健康数据可视化

周亮

北京大学健康医疗大数据国家研究院

北京大学 健康医疗大数据国家研究院

NATIONAL INSTITUTE OF HEALTH DATA SCIENCE AT PEKING UNIVERSITY

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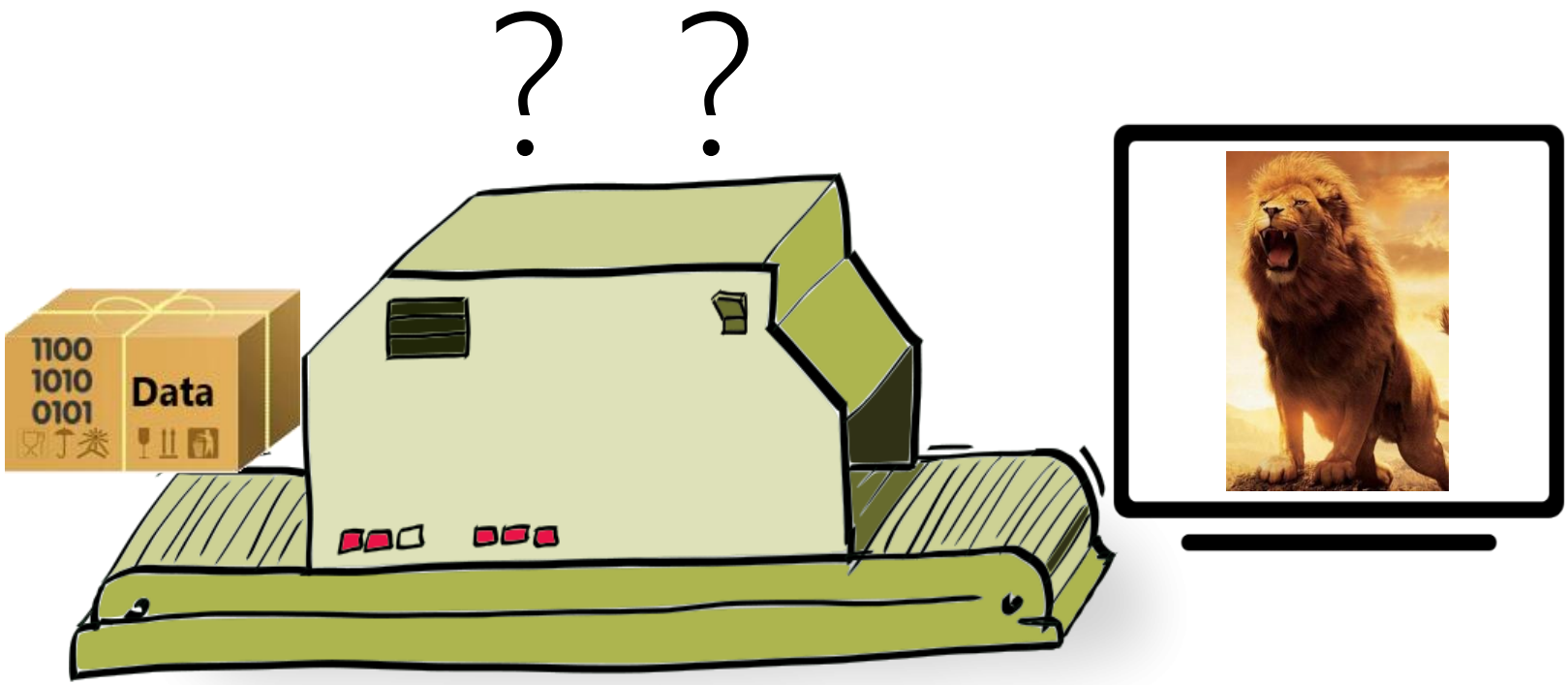
3. 可视化实现

如何实现可视化?

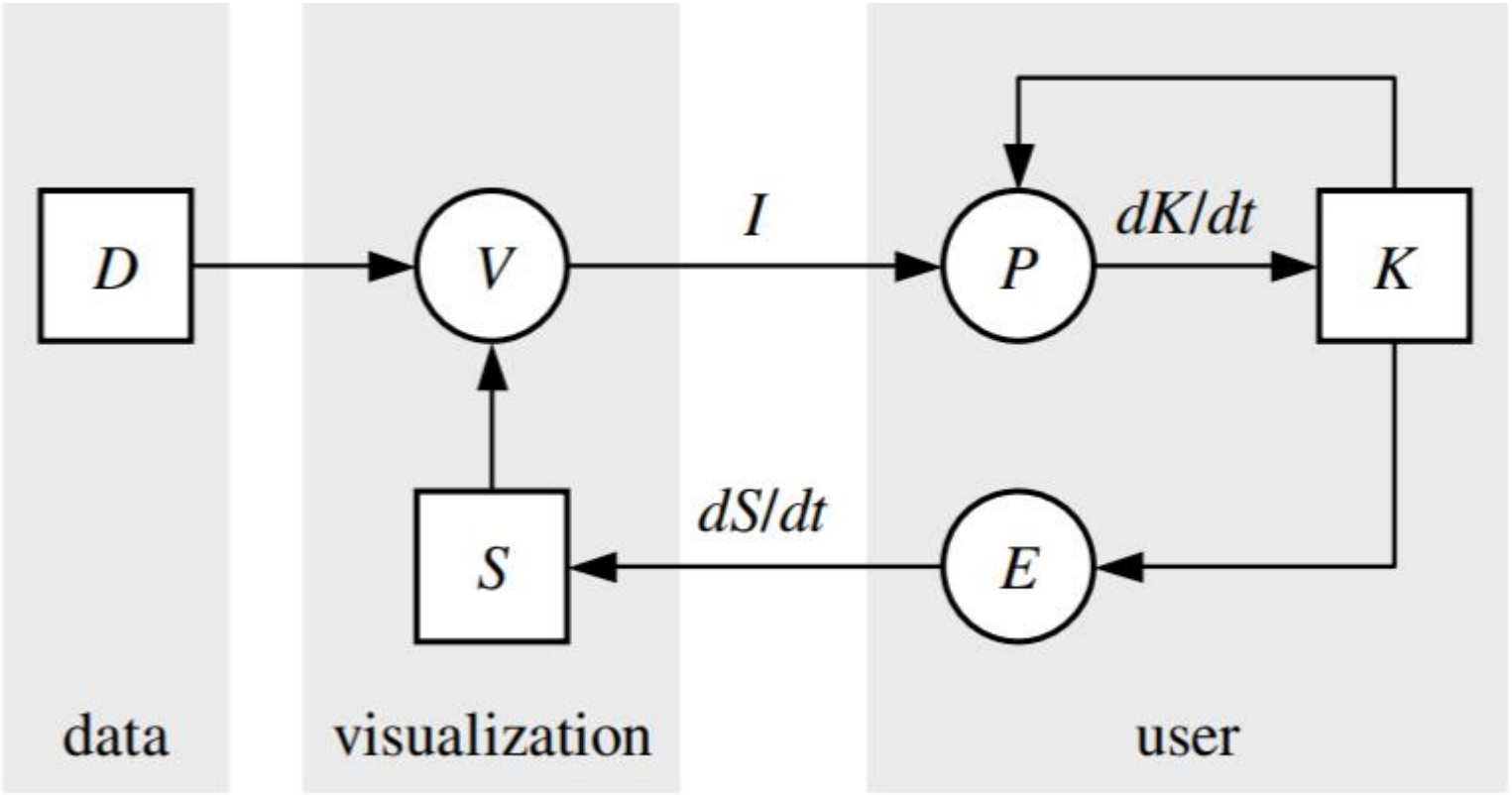
- 需要解决哪些基本问题?



可视化流水线

如何实现可视化?

- 分解可视化流水线各部分可得知可视化方法实现需要的元素
  - 数据预处理
  - 数据变换
  - 图形绘制
  - 用户交互



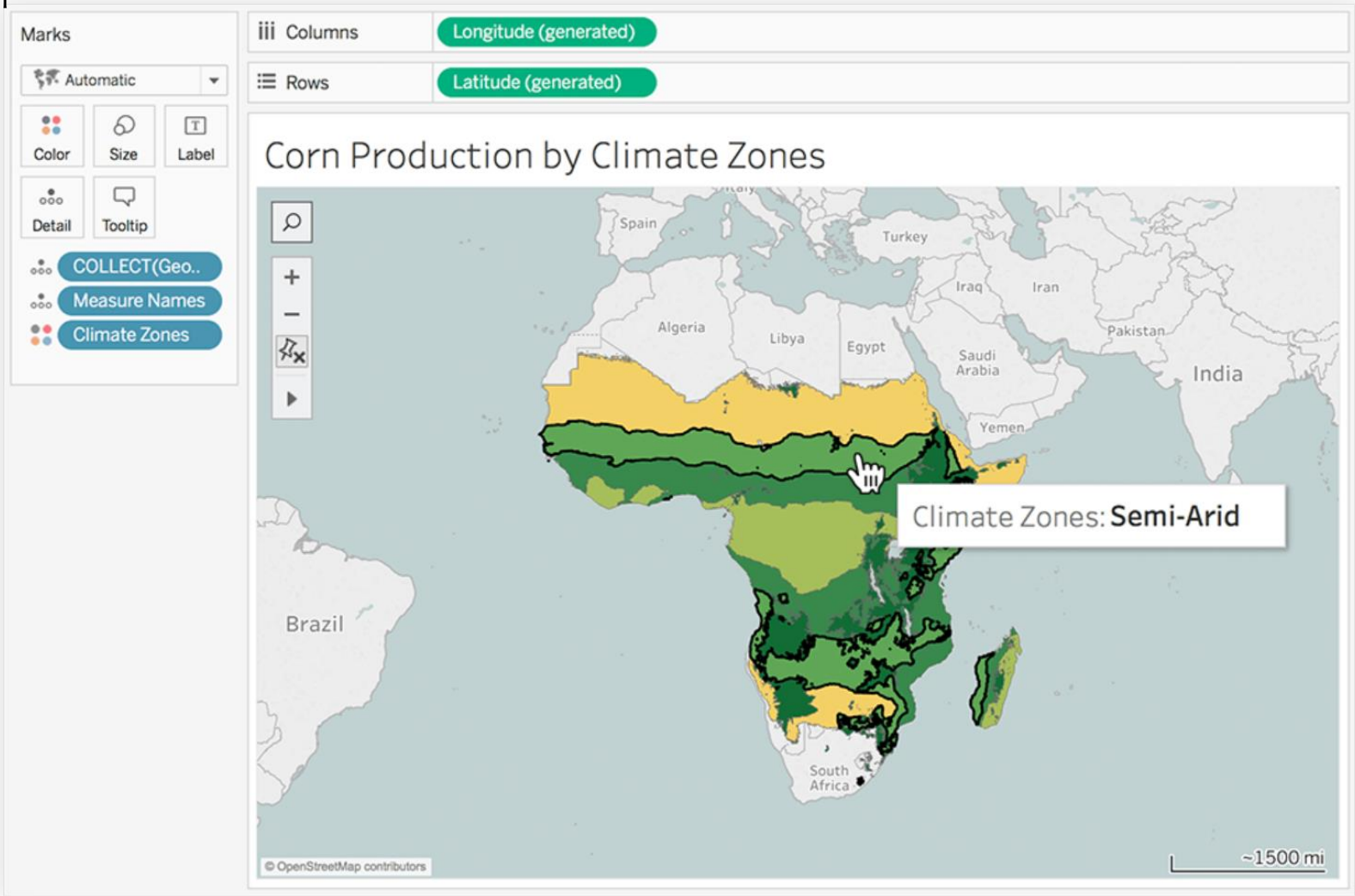
[Jarke van Wijk. The Value of Visualization. Proceedings of the IEEE Visualization Conference, pp. 79-86, 2005.]

可视化和可视分析工程实现

- 可视化和可视分析工具
  - 科学可视化：
    - ParaView https://www.paraview.org/
    - SCI Institute的各种工具 https://www.sci.utah.edu/sci-software/visualization.html
    - Inviwo https://inviwo.org/
    - Voreen https://www.uni-muenster.de/Voreen/index.html
    - ……
  - 信息可视化，可视分析：
    - Tableau https://www.tableau.com/
    - Power BI https://powerbi.microsoft.com/
    - ……
- 可视化软件库
    - VTK https://vtk.org/
    - D3 https://d3js.org/
- 编码实现可视化可视分析
  - 编程语言：
    - C++, JavaScript, Python, R……
  - 技能：
    - 交互界面（UI） 编程——Qt, Vue.js……
    - 图形编程——OpenGL, WebGL
    - 图形处理器（GPU） 编程——Shaders, CUDA

Tableau

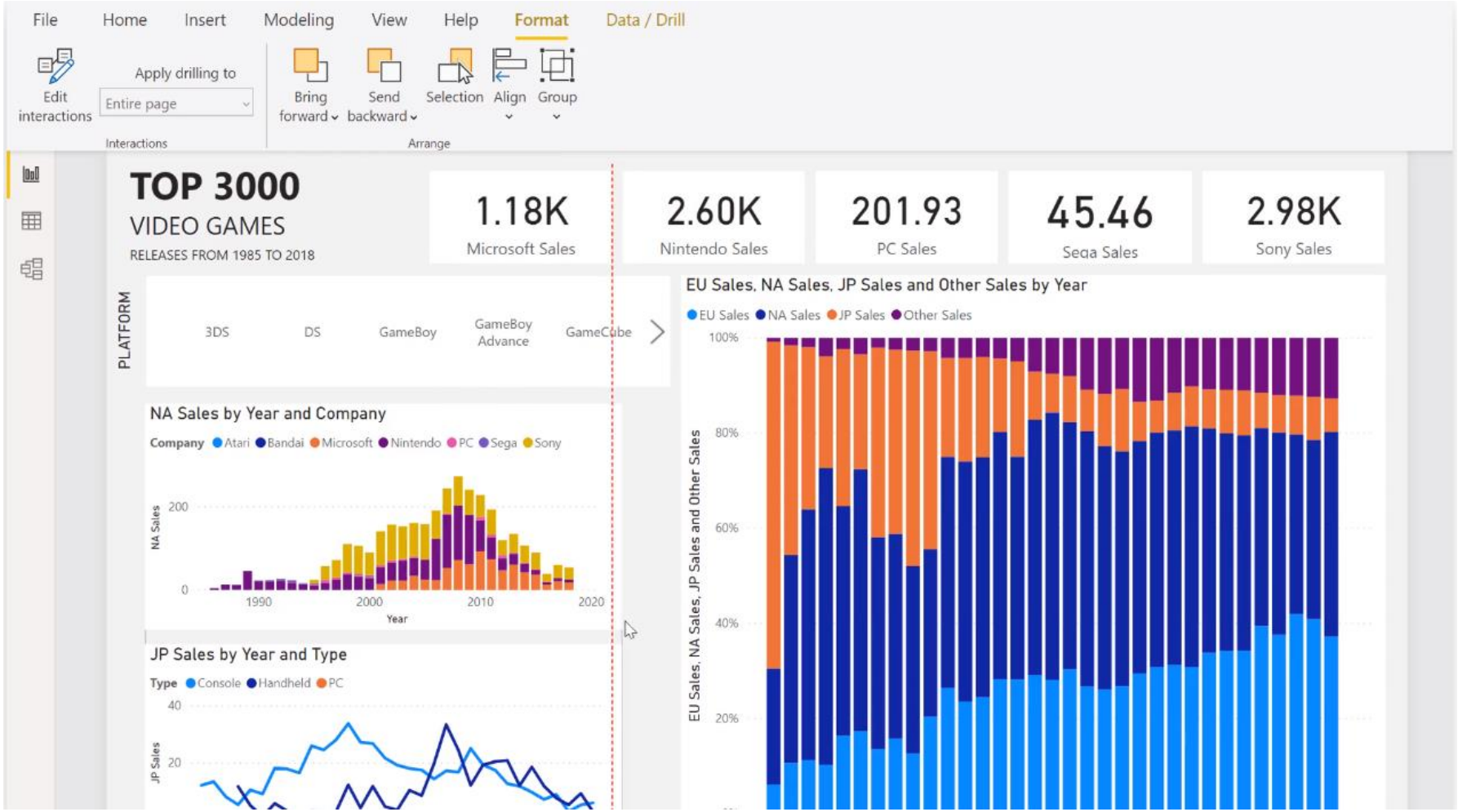
- 信息可视化、可视分析
- 商业软件



https://www.tableau.com

Power BI

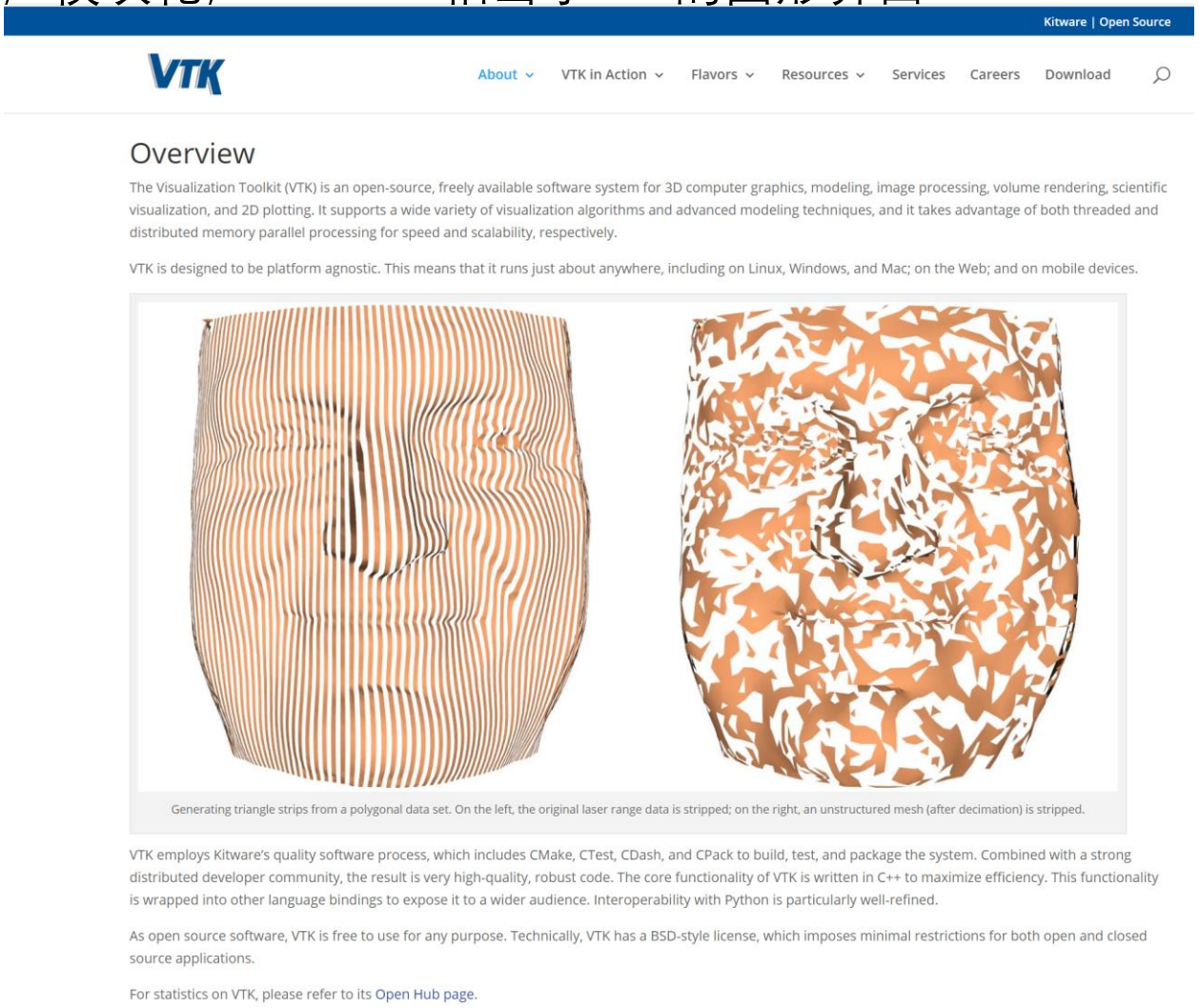
- 信息可视化、可视分析
- 商业软件



https://powerbi.microsoft.com/

VTK——The Visualization Toolkit

- 科学可视化，图像处理
- 开源软件；模块化；Paraview相当于VTK的图形界面

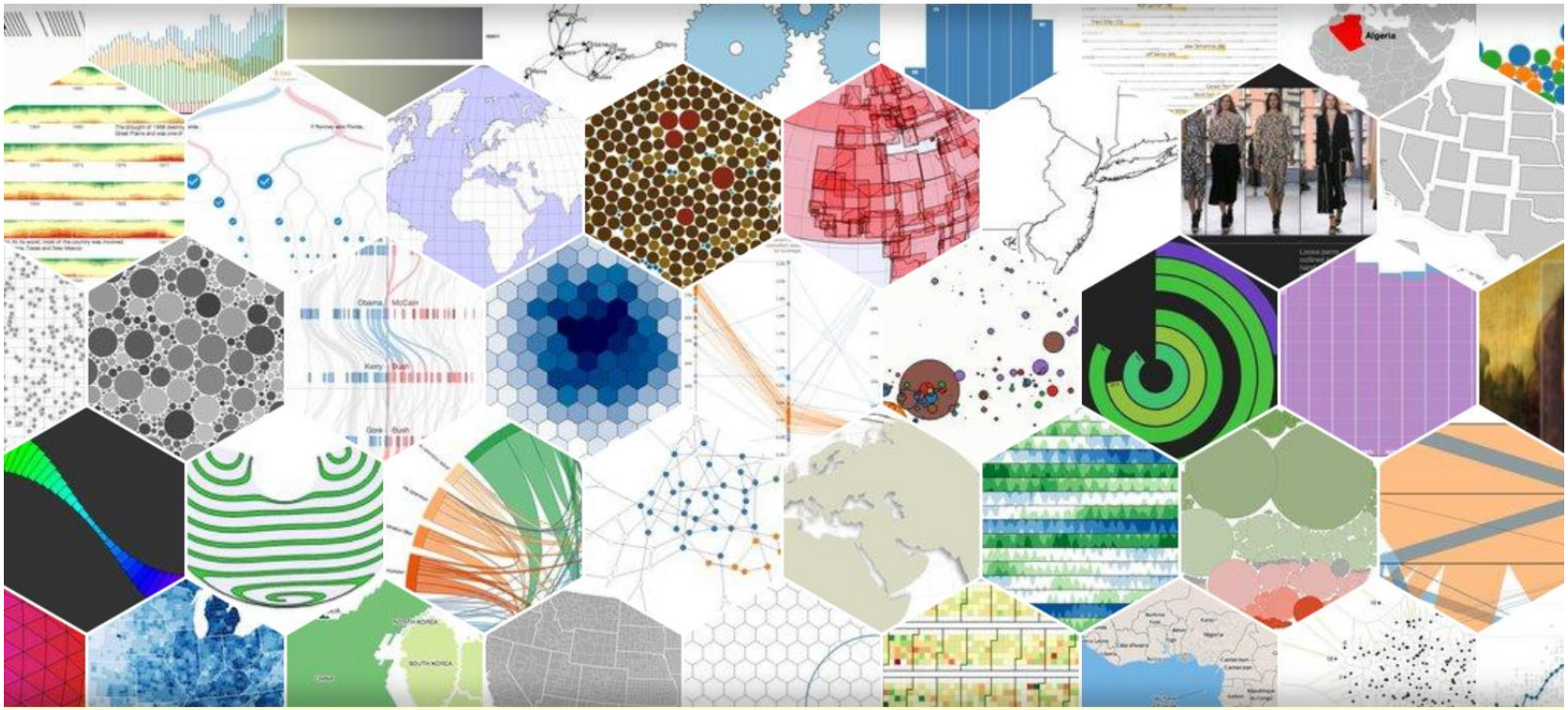


https://vtk.org/

D3—Data-Driven Documents

- JavaScript库
- 开源（一个.js文件）；方便操纵网页DOM；包含大量例子

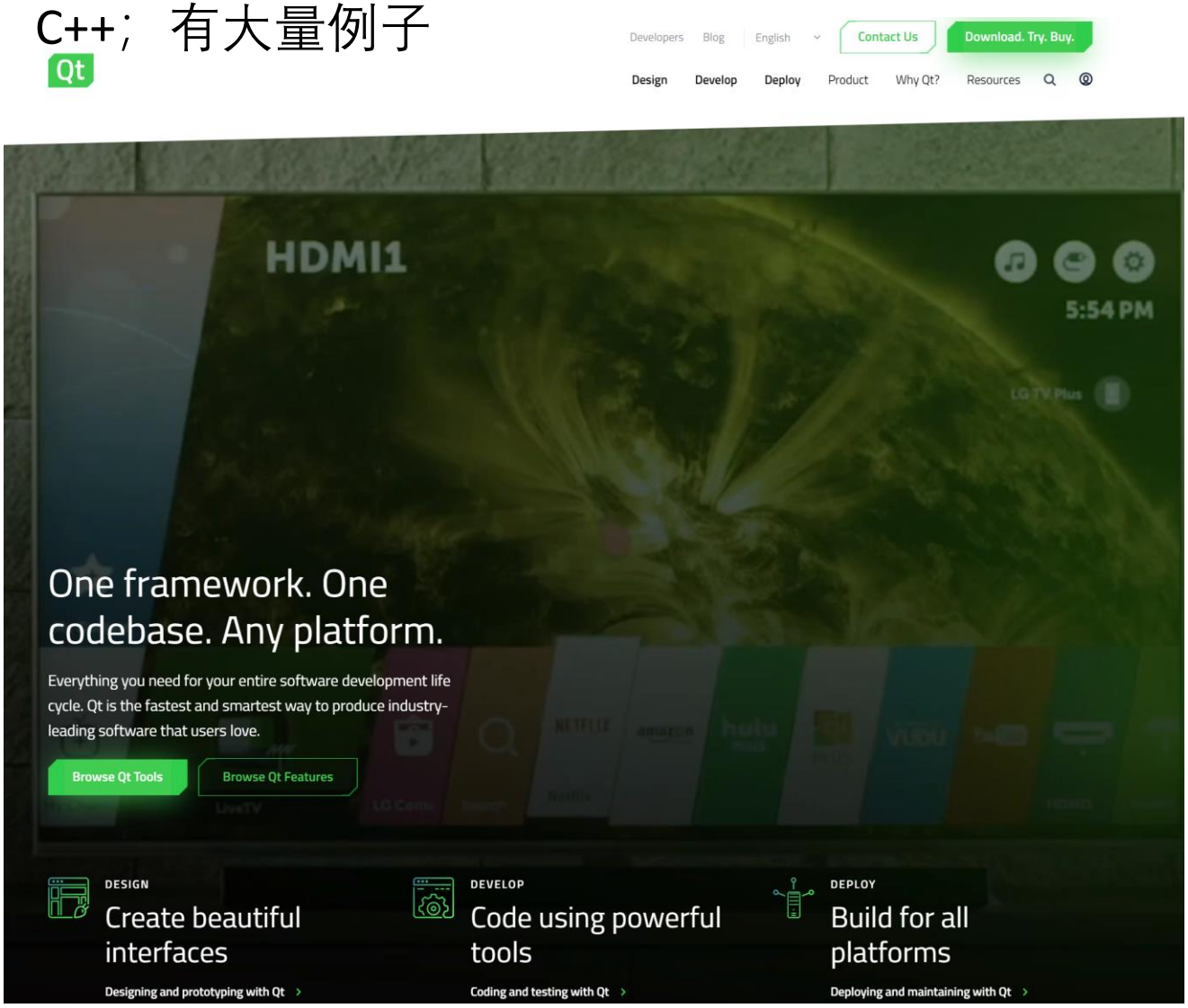
Data-Driven Documents



https://d3js.org/

Qt

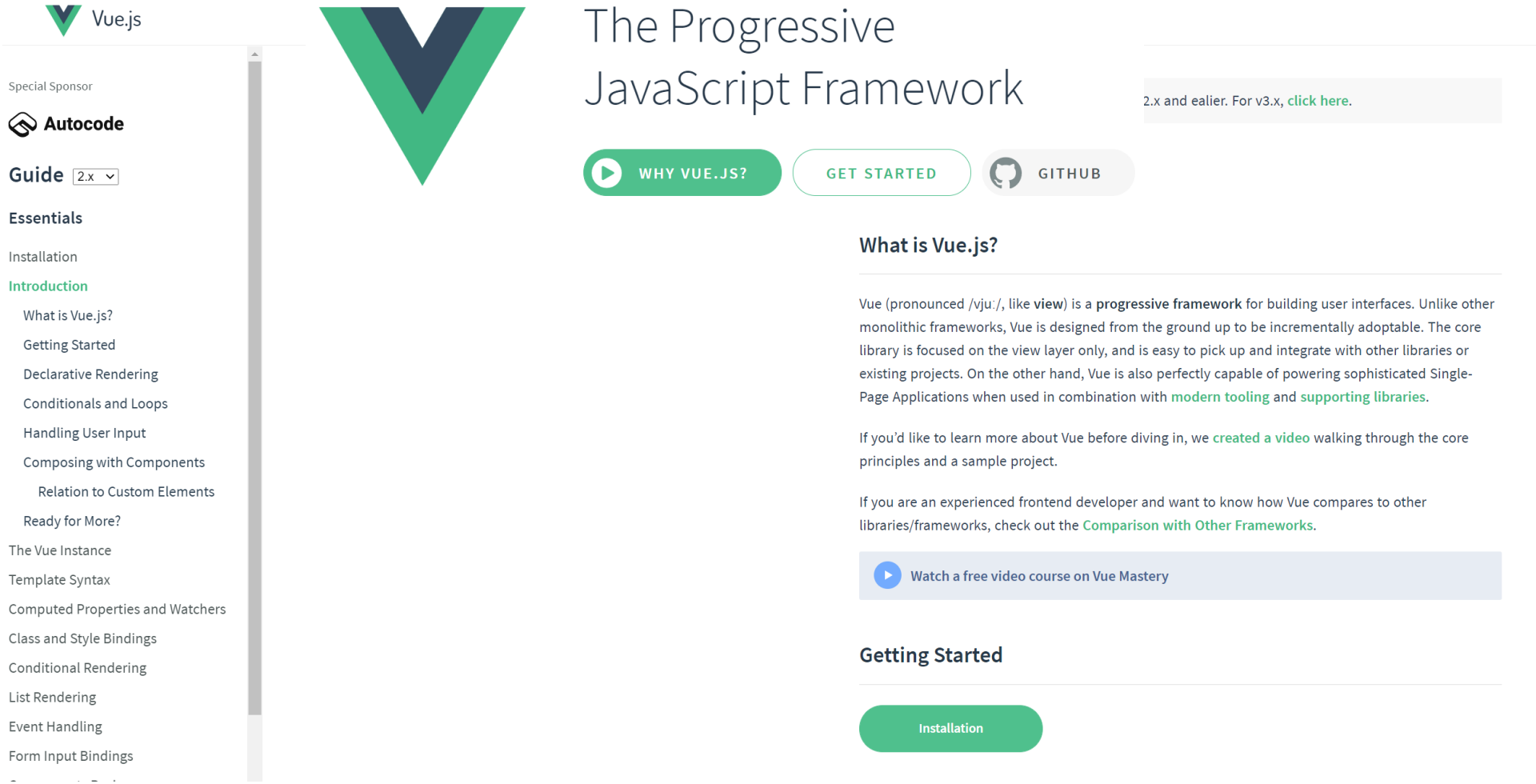
- 跨平台图形界面库——适合科学可视化可视分析应用
- 有开源版本；C++；有大量例子



https://www.qt.io/

Vue.js

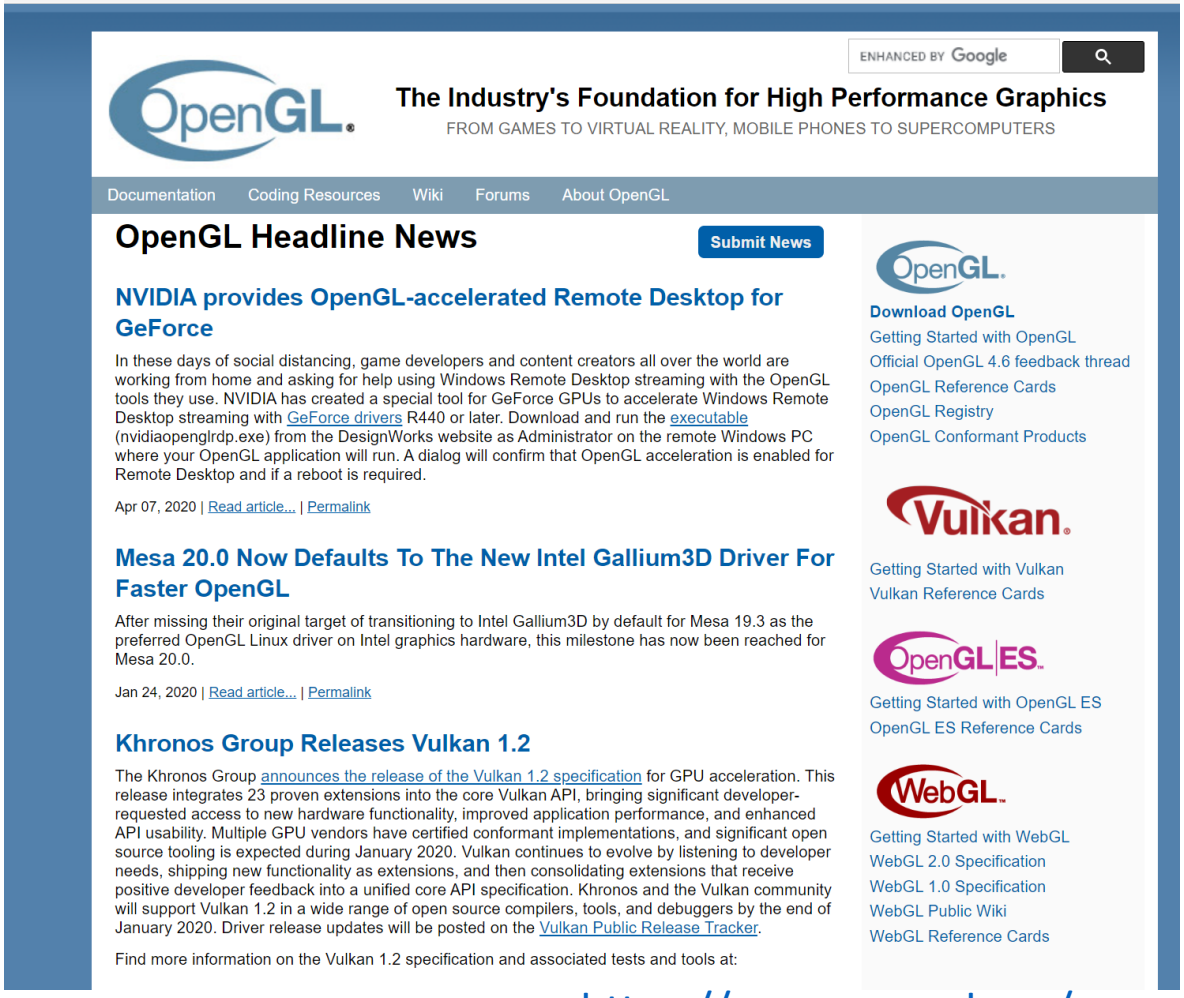
- JavaScript图形界面库——适合信息可视化可视分析应用
- 开源；有大量例子



https://vuejs.org/

图形编程——OpenGL，WebGL

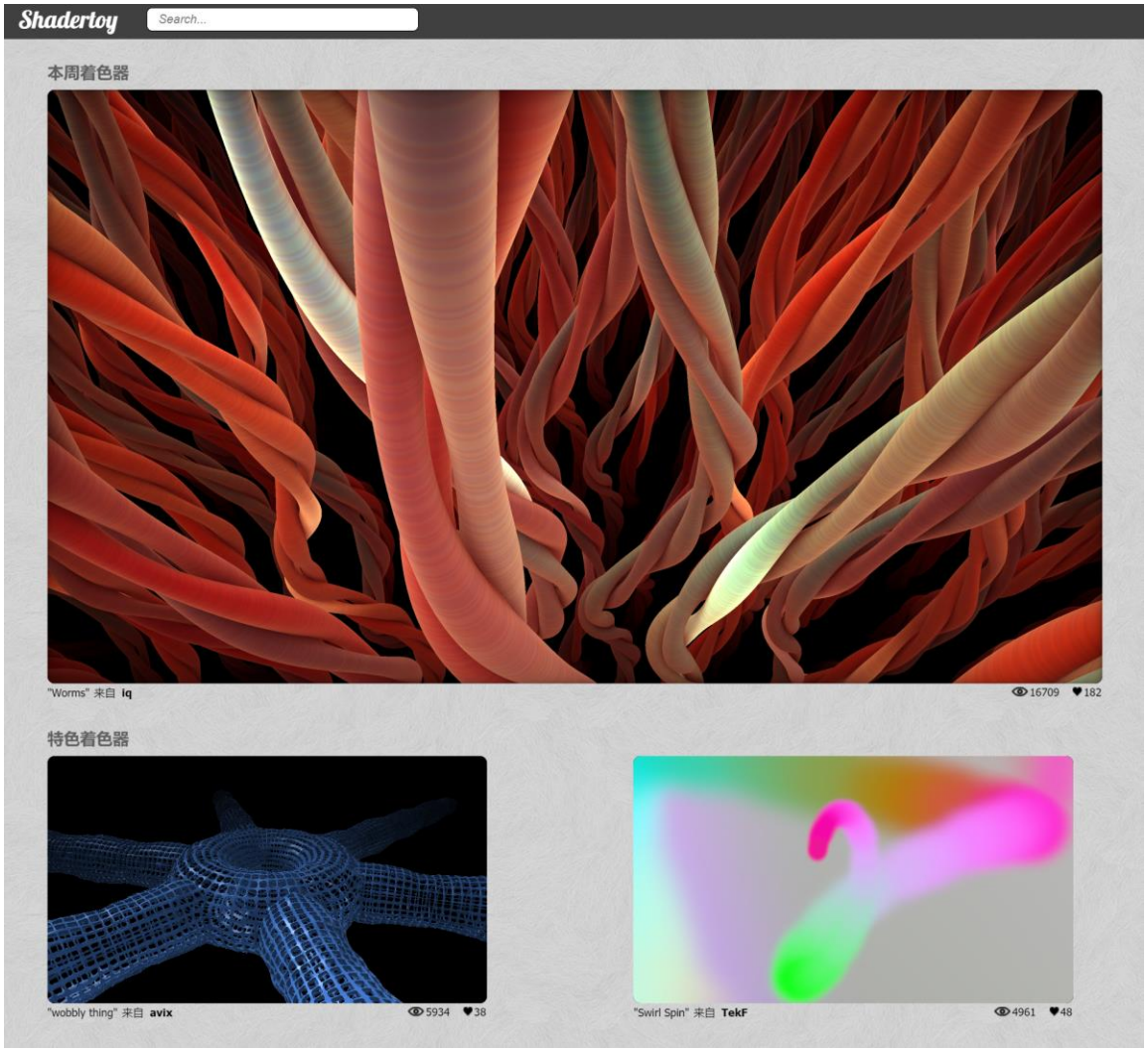
- 跨平台硬件加速图形接口
- OpenGL：单机应用；WebGL：网络应用
- 需熟悉现代图形流水线CPU+GPU；代码量较大；要仔细考虑计算效率



https://www.opengl.org/

图形处理器（GPU）编程——着色器（shaders）

- 在GPU上运行的并行程序编程，主要负责绘制
- GLSL（OpenGL着色器）； WebGL



WebGL着色器编程分享平台（有大量例子）：
https://www.shadertoy.com/

图形处理器（GPU）编程——CUDA

- CUDA (Compute Unified Device Architecture)：nVidia公司的GPU加速的并行高性能计算平台和接口
- 大规模计算；需深刻理解硬件和并行计算原理；各种科学计算；深度学习

CUDA Toolkit

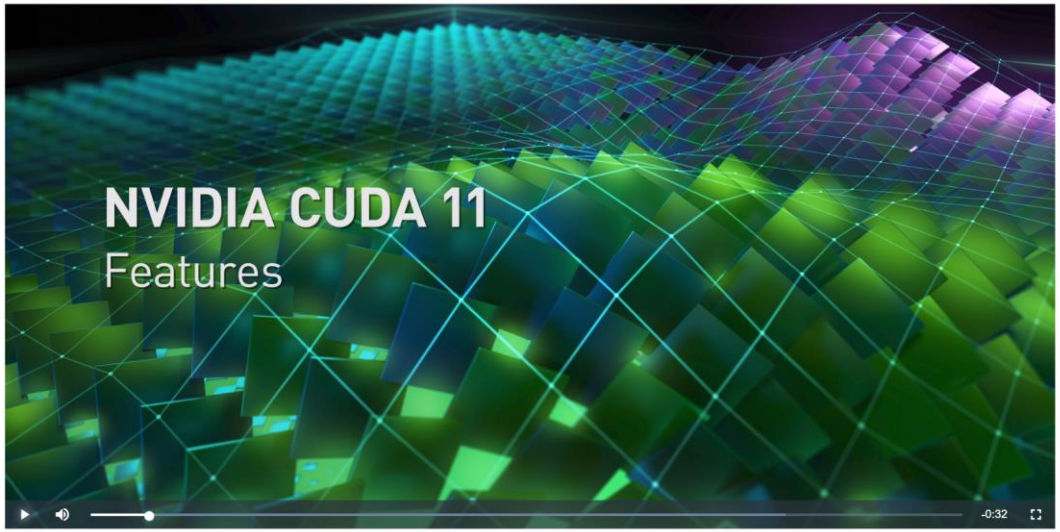
Develop, Optimize and Deploy GPU-Accelerated Apps

The NVIDIA® CUDA® Toolkit provides a development environment for creating high performance GPU-accelerated applications. With the CUDA Toolkit, you can develop, optimize, and deploy your applications on GPU-accelerated embedded systems, desktop workstations, enterprise data centers, cloud-based platforms and HPC supercomputers. The toolkit includes GPU-accelerated libraries, debugging and optimization tools, a C/C++ compiler, and a runtime library to build and deploy your application on major architectures including x86, Arm and POWER.

Using built-in capabilities for distributing computations across multi-GPU configurations, scientists and researchers can develop applications that scale from single GPU workstations to cloud installations with thousands of GPUs.

Download Now

CUDA 11 Features



CUDA 11 introduces support for the NVIDIA Ampere architecture, Arm server processors, performance-optimized libraries, and new developer tool capabilities.

Support for the NVIDIA Ampere architecture includes next generation Tensor Cores, mixed precision modes, Multi-Instance GPU (MIG), advanced memory management, and standard C++/Fortran parallel language constructs.

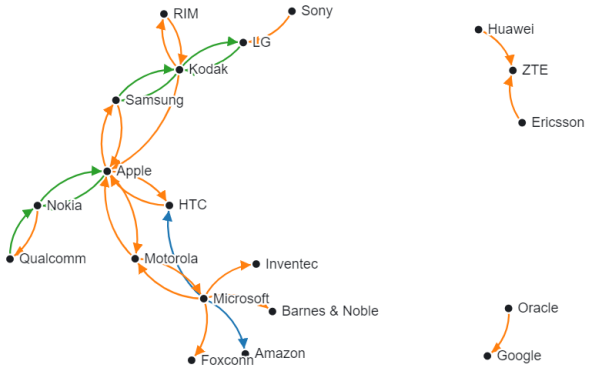
https://developer.nvidia.com/cuda-toolkit

信息可视化的实现

- 过去：编写桌面应用，例如，Windows上的应用程序
  - 所需语言：
    - C++
  - 所需软件库
    - OpenGL，DirectX，Qt
  - 优点？
  - 缺点？

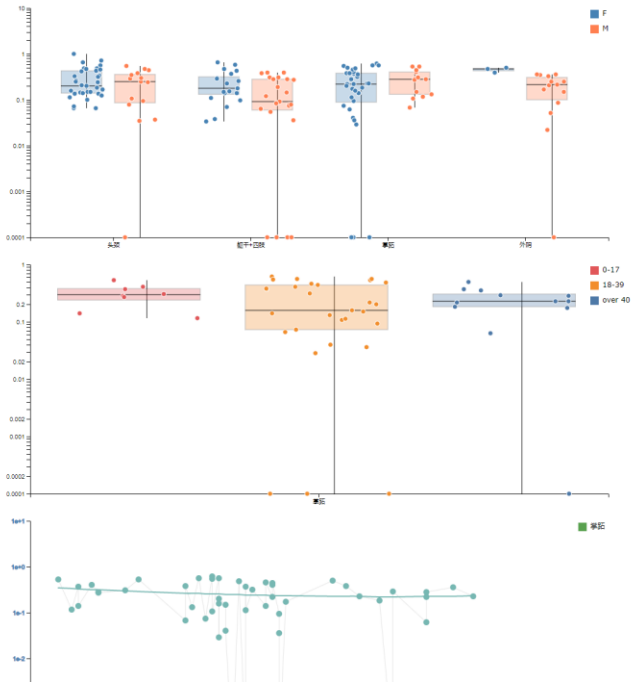
信息可视化的实现

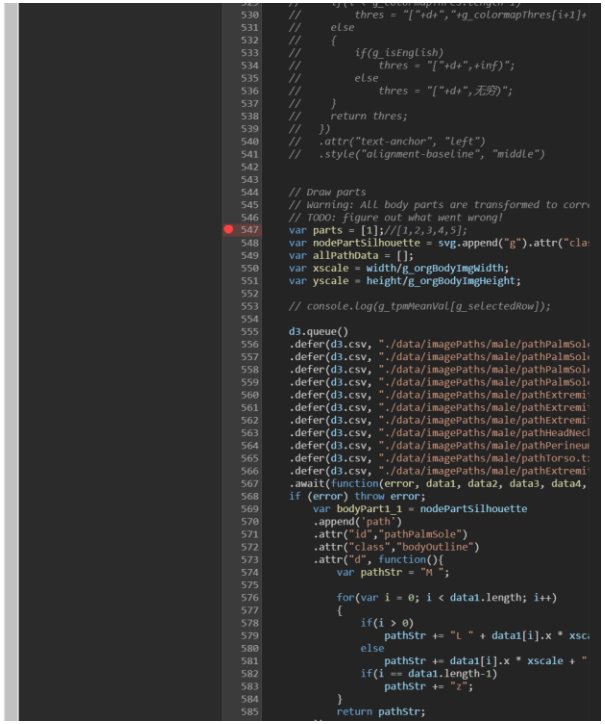
- 现在：编写基于网页的应用（Web应用）
  - 所需语言：
    - JavaScript
  - 所需软件库：
    - D3js，three.js，CanvasJS
    - Vue，React
  - 优点？
  - 缺点？



基于网页的可视化应用开发所需工具

- 运行、调试工具：
  - 支持HTML5的各种网络浏览器
  - 推荐Firefox
  - 如何查看当前网页的源代码？

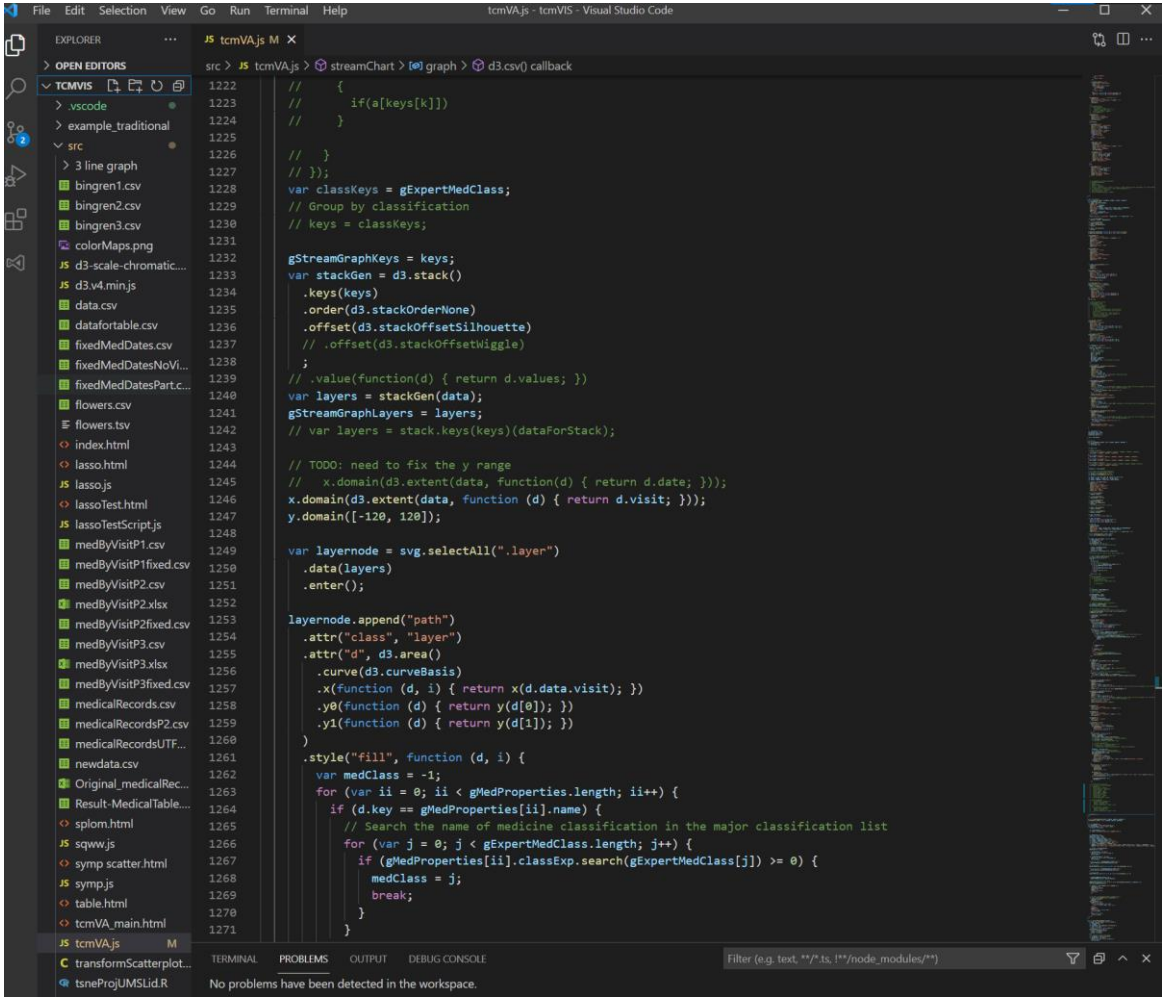




```
//         thres = "["+d+","+g_colormapThres[i+1]+
//     else
//     {
//         if(g_isEnglish)
//             thres = "["+d+",+inf)";
//         else
//             thres = "["+d+",无穷)";
//     }
//     return thres;
// })
// .attr("text-anchor", "left")
// .style("alignment-baseline", "middle")


// Draw parts
// Warning: All body parts are transformed to corr
// TODO: figure out what went wrong!
var parts = [1];//[1,2,3,4,5];
var nodePartSilhouette = svg.append("g").attr("cla
var allPathData = [];
var xscale = width/g_orgBodyImgWidth;
var yscale = height/g_orgBodyImgHeight;

// console.log(g_tpmMeanVal[g_selectedRow]);

d3.queue()
.defer(d3.csv, "./data/imagePaths/male/pathPalmSol
.defer(d3.csv, "./data/imagePaths/male/pathPalmSol
.defer(d3.csv, "./data/imagePaths/male/pathPalmSol
.defer(d3.csv, "./data/imagePaths/male/pathPalmSol
.defer(d3.csv, "./data/imagePaths/male/pathExtremi
.defer(d3.csv, "./data/imagePaths/male/pathExtremi
.defer(d3.csv, "./data/imagePaths/male/pathExtremi
.defer(d3.csv, "./data/imagePaths/male/pathHeadNeck
.defer(d3.csv, "./data/imagePaths/male/pathMerineur
.defer(d3.csv, "./data/imagePaths/male/pathTorso.t
.defer(d3.csv, "./data/imagePaths/male/pathExtremi
.await(function(error, data1, data2, data3, data4,
if (error) throw error;
    var bodyPart1_1 = nodePartSilhouette
    .append('path')
    .attr("id","pathPalmSole")
    .attr("class","bodyOutline")
    .attr("d", function(){
        var pathStr = "M ";

        for(var i = 0; i < data1.length; i++)
        {
            if(i > 0)
                pathStr += "L " + data1[i].x * xsc
            else
                pathStr += data1[i].x * xscale + "
            if(i == data1.length-1)
                pathStr += "Z";
        }
        return pathStr;
```

基于网页的可视化应用开发所需工具

- 程序编码工具
  - 各种文本编写工具
  - 推荐Visual Studio Code



网页编程入门

- HTML语言
- 静态网页
- 网页应用的入口都是html网页
- 试试下边的html语句

```
<!DOCTYPE html>

<!-- Add a title -->
<h1>第一个网页</h1>

 <!-- Add a bit of text --> <p>你好</p>

<!-- Add a link --> <p>这是 <a
href="http://www.nihds.pku.edu.cn/">北京大学健康医学大数据
国家研究院的链接</a></p>
```

参考：https://www.d3-graph-gallery.com/intro_d3js.html

网页编程入门

- 如何设定网页中各元素的风格?
- Cascading Style Sheet (CSS)

```
<!DOCTYPE html>
<style> .inBlue { color: blue; } </style>
<!-- Add a title -->
<h1 class="inBlue"第一个网页</h1>

 <!-- Add a bit of text --> <p>你好</p>

<!-- Add a link --> <p>这是 <a
href=“http://www.nihds.pku.edu.cn/”>北京大学健康医学
大数据国家研究院的链接</a></p>
```

参考: https://www.d3-graph-gallery.com/intro_d3js.html

网页编程入门

- 如何在网页中绘制图形?
- 一个方法是使用Scalar Vector Graphic (SVG)

```
<!DOCTYPE html>
<style> .inBlue { color: blue; } </style>
<!-- Add a title -->
<h1 class="inBlue"第一个网页</h1>

 <!-- Add a bit of text --> <p>你好</p>

<!-- Add a link --> <p>这是 <a
href=“http://www.nihds.pku.edu.cn/”>北京大学健康医
学大数据国家研究院的链接</a></p>

<svg> <circle style="fill: #69b3a2" stroke="black"
cx=50 cy=50 r=40></circle> </svg>
```

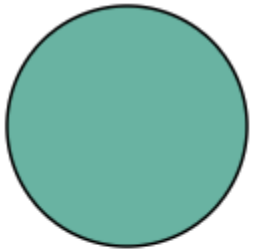
网页编程入门

- 看看效果是否一样?

第一个网页

你好

这是 北京大学健康医学大数据国家研究院的链接



网页编程入门

- 试试绘制其他图形

```
<line x1="0" y1="0" x2="10" y2="10" stroke="black"></line>
<rect x="0" y="0" width="10" height="10"></rect>
<circle cx="5" cy="5" r="5"></circle>
 <ellipse cx="10" cy="5" rx="10" ry="5"></ellipse>
<polygon points="0,0 10,5 20,0 20,20 10,15 0,20"></polygon>
<polyline points="0,0 10,5 20,0 20,20 10,15 0,20" stroke="black"></polyline>
<path d="M65,10 a50,25 0 1,0 50,25"></path>
```

网页编程入门

- 如何用程序控制，实现动态网页？
- JavaScript编程
- 脚本语言
- 语法类似C，C++
- 教程https://developer.mozilla.org/en-US/docs/Web/javascript

https://developer.mozilla.org/en-US/docs/Web/javascript

网页编程入门

- 理论上，可以用JavaScript以及HTML5接口制作可视化网页
- 如何与数据建立关联？
- D3js库的基本原理
  - 控制网页的Document Object Model (DOM)

```
<!DOCTYPE html>
<style> .inBlue { color: blue; } </style>
<!-- Add a title -->
<h1 class="inBlue">第一个网页</h1>

 <!-- Add a bit of text --> <p>你好</p>

<!-- Add a link --> <p>这是 <a href="http://www.nihds.pku.edu.cn/">北京大学健康医学大数据国家
研究院的链接</a></p>

<svg>
<circle class="target" style="fill: #69b3a2" stroke="black" cx=50 cy=50 r=40></circle>
</svg>
<!-- Load d3.js --> <script src="https://d3js.org/d3.v4.js"></script>
<script> d3 .select(".target") // select the elements that have the class 'target'
.style("stroke-width", 8) // change their style: stroke width is not equal to 8 pixels
</script>
```

网页编程入门

- 看看效果?

第一个网页

你好

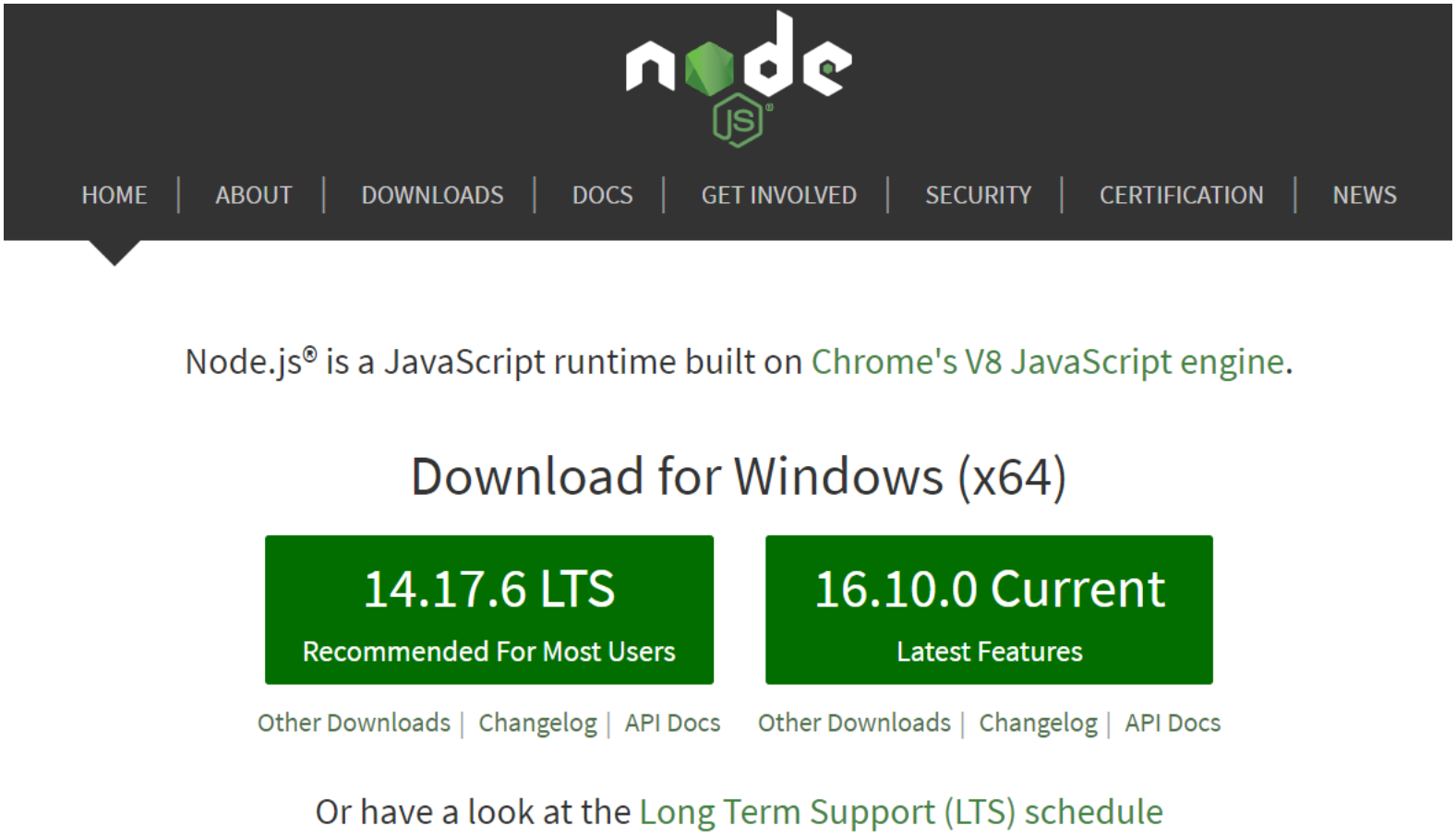
这是 北京大学健康医学大数据国家研究院的链接

网页编程入门

- 常见问题
- 为什么我修改了网页代码但刷新网页没有变化?
  - 清理浏览器缓存
- 为什么有的网页直接打开.html就可以运行，但我写的网页无法运行?
  - 双击.html后无反映
  - ？？？？
  - 涉及到读取本地文件的操作，由于安全性原因都无法直接运行!
  - 需要http服务器!

如何在本地搭建http服务器？

- 步骤1：安装node.js https://nodejs.org/en/



如何在本地搭建http服务器？

- 步骤2：使用node js的npm工具按照http-server
- 在命令行中输入：
- **npm install http-server**

- 步骤3：启动http-server
  - 在命令行环境下
  - 在想要运行网页所在目录下输入：
  - **http-server&**

```
Starting up http-server, serving ./
Available on:
  http://172.27.96.1:8080
  http://192.168.0.101:8080
  http://127.0.0.1:8080
Hit CTRL-C to stop the server
```

可视化和可视分析工程实现

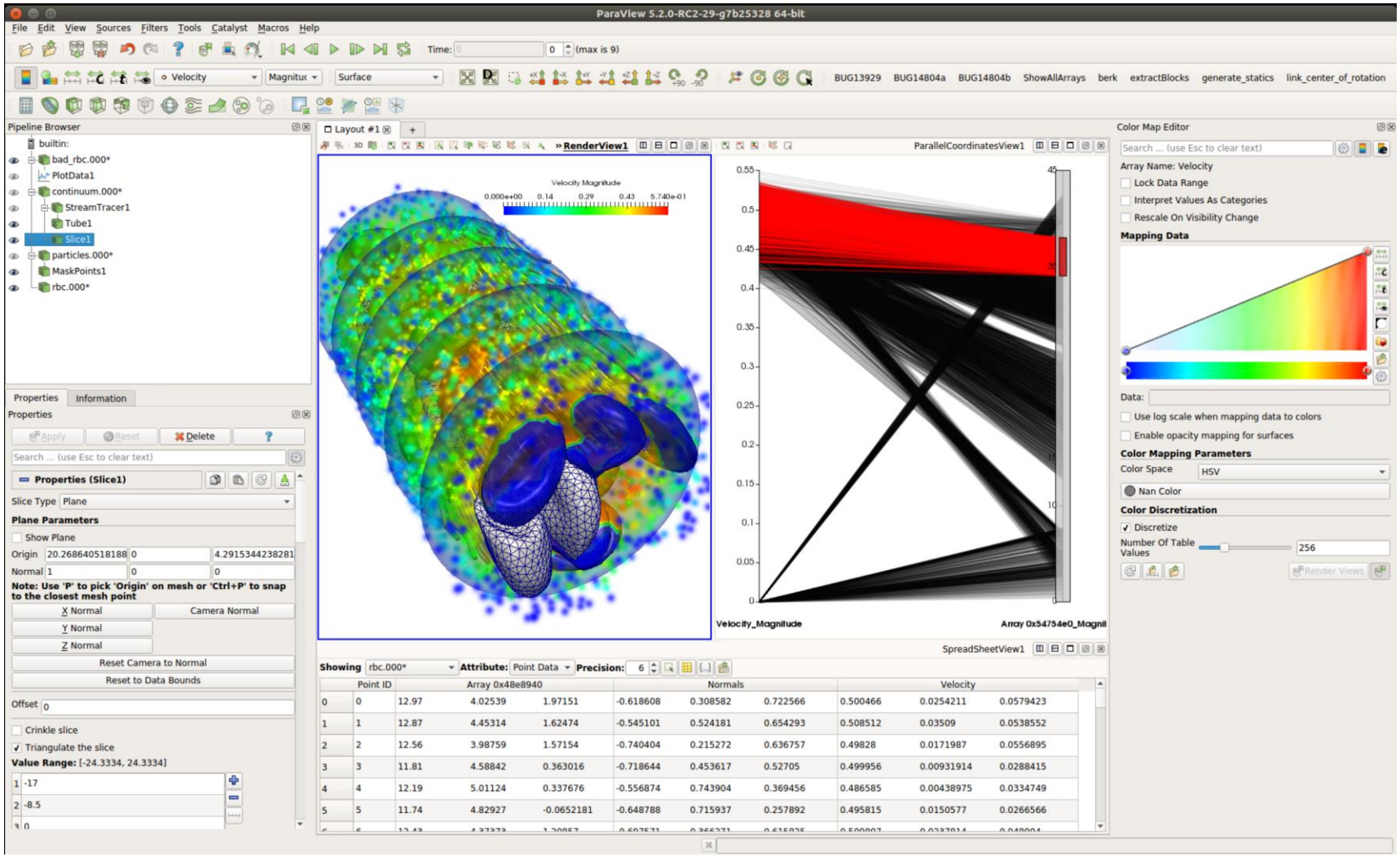
- 可视化和可视分析工具
  - 科学可视化：
    - ParaView https://www.paraview.org/
    - SCI Institute的各种工具 https://www.sci.utah.edu/sci-software/visualization.html
    - Inviwo https://inviwo.org/
    - Voreen https://www.uni-muenster.de/Voreen/index.html
    - ……
  - 信息可视化，可视分析：
    - Tableau https://www.tableau.com/
    - Power BI https://powerbi.microsoft.com/
    - ……
- 可视化软件库
    - VTK https://vtk.org/
    - D3 https://d3js.org/
- 编码实现可视化可视分析
  - 编程语言：
    - C++, JavaScript, Python, R……
  - 技能：
    - 交互界面（UI） 编程——Qt, Vue.js……
    - 图形编程——OpenGL, WebGL
    - 图形处理器（GPU） 编程——Shaders, CUDA

科学可视化的实现

- 过去：编写桌面应用，例如，Windows上的应用程序
  - 所需语言：
    - C++
  - 所需软件库
    - OpenGL，DirectX，Qt
  - 优点？
  - 缺点？
- 现在：基于网页的应用越来越多
- 但是，由于对性能的高要求，大部分应用还是基于桌面应用

Paraview

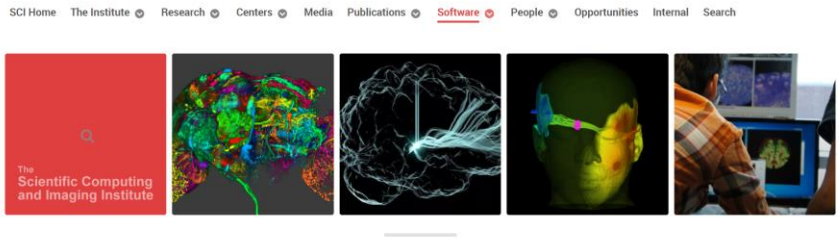
- 科学可视化、可视分析，数据处理
- 开源软件；使用VTK库；支持大规模数据



https://www.paraview.org/

SCI Institute的各种工具

- 科学可视化的各种开源工具
- 包括集成式问题解决、图像分析、几何形状建模、模拟、可视化



SCI Software

Scientific Software Environments

Software at the SCI Institute is developed in close collaboration with application users to satisfy real needs within their research communities. We use a robust, yet agile software process that is fully open-source to produce software environments that integrate leading-edge algorithms in image processing, scientific visualization, and scientific computing. Software products developed at the SCI Institute can be categorized in the following ways: Problem Solving Environments (Integrated Modeling, Simulation, and Visualization), Image Analysis, Geometric and Shape Modeling, Simulation, and Visualization.

Problem Solving Environments | Image Analysis | Geometric and Shape Modeling | Simulation | Visualization

Problem Solving Environments (Integrated Modeling, Simulation, and Visualization)

FEBio

FEBio is a nonlinear finite element solver that is specifically designed for biomechanical applications. It offers modeling scenarios, constitutive models and boundary conditions that are relevant to many research areas in biomechanics. All features can be used together seamlessly, giving the user a powerful tool for solving 3D problems in computational biomechanics. The software is open-source, and pre-compiled executables for Windows, Mac OS X and Linux platforms are available.
More information and links to downloads

PreView

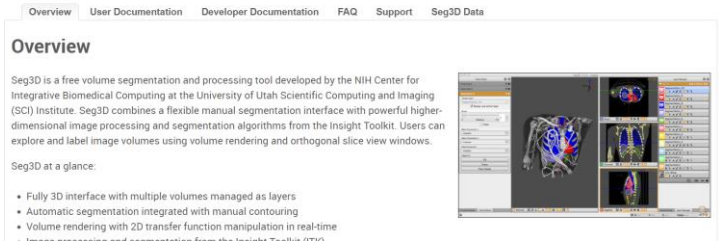
PreView is a Finite Element (FE) preprocessor that has been designed specifically to set up FE problems for FEBio. It allows the user to specify the boundary conditions and material properties in a user-friendly graphical environment.
More information and links to downloads

PostView

Postview is a finite element post-processor that is designed to visualize and analyze results from an FE analysis. It can import the FEBio extendible plot file format (XPLT), as well as several other data formats (e.g. LSDYNA Keyword, LSDYNA binary database, VTK). It also offers a way to add additional data to an already loaded model.
More information and links to downloads

https://www.sci.utah.edu/sci-software/visualization.html

Seg3D



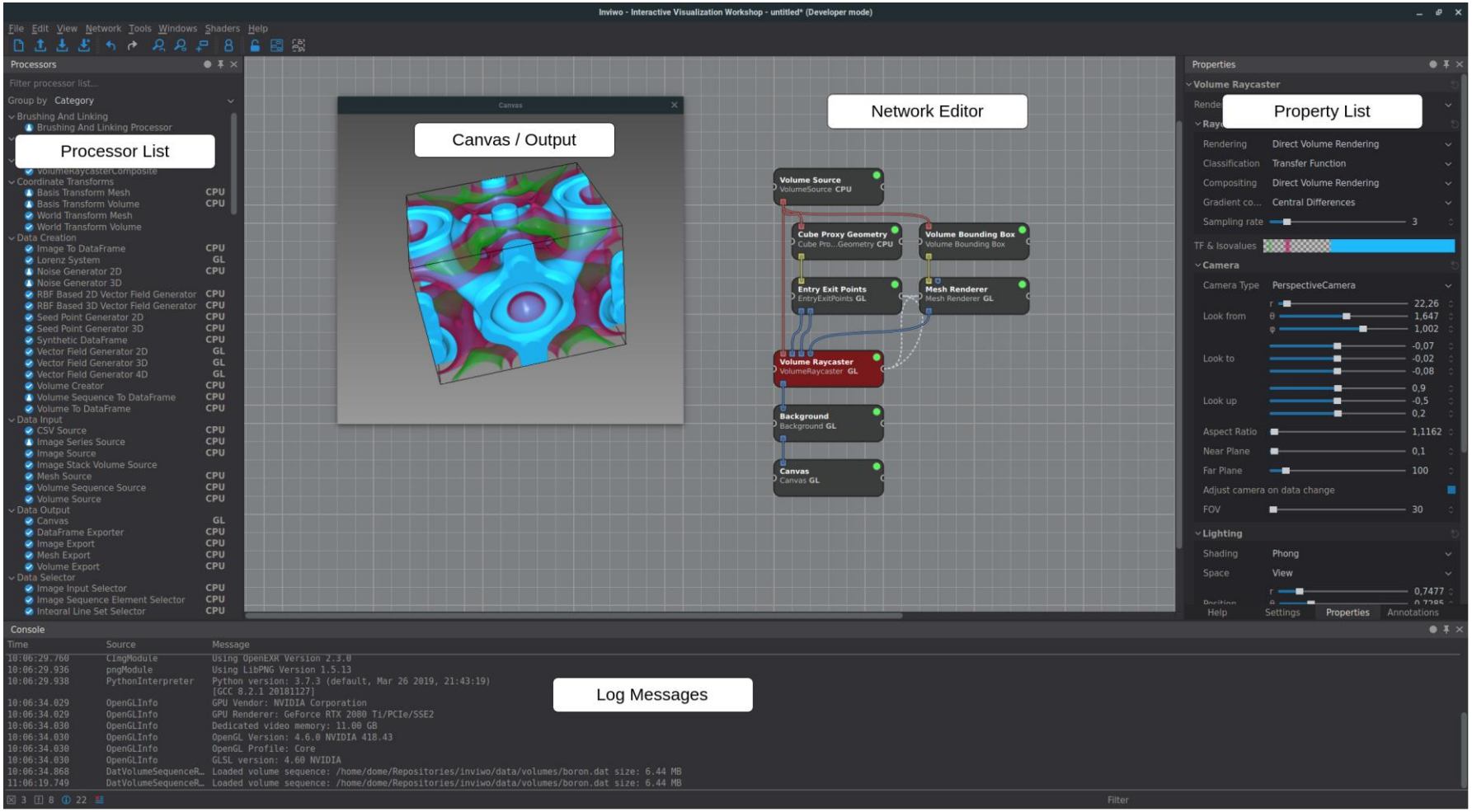
https://www.sci.utah.edu/software/seg3d.html

ImageVis3D

https://www.sci.utah.edu/software/imagevis3d.html

Inviwo

- 科学可视化
- 开源软件；模块化搭建可视化；高质量渲染



https://inviwo.org

Voreen

- 科学可视化
- 开源软件；模块化搭建可视化；高质量渲染

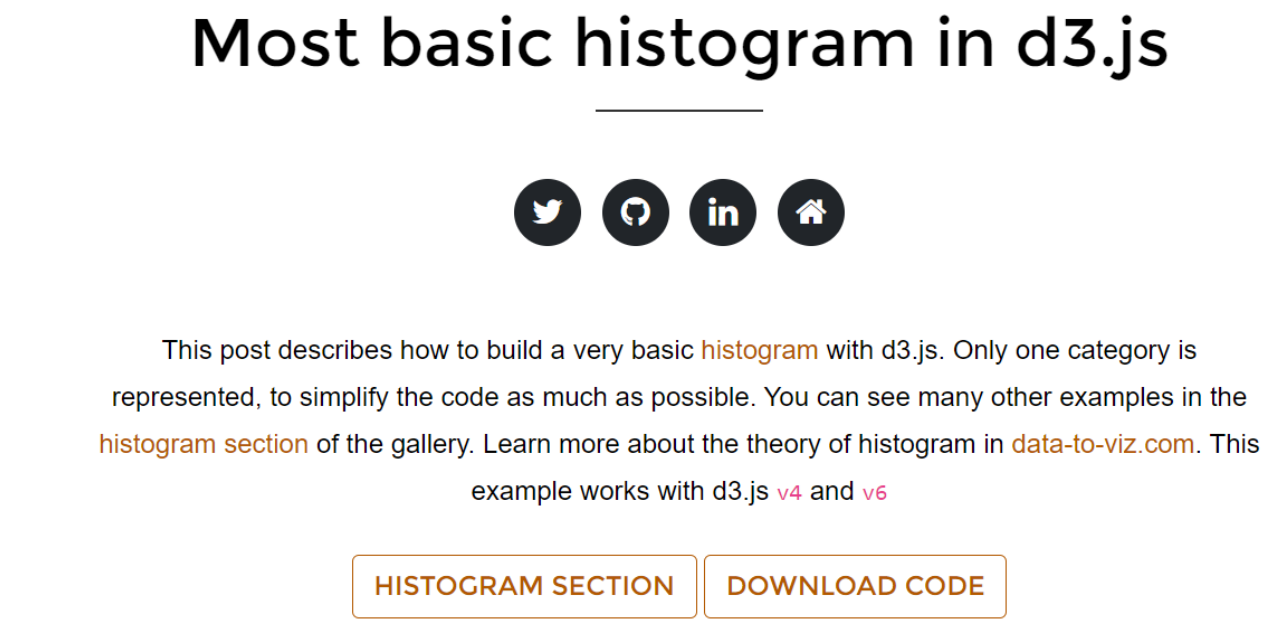
https://www.uni-muenster.de/Voreen/index.html

D3 初步介绍

- 基于网站https://www.d3-graph-gallery.com/intro_d3js.html

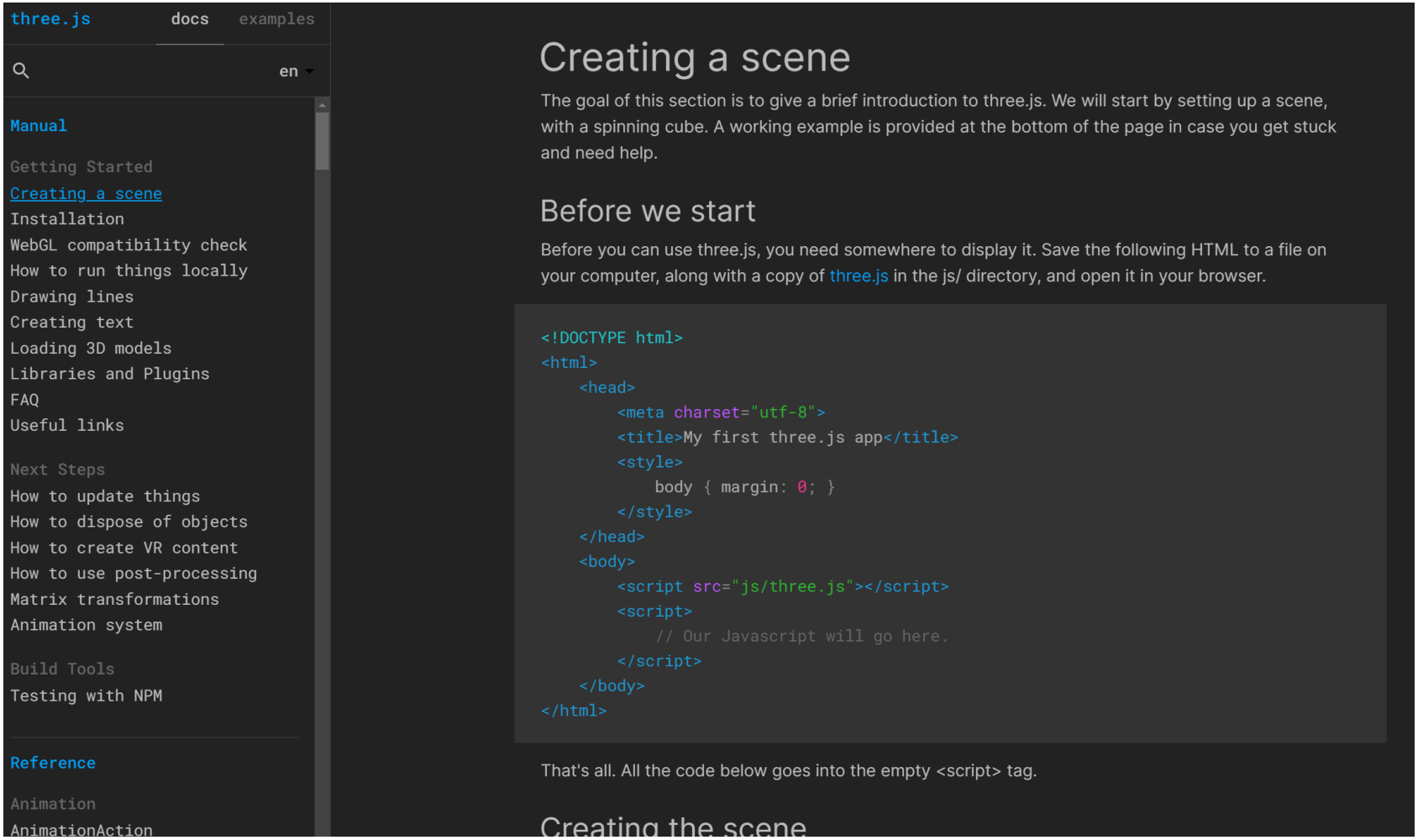
D3 初步介绍

- 目标：实现自己的第一个直方图（histogram）



THREE.js创建三维可视化

- https://threejs.org/docs/index.html#manual/en/introduction/Creating-a-scene



THREE.js创建三维可视化

- 目标：实现绘制一个立方体