RTVis WebGPU Tutorial

By your host: **Lucas Melo** - lmelo@cg.tuwien.ac.at

PLEASE STAND BY

The tutorial will begin shortly

In the meantime:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

RTVis WebGPU Tutorial

By your host: **Lucas Melo** - lmelo@cg.tuwien.ac.at

WELCOME!

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

✔ Chill

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

✔ Chill

❌ Not a lecture - no science today

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

✔️ Chill

❌ Not a lecture - no science today

✔️ A copy-paste fiesta!

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

✔️ Chill

❌ Not a lecture - no science today

✔️ A copy-paste fiesta!

❌ Not long enough - 90 minutes

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

This tutorial is...

✔ Chill

❌ Not a lecture - no science today

✔ A copy-paste fiesta!

❌ Not long enough - 90 minutes

✔ Low-level

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Our goal: trees

Please clone our repo:

git clone https://github.com/Welko/rtvis-webgpu-tutorial

WebGPU

✔ Web API to access GPU capabilities

Please clone our repo:

```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

WebGPU

✔️ Web API to access GPU capabilities

✔️ Released this year! 2023

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

WebGPU

✔ Web API to access GPU capabilities

✔ Released this year! 2023

✔ Closer to Vulkan than to OpenGL

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Data

Baumkataster bzw. Bäume Standorte Wien

Trees in Vienna

https://www.data.gv.at/katalog/dataset/c91a4635-8b7d-43fe-9b27-d95dec8392a7

Please clone our repo:

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Tasks

Compute	Render
Task 1 - Compute Shader Basics	Task 3 - Render an Image
Task 2 - Processing Real Data	Task 4 - Render Trees as Markers
Task 5 - Compute and Render Heatmap	

Please clone our repo:

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

RTVis WebGPU Tutorial

PLEASE SET UP YOUR ENVIRONMENTS

Make sure that your computer can run WebGPU

Setup instruction in our repo:

```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

Task 0 - Initialize WebGPU

(5 minutes)

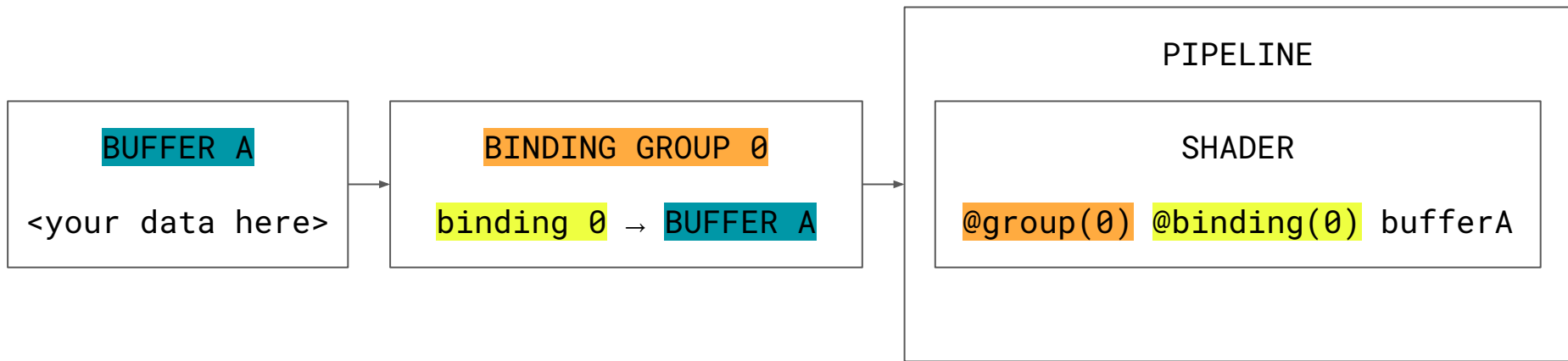Not all browsers support WebGPU

Does yours?

Your playground: `tutorial.js`

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

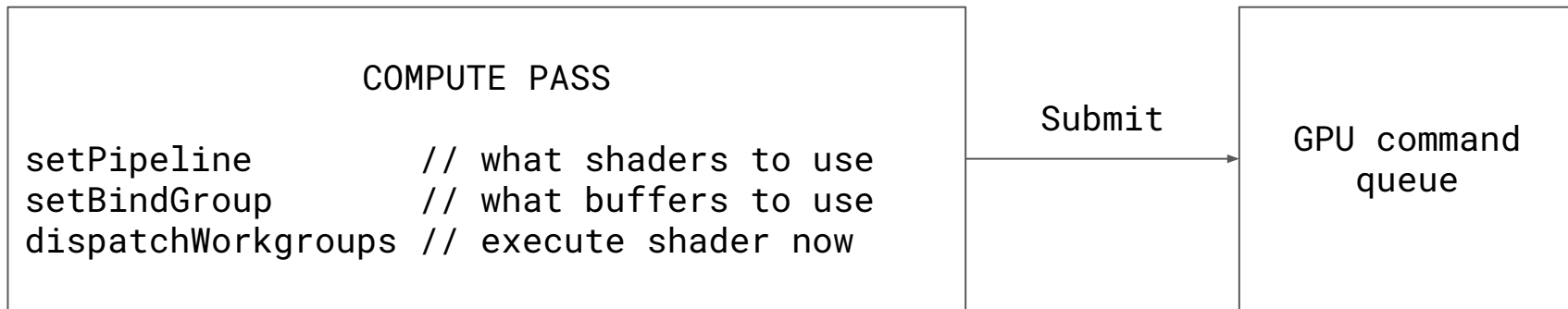# Task 1 - Compute Shader Basics

(10 minutes)

From buffer to shader

BUFFER A

<your data here>

BINDING GROUP 0

binding 0 → BUFFER A

PIPELINE

SHADER

@group(0) @binding(0) bufferA

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 1 - Compute Shader Basics

(10 minutes)

Why this matters

```
COMPUTE PASS

setPipeline        // what shaders to use
setBindGroup       // what buffers to use
dispatchWorkgroups // execute shader now
```
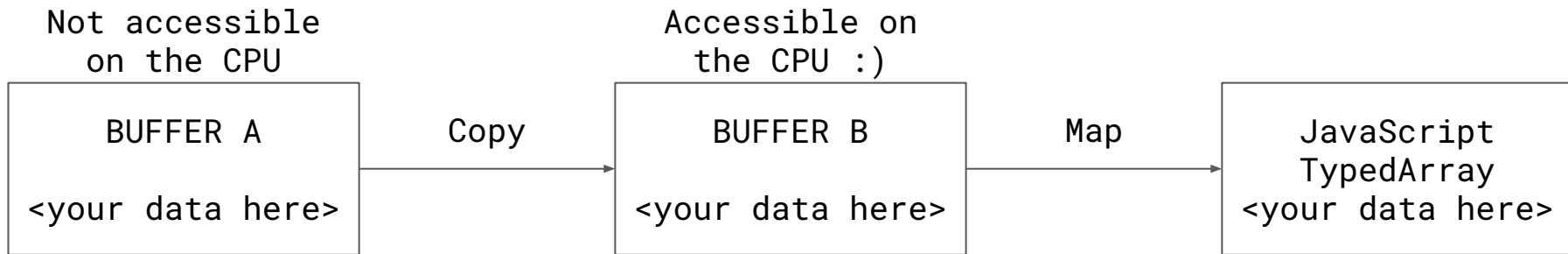
Submit →

```
GPU command
queue
```

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 1 - Compute Shader Basics

(10 minutes)

Reading a GPU buffer on the CPU

Not accessible
on the CPU

```
BUFFER A

<your data here>
```

Copy →

Accessible on
the CPU :)

```
BUFFER B

<your data here>
```

Map →

```
JavaScript
TypedArray
<your data here>
```

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 2 - Processing Real Data

(15 minutes)

LOADER.loadTrees() provides a TreeStore

```
                    TreeStore

getNumTrees(): number
getInfoBuffer(): Float32Array
getCoordinatesLatLonBuffer(): Float32Array
...
```
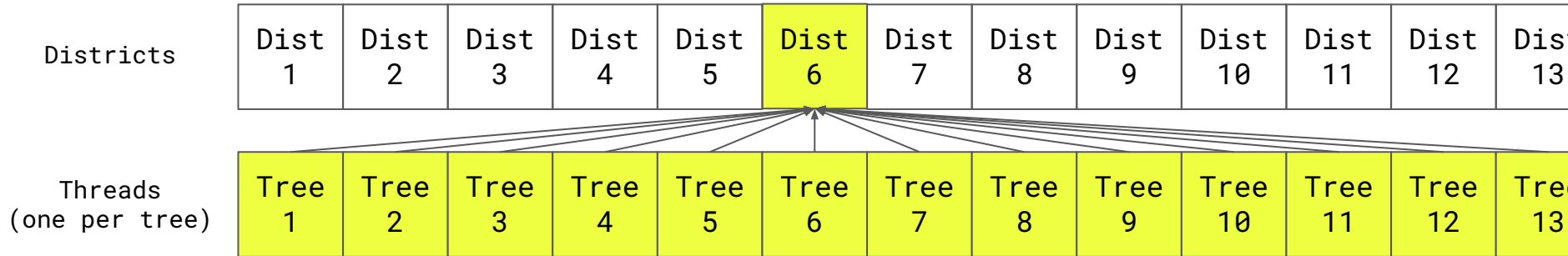
git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 2 - Processing Real Data

(15 minutes)

Concurrent writing into buffer

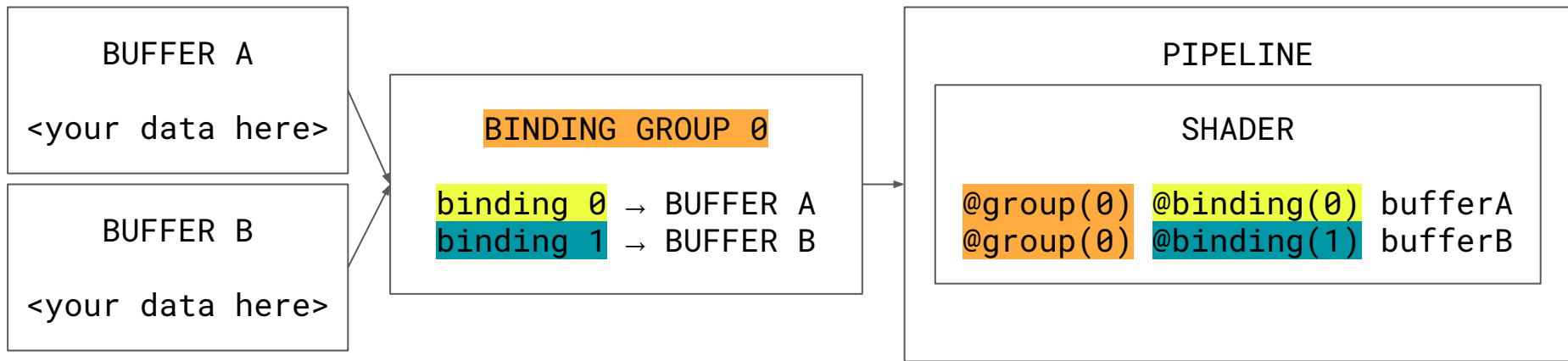| Districts	Dist 1	Dist 2	Dist 3	Dist 4	Dist 5	Dist 6	Dist 7	Dist 8	Dist 9	Dist 10	Dist 11	Dist 12	Dist 13
Threads (one per tree)	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10	Tree 11	Tree 12	Tree 13

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Task 2 - Processing Real Data

(15 minutes)

Two buffers now

BUFFER A

<your data here>

BUFFER B

<your data here>

BINDING GROUP 0

binding 0 → BUFFER A
binding 1 → BUFFER B

PIPELINE

SHADER

@group(0) @binding(0) bufferA
@group(0) @binding(1) bufferB
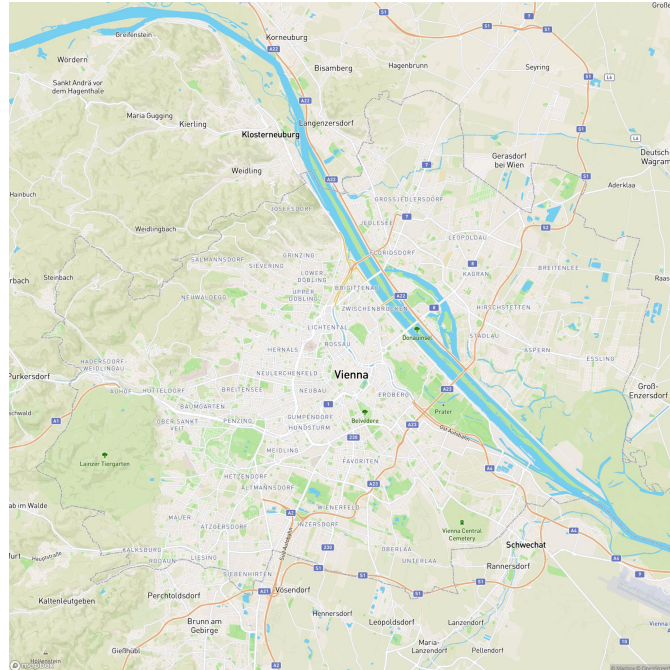
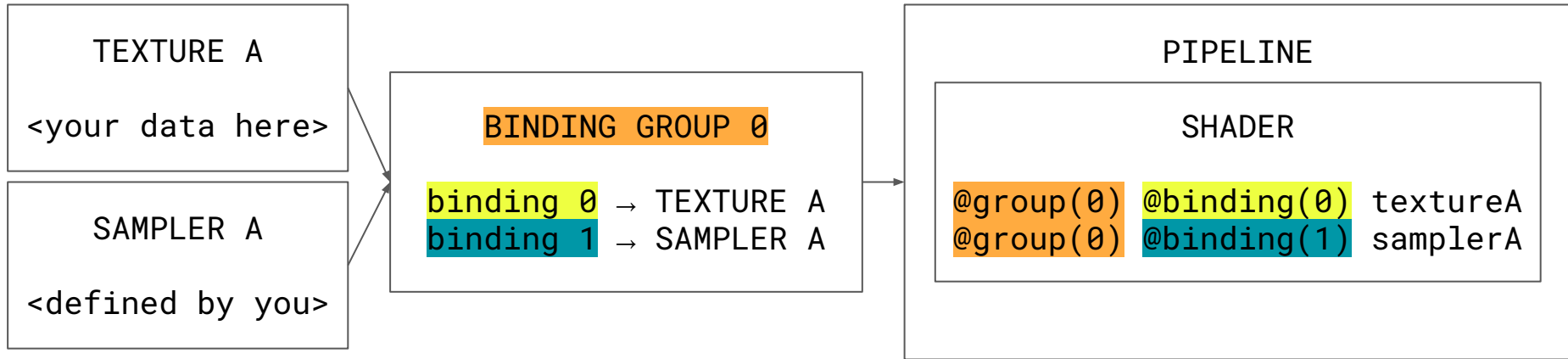git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 3 - Render an Image

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Task 3 - Render an Image

(10 minutes)

Binding textures/samplers is the same

```
┌─────────────────────┐        ┌──────────────────────────────┐        ┌──────────────────────────────────────────┐
│   TEXTURE A         │        │      BINDING GROUP 0         │        │              PIPELINE                      │
│                     │        │                              │        │                                            │
│  <your data here>   │───┐    │  binding 0 → TEXTURE A       │───▶    │              SHADER                        │
└─────────────────────┘   │    │  binding 1 → SAMPLER A       │        │                                            │
┌─────────────────────┐   │    └──────────────────────────────┘        │  @group(0) @binding(0) textureA            │
│   SAMPLER A         │───┘                                             │  @group(0) @binding(1) samplerA            │
│                     │                                                 │                                            │
│  <defined by you>   │                                                 │                                            │
└─────────────────────┘                                                 └──────────────────────────────────────────┘
```

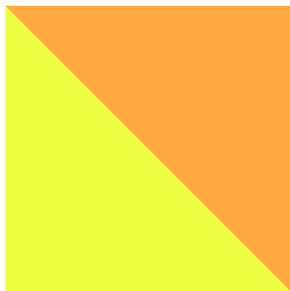git clone https://github.com/Welko/rtvis-webgpu-tutorial

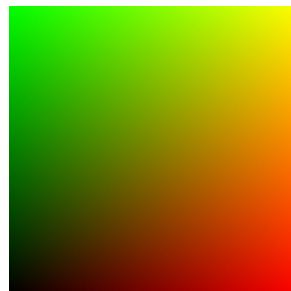# Task 3 - Render an Image

(10 minutes)

Drawing without vertex buffers

VERTICES

```
[-1, -1]
[-1,  1]
[ 1, -1]
[ 1,  1]
[-1,  1]
[ 1, -1]
```

UVS

```
[0, 0]
[0, 1]
[1, 0]
[1, 1]
[0, 1]
[1, 0]
```

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 3 - Render an Image

(10 minutes)

Render pass kinda the same

```
            RENDER PASS

setIndexBuffer  //   not used in
setVertexBuffer //   this tutorial

setPipeline  // what shaders to use
setBindGroup // what buffers to use
draw         // execute shader now
```
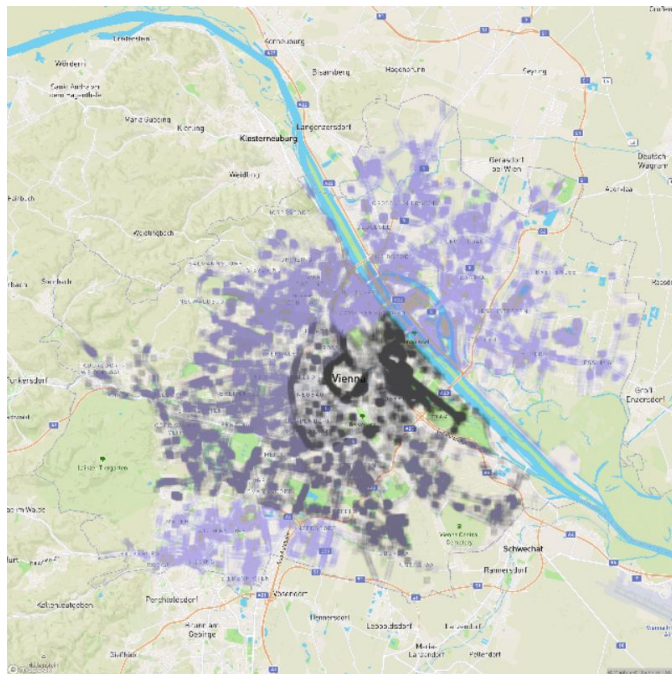
Submit →

```
GPU command
   queue
```

git clone https://github.com/Welko/rtvis-webgpu-tutorial
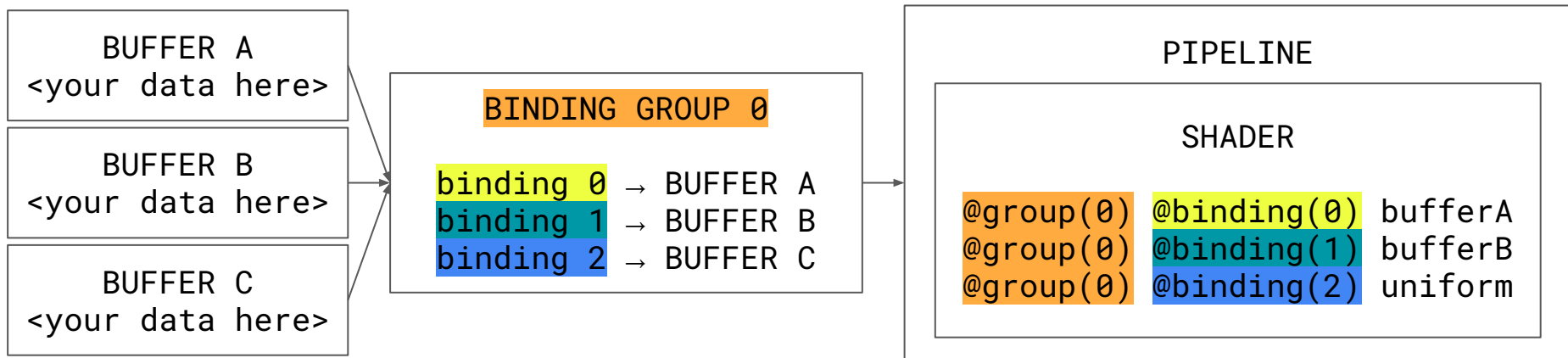
Task 4 - Render Trees as Markers

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 4 - Render Trees as Markers

(20 minutes)

Three buffers now

BUFFER A <your data here>	BINDING GROUP 0	PIPELINE

BUFFER A
<your data here>

BUFFER B
<your data here>

BUFFER C
<your data here>

BINDING GROUP 0

binding 0 → BUFFER A
binding 1 → BUFFER B
binding 2 → BUFFER C

PIPELINE

SHADER

@group(0) @binding(0) bufferA
@group(0) @binding(1) bufferB
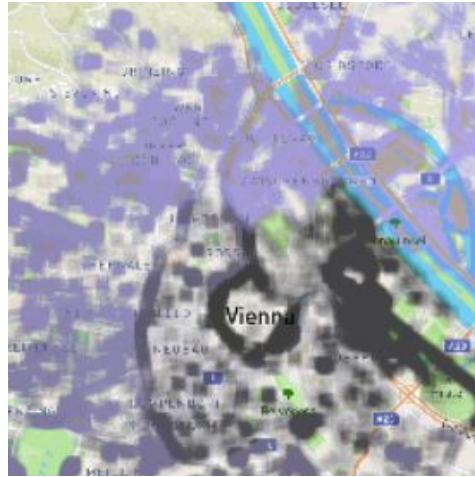@group(0) @binding(2) uniform

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 4 - Render Trees as Markers

(20 minutes)

Mapping district to sequential color scheme = **BAD IDEA**

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 4 - Render Trees as Markers

(20 minutes)

Multiple dispatches in one compute pass

```
COMPUTE PASS

setPipeline          // what shaders to use
setBindGroup         // what buffers to use
dispatchWorkgroups   // execute shader now

setPipeline          // now use this shader
setBindGroup         // and these buffers
dispatchWorkgroups   // execute again
```
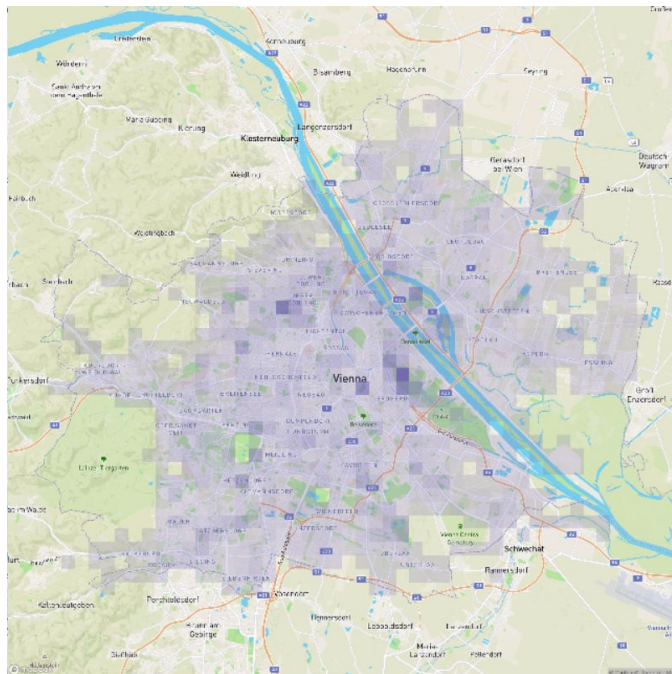
Submit →

GPU command
queue

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 5 - Compute and Render Heatmap

git clone https://github.com/Welko/rtvis-webgpu-tutorial

Task 5 - Compute and Render Heatmap

(30 minutes)

Grid as one-dimensional buffer

0	1	2	3	4	5	6	7	8	9	10	11	12	13	1

Index from xy: `index = y * width + x`
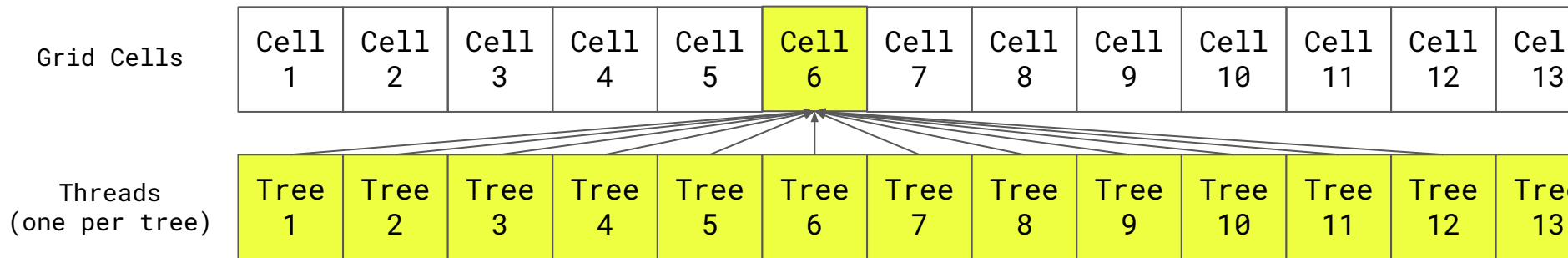
0	1	2	3
4	5	6	7
8	9	10	11

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Task 5 - Compute and Render Heatmap

(30 minutes)

Concurrent writing into buffer

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8	Cell 9	Cell 10	Cell 11	Cell 12	Cell 13
Grid Cells													
Threads (one per tree)	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10	Tree 11	Tree 12	Tree 13

`git clone https://github.com/Welko/rtvis-webgpu-tutorial`

Task 5 - Compute and Render Heatmap

(30 minutes)

One bind group, many pipelines

```
                    COMPUTE PASS

setBindGroup        // what buffers to use

setPipeline         // what shaders to use
dispatchWorkgroups  // execute shader now

setPipeline         // now use this shader
dispatchWorkgroups  // execute again with same buffers
```

Submit → GPU command queue

git clone https://github.com/Welko/rtvis-webgpu-tutorial

RTVis WebGPU Tutorial

By your host: **Lucas Melo** - lmelo@cg.tuwien.ac.at

THANK YOU FOR PARTICIPATING

Questions? Contact me!

git clone https://github.com/Welko/rtvis-webgpu-tutorial