

RTVis WebGPU Tutorial

By your hosts:

Patrick Komon - `pkomon@cg.tuwien.ac.at`

Stefan Brandmair - `e12024754@student.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 hosts:

Patrick Komon - pkomon@cg.tuwien.ac.at

Stefan Brandmair - e12024754@student.tuwien.ac.at

WELCOME!

Please clone our repo:

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

This tutorial is...

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This tutorial is...

✓ Chill

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✗ Not a lecture - no science today

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This tutorial is...

- ✓ Chill
- ✗ Not a lecture - no science today
- ✓ Copy-paste friendly

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This tutorial is...

- ✓ Chill
- ✗ Not a lecture - no science today
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- ✗ Not long enough - 90 minutes

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```

This tutorial is...

- ✓ Chill
- ✗ Not a lecture - no science today
- ✓ Copy-paste friendly
- ✗ Not long enough - 90 minutes
- ✓ Low-level

Please clone our repo:

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```




Our goal: trees

Please clone our repo:

git clone <https://github.com/Welko/rtnvis-webgpu-tutorial>

WebGPU

✓ Web API to access GPU capabilities

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WebGPU

- ✓ Web API to access GPU capabilities
- ✓ Released last year! 2023

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WebGPU

- ✓ Web API to access GPU capabilities
- ✓ Released last year! 2023
- ✓ Closer to Vulkan than to OpenGL

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```

GPU Parallelism

GPUs are good at running **many threads** in parallel

But only if each thread is executing **the same code**

Useful for **processing** lots of data **independently**

Useful for **displaying** lots of data (aka **rendering**)

```
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```

Data

Baumkataster bzw. Bäume Standorte Wien

Trees in Vienna

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

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```

Tasks

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

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```
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```

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
```


Tutorial Structure

We'll use JavaScript!

You will edit:

- tutorial.js
- shaders/

Solutions to all tasks can be found in the tasks/ folder

```
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```

Task 0 - Initialize WebGPU

(5 minutes)

Not all browsers support WebGPU yet

Does yours?

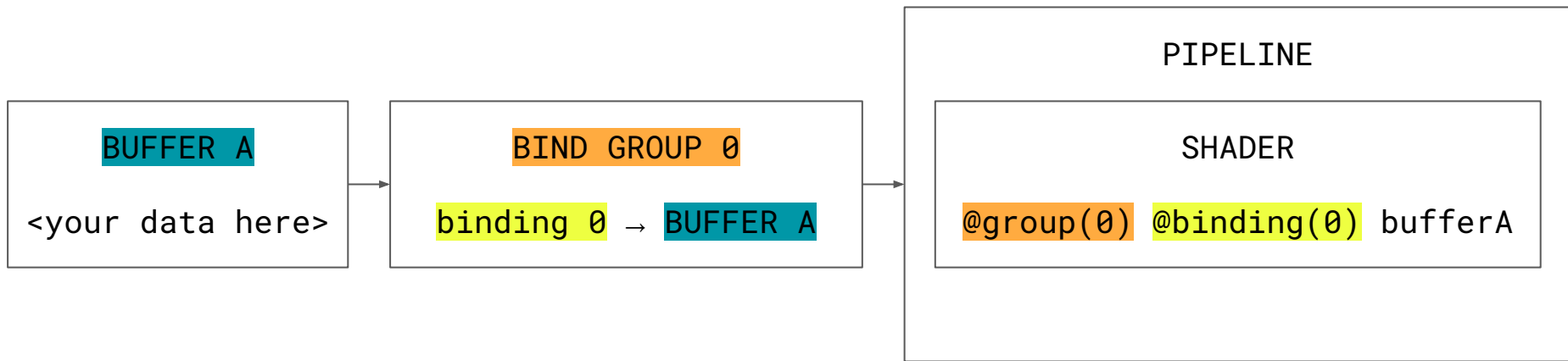
Your playground: `tutorial.js`

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

Task 1 – Compute Shader Basics

(15 minutes)

From buffer to shader

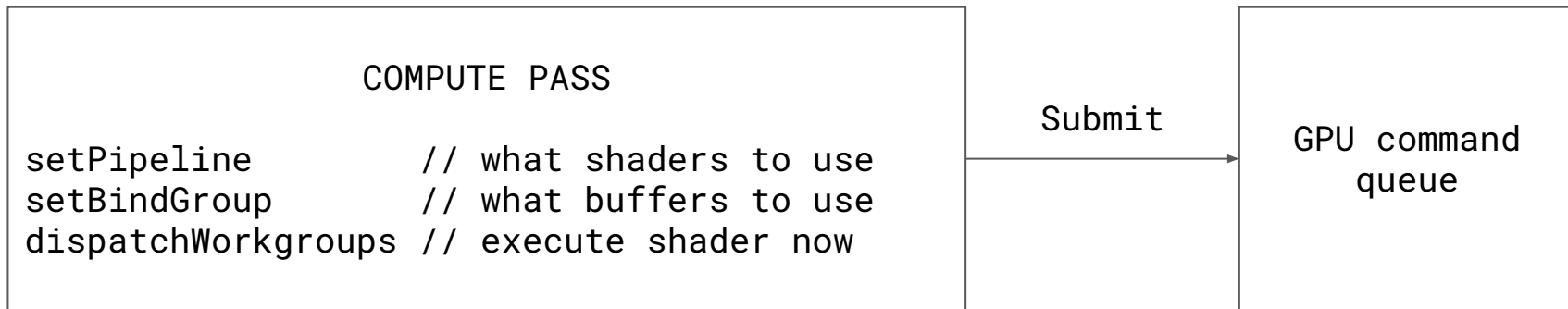


```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

Task 1 – Compute Shader Basics

(15 minutes)

Why this matters

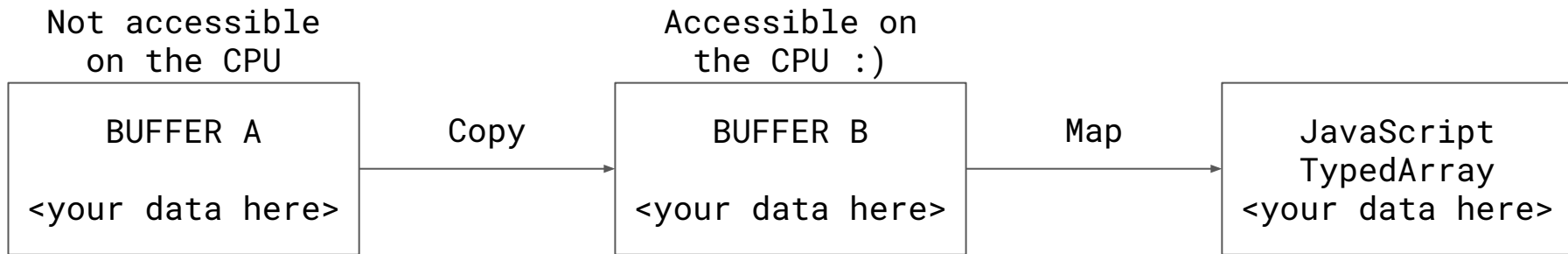


```
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```

Task 1 - Compute Shader Basics

(15 minutes)

Reading a GPU buffer on the CPU



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

Task 2 – Processing Real Data

(20 minutes)

LOADER.loadTrees() provides a TreeStore

TreeStore

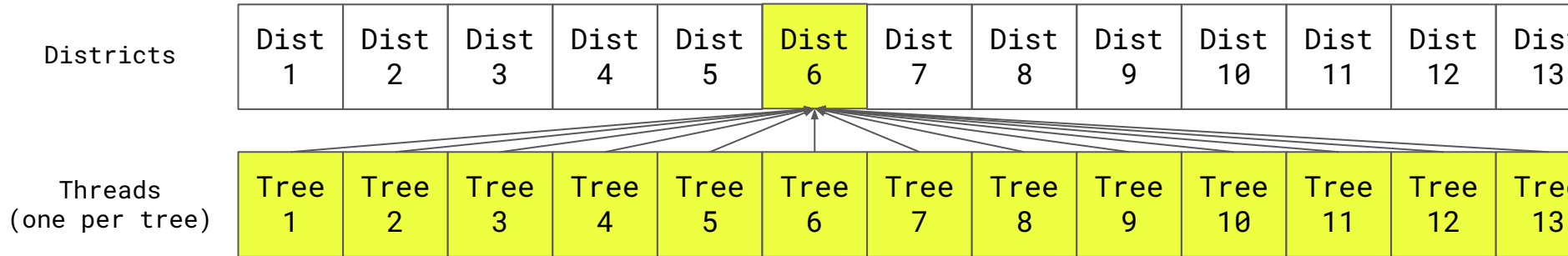
```
getNumTrees(): number  
getInfoBuffer(): Float32Array  
getCoordinatesLatLonBuffer(): Float32Array  
...
```

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

Task 2 - Processing Real Data

(20 minutes)

Concurrent writing into buffer

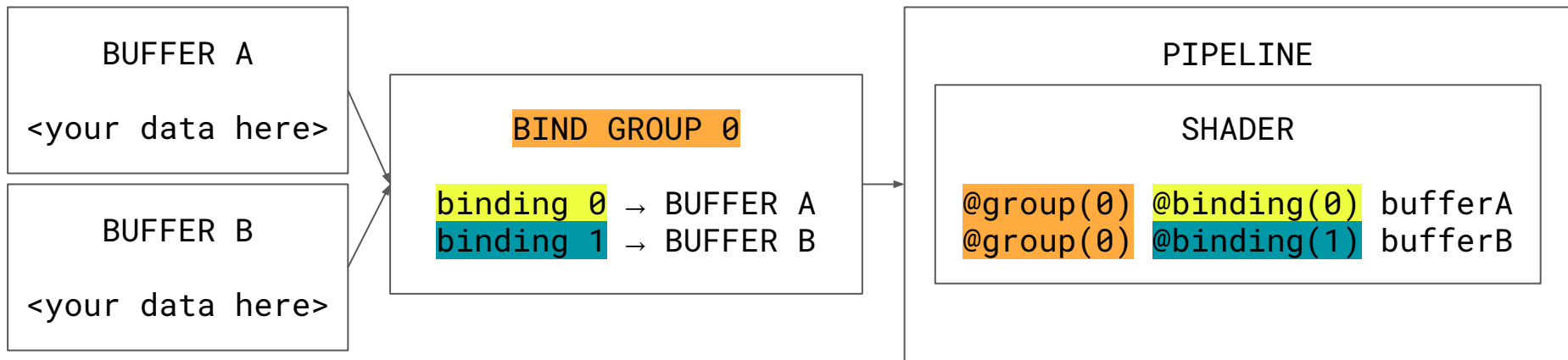


```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

Task 2 - Processing Real Data

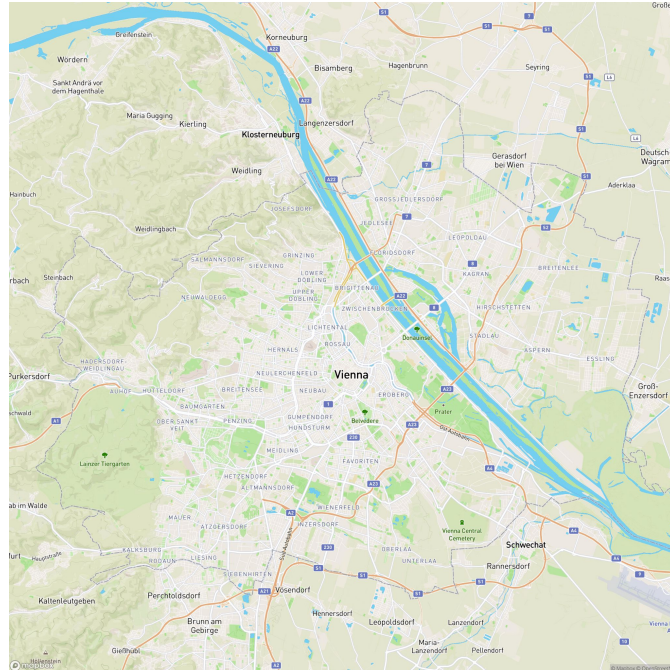
(20 minutes)

Two buffers now



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

Task 3 – Render an Image

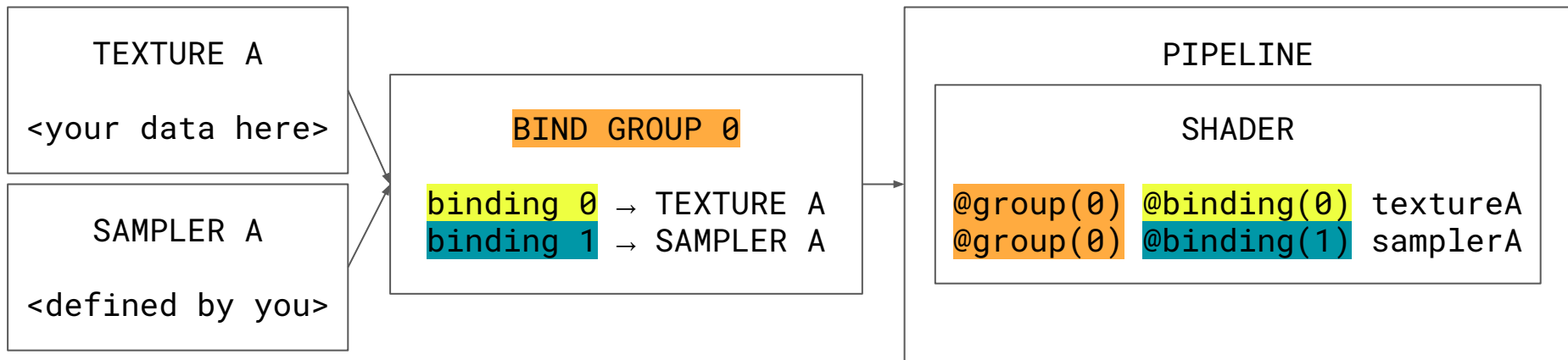


```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

Task 3 – Render an Image

(15 minutes)

Binding textures/samplers is the same



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

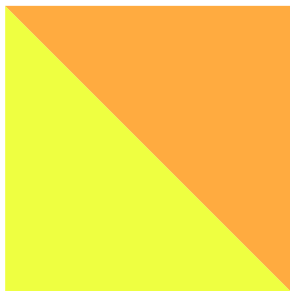
Task 3 – Render an Image

(15 minutes)

Drawing without vertex buffers

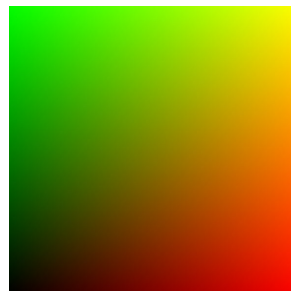
VERTICES

```
[ -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

(15 minutes)

Render pass kinda the same

RENDER PASS

```
setIndexBuffer // not used in  
setVertexBuffer // this tutorial
```

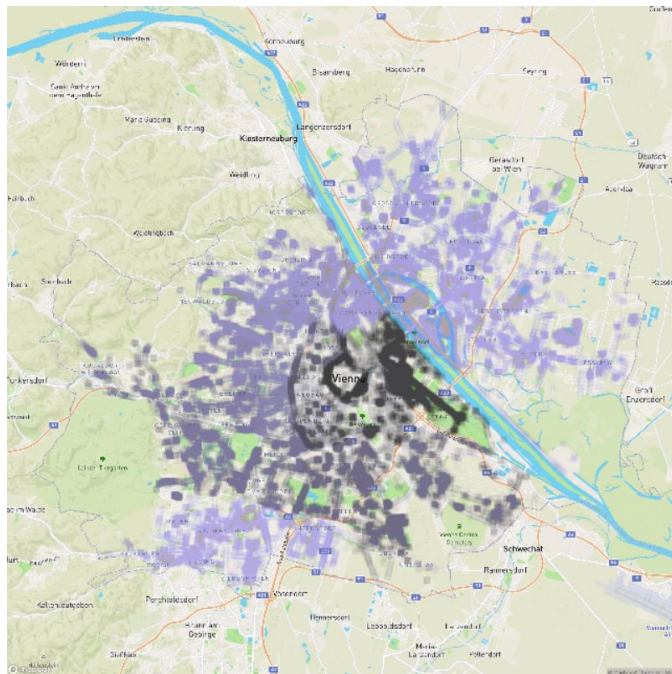
```
setPipeline // what shaders to use  
setBindGroup // what buffers to use  
draw // execute shader now
```

Submit

GPU command
queue

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

Task 4 – Render Trees as Markers

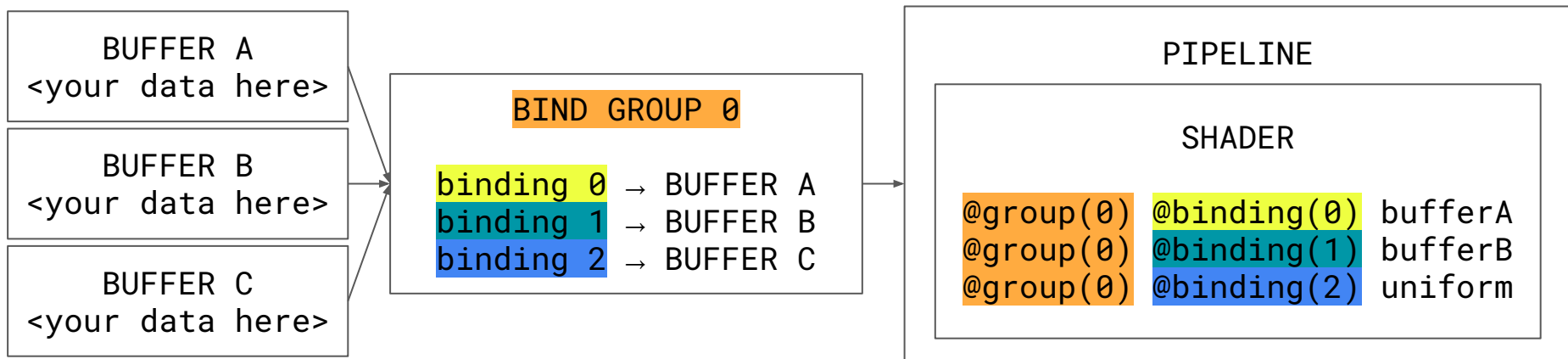


```
git clone https://github.com/Welko/rtvis-webgpu-tutorial
```

Task 4 – Render Trees as Markers

(35 minutes)

Three buffers now

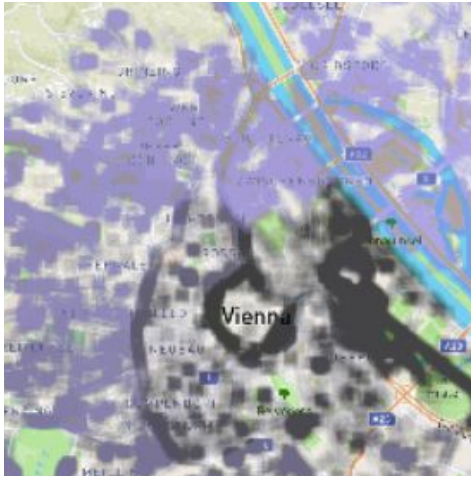


git clone <https://github.com/Welko/rtvis-webgpu-tutorial>

Task 4 – Render Trees as Markers

(35 minutes)

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



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

Task 4 – Render Trees as Markers

(35 minutes)

Multiple dispatches in one pass

RENDER PASS

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

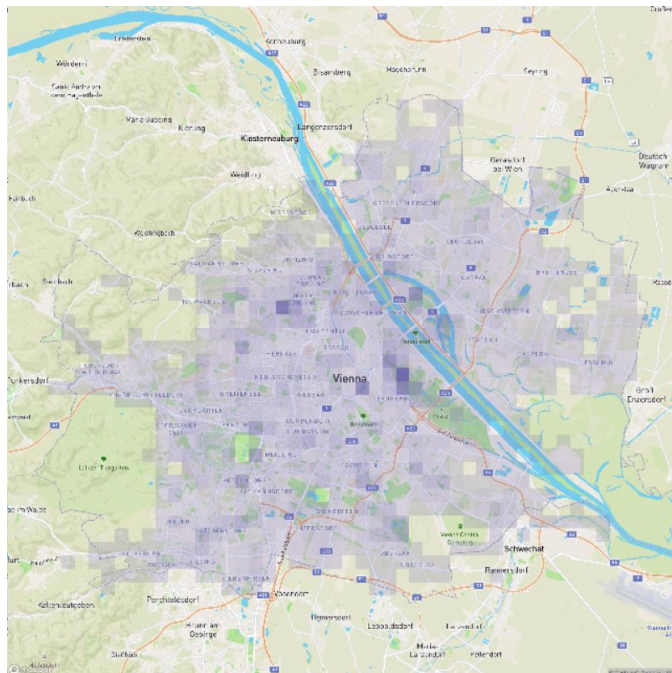
```
setPipeline      // now use this shader  
setBindGroup     // and these buffers  
dispatchWorkgroups // execute again
```

Submit

GPU command
queue

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


Bonus Task – Compute and Render Heatmap



```
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```

Bonus Task – Compute and Render Heatmap

Grid as one-dimensional buffer

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
---	---	---	---	---	---	---	---	---	---	----	----	----	----	----

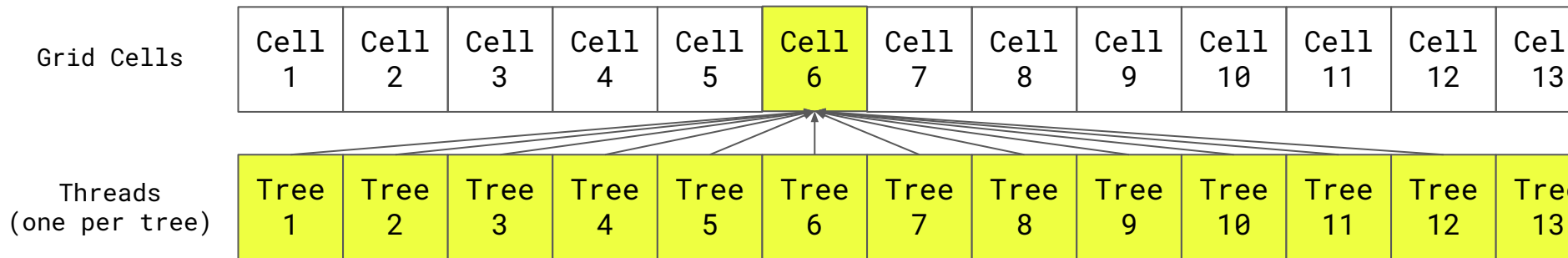
Index from xy: $\text{index} = y * \text{width} + x$

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

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

Bonus Task – Compute and Render Heatmap

Concurrent writing into buffer



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

Bonus Task – Compute and Render Heatmap

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 hosts:

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Lukas Herzberger - herzberger@cg.tuwien.ac.at

THANK YOU FOR PARTICIPATING

Questions? Contact us!

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```