paint (LCP)

Cumulative Layout Shift (CLS)

Next steps

Field metrics

See how your local metrics compare to real user data in the Chrome UX Report.

Set up



Elements Console Sources Application

Storage
- Local storage
- Session storage
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- Cookies
- Private state tokens
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- Cache storage
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Background services
- Back/forward cache
- Background fetch
- Background sync
- Bounce tracking mi...
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- Payment handler
- Periodic backgroun...
- Speculative loads
  - Rules
  - Speculations
- Push messaging
- Reporting API
- Device bound sessi...

Frames

All speculative ... | Filter

URL	Action	Rule set	Status
/luigi.html	Prefetch	index....	Not triggered
/luigi.html	Prerender	index....	Not triggered

No element selected

Select an element for more detail



Elements Console Sources Application

Storage
- Local storage
- Session storage
- Extension storage
- IndexedDB
- Cookies

Background services
- Back/forward cache
- Notifications
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- Periodic backgroun...
- Speculative loads
  - Rules
  - Speculations
- Push messaging
- Reporting API
- Device bound sessi...

Frames

All speculative ... Filter

URL	Action	Rule set	Status
/luigi.html	Prefetch	index....	Ready
/luigi.html	Prerender	index....	Not triggered

No element selected

Select an element for more details

Prerender JavaScript

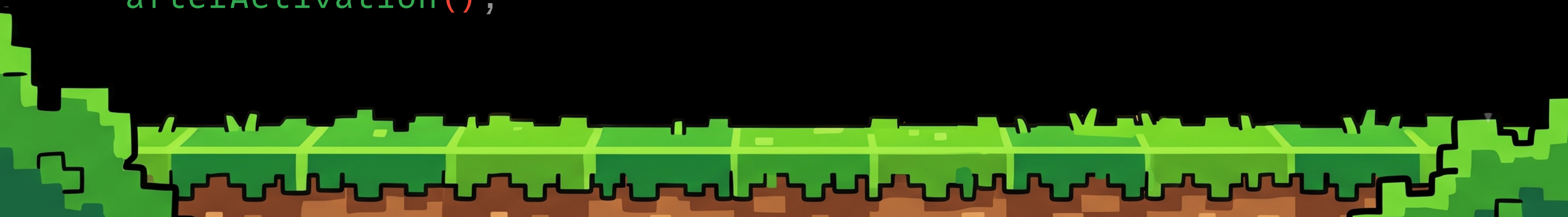
This can completely mess up your analytics by counting fake visits instead of real people, making it impossible to know how many actual humans are visiting your site, where they are from, or what they are really clicking on.



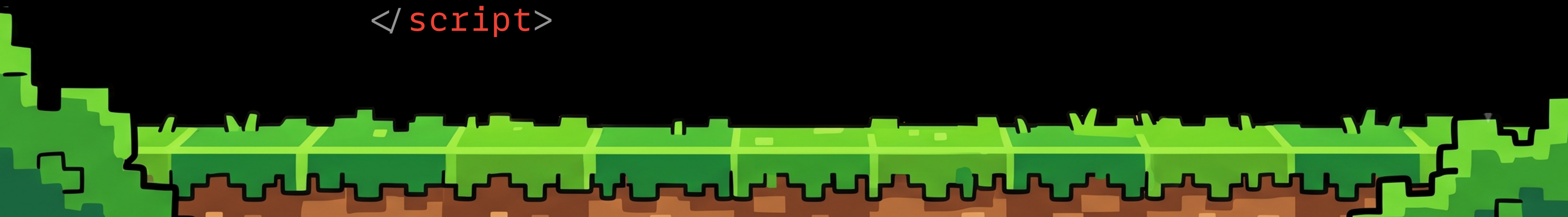
```
const isActivated = new Promise((resolve) => {
  if (document.prerendering) {
    document.addEventListener("prerenderingchange",
                              resolve, { once: true });
  } else {
    resolve();
  }
});

async function afterActivation() {
  await isActivated;
  // initialise your analytics, ad services, etc.
}

afterActivation();
```



```
<script type="speculationrules">
{
  "prefetch": [
    {
      "where": { "href_matches": "/*" },
      "eagerness": "eager"
    }
  ],
  "prerender_until_script": [
    {
      "where": { "href_matches": "/*" },
      "eagerness": "moderate"
    }
  ]
}
</script>
```



async and defer

<script> elements without async or defer pause parsing

Put them just before </body>, not in <head>



Add speculation rules via JS

```
const scriptElement = document.createElement("script");
scriptElement.type = "speculationrules";
const speculationRules = {
  prerender: [
    {
      urls: ["princes-peach.html"],
    },
  ],
};
scriptElement.textContent = JSON.stringify(speculationRules);
document.body.append(scriptElement);
```



No Speculation

Save-Data

Energy saver

Low memory

Cross-origin iframes





✓ 121

Januari 2024



✓ 121

Januari 2024



✗



26.2

December 2025


Service Workers
Think of a Service Worker as a mechanic Toad operating in the background pipes while Mario runs the main level.

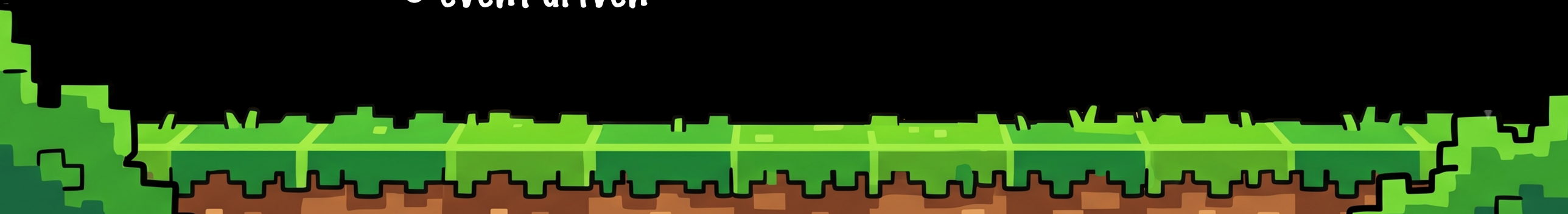
Service Workers



When Mario needs data but the Wi-Fi connection to Peach's Castle is broken, Toad intercepts the request and instantly hands him a cached Fire Flower so the game never stops.

Service Workers

- JavaScript file
- runs in the background in a separate thread
- non-blocking
- scoped to a website
- can't modify page; no direct access to DOM
- asynchronous; promises or async/await
- event driven



```
self.addEventListener("install", async () => {
  console.info("Service Worker installed");
  // activate service worker immediately after installation
  self.skipWaiting();
});


self.addEventListener("activate", async () => {
  console.info("Service Worker activated");
  // service worker controls the pages immediately after activation
  await self.clients.claim();
});
```



```
self.addEventListener("fetch", async (event) ⇒ {
  event.respondWith(
  );
});
```

service-worker.js



```
self.addEventListener("fetch", async (event) => {
  event.respondWith(
    (async () => {
      const cache = await caches.open("yoshi");

    })(),
  );
});
```

service-worker.js

```
self.addEventListener("fetch", async (event) => {
  event.respondWith(
    (async () => {
      const cache = await caches.open("yoshi");
      try {
        const response = await fetch(event.request);




        return response;
      }


    })(),
  );
});
```

service-worker.js

```
self.addEventListener("fetch", async (event) => {
  event.respondWith(
    (async () => {
      const cache = await caches.open("yoshis");
      try {
        const response = await fetch(event.request);


        await cache.put(event.request, response.clone());

        return response;
      }


    })(),
  );
});
```

service-worker.js

```
self.addEventListener("fetch", async (event) => {
  event.respondWith(
    (async () => {
      const cache = await caches.open("yoshis");
      try {
        const response = await fetch(event.request);
        // never cache the service worker itself
        if (!event.request.url.includes("service-worker.js")) {
          await cache.put(event.request, response.clone());
        }
        return response;
      }


    })(),
  );
});
```

service-worker.js

```
self.addEventListener("fetch", async (event) ⇒ {
  event.respondWith(
    (async () ⇒ {
      const cache = await caches.open("yoshis");
      try {
        const response = await fetch(event.request);
        // never cache the service worker itself
        if (!event.request.url.includes("service-worker.js")) {
          await cache.put(event.request, response.clone());
        }
        return response;
      } catch {
        return await cache.match(event.request);
      }
    })(),
  );
});
```

service-worker.js

```
document.addEventListener("DOMContentLoaded", async () ⇒ {
  try {
    // register the service worker if not already registered
    if (!navigator.serviceWorker.controller) {
      await navigator.serviceWorker.register("service-worker.js");
      console.info("Service Worker registered");
    }
  } catch (e) {
    console.error("Error during service worker registration:", e);
  }
});
```



```
<script src="script.js" defer></script>
```





Mario



Luigi





Elements Console Sources Network Application Performance

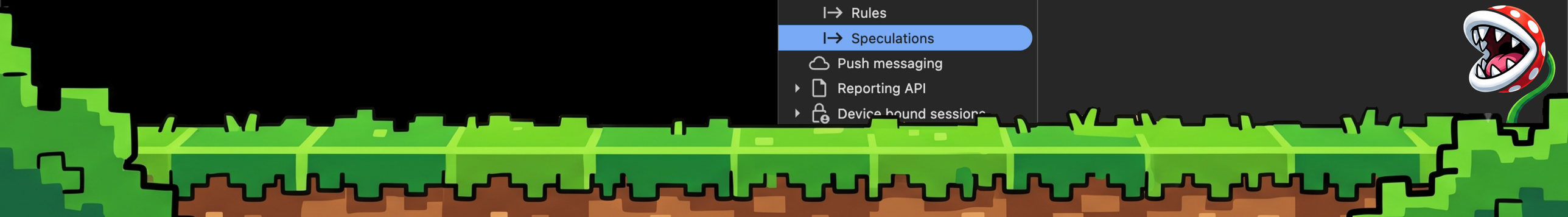
Application
- Manifest
- Service workers
- Storage
- WebMCP NEW
- Ads

Storage
- Local storage
- Session storage
- Extension storage
- IndexedDB
- Cookies
- Private state tokens
- Cache storage
- Storage buckets

Background services
- Back/forward cache
- Background fetch
- Background sync
- Bounce tracking mitigations
- Notifications
- Payment handler
- Periodic background sync
- Speculative loads
  - Rules
  - Speculations
- Push messaging
- Reporting API
- Device bound sessions

All speculative ... Filter

URL	Action	Rul...	Status
/5-service-worker/luigi.ht...	Prerender	5-s...	Not triggered
/5-service-worker/luigi.ht...	Prefetch	5-s...	Not triggered





Elements Console Sources Network Application 11 5

Keep log Disable cache Offline

Filter Invert More filters

All Fetch/XHR Doc CSS JS Font Img Media Manifest Socket Wasm Other

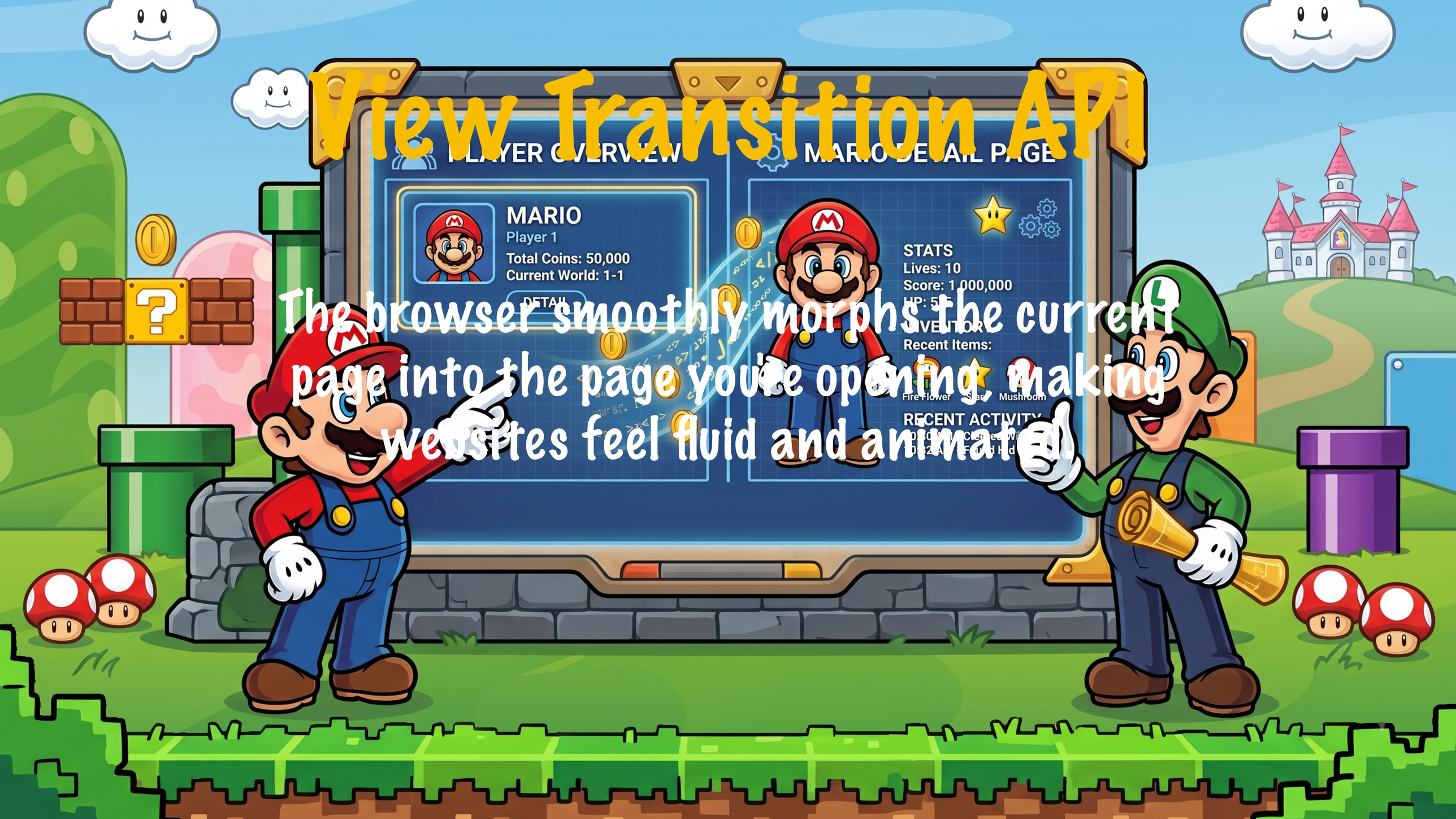
20 ms 40 ms 60 ms 80 ms 100 ms

Currently recording network activity

Perform a request or reload the page by using the "Reload page" button or by pressing ⌘ R Learn more

Reload page


45
September 2015
17
April 2018
44
January 2016
11.1
March 2018

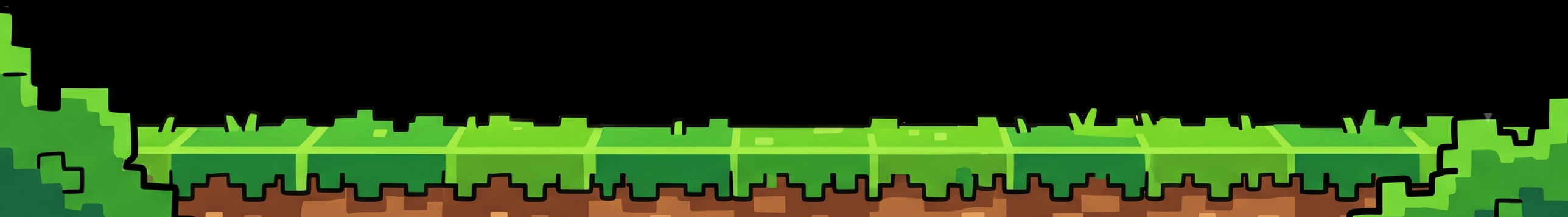

View Transition API
PLAYER OVERVIEW
MARIO
Player 1
Total Coins: 50,000
Current World: 1-1
DETAIL
MARIO DETAIL PAGE
STATS
Lives: 10
Score: 1,000,000
Recent Items:
Fire Flower
Star
Mushroom
RECENT ACTIVITY
The browser smoothly morphs the current page into the page you're opening, making websites feel fluid and animated

Cross-document MPA

MPA is a stupid word for website

Full page load from server (no SPA)

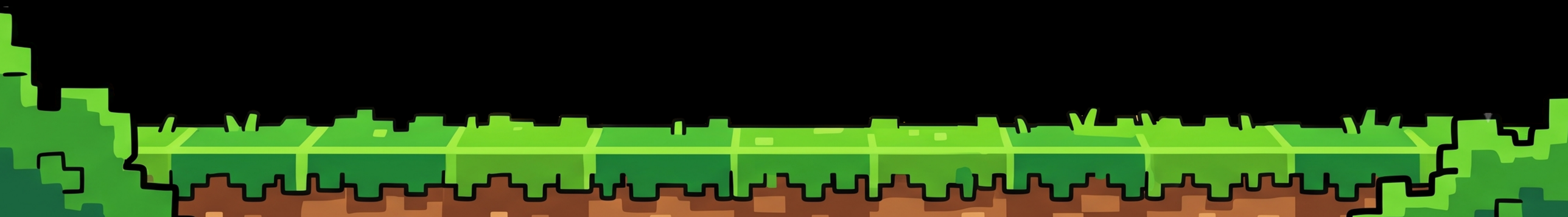
Same-origin navigation only



Same-origin

https://www.example.com:443

scheme hostname port



@view-transition

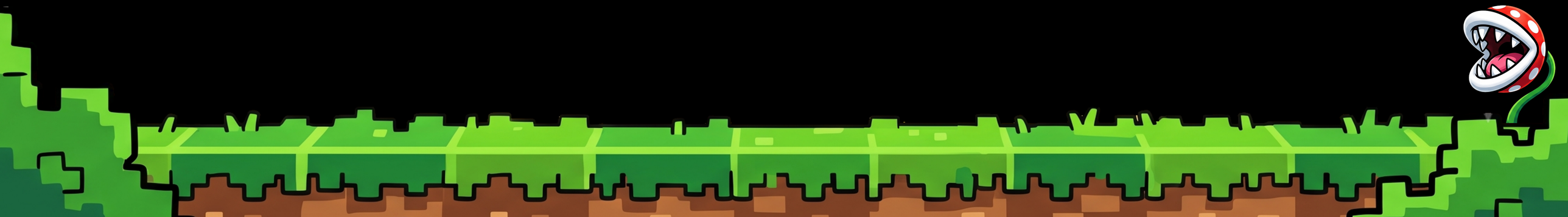
Default transition is cross-fade

Both pages need to opt-in



Opt-in

```
@view-transition {
  navigation: auto;
}
```

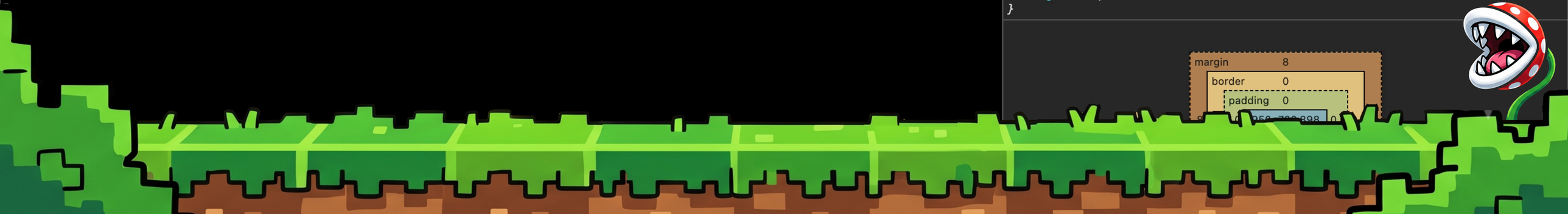




Mario



Luigi




```
<!DOCTYPE html>
<html lang="en">  view-source
 ▸ <head> … </head>
••• ▾ <body> == $0
   ▸ <main> … </main>
     <!-- Code injected by live-server -->
   ▸ <script type="text/javascript"> … </script>
   </body>
</html>
```

```
element.style {
}
body {                                                    style.css:9
   font-size: 1.25rem;
   font-family: "Marker Felt", sans-serif;
   background-color: rgb(0, 0, 0);
   color: rgb(255, 255, 255);
   line-height: 1.8;
}
body {                                                    user agent stylesheet
   display: block;
   margin: ▸ 8px;
}
```

margin 8
border 0
padding 0



Mario



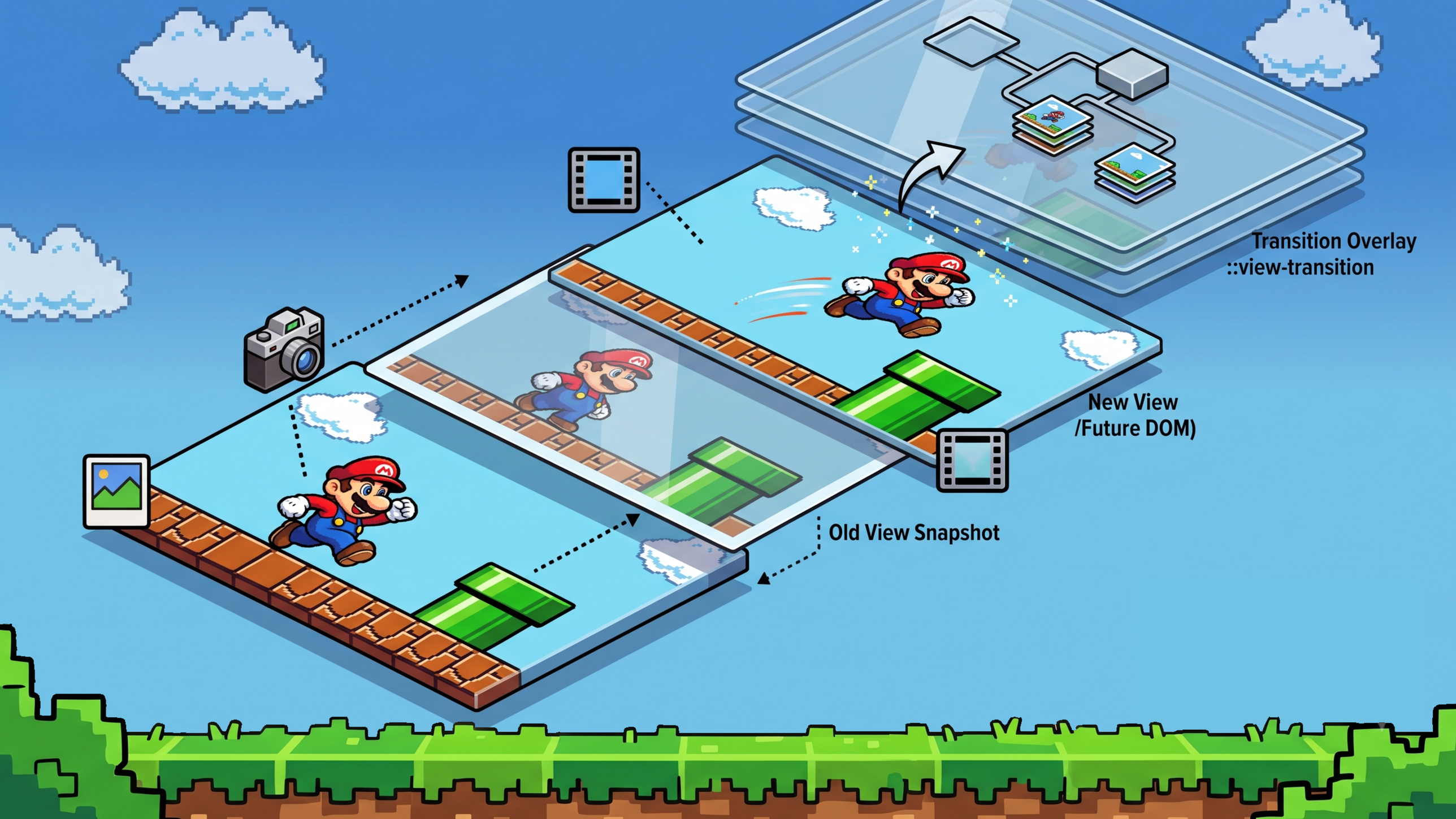
Luigi





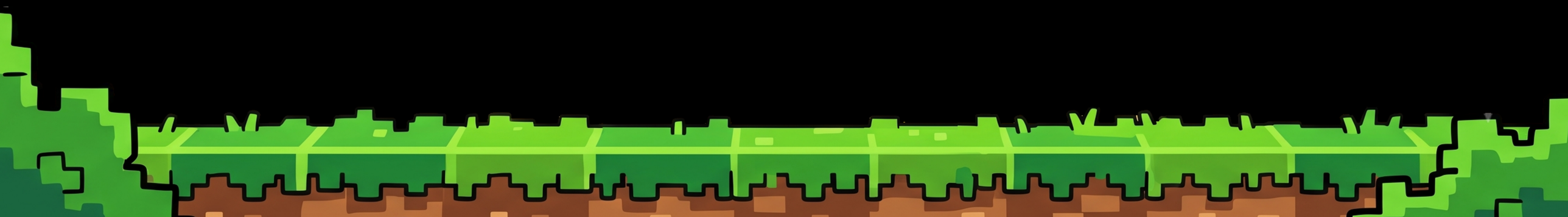

```
<!DOCTYPE html>
<html lang="en">  view-source
  <head> … </head>
  <body> == $0
    <main> … </main>
    <!-- Code injected by live-server -->
    <script type="text/javascript"> … </script>
  </body>
</html>
```

```
element.style {
}
body {                                                    style.css:9
  font-size: 1.25rem;
  font-family: "Marker Felt", sans-serif;
  background-color: rgb(0, 0, 0);
  color: rgb(255, 255, 255);
  line-height: 1.8;
}
body {                                                    user agent stylesheet
  display: block;
  margin: 8px;
}
```


Transition Overlay
::view-transition
New View
/Future DOM)
Old View Snapshot

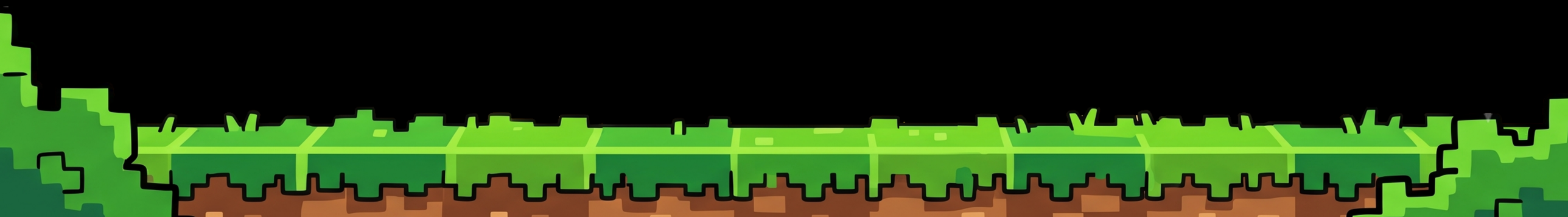
Overwrite default behavior

```
@view-transition {
  navigation: auto;
}
```



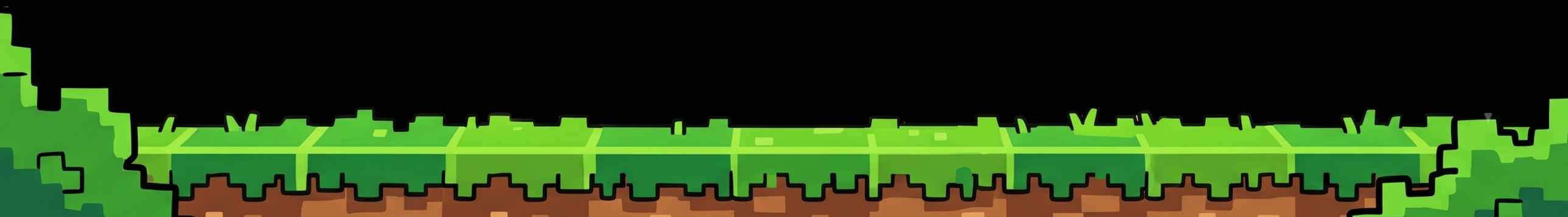
```css
/* the outgoing page snapshot fading out */
::view-transition-old(root) {
  animation-name: -ua-view-transition-fade-out;
  /* animates opacity from 1 to 0 */
}

/* the incoming page snapshot fading in */
::view-transition-new(root) {
  animation-name: -ua-view-transition-fade-in;
  /* animates opacity from 0 to 1 */
}
```



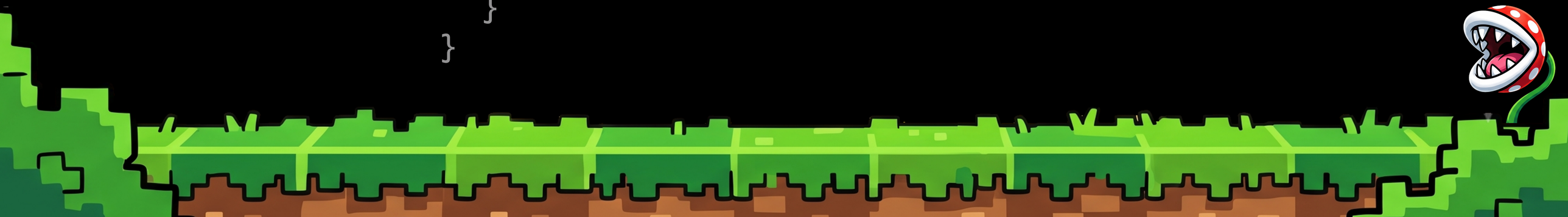
```css
::view-transition-old(root) {
  animation: 400ms ease-out both slide-out-to-left;
}


::view-transition-new(root) {
  animation: 400ms ease-out both slide-in-from-right;
}
```



```css
@keyframes slide-out-to-left {
  from {
    transform: translateX(0);
  }
  to {
    transform: translateX(-100%);
  }
}

@keyframes slide-in-from-right {
  from {
    transform: translateX(100%);
  }
  to {
    transform: translateX(0);
  }
}
```





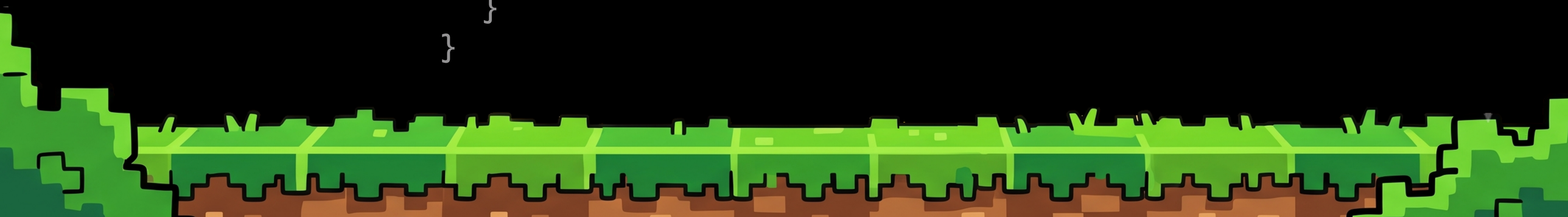
Mario



Luigi

```
@keyframes slide-out-to-right {
  from {
    transform: translateX(0);
  }
  to {
    transform: translateX(100%);
  }
}

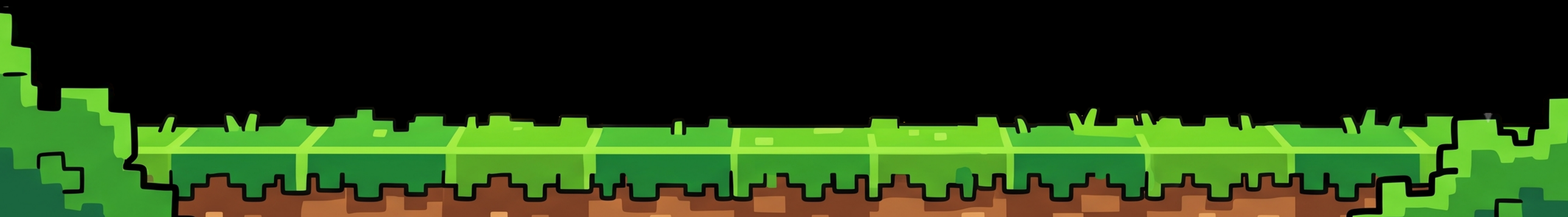
@keyframes slide-in-from-left {
  from {
    transform: translateX(-100%);
  }
  to {
    transform: translateX(0);
  }
}
```



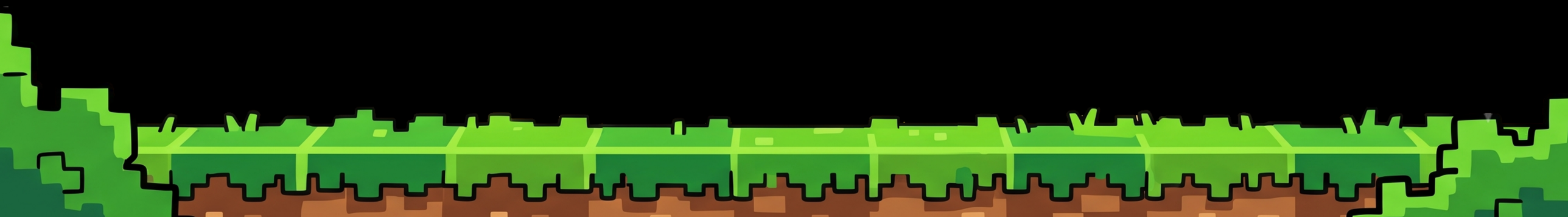
```
html:active-view-transition-type(back) {

  &::view-transition-old(root) {
    animation-name: slide-out-to-right;
  }

  &::view-transition-new(root) {
    animation-name: slide-in-from-left;
  }
}
```



```
// fires when the new page is rendering its first frame
window.addEventListener("pagereveal", applyTransitionType);
```



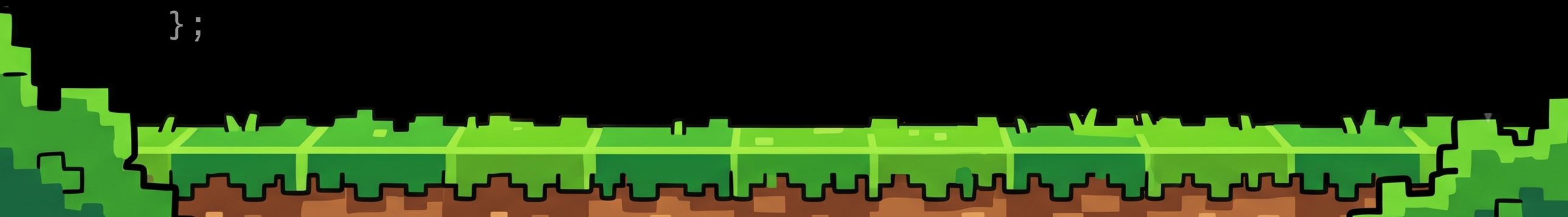
```
// fires when the new page is rendering its first frame
window.addEventListener("pagereveal", applyTransitionType);


const applyTransitionType = (event) => {

  if (
      navigation.activation.from.index >
      navigation.currentEntry.index
    )
  {

    event.viewTransition.types.add("back");
  }

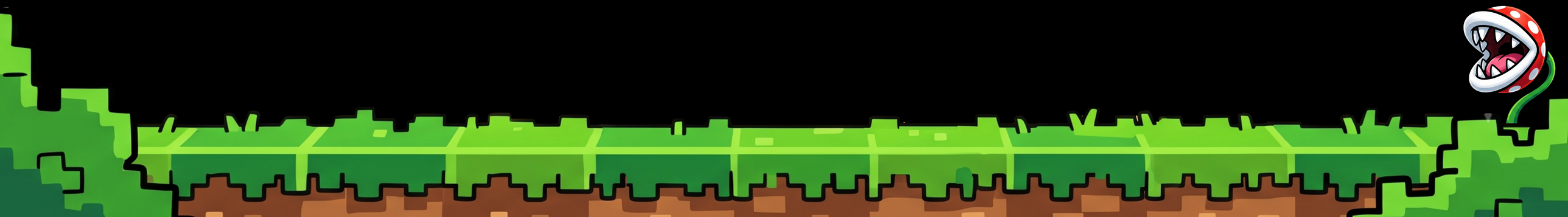
};
```



```
html:active-view-transition-type(back) {

  &::view-transition-old(root) {
    animation-name: slide-out-to-right;
  }

  &::view-transition-new(root) {
    animation-name: slide-in-from-left;
  }
}
```





Mario



Luigi

view-transition-name

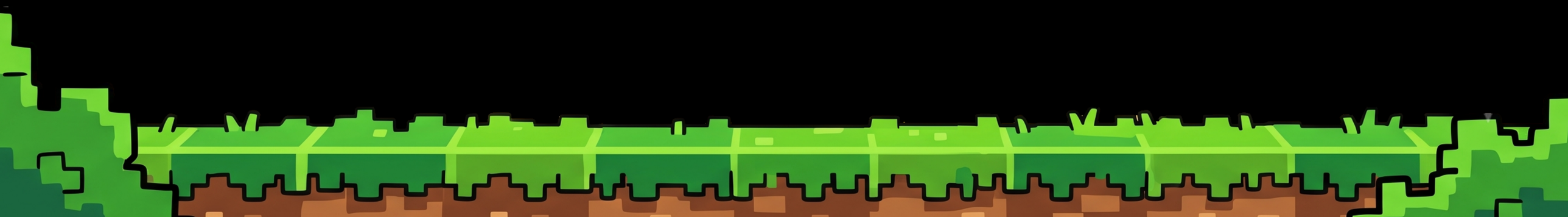
Animate specific elements

Both pages need to opt-in



```
<img src="/assets/img/luigi.webp" class="luigi" alt="Luigi"/>

<a class="luigi" href="luigi.html">Luigi</a>
```



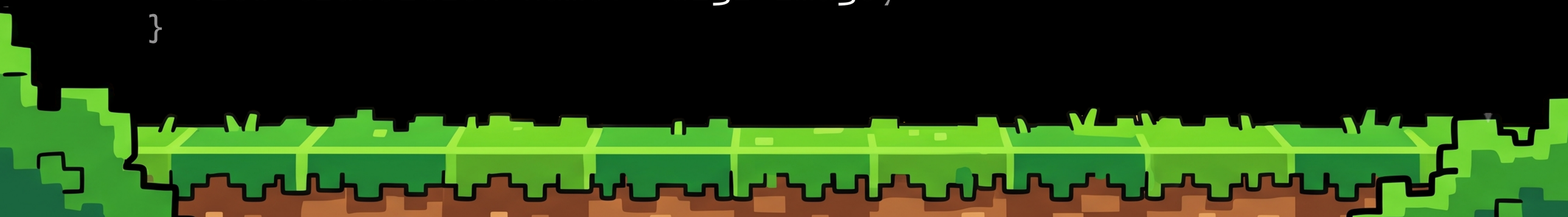
```html
<img src="/assets/img/luigi.webp" class="luigi" alt="Luigi" />

<a class="luigi" href="luigi.html">Luigi</a>
```

```css
@view-transition {
  navigation: auto;
}

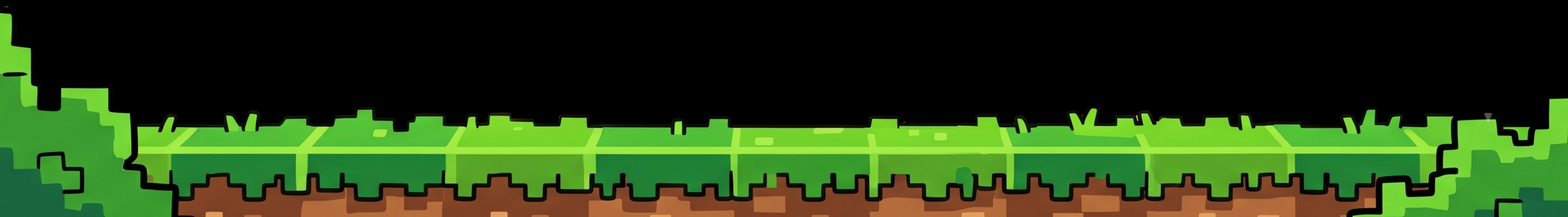
a.luigi {
  view-transition-name: luigi-text;
}

img.luigi {
  view-transition-name: luigi-image;
}
```



```
<img src="/assets/img/luigi450.png" class="luigi" alt="Luigi" />

<h1 class="luigi">Luigi</h1>
```



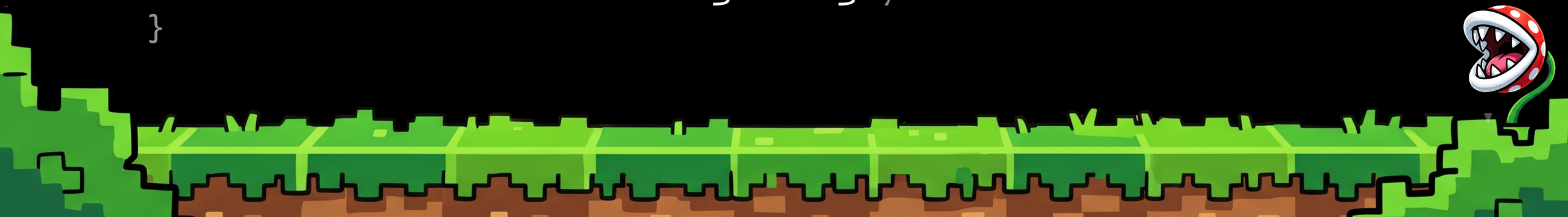
```
<img src="/assets/img/luigi450.png" class="luigi" alt="Luigi" />

<h1 class="luigi">Luigi</h1>


@view-transition {
  navigation: auto;
}

h1 {
  view-transition-name: luigi-text;
}

img {
  view-transition-name: luigi-image;
}
```



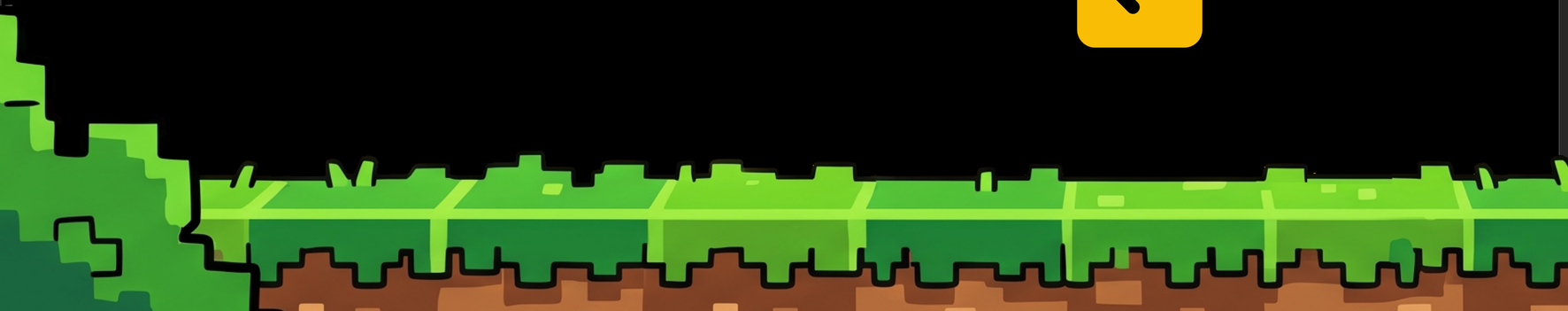


Mario



Luigi





Elements Console 1 Main

html body

Styles Computed Layout Event Listeners DOM breakpoints

Filter (.*) :hov .cls

```
element.style {
}
body {                                                    style.css:9
  font-size: 1.25rem;
  font-family: "Marker Felt", sans-serif;
  background-color: rgb(0, 0, 0);
  color: rgb(255, 255, 255);
  line-height: 1.8;
}
body {                                          user agent stylesheet
  display: block;
  margin: 8px;
}
```

margin 8
border 0
padding 0
8 0 0 1018×720.898 0 0 8

Console AI assistance Issues Animations

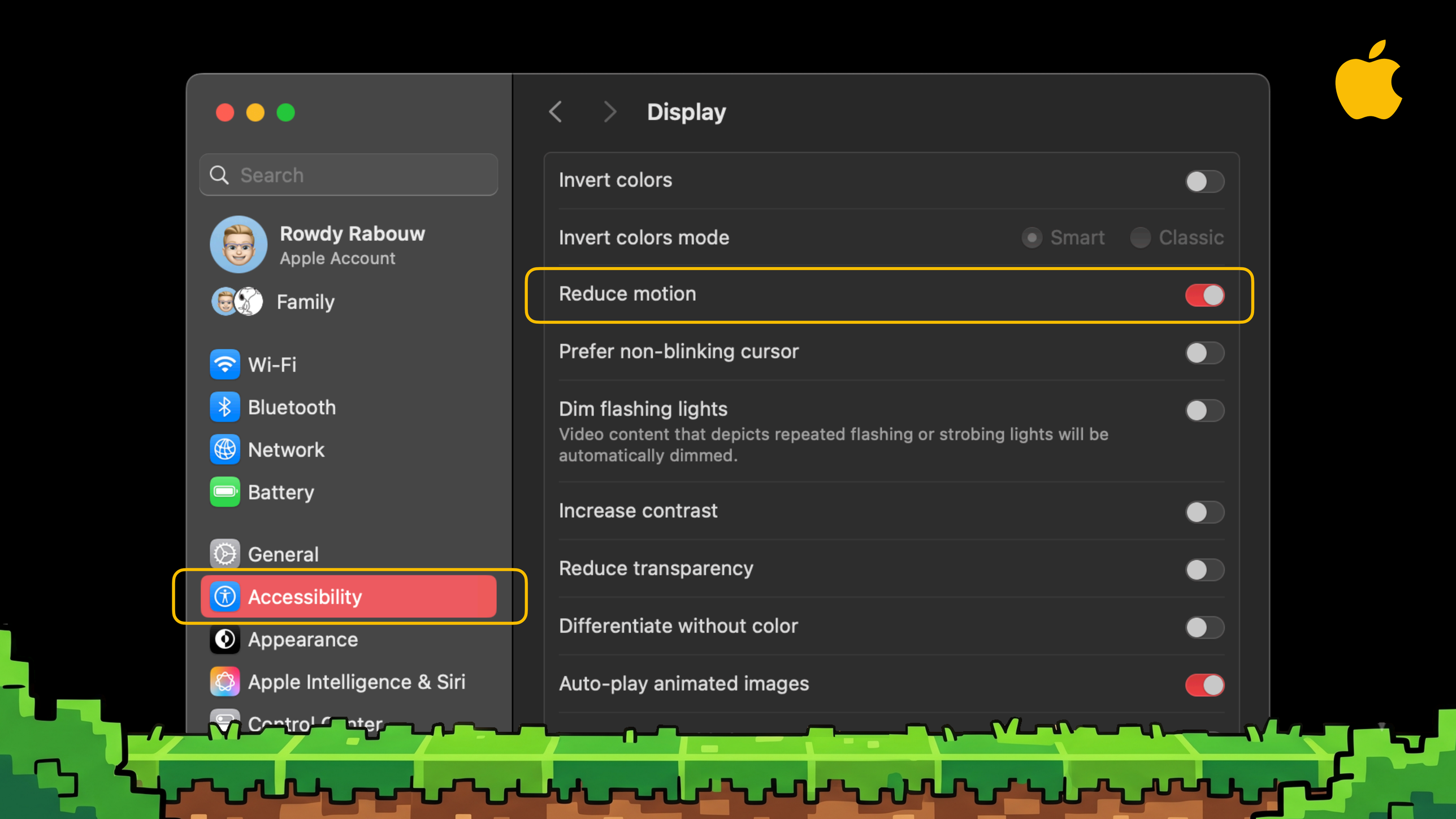
100% 25% 10%

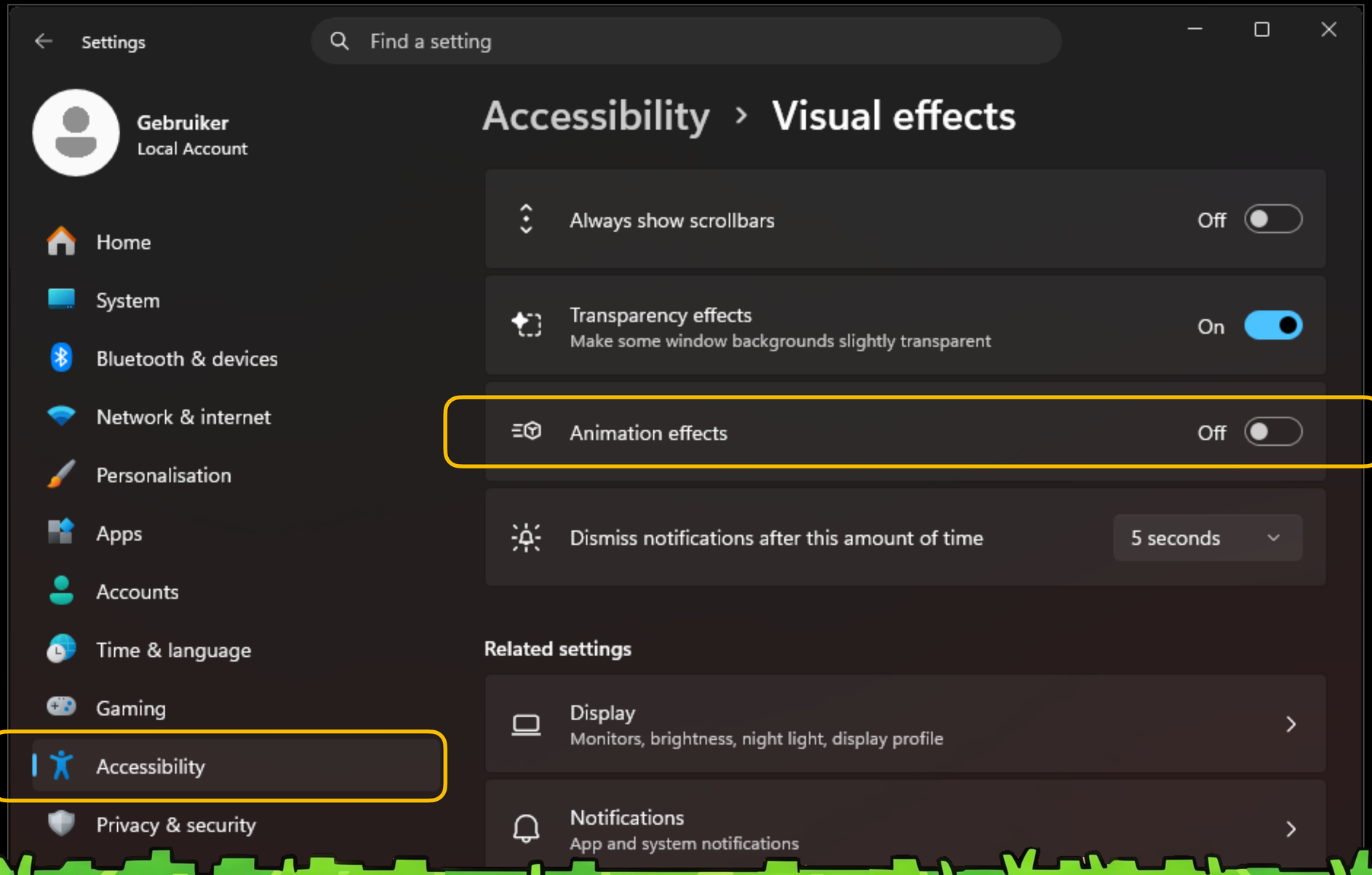
0 ms

No animation effect selected

Select an effect above to inspect and modify



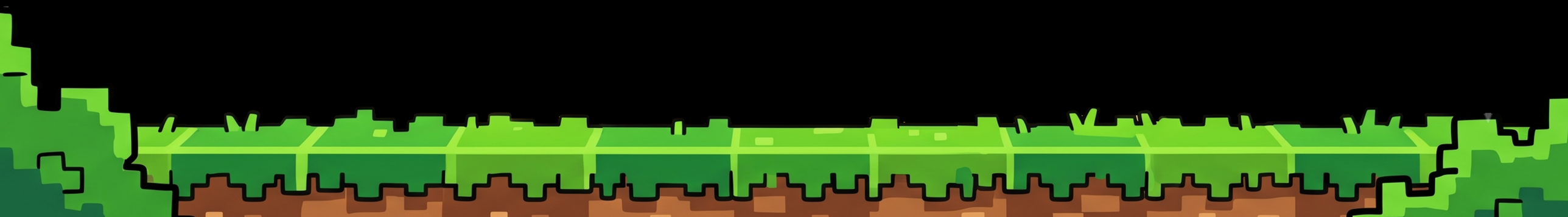

Search
Rowdy Rabouw
Apple Account
Family
Wi-Fi
Bluetooth
Network
Battery
General
Accessibility
Appearance
Apple Intelligence & Siri
Display
Invert colors
Invert colors mode
Smart
Classic
Reduce motion
Prefer non-blinking cursor
Dim flashing lights
Video content that depicts repeated flashing or strobing lights will be automatically dimmed.
Increase contrast
Reduce transparency
Differentiate without color
Auto-play animated images


Settings
Find a setting
Gebruiker
Local Account
Home
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Accessibility › Visual effects
Always show scrollbars
Off
Transparency effects
Make some window backgrounds slightly transparent
On
Animation effects
Off
Dismiss notifications after this amount of time
5 seconds
Related settings
Display
Monitors, brightness, night light, display profile
Notifications
App and system notifications

prefers-reduced-motion

```
@media (prefers-reduced-motion: reduce) {
  /* less motion for users who prefer reduced motion */
}


@media (prefers-reduced-motion: no-preference) {
  /* normal motion for users who do not prefer reduced motion */
}
```



```css
@view-transition {
  navigation: auto;
}


@media (prefers-reduced-motion: no-preference) {

  a.luigi {
    view-transition-name: luigi-text;
  }

  img.luigi {
    view-transition-name: luigi-image;
  }

}
```



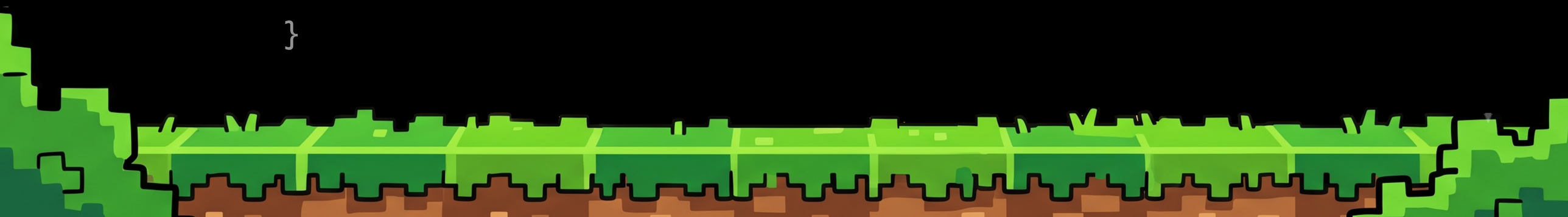
```css
@view-transition {
  navigation: auto;
}


@media (prefers-reduced-motion: no-preference) {

  h1 {
    view-transition-name: luigi-text;
  }

  img {
    view-transition-name: luigi-image;
  }

}
```




✓ 126
June 2024
✓ 126
June 2024
✗
✓ 18.2
December 2024


rowdy.codes/belgium