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Using AI to solve a key a11y problem of maps!

a11y – Accessibility

- Create an inclusive web for everyone
 - for the visually, motorically, cognitive impaired ...
- became more and more important over the past years, even by law

- **A11Y IS NOT "JUST A FEATURE"!**

- and adding it afterwards means a lot of effort....

- Typical Problems:

- **Keyboard accessibility:** Many interactive elements can only be reached with a mouse or touch.
 - **Semantic structure:** Screen readers can't interpret if elements are built without **ARIA roles or labels**.
 - **Focus and live region:** Dynamic content changes (e.g., AJAX/SPAs) without notifying the screen reader.
 - **Contrast and readability:** Low color contrast and non-scalable text make use difficult for many users.



Image created with ChatGPT

a11y – Problems with maps

- Maps are inherently **visual**, dynamical and intercative
 - Screen readers usually only encounter an **empty <div>** or **<canvas>**
- Missing alternatives
 - POIs and layer information are rarely available as accessible lists or tables (**Non-Visual View**)
- Maps have no linear structure
 - Spatial **relationships** are mainly visual (e.g., “north of...”) can roughly be transported with plain text in lists
- Interaction issues
 - Zooming, panning, or clicking markers or popups often isn’t **keyboard-accessible**.
- Dynamic content:
 - Screen readers are not automatically informed when maps move, filters change, or layers switch.



Image created
with ChatGPT

Another approach to a11y: AI

- LLMs (Large Language Models) nowadays offer strong capabilities to generate textual descriptions of images
- Why not use this for a11y?
 - Concept
 - Users can actively trigger a textual description of the current map view.
 - The application creates a **screenshot**, an LLM analyzes it, and generates a semantic textual description.
 - The description can be read out by a screen reader
 - Assumed example output:
 - *“The map shows the city center of Frankfurt with the train station. A river runs along in the south.”*



Image created with ChatGPT



Advantages of the approach

- **Provides access** to dynamic, visually rendered maps (e.g., WebGL, raster maps) that were **previously unreadable** for screen readers.
- **Independent and extensible:** works with any type of layer, map, data type, client
 - Potentially applicable to heatmaps, 3D views, or any thematic maps.
- **Spatial orientation** becomes linguistically perceptible (“north of the city center,” “nearby...”).
- **Visual context** can be included in the analysis like street patterns, map labels, colors of POIs
- **User-controlled interaction:** The user triggers the description on demand, avoiding information overload.

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with ChatGPT

Challenges

- **Accuracy:** AI-generated descriptions may be **incorrect** ("hallucinations")
 - Output is not **deterministic**, small changes in the input can have different results
 - **Can I trust the output?** ("I think, this could be ...")
 - **Context is King!** Best results may be achieved in combination with additional feature data
- **Complement, not replacement:** Screenshot descriptions should supplement, not replace, accessible structured alternatives (e.g., ARIA-based POI lists)
- **Latency:** Processing must be fast enough for practical use, screenshot upload needs to be considered
- **Data protection:** Screenshots may contain sensitive (geo-)data
- **Lack of standards:** No WCAG-compliant guidelines **yet** for AI-based descriptions.



Image created with ChatGPT

Technical realisation – What do you need for a prototype?

- Depends on the target client:
 - Prototyping in **map.apps**, which is based on the ArcGIS Maps SDK for JavaScript
- OpenAI API <https://platform.openai.com/docs/api-reference/introduction>
 - Rest API to communicate with an LLM like GPT-4.1 (basically, just like ChatGPT)
 - Completions API / Responses API
- API-Key: Directly from OpenAI or from a deployment in Azure Open AI
- Access to a model: I.e.g. **GPT-4.1** hosted in West-Europe
- Node.js packages: <https://www.npmjs.com/package/openai> /
<https://www.npmjs.com/package/@azure/openai>
- `view.screenshot()` from the Maps SDK 😊

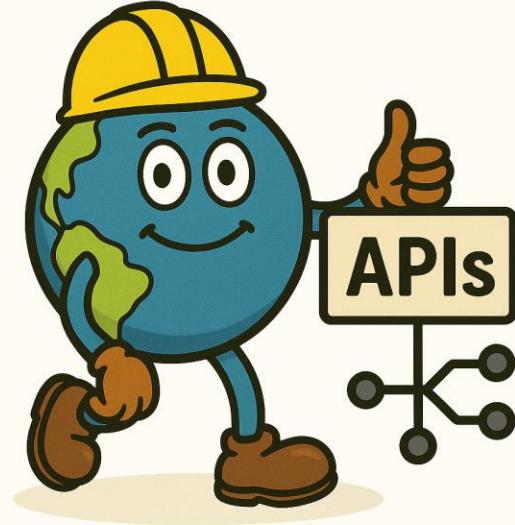


Image created with ChatGPT

No LLM evaluation has been done, yet!



Prompting / Interacting with the API

```
1 [ "messages": [
2     "role": "system",
3     "content": [
4         { "type": "text",
5             "text": "Always respond in the language from the locale 'de'.
6                         Please provide your answer in visually appealingly formatted html.
7                         Make the output accessible, so a screen reader can read it out loud.
8                         Do not include markers for the file format in the content.
9                         Do not include images in your response."
10        }]
11    },
12    {
13        "role": "user",
14        "content": [
15            { "type": "text",
16                "text": "Give me a description of what can be seen on the map.
17                         Assume that a visually impaired person is asking you.
18                         Make a guess about the location."
19            },
20            { "type": "image_url",
21                "image_url": {
22                    "url": "data:image/png;base64,..."
23                }
24            }
25        ],
26        "model": "aoai-gpt-4.1-demo-m.scherpinski",
27        "store": true
28    }
```

Image created
with ChatGPT

Demo 1 – General workflow with satellite images

Esri European Developer & Technology Summit 2025 | Using AI to Solve a Key a11y Problem of Maps! | Basemap Topographical Map | Language English

Map Explanation x

Description of the Map

- The image is a detailed satellite view of an urban area with a dense network of streets.
- There is a significant railway station near the center of the map, with many tracks converging in one area.
- A curved river runs diagonally from the lower right corner to the middle right, spanned by several bridges.
- Clusters of large buildings, possibly commercial or governmental, are visible close to the river and railway station.
- Residential neighborhoods with regular blocks and green spaces surround the central area.
- Parks and open areas can be seen, especially towards the upper left.

Location Guess

Frankfurt am Main, Germany

Request Explanation ⚙️

200 m

Microsoft, Vantoor

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NVDA Speech Viewer

Close window

Request Explanation button

Abort request button

alert busy Loading response from AI...

Request Explanation button

AI Response Text Area alert

<h2> Description of the Map</h2> The image is a detailed satellite view of an urban area with a dense network of streets. There is a significant railway station near the center of the map, with many tracks converging in one area. A curved river runs diagonally from the lower right corner to the middle right, spanned by several bridges. Clusters of large buildings, possibly commercial or governmental, are visible close to the river and railway station. Residential neighborhoods with regular blocks and green spaces surround the central area. Parks and open areas can be seen, especially towards the upper left. <h2> Location Guess</h2> <p> Frankfurt am Main, Germany </p>

Show Speech Viewer on Startup

Map Content Legend Imprint Privacy Statements

Demo 2 – Different Prompts and Geodata

Esri European Developer & Technology Summit 2025 | Using AI to Solve a Key a11y Problem of Maps!

Basemap Street Map (gray) Language English

Map Explanation

Click the button below to request an AI-generated explanation of the current map view.

Current Prompt:

Give me a description of what can be seen on the map. Assume that a visually impaired person is asking you. Make a guess about the location.

New Prompt

Give me a description of what can be seen on the map. Assume that a visually impaired person is asking you. Give me the count of POIs on the map.

Send prompt

200 m

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Problem of Maps! — Mozilla Firefox button
System audio unmuted.
Select to mute system audio button
DesktopWindowXamlSource
http://office.conterra.de:9090/?lang=en&vm=2D&s=18055.9548215&c=964309.210966704%&b=gray&l=erfrischungsbrunnen&r=0
Using AI to Solve a Key a11y Problem of Maps!
Using AI to Solve a Key a11y Problem of Maps! — Mozilla Firefox
Map Explanation
clickable Can be moved with arrow keys heading level 2 Map Explanation
tool bar button Close window out of tool bar
Click the button below to request an AI-generated explanation of the current map view.
tool bar
Close window button alert Close window Request Explanation button
Configure Prompt button New Prompt edit multi line Enter a new prompt... blank Send prompt button
Show Speech Viewer on Startup

Demo 2 – Different Prompts and Geodata

Demo 3 – GeoGuesser and spatial context

Esri European Developer & Technology Summit 2025 Using AI to Solve a Key a11y Problem of Maps!

Basemap Topographical Map Language English

Map Explanation dialog
Can be moved with arrow keys
clickable Can be moved with arrow keys heading level 2 Map Explanation tool bar
Close window button alert Close window Request Explanation button
Configure Prompt button New Prompt edit multi line Enter a new prompt... blank Send prompt button Abort request button alert busy Loading response from AI... Request Explanation button
AI Response Text Area alert
Stadium Identification

- Guess: Volksparkstadion
- Location: Hamburg, Germany
- Notable for: Home of Hamburger SV
- Clues: The logo visible in the seats and the surrounding training pitches help identify it.

Request Explanation

GeoGuesser

Location 1a Location 1b

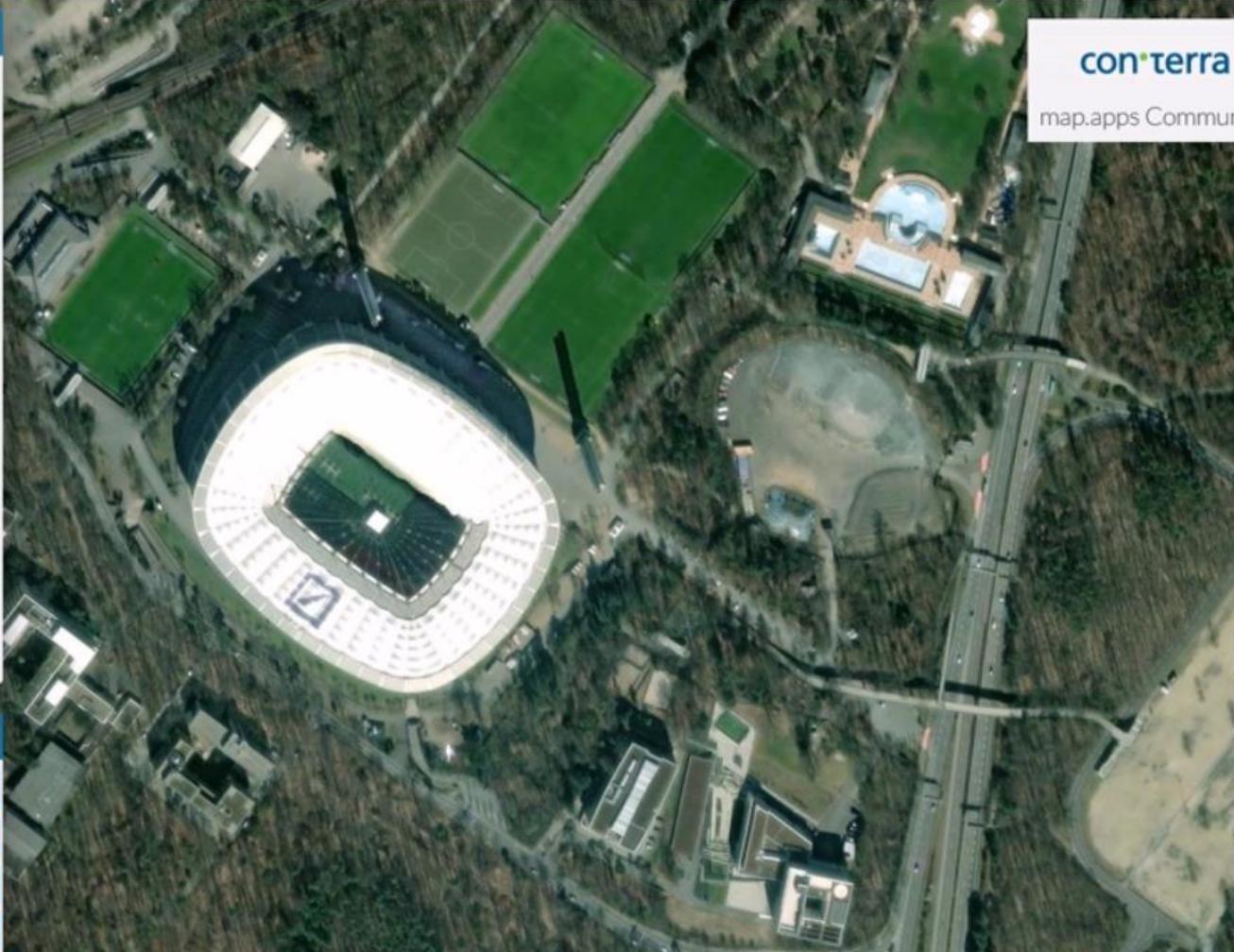
Location 2

Location 3

Location 4

Microsoft, Vantor Powered by Esri

Map Content Legend Imprint Privacy Statements Show Speech Viewer on Startup



NVDA Speech Viewer

Firefox

Map Explanation dialog
Can be moved with arrow keys
clickable Can be moved with arrow keys heading level 2 Map Explanation tool bar
Close window button alert Close window Request Explanation button
Configure Prompt button New Prompt edit multi line Enter a new prompt... blank Send prompt button Abort request button alert busy Loading response from AI... Request Explanation button
AI Response Text Area alert
Stadium Identification

- Guess:** Volksparkstadion
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map.apps Community

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Demo 3 – GeoGuesser and spatial context

Esri European Developer & Technology Summit 2025 | Using AI to Solve a Key a11y Problem of Maps!

Basemap Topographical Map | Language English

Map Explanation

Stadium Identification

Based on the satellite image, the stadium shown is most likely:

- Deutsche Bank Park (formerly known as Waldstadion) in Frankfurt am Main, Germany.

This stadium is home to Eintracht Frankfurt and is located on the edge of a large forested area, fitting the context of the image.

Request Explanation

GeoGuesser

Location 1a	Location 1b
Location 2	
Location 3	
Location 4	

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NVDA Speech Viewer

Close window button
alert Close window
Location 1a button
Location 1b button
Location 1a button
tool bar
Close window button
alert Close window
GeoGuesser dialog Can be moved with arrow keys
Map Explanation dialog Can be moved with arrow keys
button Configure Prompt
Request Explanation
button Abort request button
alert busy Loading response from AI...
Request Explanation
button AI Response Text Area alert
<h2>Stadium Identification</h2> <p>Based on the satellite image, the stadium shown is most likely:</p> Deutsche Bank Park (formerly known as Waldstadion) in Frankfurt am Main, Germany. <p>This stadium is home to Eintracht Frankfurt and is located on the edge of a large forested area, fitting the context of the image.</p>

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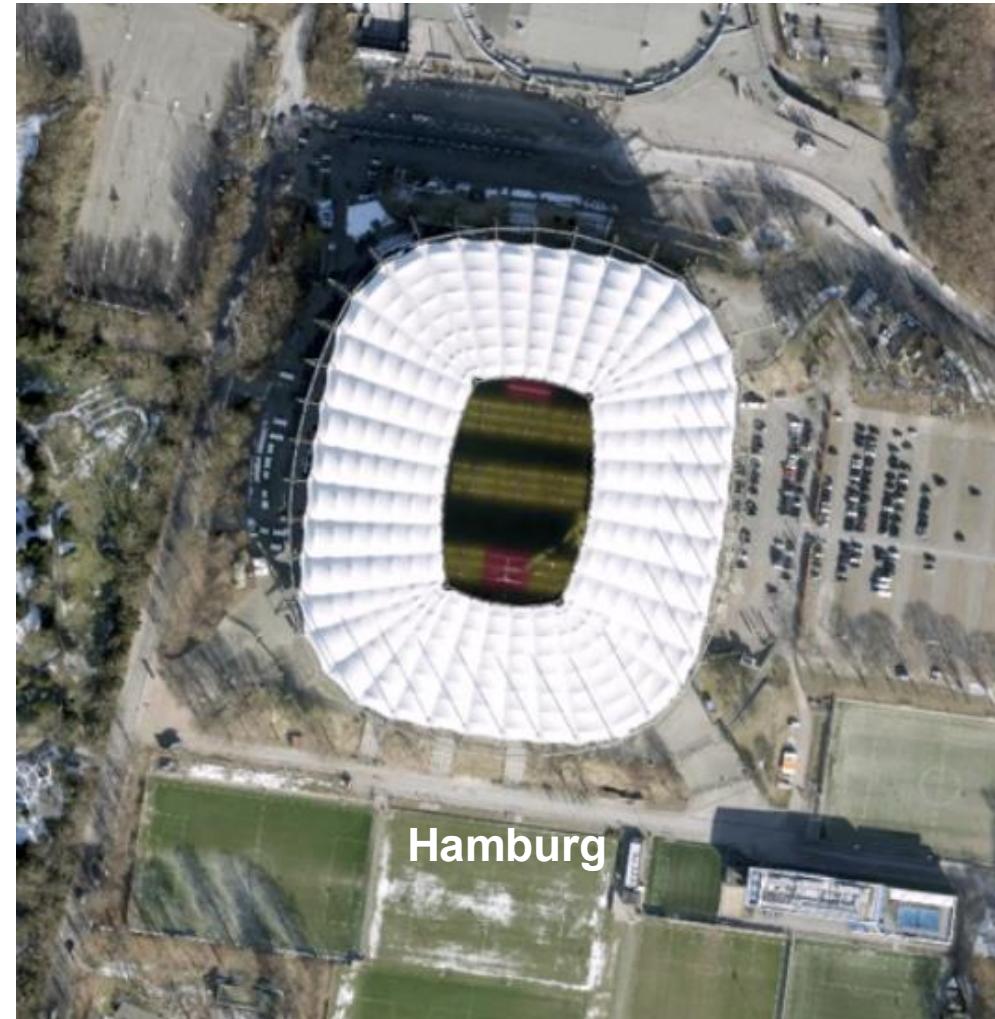
Microsoft, Vantor

Map Content Legend Imprint Privacy Statements Show Speech Viewer on Startup

Demo 3 – GeoGuesser and spatial context



Frankfurt



Hamburg

Demo 4 – GeoGuesser with more obvious data

Esri European Developer & Technology Summit 2025 Using AI to Solve a Key a11y Problem of Maps!

Basemap Topographical Map Language English

Map Explanation

Stadium Identification

Based on the aerial view and distinctive oval shape, my guess is:

- Olympiastadion Berlin

This stadium is located in Berlin, Germany, and is known for hosting major sports events, including football matches and the 1936 Summer Olympics.

Request Explanation

GeoGuesser

Location 1a Location 1b

Location 2

Location 3

Location 4

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NVDA Speech Viewer

Location 1b button
Location 2 button
Location 3 button
Location 2 button
Location 1b button
Location 1a button
tool bar
Close window button
GeoGuesser dialog Can be moved with arrow keys
Map Explanation dialog Can be moved with arrow keys
button Request Explanation
Configure Prompt button
Request Explanation button
Abort request button
alert busy Loading response from AI...
Request Explanation button
AI Response Text Area alert

Stadium Identification

Based on the aerial view and distinctive oval shape, my guess is:
Olympiastadion Berlin

This stadium is located in Berlin, Germany, and is known for hosting major sports events, including football matches and the 1936 Summer Olympics.

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Geoportal Berlin, Microsoft, Vantoor

Map Content Legend

Imprint Privacy Statements

Show Speech Viewer on Startup



The screenshot shows an aerial satellite view of the Olympiastadion Berlin. The stadium is a large, oval-shaped structure with a white outer ring and a green field inside. It is surrounded by various buildings, roads, and parking lots. The interface includes a 'Map Explanation' dialog on the left identifying the stadium as the 'Olympiastadion Berlin' in Berlin, Germany, which hosted the 1936 Summer Olympics. A 'GeoGuesser' sidebar lists five locations, with 'Location 1a' being the stadium. On the right, there is a vertical toolbar with icons for zooming and a speech viewer interface showing the AI's explanation text. The top of the screen displays the Esri European Developer & Technology Summit 2025 logo and the title 'Using AI to Solve a Key a11y Problem of Maps!'. The bottom features links for Geoportal Berlin, Microsoft, and Vantoor, along with standard map navigation buttons like 'Map Content' and 'Legend'.

Demo 5 – GeoGuesser with labels for context

Esri European Developer & Technology Summit 2025 Using AI to Solve a Key a11y Problem of Maps!

Basemap Topographical Map Language English

NVDA Speech Viewer

Location 2
Location 3
Location 4
Using AI to Solve a Key a11y Problem of Maps! — Mozilla Firefox
GeoGuesser dialog Can be moved with arrow keys
button Location 3
Location 4 button
Location 3
Location 2
Request Explanation
Map Explanation dialog
Can be moved with arrow keys
button Request Explanation
Request Explanation Abort request button
alert busy Loading response from AI...
Request Explanation button
AI Response Text Area alert
<section aria-label="Stadium Guess">
<h2>Stadium Guess</h2>
 Eintracht-Stadion Location: Braunschweig, Germany Characteristic features: Distinct rectangular stadium with adjacent athletics track and training grounds </section>

Map Explanation

Stadium Guess

- Eintracht-Stadion
- Location: Braunschweig, Germany
- Characteristic features: Distinct rectangular stadium with adjacent athletics track and training grounds

Request Explanation

GeoGuesser

Location 1a Location 1b

Location 2

Location 3

Location 4

Microsoft Vantor Powered by Esri

Map Content Legend Imprint Privacy Statements Show Speech Viewer on Startup



Demo 5 – GeoGuesser with labels for context

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Map Explanation

Stadium Identification

Based on the visible labels and layout, the stadium in the image is the **Ostseestadion** in Rostock, Germany.

- Location: Rostock, Mecklenburg-Vorpommern
- Main tenant: FC Hansa Rostock
- Commonly used for: Football matches and events

Request Explanation

GeoGuesser

Location 1a Location 1b

Location 2

Location 3

Location 4

NVDA Speech

Request Explanation

Topographical Map menu

Basemap selection. Selected basemap is Topographical Map

Topographical Map Basemap

Topographical Map expanded

Aerial (hybrid) row 4 of 4

Basemap selection. Selected basemap is Aerial (hybrid)

Basemap Aerial (hybrid) collapsed

Request Explanation button

Abort request button Abort request

Abort request button alert busy Loading response from AI...

Request Explanation button

AI Response Text Area alert

<h2>Stadium Identification</h2>

Based on the visible labels and layout, the stadium in the image is the **Ostseestadion** in Rostock, Germany.

Location: Rostock, Mecklenburg-Vorpommern

Main tenant: FC Hansa Rostock

Commonly used for: Football matches and events

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Microsoft, Vantoor | Esri Community Maps Contributors, Hansestadt Rostock, Esri, TomTom, Garmin, GeoTechnologies, Inc., METI/NASA, USGS

Map Content Legend

Imprint Privacy Statements

Show Speech Viewer on Startup

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Conclusion

- Accessibility for web maps has long been challenging because screen readers cannot interpret spatial structures.
- The **AI approach** with screenshots represents an **innovative bridge**:
 - It translates visual map content into textual, semantic descriptions, making it **understandable for visually impaired users**.
- **Good Practice for map a11y:**
 - **Combine traditional accessibility methods (ARIA, keyboard navigation, structured lists) with an optional AI-powered descriptive layer** for contextual understanding. Use screenshots and actual feature data to boost the results.



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Thank you very much!

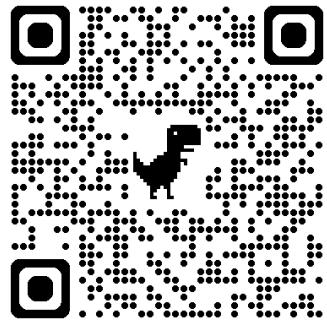
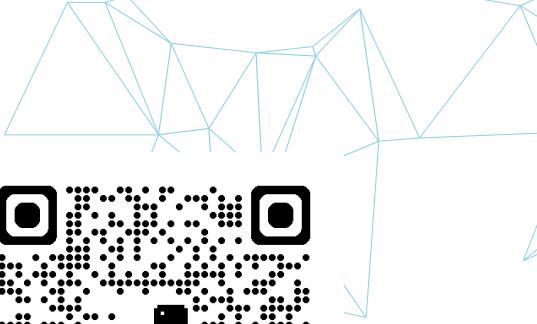
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questions!

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Slides

<https://github.com/m-scherpi/a11y-ai>



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