



中国科学院大学
University of Chinese Academy of Sciences

计算机科学导论

网络思维-1

网络思维概述，名词术语

zxu@ict.ac.cn

课堂小测验



提纲

Acu-Exams-CP

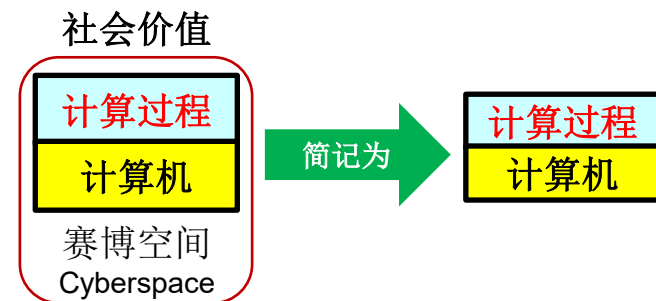
- 什么是网络思维
- 网络名词术语
- Web编程与个人作品讨论

媒体	软件	数据	网络	智能	安全
程序 进程 指令 冯氏结构 指令流水线 时序电路 组合电路					

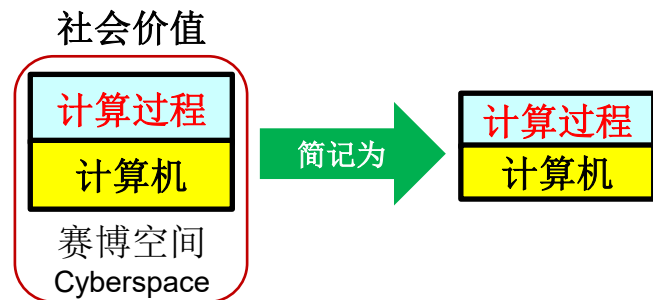
课件中包含教科书未包括的素材引用，特此致谢

计算机科学中网络思维的目的和三个主要来源

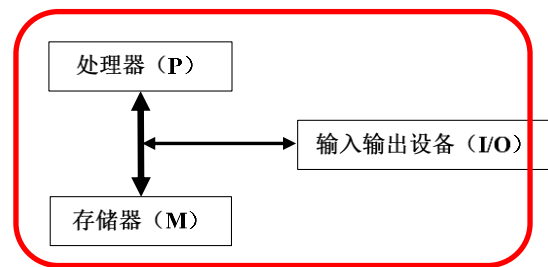
- 目的：将逻辑思维、算法思维、系统思维拓展到网络系统
 - 计算过程在多个节点组成的网络上运行，体现正确性、巧妙性、实用性
 - 为什么？现在的计算机应用大都是网络应用（上网）
 - Cyberspace主要是计算机网络及其应用



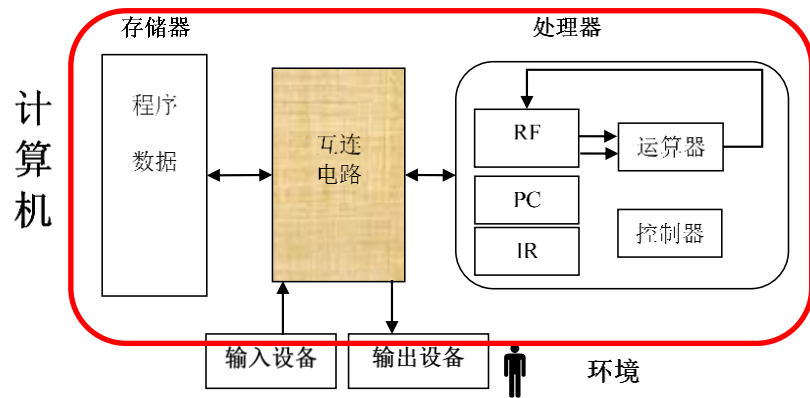
计算机科学中网络思维的目的和三个主要来源



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- 硬件互联（interconnect）
 - 冯诺依曼模型
- 人类社会网络
 - 文献网络
- 计算机网络
 - 互联网（Internet, Web）



(a) 计算机简图：三个子系统连为一体形成计算机系统



(b) 更加详细的刻画

1. 什么是网络思维？

- 通过连通性与协议栈，研究多个节点连接而成的网络
 - 很多问题涉及用户/数据/算法/部件的连接体，而非单体
- 连接体就是网络，即多个节点连接或通信的整体
 - 必有连接，可有通信
- 网络是客体（**object**，宾语）：文献网
 - 全球计算机科学文献网络，连接是引用；无通信
- 网络是主体（**subject**，主语）：机群（**cluster of computers**）
 - 机群 算出 文献网；机群的节点之间有通信
- 三类网络：硬件互联（**interconnect**）、社会网络、互联网
 - 以互联网为主要场景

网络思维使人们发现了很多有趣现象

- E.g., what is your **Erdős Number**?
 - Measuring interdisciplinary nature of modern research
 - <https://mathscinet.ams.org/mathscinet/freeTools.html?version=2>
- Paul Erdős（爱尔迪西），匈牙利数学家 (1913–1996)
 - 图论的奠基者之一
 - 活跃在数论、图论、组合数学、概率论、集合论等领域
 - “**Master of Collaboration**”，1400篇论文，500合著者
 - 沃尔夫奖获得者
 - 匈牙利科学院、美国科学院、英国皇家科学院院士



金芳蓉教授网站

<https://mathweb.ucsd.edu/~fan/photo/ep.html>



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- Paul Erdős, 匈牙利数学家 (1913–1996)
- “Master of Collaboration”, 1400篇论文, 500合著者
- Erdős Number = 0 → Erdős himself
- Erdős Number = 1 → Erdős' coauthor
- Erdős Number = 2 → Erdős' coauthor's coauthor
- Erdős Number = 3 → Erdős' coauthor's coauthor's coauthor
- 徐志伟: Erdős Number = ? 计算机系统
- 张家琳: Erdős Number = ? 计算机理论

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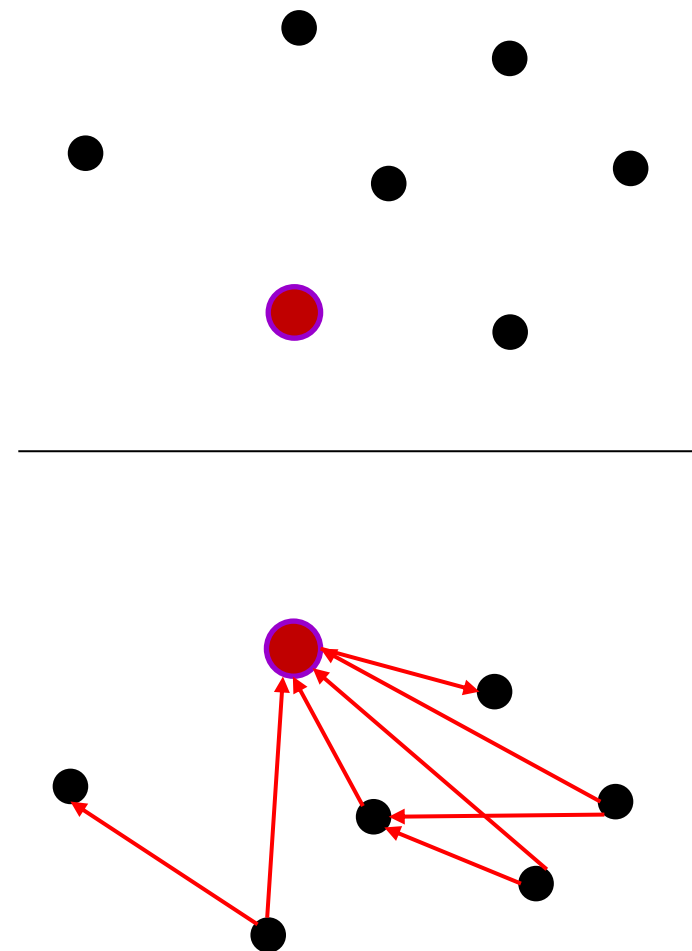
- 徐志伟: Erdős Number = ? 计算机系统
- 张家琳: Erdős Number = ? 计算机理论
- Zhiwei Xu: 4
- Jialin Zhang: 3

网络思维催生新概念、新方法

- 第一代 vs. 第二代搜索引擎
- 1st generation search engines
 - Computed search results by matching the keywords in search queries to the contents of webpages (*nodes*)
 - Only utilized **nodes** of the network of webpages
- 2nd generation search engines
 - Around 1996, Jon Kleinberg, Robin Li (李彦宏), and Larry Page observed a phenomenon:
 - Web links also significantly influence the relevance of search results
 - Utilized both **nodes** and **edges** to develop the 2G search engines with better results
 - More fully utilizes network thinking and created Google and Baidu, serving billions of users and generating annual revenue over \$100 billion

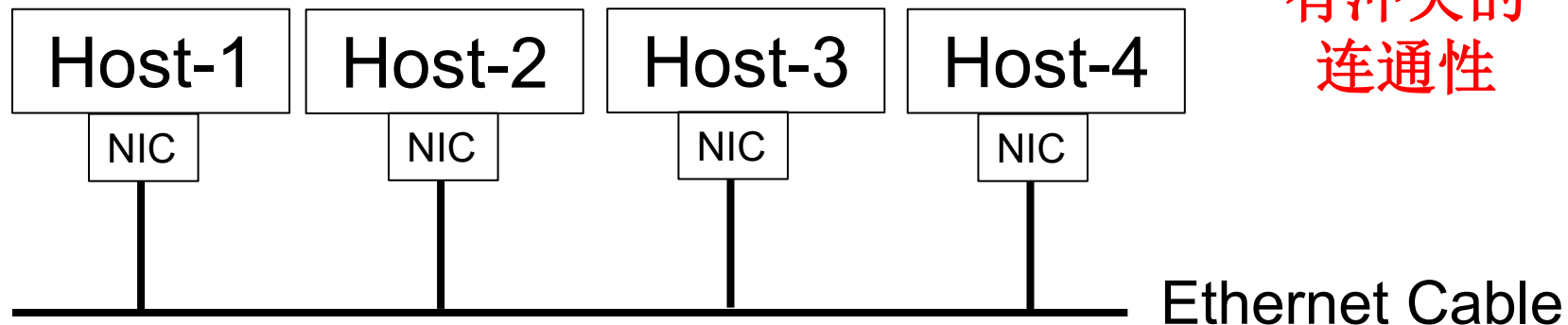
第一代搜索引擎只利用了节点（网页）

第二代搜索引擎利用了节点（网页）和边（超链接）



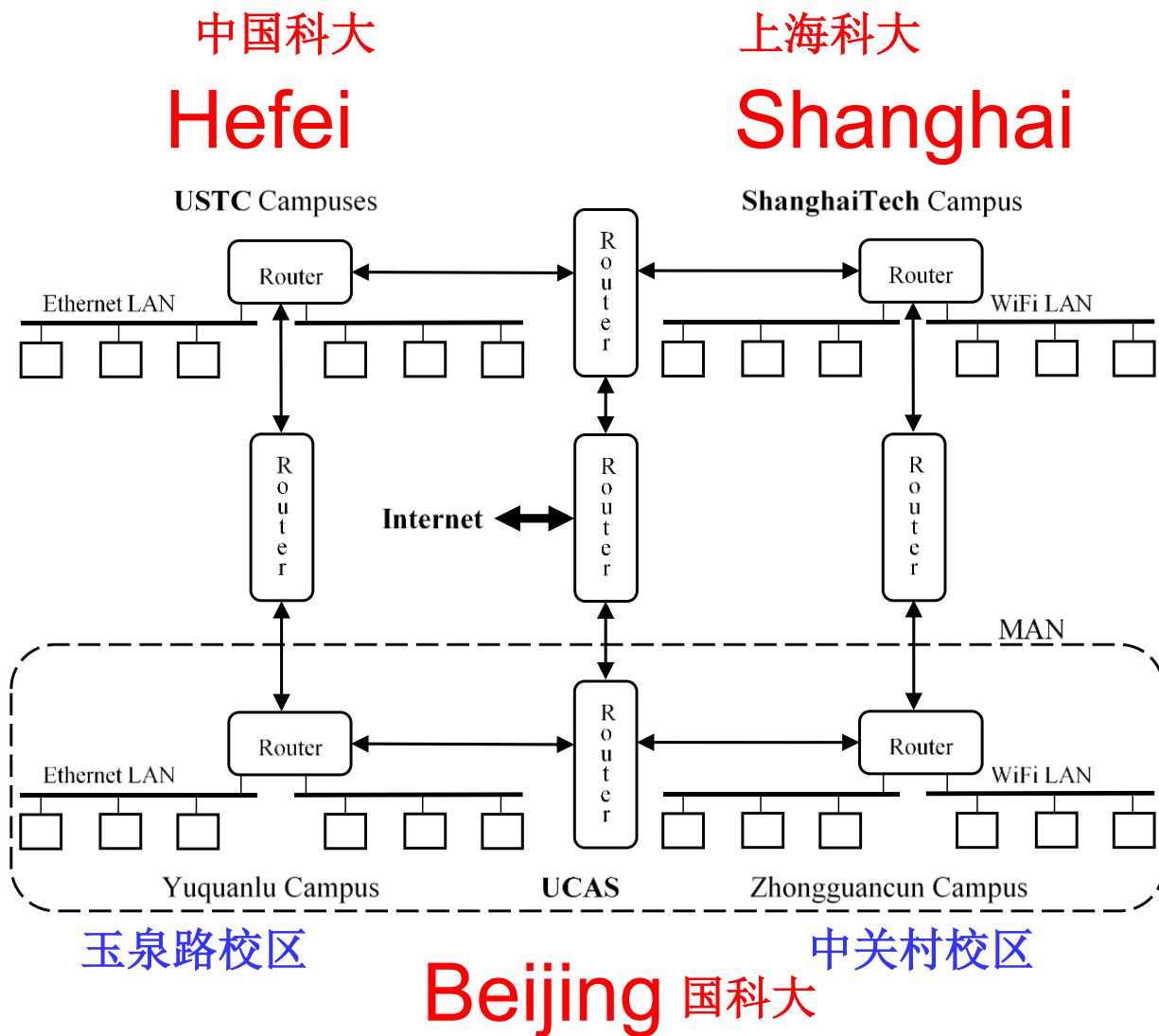
化解冲突的巧妙方法

- Four hosts connected by an Ethernet
 - NIC (network interfacing circuitry) for networking operations
- Conflict example: Host-3与4在通信时，Host-1与2试图通信
 - Host-1 tries to send a message to Host-2, while the cable is used by Host-3 communicating with Host-4
- Exponential backoff to resolve conflict 指数退避方法
 - When first try fails, Host-1 waits for a random time in $[0, T]$
 - When second try fails, Host-1 waits for a random time in $[0, 2T]$
 - When third try fails, Host-1 waits for a random time in $[0, 4T]$



2. 网络名词术语

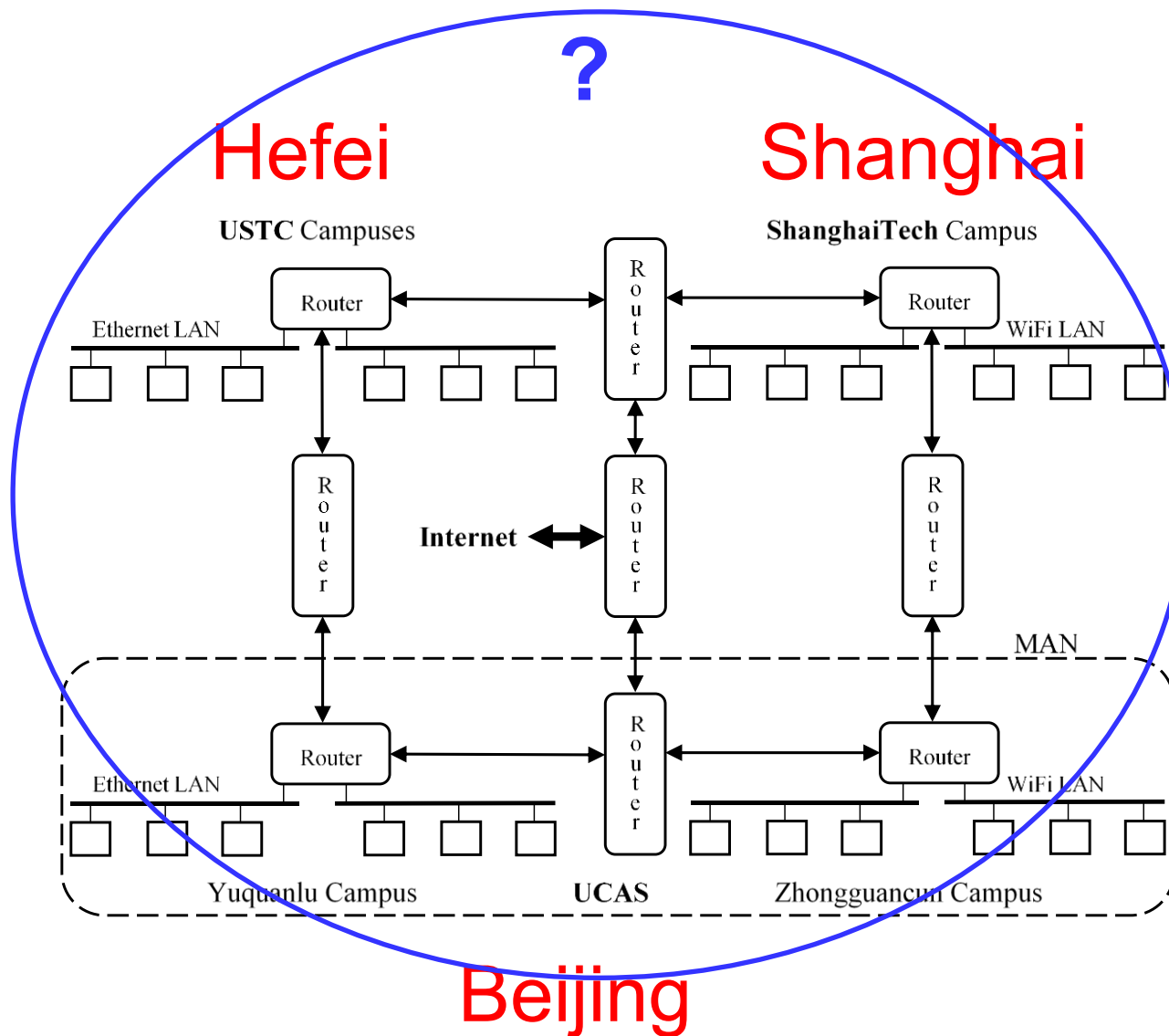
- LAN 局域网
Local Area Network
- MAN 城域网
Metropolitan Area Network
- WAN 广域网
Wide Area Network



Network terms

- **ISP** Internet Service Provider
互联网服务提供商

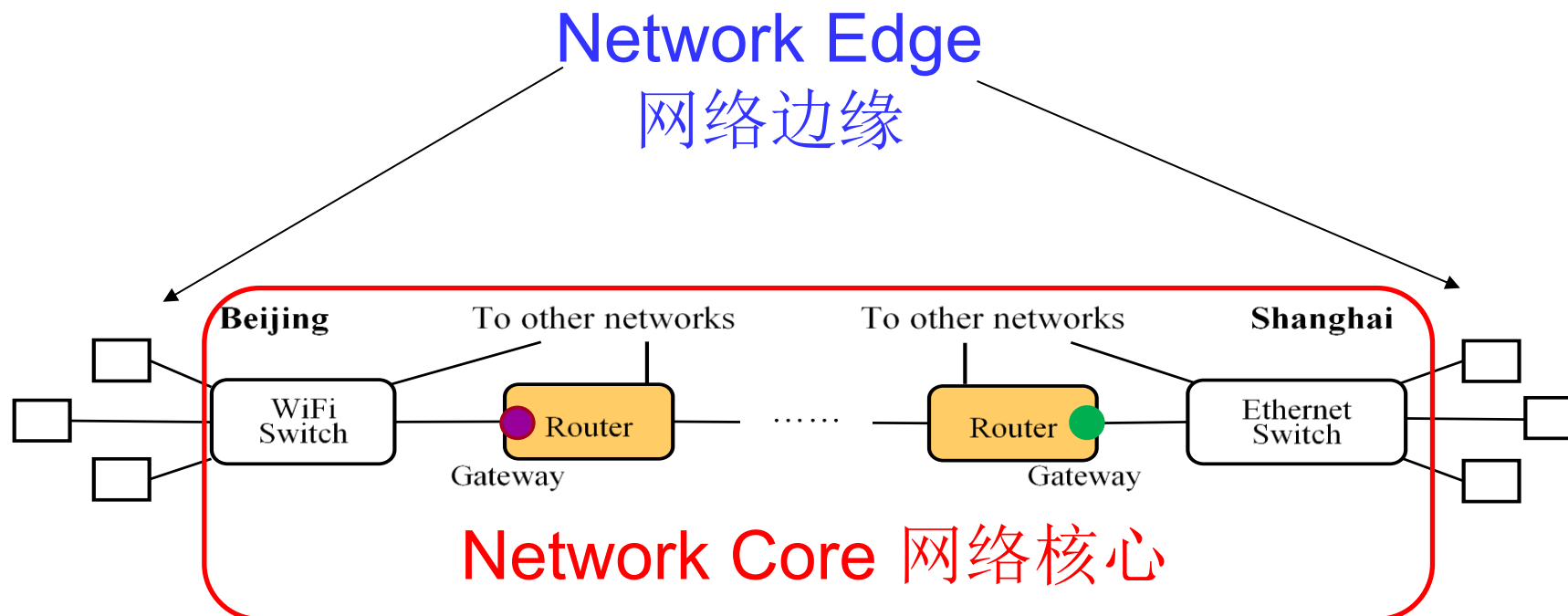
- An institution providing Internet connection services
- CSTNET for ...ac.cn
- CERNET for ...edu.cn



两类网络节点

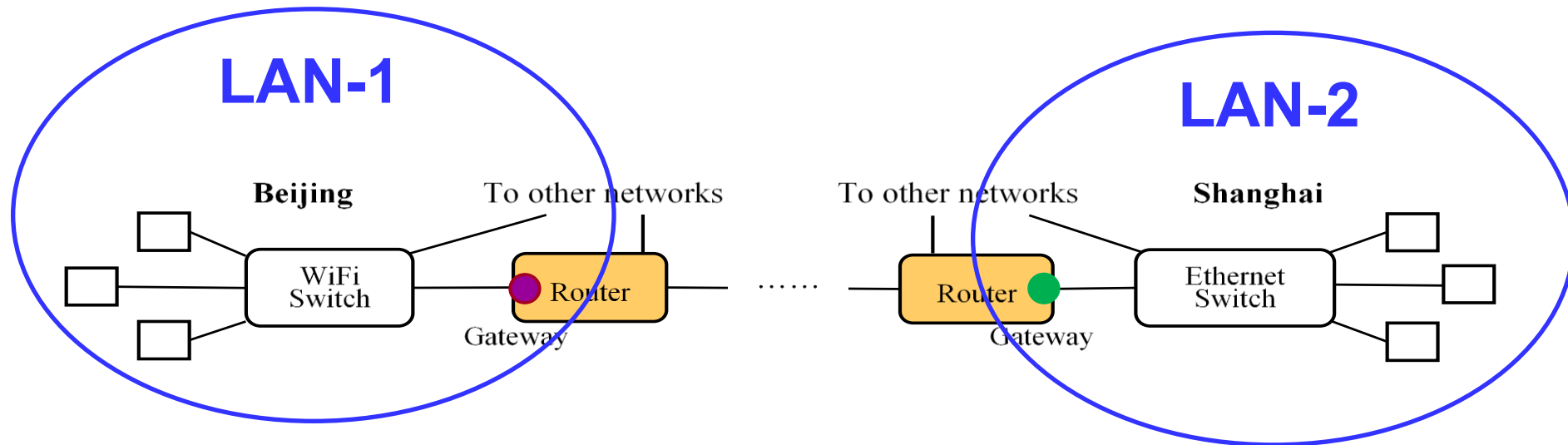
宿主节点（宿主机）、组网设备节点

- **Hosts**: client nodes and server nodes at the network edge
 - 6 edge devices (hosts) are shown 宿主机构成网络边缘
 - Client devices: laptop and desktop computers, smartphones, etc. 客户端设备
 - Server devices: servers, Internet datacenters, supercomputers, etc. 服务器设备
- **Networking devices** in the core of the network
 - 4 networking devices are shown 组网设备构成网络核心



Internal network and outside network of an organization

- 网关：连接局域网与外界的路由器（端口）
- Gateway of network LAN-1 (purple)
 - The router connecting a network to the outside
 - In more detail, the port address of the router
- Gateway of network LAN-2 (green)



万维网网址（URL）入门知识

- Uniform Resource Locator

http **://** **cs101ucas.edu.cn**
协议 网站（域名或IP地址）

/中文/
路径（服务器中的文件名）

- 其他协议：

- **file**：访问本计算机的文件
- **ftp**：访问互联网上任意计算机的文件
- **https**：安全地访问Web资源
- **mailto**：访问电子邮件地址

3. 个人作品讨论

- 提升自己的学习与创造性表达
 - 可参考往届同学个人作品库

https://course.things.ac.cn:10088/exp/personal_artifact

创造性表达实例

- 国科大一年级同学的个人作品

- 每个同学创建自己的动态网页（**演示**）

- [猫猫指挥家](#)
- [绮](#)
- [宇宙沙箱](#)
- [勾股定理证明](#)

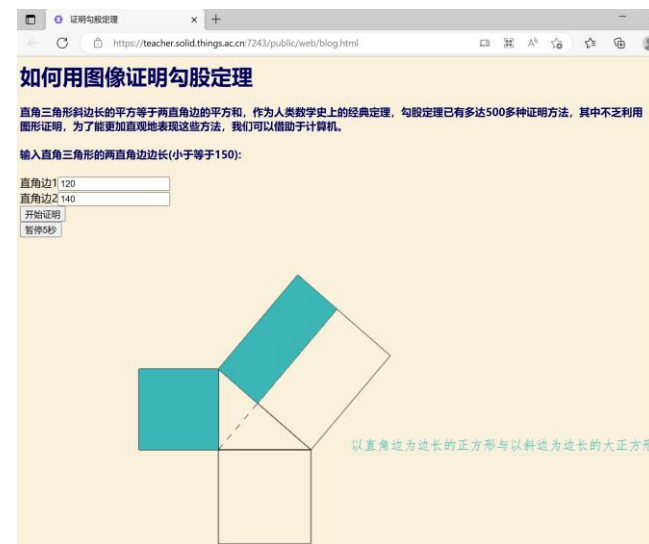
- 大部分网页编程知识是自学的



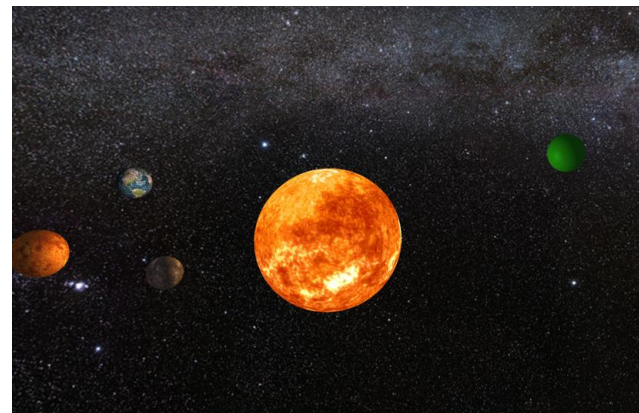
2019级物理系李思悦同学创建“猫猫指挥家”
花了三天，50%构思、设计，50%编码
155行代码



2020级生物系董可昕同学创建“绮”
“绮 2.0”版172行代码
“绮 3.0”版215行代码



2021级人工智能专业夏扬同学创建
可用于教学的“勾股定理证明”
332行代码



2021级物理专业吴奕君同学
创建满足物理学定律的“宇宙沙箱”
4千行代码

Other HTML elements besides paragraph

- Canvas to draw a picture

```
<body>
.....
  <canvas id="myCanvas" width="600" height="450" >
  </canvas>
  <br/>
  <input type="button" value="Hide Button"
  onclick="hide_info();">
  <br/>
  <textarea id="hide_text" style="width: 600; height: 100px;">
  </textarea>
  <br/><br/>
.....
  <script>
    // load the image
    var img = new Image();
    var context1 = document.getElementById("myCanvas").getContext("2d");
    img.onload = function(){context1.drawImage(img,0,0);}
    img.src="/ucas.bmp";
.....
  </script>
</body>
```



网页作品例子：信息隐藏

信息隐藏网页

127.0.0.1/hide-0.html

80%

在此搜索

书签

导入书签

找回书签

信息隐藏网页



Hide Button

Recover Button

Decode Button

说明：对输入字符的每个ASCII字符的用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover Button显示从图片里提取出的加密后的文本；Decode Button显示从图片里提取出的解密后的文本。

初始界面

网页作品例子：信息隐藏

信息隐藏网页

127.0.0.1/hide-0.html

80%

在此搜索

★ 书签

📄 导入书签

★ 找回书签

信息隐藏网页



Hide Button

Your friend is your needs answered.
He is your field which you sow with love and reap with thanksgiving.
And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace.

Recover Button

Decode Button

说明：对输入字符的每个ASCII字符的用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover Button显示从图片里提取出的加密后的文本；Decode Button显示从图片里提取出的解密后的文本。

输入文字后点击**Hide**按钮

图像貌似没有变化
文字确实被隐藏了

网页作品例子：信息隐藏

信息隐藏网页

127.0.0.1/hide-0.html

80%

在此搜索

书签

导入书签

找回书签

信息隐藏网页



Hide Button

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And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace.

Recover Button

tzw%kwnjsi%nx%`tzw%sjix%fx|jwji3□Mj%nx%`tzw%knjq%|mhm%`tzxt|%|nym%qt(j%fsi%wjfu%|n
ym%ymfpxln[ns17□Fsi%Mj%nx%`tzw%gtfwi%fsi%`tzw%krwxi3□Ktw%`tz%htrj%yt%mr%|nym%`tzw%
zsljw1%fsi%`tz%xj%mr%ktw%uifh7□

Decode Button

说明：对输入字符的每个ASCII字符的用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover Button显示从图片里提取出的加密后的文本；Decode Button显示从图片里提取出的解密后的文本。

点击**Recover**按钮
显示密文

网页作品例子：信息隐藏

127.0.0.1/hide-0.html

★ 书签

➡ 导入书签

★ 找回书签

信息隐藏网页



Hide Button

Your friend is your needs answered.
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And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace.

Recover Button

`"tzw%kwnjs1%nx%~tzw%sjix%fsx|jwj13□Mj%nx%~tzw%knjq1%|mnhm%~tz%xt|%|nym%qt(j%fs1%wjfu%|n
ym%ymfpxln|nsl7□Fs1%mj%nx%~tzw%gtfwl%fs1%~tzw%knwjxni3□Ktw%~tz%htrj%yt%mur%|nym%~tzw%
zsljwl%fs1%~tz%xjje%mur%ktw%ujfhj7□`

Decode Button

Your friend is your needs answered.
He is your field which you sow with love and reap with thanksgiving2
And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace2

点击**Decode**按钮
恢复明文



```
<html>
  <head>
    <meta charset="UTF-8">
    <title>信息隐藏网页</title>
  </head>
  <body>
    <h1>信息隐藏网页</h1>
    <canvas id="myCanvas" width="600" height="450" ></canvas><br/>
    <input type="button" value="Hide Button" onclick="hide_info();"><br/>
    <textarea id="hide_text" style="width: 600; height: 100px;"></textarea><br/><br/>
    <input type="button" value="Recover Button" onclick="show_info(0);"><br/>
    <textarea id="show_info_0" style="width: 600px; height:
100px;"></textarea><br/><br/>
    <input type="button" value="Decode Button" onclick="show_info(1);"><br/>
    <textarea id="show_info_1" style="width: 600px; height:
100px;"></textarea><br/><br/>
    <p>
      说明：对输入字符的每个ASCII字符用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover Button显示从图片里提取出的加密后的文本；Decode Button显示从图片
      里提取出的解密后的文本。
    </p>
    <script>
      // load the image
      var img = new Image();
      var context1 = document.getElementById("myCanvas").getContext("2d");
      img.onload = function(){context1.drawImage(img,0,0);}
      img.src="./ucas.bmp";

      .....
    </script>
  </body>
</html>
```

More details
on next page

说明：对输入字符的每个ASCII字符的用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover Button显示从图片里提取出的加密后的文本；Decode Button显示从图片里提取出的解密后的文本。



★ 书签 ➡ 导入书签 ★

信息隐藏网页



Hide Button

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He is your field which you sow with love and reap with thanksgiving.
And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace.

Recover Button

~tzw%kwnjsi%nx%~tzw%sjji%fsx|jwji3□Mj%nx%~tzw%knjq%|mrhm%~tzw%xt%|nym%qt(j%fsi%wjfu%|n
ym%ymfpxln|nel7□Fsi%mj%nx%~tzw%gtfw%fsi%~tzw%knwjxni3□Ktw%~tzhtrj%yt%mr%|nym%~tzw%
zsljwl%fsi%~tzw%xjpp%mr%ktw%ujfhj7□

Decode Button

Your friend is your needs answered.
He is your field which you sow with love and reap with thanksgiving2
And he is your board and your fireside.
For you come to him with your hunger, and you seek him for peace2

```
func modify(data int, array []byte, size int) {  
    for i := 0; i < size; i++ {  
        v := byte(data & 0x3)  
        array[i] = array[i] & 0xFC  
        array[i] = array[i] | v  
        data = data >> 2  
    }  
}
```

Go Code

```
func main() {  
    txt_path           := "./Richard_Karp.txt"  
    src_img_path       := "./ucas.bmp"  
    dest_img_path      := "./modified_ucas.bmp"  
    d, _ := ioutil.ReadFile(src_img_path) // read ucas.bmp into d  
    t, _ := ioutil.ReadFile(txt_path) // read Richard_Karp.txt into t  
    modify(len(t), d[S : S+T], T) // hide length of Richard_Karp.txt  
    for i:=0; i<len(t); i++){ // hide contents of Richard_Karp.txt  
        offset := S+T+(i*4)  
        modify(int(t[i]),d[offset:offset+C],C)  
    }  
    ioutil.WriteFile(dest_img_path, d, 0666) // output to modified_ucas.bmp  
}
```

Go Code

```
function hide_info(){  
    // 1. get original pixel_array  
    var context1 = document.getElementById("myCanvas").getContext("2d");  
    var img_data = context1.getImageData(0,0,600,450);  
    var pixel_array = img_data.data;  
    // 2. get input string  
    var str = document.getElementById("hide_text").value;  
    // 3. hide length  
    modify(str.length, pixel_array, 16, 0);  
    // 4. hide string  
    for(var i=0;i<str.length; i++){  
        var ch = str[i].charCodeAt() + 5; // +5是加密操作  
        modify(ch, pixel_array, 4, 16+4*i);  
    }  
    // 5. show modified image  
    context1.putImageData(img_data,0,0);  
}  
function modify(data, array, size, left) {  
    for (var i = left; i < left+size; i++) {  
        var v = data & 0x3; // retain last 2 bits of data  
        array[i] = array[i] & 252; // clear last 2 bits of array[i]  
        array[i] = array[i] | v; // set last 2 bits of array[i] with those of data  
        data = data >> 2; // repeat with the next 2 bits  
    }  
}
```

JavaScript Code

说明：对输入字符的每个ASCII字符的用 ASCII码+5 的加密方式，加密后隐藏进图片。Recover button显示从图片里提取出的解密后的文本；Decode button显示从图片里提取出的解密后的文本。