Chapter 1

Linux基础命令

chroot 在多 Linux 系统下, 在指定根目录下运行指令.

```
sudo mount -t ext3 /dev/sdb1/mnt/
cd /mnt
sudo chroot /mnt/
```

arch: 打印当前硬件架构.
df -T: 显示文件系统类型.
info emacs buffers -o info-out.txt: 将 emacs 中 buffers 节点信息存入文件.
bc file: 计算 file 中的任务.
lp: 用于打印文件或修改排队的打印任务. lp (选项) (参数)

-E: 打印时强制加密

-d: 接收打印任务的目标打印机

-i: 指定存在的打印任务号

-m: 打印完发e-mail

-n: 指定打印份数

-p: 打印页码

ifconfig: 配置和显示 linux 网络接口的网络参数.

```
## 为网络接口 eth0 设 IP 和掩码
ifconfig eth0 192.168.0.2 netmask 255.255.255.224
```

elinks: 文本界面访问 web 页面. elinks (选项) (参数)

```
elinks -dump: html 文档以文本方式到输出流.
```

emacs (选项) (参数): 参数指定文本文件, 选项有

+⟨行号⟩ 启动 emacs, 光标到行号处

-q 不加载初始文件启动 emacs

u ⟨用户⟩ 加载指定用户初始化文件启动文件

-t ⟨文件⟩ 指定文件作终端启动 emacs, 不适用 stdin 和 stdout

-f ⟨函数⟩ 执行指定 lisp (广泛用于人工智能邻域的编程语言) 函数

代码文件⟩ 加载指定 lisp 文件

-batch 批处理模式运行 emacs

scp: 以加密方式在本地/远程主机和远程/本地主机之间复制文件.
dump: 用于备份 ext2/ext3 文件系统
restore 命令与 dump 互逆, 用于还原备份文件.

```
sudo dump -f boot-dum.bak /boot/
sudo rm -fr /boot/*
cd /boot
sudo restore -tf boot-dump.bak
```

cpio: 复制文件到归档包中或从归档包中复制文件.

```
find /etc -print | cpio -o > etc.bak
```

tar 主要用于创建和解压归档文件, 其本身没有压缩功能, 但可以调用 gzip, bzip2 进行压缩处理. 参数解释:

-c 创建归档

-x 解压归档

-v 显示处理过程

-f 目标文件

-j 调用 bzip2 进行解压缩

-z 调用 gzip 进行解压缩

-t 列出归档中文件

useradd 与 passwd

```
## -m 创建 home 目录
## -g 所属的主组
## -G 指定用户在哪些附加组
## -s 设定默认的 shell
## newuser 新的用户名
useradd -m -g users -G audio -s /usr/bin/bash newuser
## 不带参数更改当前用户密码
passwd
## 更改 newuser 的用户密码
passwd newuser
```

whereis 用于查找文件, 手册等

```
whereis bash
## 仅查找 binary
whereis -b bash
## 仅查找 manual
whereis -m bash
```

find 用于查找文件, 支持正则, 并可将查找结果传递到其他命令

```
## 当前目录查找符合 pattern 的文件
find . -name pattern
## 从 home 目录查找所有符合 pattern 的文件, 并交由 ls 输出详细信息
find /home -name pattern -exec ls -l {} \;
```

wget 用于下载

```
## 下载文件并重命名为 newname.md
wget -O newname.md url
```

```
## 下载 url 并开启断点续传
wget -c url
```

在终端使用powerline, tmux, 可以美化终端. 首先由dnf安装powerline, 然后在.bashrc文件中添加

```
if [ -f `which powerline-daemon` ]; then
  powerline-daemon -q
  POWERLINE_BASH_CONTINUATION=1
  POWERLINE_BASH_SELECT=1
  . /usr/share/powerline/bash/powerline.sh
fi
```

用dnf安装tmux-powerline, 然后编辑`~/.tmux.conf`添加一行

```
source "/usr/share/tmux/powerline.conf"
```

安装`vim-plugin-powerline`可以美化vim编辑器的状态栏.

1.0.1 Markdown工具

Markdown是一款文本标记语言, 易写易读.

```
*强调*
# This is an H1
## This is an H2
###### This is an H6
```

首行的#字数量决定标题的级别. 无序列表使用星号, 加号, 减号.

```
* Red
* Green
* Blue
+ Red
+ Green
+ Blue
- Red
- Green
- Blue
```

在列表项目内放进引用, 那¿就要缩进.

```
A list item with a blockquote:
> This is a blockquote
> inside a list item.
```

代码区块, 只要缩进4个空格或一个制表符即可.
分割线: 一行中用三个以上的星号, 减号, 底线建立, 行内不能有任何其他东西, 星号或减号中间可以插入空格.
用反引号`包起来标记一小段代码.

- 语法
  - 行内HTML
  - 特殊字符转换
- 区块元素
  - 段落, 换行
  - 标题
  - 区块引言

  - 列表
  - 程序代码块
  - 分割线
- 区段元素
  - 链接
  - 强调
  - 程序代码
  - 图片
- 其他
  - 转义字符
  - 自动链接

1.1 Linux C

1.1.1 linux GCC/G++编译器与调试器

GCC是GNU的一个子项目, 最初作为C语言的编译器. 现在GCC能编译C, C++, Ada, Object C和Java等语言, 同时还可执行跨硬件平台的交叉编译.

安装GCC和G++的命令如下:

```
yum install make gcc gcc-c++
```

GCC/G++编译选项

Table 1.1: 常用GCC/G++编译选项

编译选项	说明
-c	只进行预处理, 编译和汇编, 生成.o文件
-S	只进行预处理和编译, 生成.s文件
-E	只进行预处理, 产生预处理后的结果到标准输出
-C	预处理时不删除注释信息, 常与-E同时使用
-o	指定目标名称, 常与-c, -S同时使用, 默认是.out
-include file	插入一个文件, 功能等同源代码中的#include
-Dmacro[=defval]	定义一个宏, 功能等同源代码中的#define macro [defval]
-Umacro	取消宏定义, 功能等同源代码中的#undef macro
-Idir	优先在选项后的目录中查找包含的头文件
-lname	链接后缀为.so的动态链接库来编译程序
-Ldir	指定编译搜索库的路径
-O[0-3]	编译器优化, 数值越大优化级别越高, 0没有优化
-g	编译器编译时加入编译信息
-pg	编译器加入信息给gprof
-share	使用动态库
-static	禁止使用动态库

1.1.2 程序和进程

程序是指一组指示计算机或其他具有信息处理能力设备每一步动作的指令. 进程是一个具有独立功能的程序关于某个数据集合的一次可以并发执行的运行活动, 是处于活动状态的程序. 在Linux系统中, 用户创建进程时会先在系统的进程表中为进程创建独一无二的编码, 即PID.

1.1.3 GDB调试器

用 `$ sudo yum install gdb` 安装GDB调试器. GDB调试器调试的对象是可执行文件, 使用GCC或G++编译器编译源代码时, 必须加上选项-g才能使目标可执行文件包含被调试的信息. 如

```
gcc -g -o helloworld helloworld.c // 编译并连接程序, 使之包含可被调试信息
gdb helloworld // 使用GDB调试器打开 helloworld 可执行文件
```

Table 1.2: 常用GDB命令及解释

命令	解释
file [文件名]	在GDB中打开执行文件
break	设置断点, 支持的形式由break 行号, break 函数名, break 行号/函数名 if 条件
info	查看和可执行文件相关的各种信息
kill	终止正在调试的程序
print	显示变量或表达式的值
set args	设置调试程序的运行参数
delete	删除设置的断点或观测点
clear	删除设置在指定行号或函数上的断点
continue	从断点处继续执行程序
list	列出GDB中打开的可执行文件代码
watch	在程序中设置观测点
run	运行打开的可执行文件
next	单步执行程序
step	进入所调用的函数内部, 查看执行情况
whatis	查看变量或函数类型, 调用格式为"whatis 变量名/函数名"
ptype	显示数据结构定义情况
make	编译程序
quit	退出GDB

1.1.4 Linux开发环境

VIM

要使用C语言源代码语法高亮, 需要配置文件 /etc/vim/vimrc, 加入代码 syntax on. 另外, 源代码文件的后缀名必须为 ".c".

Emacs

```
emacs helloworld.c // 启动Emacs, 并新建了文件helloworld.c
```

在 Emacs 中编辑 helloworld 程序代码, 按组合键 `Alt+X`, 然后键入 compile 后按 Enter, 这时出现提示输入编译命令. 删除原有编译命令, 输入 `gcc -g -o helloworld helloworld.c` 后按 Enter 键, 完成编译. 按组合键 `Alt+X`, 然后输入 shell 后按 Enter 键, 系统会弹出一个终端窗口, 在该窗口运行程序.

集成开发环境

集成开发环境是将一些开发工具集合到同一个操作界面的工具软件. 最初 Eclipse 用于开发 Java 语言程序, 但加入 CDT 插件后就能进行 C 和 C++ 语言程序开发. Eclipse 卸载插件:

```
Help -> Install New Software -> already installed ...
```

即可. Kdevelop 是一个支持多种程序设计语言的集成开发环境.

1.1.5 C 语言编程基础

程序设计语言是用来描写计算机程序的逻辑语法结构. 高级语言的下一个发展目标是面向应用, 自动生成算法. C 语言通常称为中级语言, 具有直接访问计算机底层资源的能力.

从本质上来说, 数据类型是告诉编译器如何为数据分配内存, 内存的读取和写入方式却是相同的.

C 语言的另一个重要特点是它仅有32个关键字.

C 语言是结构化语言, 结构化语言所使用的设计方法为模块化设计方法, 每个子问题求解的步骤被定义为模块.

C 语言是程序员的语言, Linux 内核和大多数硬件的驱动程序是使用 C 语言设计的.

C 语言预处理命令以 “#” 开始.

从技术上讲, 主函数不是 C 语言的一个成分, 但它仍被看作是其中的一部分, 因此, main 不能用作变量名.

stdio.h 头文件存放的是输入输出相关的函数.

函数的集合称之为函数库, 遵守 ANSI C 标准的编译器所提供函数组成的函数库称之为 ANSI C 标准函数库.

编译器编译源代码时以函数为单位进行编译, 并记忆函数的名字.

通用建模语言(UML)?

C 语言程序中的变量在习惯上使用小写英文字母, 常量和其他用途的符号可用大写字母. C 语言对大小写字母是敏感的, 关键字必须小写.

程序测试经常出现的问题有逻辑错误, 目标错误, 语法错误和编写错误.

Table 1.3: C 语言关键字表

auto	break	case	char	const	continue	default	do
double	else	enum	extern	float	for	goto	if
int	long	register	short	signed	sizeof	static	return
struct	switch	typedef	union	unsigned	void	volatile	while

计算机程序的定义, 程序等于数据结构加算法. 数据结构是将事物抽象成为可运算的数据形式输入到计算机中, 算法是对这些数据计算的方法.

汇编语言等非结构化程序使用 goto 命令, 该命令能够使程序以行为单位跳转到任何位置. 代码中大量的 goto 命令使流程过于混乱, 源代码的维护难度极高.

C 语言3种基本的程序结构: 顺序结构, 选择结构和循环结构.

N-S 图描述算法, 适合于设计系统程序, 特别是分支间相互独立的程序.

PAD 图(Problem Analysis Diagram)是国际上专业的程序员广泛使用的一种程序流程表示法.

软件是程序与文档的总和. 程序设计只包含了程序设计和编码的反复迭代过程.

1.1.6 终止编译命令

1.1.7 条件编译命令

1.1.8 修改行号命令

1.1.9 编译指示命令

1.1.10 预定义的宏名

Chapter 2

BPNN

输入向量为$(x_1, x_2, \cdots, x_m)$, $m \to innode$为输入神经节点数. 训练数据为$X_1, X_2, \cdots, X_M$, 对于每个$X_i = (x_1^{(i)}, x_2^{(i)}, \cdots, x_m^{(i)})$是一个输入训练向量.

现设输入数据为$X = (x_1, x_2, \cdots, x_m)^T$, 隐藏层有$N = 1 \to hidelayer$层, 隐藏层的神经元数为$q \to hidenode$个. 设节点$i(1 \le i \le m)$和节点$j(1 \le j \le q)$之间的权值为$v_{ij}$, $v_j = (v_{1j}, v_{2j}, \cdots, v_{mj})$, $V = (v_1, v_2, \cdots, v_q)^T$, 节点$j$的阈值$b_j$, $b = (b_1, b_2, \cdots, b_q)$, 则隐藏层的第$j$个节点的纯输入值为

$$z'_j = \sum_{i=1}^{m} v_{ij} x_i + b_j = v_j X + b_j,$$

其实, 若设$Z' = (z'_1, z'_2, \cdots, z'_q)^T$, 则上式可简写为$Z' = VX + b$. 而使用爱森斯坦因记号(作为张量分析的基本工具), 上式可简化为$z'_j = v_{ij} x_i + b_j$. 有时, 为方便表达, 可令$x_0 = 1$, $v_{0j} = b_j$, 而使上式简化为$z'_j = \sum_{i=0}^{m} v_{ij} x_i$. 从而$Z' = VX$.

激活函数用于将z'_j转化为隐藏层的输入数据$z_j = f_1(z'_j)$, 记$Z = (z_1, z_2, \cdots, z_q)^T$, 并经过隐藏层到输出层的权矩阵得出隐藏层的正向纯输出$y'_k = w_{jk} z_j + c_k$, $(1 \le k \le n)$. 最后再用一个激活函数$f_2(\cdot)$将y'_k转化为输出数据

$$\hat{y}_k = f_2(y'_k) = f_2\left(\sum_{j=1}^{q} w_{jk} z_j + c_k\right) = f_2(w_k Z + c_k).$$

最后根据输出数据$\hat{Y} = (\hat{y}_1, \hat{y}_2, \cdots, \hat{y}_n)^T$和训练数据的真实输出$Y = (y_1, y_2, \cdots, y_n)^T$比较误差, 使用平方误差

$$E = \frac{1}{2}\|\hat{Y} - Y\|_2^2 = \frac{1}{2}\sum_{k=1}^{n}(\hat{y}_k - y_k)^2.$$

现在假设输入的训练数据有P个, 分别为$X^{(1)}, X^{(2)}, \cdots, X^{(P)}$, 输入$X^{(p)}$对应输出$Y^{(p)}$, 神经网络的正向输出

$$\hat{Y}^{(p)} = f_2(WZ^{(p)} + c) = f_2(W f_1(VX^{(p)} + b) + c).$$

根据V, b的定义可类似的定义W和c, 记第p个样本的误差为E_p,

$$E_p = \frac{1}{2}\|Y^{(p)} - \hat{Y}^{(p)}\|_2^2 = \frac{1}{2}\sum_{k=1}^{n}\left(y_k^{(p)} - \hat{y}_k^{(p)}\right)^2.$$

于是对于每个给定的四元组(V, W, b, c), 都有一个对应的样本误差, $E_p = E_p(V, W, b, c)$, BPNN的主要思想是找出(V_0, W_0, b_0, c_0), 使

$$\begin{aligned} E(V_0, W_0, b_0, c_0) &= \min_{(V,W,b,c)} E(V, W, b, c) = \min_{(V,W,b,c)} \sum_{p=1}^{P} E_p(V, W, b, c) \\ &= \frac{1}{2}\min_{(V,W,b,c)} \sum_{p=1}^{P}\sum_{k=1}^{n}\left(y_k^{(p)} - \hat{y}_k^{(p)}\right)^2 = \frac{1}{2}\min_{(V,W,b,c)} \sum_{p=1}^{P}\sum_{k=1}^{n}\left(y_k^{(p)} - f_2(w_k f_1(VX^{(p)} + b) + c_k)\right)^2. \end{aligned}$$

由于$E(V, W, b, c)$为多维函数, 多元函数总是沿着负梯度方向递减, 所以可取(V, W, b, c)的修正项$\Delta(V, W, b, c)$为:

$$\Delta(V, W, b, c) = -\eta \frac{\nabla E}{\nabla(V, W, b, c)},$$

其中$\eta \to learningRate$, 为学习速率. 所以

$$\Delta v_{ij} = \eta \sum_{p=1}^{P} \sum_{k=1}^{n} (y_k{}^{(p)} - \hat{y}_k^{(p)}) f_2'(y_k'{}^{(p)}) w_{jk} \cdot f_1'(z_j'{}^{(p)}) \cdot x_i{}^{(p)}$$

$$\Delta w_{jk} = \eta \sum_{p=1}^{P} (y_k{}^{(p)} - \hat{y}_k^{(p)}) \cdot f_2'(y_k'{}^{(p)}) z_j{}^{(p)}$$

Chapter 3

加密

3.1 RSA加密

先选择两个大素数p, q, 并令$n = pq$, 则$\varphi(n) = (p-1)(q-1)$, 并取e使$(e, \varphi(n)) = 1$, 取d满足$ed \equiv 1 \pmod{\varphi(n)}$, 则对于任意的$m$, $m^{ed} \equiv m \pmod{n}$, 加密m为密文c的过程为

加密 $c \equiv m^e \pmod{n}$;

解密 $m \equiv c^d \pmod{n}$.

3.2 Okamoto-Uchiyama加密

取两个素数p, q, 让$n = p^2 q$, 取$g \in \mathbb{Z}_n^*$, 使得$g^{p-1} \not\equiv 1 \pmod{p^2}$, 让$h \equiv g^n \pmod{n}$, 则$(n, h, g)$为公钥, (p, q)为私钥. 则

加密 加密m为c, 任取$r \in \mathbb{Z}_n$, $c \equiv g^m h^r \pmod{n}$;

解密 定义$L(x) = \frac{x-1}{p}$, 其中$x \equiv 1 \pmod{p}$, 则$m = \frac{L(c^{p-1} \pmod{p^2})}{L(g^{p-1} \pmod{p^2})} \pmod{p}$.

解. 证明解密正确. $\mathbb{Z}_n^* \simeq \mathbb{Z}_{p^2}^* \times \mathbb{Z}_q^*$, $\mathbb{Z}_{p^2}^*$有唯一非平凡正规子群$H = \{x : x^p \equiv 1 \pmod{p}\}$, 然后证明

$$\{x^{p-1} \pmod{p^2} : x \in \mathbb{Z}_{p^2}^*\} = H,$$

$L : <H, \cdot> \to <\mathbb{Z}_p, +>$是同态映射, 由$c \equiv g^m h^r \pmod{n}$, 所以

$$c^{p-1} \equiv (g^{p-1})^m g^{p(p-1)rpq} \equiv (g^{p-1})^m \pmod{p^2}$$

所以$L((g^{p-1})^m) \equiv mL(g^{p-1}) \pmod{p}$, 所以$m = \frac{L(c^{p-1})}{L(g^{p-1})} \pmod{p}$. □

这是一个同态加密算法, 即若记$\varepsilon(m)$为明文m的密文, 则$\varepsilon(m_1)\varepsilon(m_2) = \varepsilon(m_1 + m_2)$.

Chapter 4

C

4.1 文件读写

文件指针: FILE* pf; 写文本文件: fprintf(pf, “格式控制字符串”, 输出变量列表); 读文本文件: fscanf(pf, “格式控制字符串”, 地址列表);

code/file001.c

```c
/*************************************************************************
    > File Name: file.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 09:42:47 PM CST
 ************************************************************************/

#include<stdio.h>

int main(int argc, char** argv) {
        int A[3][3]={{11,12,13},{21,22,23},{31,32,33}};
        FILE *pf;
        // fopen(文件名, 打开方式)
        // 打开方式: r读, w写, +读写, t文本, b二进制
        // 返回指向文件的指针或NULL指针
        pf=fopen("data1.dat","wb");
        // fwrite(buffer, size, count, pf)
        // 将count个长度为size的连续数据写入pf指向的文件
        // buffer数据的首地址
        fwrite(A, sizeof(int),9,pf);
        // fwrite(A, sizeof(A),1,pf);
        // fclose关闭成功返回0, 否则非零
        fclose(pf);

        int B[3][3];
        pf=fopen("data1.dat","rb");
        // 从pf指向的文件中读取count个长度为size的连续数据
        // buffer是存放数据的首地址
        fread(B, sizeof(int), 9, pf);
        fclose(pf);
        return 0;
}
```

4.2 可变参数

C语言中有一种长度不确定的参数, 主要用在参数个数不确定的函数中. 首先解释代码需求:

(1) va_list型的变量是存储参数地址的指针, 再结合参数类型得到参数的值.

(2) va_start宏初始化va_list型的变量, 宏的第二个参数是可变参数列表的最后一个固定参数.

(3) 依次用va_arg宏使arg_ptr返回可变参数的地址, 结合参数的类型, 可以得到参数的值.

(4) 被调的函数在调用时不知道可变参数的正确数目, 必须在代码中指明结束条件.

code/stdarg001.c

```c
/*************************************************************************
    > File Name: stdarg.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 05:10:24 PM CST
 ************************************************************************/

#include<stdio.h>
#include<stdarg.h>

void simple_va_fun(int start, ...){
        va_list arg_ptr; // 存储参数地址的指针
        int nArgValue = start;
        int nArgCount = 0; // 可变参数的数目
        va_start(arg_ptr, start); // 以固定参数的地址为起点确定
        // 变参的内存起始地址.
        do {
                ++nArgCount;
                printf("the %d-th arg: %d\n", nArgCount, nArgValue);
                nArgValue = va_arg(arg_ptr, int); // 得到下一个可变参数的值
        } while(nArgValue != -1);
    va_end(arg_ptr);
        return;
}

int main(int argc, char* argv[]) {
        simple_va_fun(100, -1);
        simple_va_fun(100, 200, -1);
        return 0;
}
```

4.2.1 cstdarg/stdarg.h

type va_arg (va_list ap, type)用于获取下一个参数, 每次调用此函数都会从参数列表 ap 中获取一个 type 类型的数据返回, 同时将 ap 指向下一个参数的地址. 此函数不会判断参数列表的实际类型, 同时也不会判断是否达到最后一个参数.

code/vaarg001.c

```c
/*************************************************************************
    > File Name: va_arg.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 06:17:04 PM CST
 ************************************************************************/

#include<stdio.h>
#include<stdarg.h>

int FindMax(int n, ...) {
        int i, val, largest;
        va_list vl;
        va_start(vl, n);
        largest = va_arg(vl, int);
        for (i = 1; i < n; i++) {
```

```
                val = va_arg(vl, int);
                largest = (largest > val) ? largest : val;
        }
        va_end(vl);
        return largest;
}

int main() {
        int m;
        m = FindMax(7,702,422,631,834,892,104,772);
        printf("The largest value is: %d\n", m);
        return 0;
}
```

void va_start(va_list ap, paramN)初始化参数列表, 调用之后记得调用va_end释放内存. va_list存储附加参数, 由va_arg获取附加参数的值, 但不包括paramN.

code/vastart001.c

```
/*************************************************************************
    > File Name: va_start.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 06:47:09 PM CST
 ************************************************************************/

#include<stdio.h>
#include<stdarg.h>

void PrintFloats(int n, ...) {
        int i;
        double val;
        printf("Printing floats:");
        va_list vl;
        va_start(vl, n);
        for (i=0;i<n;i++){
                val=va_arg(vl,double);
                printf(" [%.2f]",val);
        }
        va_end(vl);
        printf("\n");
}

int main() {
        PrintFloats(3,3.14159,2.71828,1.41421);
        return 0;
}
```

void va_end(va_list ap)结束使用参数列表, 释放内存.

code/vaend001.c

```
/*************************************************************************
    > File Name: va_end.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 07:01:23 PM CST
 ************************************************************************/

#include<stdio.h>
#include<stdarg.h>
```

```c
void PrintLines(char* first, ...) {
        char* str;
        va_list vl;

        str=first;
        va_start(vl, first);

        do{
                puts(str);
                str=va_arg(vl, char*);
        }while(str != NULL);

        va_end(vl);
}

int main() {
        PrintLines("First", "Second", "Third", "Fourth", NULL);
        return 0;
}
```

void va_copy(va_list dest, va_list src)用于拷贝参数列表数据src到dest. 同时, dest中下一个要读取的参数与src相同. 同样要记得调用va_end清理内存. (C++11)

code/vacopy001.c

```c
/*************************************************************************
    > File Name: va_copy.c
    > Author: Larry Eppes
    > Mail: larryleifeng@163.com
    > Created Time: Sat 22 Apr 2017 07:13:42 PM CST
 ************************************************************************/

#include<stdio.h>        // printf, vprintf
#include<stdlib.h>        // malloc
#include<string.h>        // strlen, strcat
#include<stdarg.h>        // va_list, va_start, va_copy, va_arg, va_end

/* print ints until a zero is found */
void PrintInts(int first, ...) {
        char* buffer;
        const char* format = "[%d] ";
        int count = 0;
        int val = first;
        va_list vl, vl_count;
        va_start(vl,first);

        // count number of arguments:
        va_copy(vl_count, vl);
        while(val != 0){
                val = va_arg(vl_count, int);
                ++count;
        }
        va_end(vl_count);

        // allocate storage for format string:
        buffer = (char*) malloc(strlen(format)*count+1);
        buffer[0]='\0';

        // generate format string:
        for(;count>0;--count) {
                strcat(buffer,format);
```

```
        }

        // print integers
        printf(format, first);
        vprintf(buffer, vl);
        printf("\n");

        va_end(vl);
}

int main() {
        PrintInts(10,20,30,40,50,0);
        return 0;
}
```

Chapter 5

C++

5.1 ACM

ACM-ICPC: 在线评测系统, Online Judge, OJ
PKU: http://poj.org
USACO: 美国信息学奥林匹克, C, C++, Java, Python, http://train.usaco.org/usacogate
CII: 2500道
SGU: http://acm.sgu.ru
SPOJ: 波兰, http://www.spoj.pl/
网上比赛: GCJ: http://code.google.com/codejam
TopCoder: (TOC/TCHS)
Code forces
SCL: 相对较难实现的常用算法的代码整理, Standard Code Library, 标准代码库.

5.2 线程池

这里给出的线程池具有动态伸缩性, 能根据执行任务的轻重自动调整线程池中线程的数量.

为什么需要线程池, 创建和销毁线程的开销可以忽略. 线程池能够减少创建的线程个数. 通常线程池所允许的并发线程是有上界的, 当并发的线程数超过上界, 则一部分线程会等待.

线程池采用预创建的技术, 在程序启动后创建一定数量(N)的线程, 放入空闲队列. 这些线程都处于阻塞状态, 不消耗CPU, 但占用较小的内存空间. 当任务到来时, 缓冲池选择一个空闲线程运行任务. 当所有N个线程都在处理任务后, 缓冲池自动创建一定数量的新线程, 用于处理更多任务. 当任务执行完, 线程不退出, 而是保持在池中等待下一次任务. 当系统比较空闲时, 大部分线程都处于暂停, 线程池自动销毁部分线程, 回收系统资源.

基于这种预创建技术, 线程池将线程创建和销毁分摊到任务上. 不过可能要考虑线程间同步带来的开销.

这里得线程池框架由五个重要部分组成 CThreadManage, CThreadPool, CThread, CJob, CWorkThread, 此外还有线程同步使用的类 CThreadMutex 和 CCondition. CThreadMutex 用于线程间的互斥, CCondition 是条件变量的封装, 用于线程间的同步.

5.3 排序算法

5.3.1 插入排序

对待排序数组$a[0...n-1]$排序.

code/sort/insert.c

```
for(i=1; i<n; i++) {
  for(j=0; j<i; j++) {
    if(a_i < a_j)
      a_j.prepend(a_i)
  }
}
```

最差和平均时间复杂度是$O(n^2)$, 最优复杂度$O(n)$. 例如数组(5,1,4,2,8)经过插入排序的过程是

1). 插入1, (1,5,4,2,8)

2). 插入4, (1,4,5,2,8)

3). 插入2, (1,2,4,5,8)

4). 插入8, (1,2,4,5,8)

5.3.2 冒泡排序

对待排序数组$a[0...n-1]$排序.

code/sort/buble.c

```
for(i=n; i>1; i--) {
  for(j=0; j<i-1; j++) {
    if(a_j < a_{j+1})
      a_j ↔ a_{j+1}
  }
}
```

时间复杂度$O(n^2)$, 每次排序选出一个最大值, 每两相邻的排序.

5.4 使用CodeViz生成C/C++函数调用关系图

首先安装 graphviz: `$ sudo dnf install graphviz graphviz-devel graphviz-doc`

```
graphviz : rich set of graph drawing tools
graphviz-devel : transitional package for graphviz-devel rename
graphviz-doc : additional documentation for graphviz
```

然后安装相关库

```
sudo dnf install graphviz-guile graphviz-lua graphviz-ocaml graphviz-perl graphviz-php graphviz-python
 ↪  graphviz-ruby graphviz-tcl
```

最后安装CodeViz: `$ sudo dnf install codeviz`. 下载git项目: `$ git clone https://github.com/petersenna/codevi`
然后编译

```
./configure
make
sudo make install
```

5.5 C++画图

Linux下编译

code/plot0001.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>

typedef struct {
    size_t width;
    size_t height;
    unsigned char *data;
} Image;

// 申请内存空间
static Image *image_new (size_t width, size_t height)
{
    Image *image;

    image = malloc (sizeof *image);
    image->width = width;
    image->height = height;
    image->data = malloc (width * height);

    return image;
}

// 释放内存
static void image_free (Image *image)
{
    free (image->data);
    free (image);
}

static void image_fill (Image *image, unsigned char value)
{
    memset (image->data, value, image->width * image->height);
}

/**
    * image_set_pixel:
    *
    * Sets a pixel passed in signed (x, y) coordinates, where (0,0) is at
    * the center of the image.
    **/
static void image_set_pixel (Image *image, ssize_t x, ssize_t y, unsigned char value)
{
    size_t tx, ty;
    unsigned char *p;

    tx = (image->width / 2) + x;
    ty = (image->height / 2) + y;

    p = image->data + (ty * image->width) + tx;

    *p = value;
}

static void image_save (const Image *image, const char *filename)
{
```

```
58      FILE *out;
59
60      out = fopen (filename, "wb");
61      if (!out)
62          return;
63
64      fprintf (out, "P5\n");
65      fprintf (out, "%zu %zu\n", image->width, image->height);
66      fprintf (out, "255\n");
67
68      fwrite (image->data, 1, image->width * image->height, out);
69
70      fclose (out);
71  }
72
73  static void draw_Taijitu(Image *image,int radius,int value)
74  {
75      int x,y;
76      int rlimit ,llimit;
77
78      int radius_2 = radius*radius;
79      for(y = -radius;y<radius;y++)
80          for(x= -radius;x<radius;x++)
81              if(x*x+y*y <= radius_2)
82                  image_set_pixel(image,x,y,0xff);
83
84      for(y = -radius;y<0;y++)
85          for(x = 0;x<radius;x++)
86              if((x*x)+(y*y) <= radius_2)
87                  image_set_pixel(image,x,y,value);
88
89      for(y = -radius;y<0;y++)
90          for(x = -(int)sqrt((double)(-radius*y-y*y));x<0;x++)
91              image_set_pixel(image,x,y,value);
92
93
94      for(y = 0;y<radius;y++)
95      {
96          llimit = (int)sqrt((double)(radius*y - y*y));
97          rlimit = (int)sqrt((double)(radius_2 - y*y));
98          for(x = llimit;x<rlimit;x++)
99              image_set_pixel(image,x,y,value);
100     }
101
102     for(y = 2*radius/6;y<4*radius/6;y++)
103     {
104         rlimit =(int) sqrt((double)(radius*y-y*y-2*radius_2/9));
105         llimit = -rlimit;
106
107         for(x = llimit;x<rlimit;x++)
108             image_set_pixel(image,x,y,value);
109     }
110
111     for(y = -4*radius/6;y<-2*radius/6;y++)
112     {
113         rlimit = sqrt(-radius*y-y*y-2*radius_2/9);
114         llimit = -rlimit;
115         for(x = llimit;x<rlimit;x++)
116             image_set_pixel(image,x,y,0xff);
117     }
118
119     return ;
```

```
120 }
121
122 int main (int argc, char *argv[])
123 {
124     Image *image;
125
126     image = image_new (800, 800);
127
128     image_fill (image, 0xaa);
129     draw_Taijitu (image, 300, 0);
130     image_save (image, "taiji_6.pgm");
131
132     image_free (image);
133
134     return 0;
135 }
```

报错`undefined reference to ‘sqrt’`, 编译时添加参数`$ gcc -lm src.cpp -o obj`.

5.6 cuckoo

Cuckoo算法

code/cuckoo/nvromTest.c

```c
/*
 * nvrom_test.c
 *
 *  Created on: Dec 10, 2016
 *      Author: math
 */


#include <stdio.h>
#include <stdlib.h>
#include <stdint.h>
#include <string.h>
#include <sys/stat.h>

#include "cuckoo_filter.h"
#include "mozilla-sha1/sha1.h"

int main(int argc, char **argv)
{
        SHA_CTX c;
        struct stat st;
        uint32_t key_num;
        uint8_t *keys;
        uint8_t **sha1_key;
        uint8_t value[DAT_LEN], *v;
        int bytes, i, j;
        FILE *f1, *f2;

        if (argc < 3) {
                fprintf(stderr, "usage: ./cuckoo_filter read_file write_file\n");
                exit(-1);
        }

        --argc;
        ++argv;

        f1 = fopen(argv[0], "rb");
        if (f1 == NULL) {
                fprintf(stderr, "Fail to open %s!\n", argv[0]);
                exit(-1);
        }
        stat(argv[0], &st);

        f2 = fopen(argv[1], "wb+");
        if (f2 == NULL) {
                fprintf(stderr, "Fail to open %s!\n", argv[1]);
                exit(-1);
        }

        /* Initialization */
        cuckoo_filter_init(st.st_size);

        /* Allocate SHA1 key space */
        key_num = next_pow_of_2(st.st_size) / DAT_LEN;
        keys = malloc(key_num * 20);
        sha1_key = malloc(key_num * sizeof(void *));
        if (!keys  !sha1_key) {
```

```
58                  fprintf(stderr, "Out of memory!\n");
59                  exit(-1);
60          }
61          for (i = 0; i < key_num; i++) {
62                  sha1_key[i] = keys + i * 20;
63          }
64
65          /* Put read_file into log on flash. */
66          i = 0;
67          do {
68                  memset(value, 0, DAT_LEN);
69                  bytes = fread(value, 1, DAT_LEN, f1);
70                  SHA1_Init(&c);
71                  SHA1_Update(&c, value, bytes);
72                  SHA1_Final(sha1_key[i], &c);
73                  cuckoo_filter_put(sha1_key[i], value);
74                  i++;
75          } while (bytes == DAT_LEN);
76
77          /* Real key number */
78          key_num = i;
79          printf("Total %u records.\n", key_num);
80
81          /* Deletion test */
82          for (i = 0; i < key_num; i += 2) {
83                  cuckoo_filter_put(sha1_key[i], NULL);
84          }
85
86          fseek(f1, 0, SEEK_SET);
87          for (i = 0; i < key_num; i++) {
88                  memset(value, 0, DAT_LEN);
89                  bytes = fread(value, 1, DAT_LEN, f1);
90                  if (!(i & 0x1)) {
91                          cuckoo_filter_put(sha1_key[i], value);
92                  }
93          }
94
95          /* Get logs on flash and write them into a new file. */
96          for (j = 0; j < key_num; j++) {
97                  v = cuckoo_filter_get(sha1_key[j]);
98                  if (v != NULL) {
99                          memcpy(value, v, DAT_LEN);
100                         fwrite(value, 1, DAT_LEN, f2);
101                 }
102         }
103
104         fclose(f1);
105         fclose(f2);
106
107         free(keys);
108         free(sha1_key);
109
110         return 0;
111 }
```

code/cuckoo/cuckooFilter.h

```
1  /*
2   * cuckoo_filter.h
3   *
4   *  Created on: Dec 10, 2016
```

```
 *      Author: math
 */
/*
 * Copyright (C) 2015, Leo Ma <begeekmyfriend@gmail.com>
 */
#ifndef SRC_CUCKOO_FILTER_H_
#define SRC_CUCKOO_FILTER_H_

//#define CUCKOO_DBG

/* Configuration */
#define SECTOR_SIZE    (1 << 5)
#define DAT_LEN        (SECTOR_SIZE - 20)  /* minus sha1 size */
#define ASSOC_WAY      (4)  /* 4-way association */
#define INVALID_OFFSET (-1)

/* Cuckoo hash */
#define force_align(addr, size)  ((void *)((((uintptr_t)(addr)) + (size) - 1) & ~((size) - 1)))
#define cuckoo_hash_lsb(key, count)  (((size_t *)(key))[0] & (count - 1))
#define cuckoo_hash_msb(key, count)  (((size_t *)(key))[1] & (count - 1))

/* Flash driver interfaces. */
#define flash_align(addr)  (!((uintptr_t)(addr) & (SECTOR_SIZE - 1)))
#define flash_read(addr)  (*(volatile uint8_t *)(addr))
#define flash_write(addr, byte)  (*(volatile uint8_t *)(addr) = (byte))
#define flash_sector_erase(addr) \
        do { \
                uint32_t __i; \
                volatile uint8_t *__addr = (volatile uint8_t *)(addr); \
                for (__i = 0; __i < SECTOR_SIZE; __i++) { \
                        *(volatile uint8_t *)__addr = 0xff; \
                        __addr++; \
                } \
        } while (0)

/* The log entries store key-value pairs on flash and
 * each entry is assumed just one sector size fit.
 */
struct log_entry {
        uint8_t sha1[20];
        uint8_t data[DAT_LEN];
};

enum { AVAILIBLE, OCCUPIED, DELETED, };

/* The in-memory hash buckets cache filter keys (which are assumed SHA1 values)
 * via cuckoo hashing function and map them to log entries stored on flash.
 */
struct hash_slot_cache {
        uint32_t tag : 30;  /* summary of key */
        uint32_t status : 2;  /* FSM */
        uint32_t offset;  /* offset on flash memory */
};

static inline int is_pow_of_2(uint32_t x)
{
        return !(x & (x-1));
}

static inline uint32_t next_pow_of_2(uint32_t x)
{
        if (is_pow_of_2(x))
```

```
67                  return x;
68          x = x>>1;
69          x = x>>2;
70          x = x>>4;
71          x = x>>8;
72          x |= x>>16;
73          return x + 1;
74  }
75
76  int cuckoo_filter_init(size_t size);
77  uint8_t *cuckoo_filter_get(uint8_t *key);
78  void cuckoo_filter_put(uint8_t *key, uint8_t *value);
79
80
81
82  #endif /* SRC_CUCKOO_FILTER_H_ */
```

code/cuckoo/cuckooFilter.c

```
1   /*
2    * cuckoo_filter.c
3    *
4    *  Created on: Dec 10, 2016
5    *      Author: math
6    */
7
8   /*
9    * Copyright (C) 2015, Leo Ma <begeekmyfriend@gmail.com>
10   */
11
12  #include <stdio.h>
13  #include <stdlib.h>
14  #include <stdint.h>
15  #include <string.h>
16  #include <assert.h>
17
18  #include "cuckoo_filter.h"
19
20  struct hash_table {
21          struct hash_slot_cache **buckets;
22          struct hash_slot_cache *slots;
23          uint32_t slot_num;
24          uint32_t bucket_num;
25  };
26
27  static uint8_t *nvrom_base_addr;
28  static uint32_t nvrom_size;
29  static uint32_t log_entries;
30  static struct hash_table hash_table;
31
32  static void dump_sha1_key(uint8_t *sha1)
33  {
34  #ifdef CUCKOO_DBG
35          int i;
36          static const char str[] = "0123456789abcdef";
37
38          printf("SHA1: ");
39          for (i = 19; i >= 0; i--) {
40                  putchar(str[sha1[i] >> 4]);
41                  putchar(str[sha1[i] & 0xf]);
42          }
```

```
43          putchar('\n');
44  #endif
45  }
46
47  static uint32_t next_entry_offset(void)
48  {
49          uint8_t *append_addr = nvrom_base_addr + log_entries * sizeof(struct log_entry);
50          assert(flash_align(append_addr));
51          if ((log_entries + 1) * sizeof(struct log_entry) >= nvrom_size) {
52                  return INVALID_OFFSET;
53          } else {
54                  return (uint32_t)(append_addr - nvrom_base_addr);
55          }
56  }
57
58  static void show_hash_slots(struct hash_table *table)
59  {
60  #ifdef CUCKOO_DBG
61          int i, j;
62
63          printf("List all keys in hash table (tag/status/offset):\n");
64          for (i = 0; i < table->bucket_num; i++) {
65                  printf("bucket[%04x]:", i);
66                  struct hash_slot_cache *slot = table->buckets[i];
67                  for (j = 0; j < ASSOC_WAY; j++) {
68                          printf("\t%04x/%x/%08x", slot[j].tag, slot[j].status, slot[j].offset);
69                  }
70                  printf("\n");
71          }
72  #endif
73  }
74
75  static uint8_t *key_verify(uint8_t *key, uint32_t offset)
76  {
77          int i;
78          uint8_t *read_addr = nvrom_base_addr + offset;
79          for (i = 0; i < 20; i++) {
80                  if (key[i] != flash_read(read_addr)) {
81                          return NULL;
82                  }
83                  read_addr++;
84          }
85          return read_addr;
86  }
87
88  static int cuckoo_hash_collide(struct hash_table *table, uint32_t *tag, uint32_t *p_offset)
89  {
90          int i, j, k, alt_cnt;
91          uint32_t old_tag[2], offset, old_offset;
92          struct hash_slot_cache *slot;
93
94          /* Kick out the old bucket and move it to the alternative bucket. */
95          offset = *p_offset;
96          slot = table->buckets[tag[0]];
97          old_tag[0] = tag[0];
98          old_tag[1] = slot[0].tag;
99          old_offset = slot[0].offset;
100         slot[0].tag = tag[1];
101         slot[0].offset = offset;
102         i = 0 ^ 1;
103         k = 0;
104         alt_cnt = 0;
```

```

KICK_OUT:
        slot = table->buckets[old_tag[i]];
        for (j = 0; j < ASSOC_WAY; j++) {
                if (offset == INVALID_OFFSET && slot[j].status == DELETED) {
                        slot[j].status = OCCUPIED;
                        slot[j].tag = old_tag[i ^ 1];
                        *p_offset = offset = slot[j].offset;
                        break;
                } else if (slot[j].status == AVAILIBLE) {
                        slot[j].status = OCCUPIED;
                        slot[j].tag = old_tag[i ^ 1];
                        slot[j].offset = old_offset;
                        break;
                }
        }

        if (j == ASSOC_WAY) {
                if (++alt_cnt > 512) {
                        if (k == ASSOC_WAY - 1) {
                                /* Hash table is almost full and needs to be resized */
                                return 1;
                        } else {
                                k++;
                        }
                }
                uint32_t tmp_tag = slot[k].tag;
                uint32_t tmp_offset = slot[k].offset;
                slot[k].tag = old_tag[i ^ 1];
                slot[k].offset = old_offset;
                old_tag[i ^ 1] = tmp_tag;
                old_offset = tmp_offset;
                i ^= 1;
                goto KICK_OUT;
        }

        return 0;
}

static int cuckoo_hash_get(struct hash_table *table, uint8_t *key, uint8_t **read_addr)
{
        int i, j;
        uint8_t *addr;
        uint32_t tag[2], offset;
        struct hash_slot_cache *slot;

        tag[0] = cuckoo_hash_lsb(key, table->bucket_num);
        tag[1] = cuckoo_hash_msb(key, table->bucket_num);

#ifdef CUCKOO_DBG
        printf("get t0:%x t1:%x\n", tag[0], tag[1]);
#endif
        dump_sha1_key(key);

        /* Filter the key and verify if it exists. */
        slot = table->buckets[tag[0]];
        for (i = 0; i < ASSOC_WAY; i++) {
                if (cuckoo_hash_msb(key, table->bucket_num) == slot[i].tag) {
                        if (slot[i].status == OCCUPIED) {
                                offset = slot[i].offset;
                                addr = key_verify(key, offset);
                                if (addr != NULL) {
```

```
167                                     if (read_addr != NULL) {
168                                             *read_addr = addr;
169                                     }
170                                     break;
171                             }
172                         } else if (slot[i].status == DELETED) {
173 #ifdef CUCKOO_DBG
174                                 printf("Key has been deleted!\n");
175 #endif
176                                 return DELETED;
177                         }
178                 }
179         }
180
181         if (i == ASSOC_WAY) {
182                 slot = table->buckets[tag[1]];
183                 for (j = 0; j < ASSOC_WAY; j++) {
184                         if (cuckoo_hash_lsb(key, table->bucket_num) == slot[j].tag) {
185                                 if (slot[j].status == OCCUPIED) {
186                                         offset = slot[j].offset;
187                                         addr = key_verify(key, offset);
188                                         if (addr != NULL) {
189                                                 if (read_addr != NULL) {
190                                                         *read_addr = addr;
191                                                 }
192                                                 break;
193                                         }
194                                 } else if (slot[j].status == DELETED) {
195 #ifdef CUCKOO_DBG
196                                         printf("Key has been deleted!\n");
197 #endif
198                                         return DELETED;
199                                 }
200                         }
201                 }
202                 if (j == ASSOC_WAY) {
203 #ifdef CUCKOO_DBG
204                         printf("Key not exists!\n");
205 #endif
206                         return AVAILIBLE;
207                 }
208         }
209
210         return OCCUPIED;
211 }
212
213 static int cuckoo_hash_put(struct hash_table *table, uint8_t *key, uint32_t *p_offset)
214 {
215         int i, j;
216         uint32_t tag[2], offset;
217         struct hash_slot_cache *slot;
218
219         tag[0] = cuckoo_hash_lsb(key, table->bucket_num);
220         tag[1] = cuckoo_hash_msb(key, table->bucket_num);
221
222 #ifdef CUCKOO_DBG
223         printf("put offset:%x t0:%x t1:%x\n", *p_offset, tag[0], tag[1]);
224 #endif
225
226         /* Insert new key into hash buckets. */
227         offset = *p_offset;
228         slot = table->buckets[tag[0]];
```

```
229         for (i = 0; i < ASSOC_WAY; i++) {
230                 if (offset == INVALID_OFFSET && slot[i].status == DELETED) {
231                         slot[i].status = OCCUPIED;
232                         slot[i].tag = cuckoo_hash_msb(key, table->bucket_num);
233                         *p_offset = offset = slot[i].offset;
234                         break;
235                 } else if (slot[i].status == AVAILIBLE) {
236                         slot[i].status = OCCUPIED;
237                         slot[i].tag = cuckoo_hash_msb(key, table->bucket_num);
238                         slot[i].offset = offset;
239                         break;
240                 }
241         }
242 
243         if (i == ASSOC_WAY) {
244                 slot = table->buckets[tag[1]];
245                 for (j = 0; j < ASSOC_WAY; j++) {
246                         if (offset == INVALID_OFFSET && slot[j].status == DELETED) {
247                                 slot[j].status = OCCUPIED;
248                                 slot[j].tag = cuckoo_hash_lsb(key, table->bucket_num);
249                                 *p_offset = offset = slot[j].offset;
250                                 break;
251                         } else if (slot[j].status == AVAILIBLE) {
252                                 slot[j].status = OCCUPIED;
253                                 slot[j].tag = cuckoo_hash_lsb(key, table->bucket_num);
254                                 slot[j].offset = offset;
255                                 break;
256                         }
257                 }
258 
259                 if (j == ASSOC_WAY) {
260                         if (cuckoo_hash_collide(table, tag, p_offset)) {
261 #ifdef CUCKOO_DBG
262                                 printf("Hash table collision!\n");
263 #endif
264                                 return -1;
265                         }
266                 }
267         }
268 
269         show_hash_slots(table);
270 
271         return 0;
272 }
273 
274 static void cuckoo_hash_status_set(struct hash_table *table, uint8_t *key, int status)
275 {
276         uint32_t i, j, tag[2];
277         struct hash_slot_cache *slot;
278 
279         tag[0] = cuckoo_hash_lsb(key, table->bucket_num);
280         tag[1] = cuckoo_hash_msb(key, table->bucket_num);
281 
282 #ifdef CUCKOO_DBG
283         printf("set status:%d t0:%x t1:%x\n", status, tag[0], tag[1]);
284 #endif
285         dump_sha1_key(key);
286 
287         /* Insert new key into hash buckets. */
288         slot = table->buckets[tag[0]];
289         for (i = 0; i < ASSOC_WAY; i++) {
290                 if (cuckoo_hash_msb(key, table->bucket_num) == slot[i].tag) {
```

```
                        slot[i].status = status;
                        return;
                }
        }

        if (i == ASSOC_WAY) {
                slot = table->buckets[tag[1]];
                for (j = 0; j < ASSOC_WAY; j++) {
                        if (cuckoo_hash_lsb(key, table->bucket_num) == slot[j].tag) {
                                slot[j].status = status;
                                return;
                        }
                }

                if (j == ASSOC_WAY) {
#ifdef CUCKOO_DBG
                        printf("Key not exists!\n");
#endif
                }
        }
}

static void cuckoo_hash_delete(struct hash_table *table, uint8_t *key)
{
        cuckoo_hash_status_set(table, key, DELETED);
}

static void cuckoo_hash_recover(struct hash_table *table, uint8_t *key)
{
        cuckoo_hash_status_set(table, key, OCCUPIED);
}

static void cuckoo_rehash(struct hash_table *table)
{
        int i;
        struct hash_table old_table;

        /* Reallocate hash slots */
        old_table.slots = table->slots;
        old_table.slot_num = table->slot_num;
        table->slot_num *= 2;
        table->slots = calloc(table->slot_num, sizeof(struct hash_slot_cache));
        if (table->slots == NULL) {
                table->slots = old_table.slots;
                return;
        }

        /* Reallocate hash buckets associated with slots */
        old_table.buckets = table->buckets;
        old_table.bucket_num = table->bucket_num;
        table->bucket_num *= 2;
        table->buckets = malloc(table->bucket_num * sizeof(struct hash_slot_cache *));
        if (table->buckets == NULL) {
                free(table->slots);
                table->slots = old_table.slots;
                table->buckets = old_table.buckets;
                return;
        }
        for (i = 0; i < table->bucket_num; i++) {
                table->buckets[i] = &table->slots[i * ASSOC_WAY];
        }

```

```
353         /* Rehash all hash slots */
354         uint8_t *read_addr = nvrom_base_addr;
355         uint32_t entries = log_entries;
356         while (entries--) {
357                 uint8_t key[20];
358                 uint32_t offset = read_addr - nvrom_base_addr;
359                 for (i = 0; i < 20; i++) {
360                         key[i] = flash_read(read_addr);
361                         read_addr++;
362                 }
363                 /* Duplicated keys in hash table which can cause eternal
364                  * hashing collision! Be careful of that!
365                  */
366                 assert(!cuckoo_hash_put(table, key, &offset));
367                 if (cuckoo_hash_get(&old_table, key, NULL) == DELETED) {
368                         cuckoo_hash_delete(table, key);
369                 }
370                 read_addr += DAT_LEN;
371         }
372
373        free(old_table.slots);
374        free(old_table.buckets);
375 }
376
377 uint8_t *cuckoo_filter_get(uint8_t *key)
378 {
379         int i;
380         uint8_t *read_addr;
381         static uint8_t value[DAT_LEN];
382
383         /* Read data from the log entry on flash. */
384         if (cuckoo_hash_get(&hash_table, key, &read_addr) != OCCUPIED) {
385                 return NULL;
386         }
387
388         for (i = 0; i < DAT_LEN; i++) {
389                 value[i] = flash_read(read_addr);
390                 read_addr++;
391         }
392
393         return value;
394 }
395
396 void cuckoo_filter_put(uint8_t *key, uint8_t *value)
397 {
398         if (value != NULL) {
399                 /* Important: Reject duplicated keys keeping from eternal collision */
400                 int status = cuckoo_hash_get(&hash_table, key, NULL);
401                 if (status == OCCUPIED) {
402                         return;
403                 } else if (status == DELETED) {
404                         cuckoo_hash_recover(&hash_table, key);
405                 } else {
406                         /* Find new log entry offset on flash. */
407                         uint32_t offset = next_entry_offset();
408
409                         /* Insert into hash slots */
410                         if (cuckoo_hash_put(&hash_table, key, &offset) == -1) {
411                                 cuckoo_rehash(&hash_table);
412                                 cuckoo_hash_put(&hash_table, key, &offset);
413                         }
414                         if (offset == -1) {
```

```
415                                 fprintf(stderr, "Not enough capacity!\n");
416                                 return;
417                         }
418
419                         /* Add new entry of key-value pair on flash. */
420                         int i;
421                         uint8_t *append_addr = nvrom_base_addr + offset;
422                         assert(flash_align(append_addr));
423                         flash_sector_erase(append_addr);
424                         for (i = 0; i < 20; i++) {
425                                 flash_write(append_addr, key[i]);
426                                 append_addr++;
427                         }
428                         for (i = 0; i < DAT_LEN; i++) {
429                                 flash_write(append_addr, value[i]);
430                                 append_addr++;
431                         }
432                         log_entries++;
433                 }
434         } else {
435                 /* Delete at the hash slot */
436                 cuckoo_hash_delete(&hash_table, key);
437         }
438 }
439
440 int cuckoo_filter_init(size_t size)
441 {
442         int i;
443
444         /* Make whole memory space large enough(but not always predictable...) */
445         nvrom_size = next_pow_of_2((size / DAT_LEN + 1) * SECTOR_SIZE);
446         nvrom_base_addr = malloc(nvrom_size + SECTOR_SIZE);
447         if (nvrom_base_addr == NULL) {
448                 return -1;
449         }
450         nvrom_base_addr = force_align(nvrom_base_addr, SECTOR_SIZE);
451
452         /* Allocate hash slots */
453         hash_table.slot_num = nvrom_size / SECTOR_SIZE;
454         /* Make rehashing happen */
455         hash_table.slot_num /= 4;
456         hash_table.slots = calloc(hash_table.slot_num, sizeof(struct hash_slot_cache));
457         if (hash_table.slots == NULL) {
458                 return -1;
459         }
460
461         /* Allocate hash buckets associated with slots */
462         hash_table.bucket_num = hash_table.slot_num / ASSOC_WAY;
463         hash_table.buckets = malloc(hash_table.bucket_num * sizeof(struct hash_slot_cache *));
464         if (hash_table.buckets == NULL) {
465                 free(hash_table.slots);
466                 return -1;
467         }
468         for (i = 0; i < hash_table.bucket_num; i++) {
469                 hash_table.buckets[i] = &hash_table.slots[i * ASSOC_WAY];
470         }
471
472         return 0;
473 }
```

code/cuckoo/mozilla-sha1/sha1.h

```
/*
 * sha1.h
 *
 *  Created on: Dec 10, 2016
 *      Author: math
 */
/*
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 * except in compliance with the License. You may obtain a copy of
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 *
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 *
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 * replace them with the notice and other provisions required by
 * the GPL.  If you do not delete the provisions above, a recipient
 * may use your version of this file under either the MPL or the
 * GPL.
 */
#ifndef SRC_MOZILLA_SHA1_SHA1_H_
#define SRC_MOZILLA_SHA1_SHA1_H_

typedef struct {
  unsigned int H[5];
  unsigned int W[80];
  int lenW;
  unsigned int sizeHi,sizeLo;
} SHA_CTX;

void SHA1_Init(SHA_CTX *ctx);
void SHA1_Update(SHA_CTX *ctx, void *dataIn, int len);
void SHA1_Final(unsigned char hashout[20], SHA_CTX *ctx);




#endif /* SRC_MOZILLA_SHA1_SHA1_H_ */
```

code/cuckoo/mozilla-sha1/sha1.c

```c
/*
 * sha1.c
 *
 *  Created on: Dec 10, 2016
 *      Author: math
 */

/*
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 * allow others to use your version of this file under the MPL,
 * indicate your decision by deleting the provisions above and
 * replace them with the notice and other provisions required by
 * the GPL.  If you do not delete the provisions above, a recipient
 * may use your version of this file under either the MPL or the
 * GPL.
 */

#include "sha1.h"

static void shaHashBlock(SHA_CTX *ctx);

void SHA1_Init(SHA_CTX *ctx) {
  int i;

  ctx->lenW = 0;
  ctx->sizeHi = ctx->sizeLo = 0;

  /* Initialize H with the magic constants (see FIPS180 for constants)
   */
  ctx->H[0] = 0x67452301;
  ctx->H[1] = 0xefcdab89;
  ctx->H[2] = 0x98badcfe;
  ctx->H[3] = 0x10325476;
  ctx->H[4] = 0xc3d2e1f0;

```

```
61    for (i = 0; i < 80; i++)
62      ctx->W[i] = 0;
63  }
64
65
66  void SHA1_Update(SHA_CTX *ctx, void *_dataIn, int len) {
67    unsigned char *dataIn = _dataIn;
68    int i;
69
70    /* Read the data into W and process blocks as they get full
71     */
72    for (i = 0; i < len; i++) {
73      ctx->W[ctx->lenW / 4] <<= 8;
74      ctx->W[ctx->lenW / 4] |= (unsigned int)dataIn[i];
75      if ((++ctx->lenW) % 64 == 0) {
76        shaHashBlock(ctx);
77        ctx->lenW = 0;
78      }
79      ctx->sizeLo += 8;
80      ctx->sizeHi += (ctx->sizeLo < 8);
81    }
82  }
83
84
85  void SHA1_Final(unsigned char hashout[20], SHA_CTX *ctx) {
86    unsigned char pad0x80 = 0x80;
87    unsigned char pad0x00 = 0x00;
88    unsigned char padlen[8];
89    int i;
90
91    /* Pad with a binary 1 (e.g. 0x80), then zeroes, then length
92     */
93    padlen[0] = (unsigned char)((ctx->sizeHi >> 24) & 255);
94    padlen[1] = (unsigned char)((ctx->sizeHi >> 16) & 255);
95    padlen[2] = (unsigned char)((ctx->sizeHi >> 8) & 255);
96    padlen[3] = (unsigned char)((ctx->sizeHi >> 0) & 255);
97    padlen[4] = (unsigned char)((ctx->sizeLo >> 24) & 255);
98    padlen[5] = (unsigned char)((ctx->sizeLo >> 16) & 255);
99    padlen[6] = (unsigned char)((ctx->sizeLo >> 8) & 255);
100   padlen[7] = (unsigned char)((ctx->sizeLo >> 0) & 255);
101   SHA1_Update(ctx, &pad0x80, 1);
102   while (ctx->lenW != 56)
103     SHA1_Update(ctx, &pad0x00, 1);
104   SHA1_Update(ctx, padlen, 8);
105
106   /* Output hash
107    */
108   for (i = 0; i < 20; i++) {
109     hashout[i] = (unsigned char)(ctx->H[i / 4] >> 24);
110     ctx->H[i / 4] <<= 8;
111   }
112
113   /*
114    *  Re-initialize the context (also zeroizes contents)
115    */
116   SHA1_Init(ctx);
117 }
118
119
120 #define SHA_ROT(X,n) (((X) << (n)) | ((X) >> (32-(n))))
121
122 static void shaHashBlock(SHA_CTX *ctx) {
```

```
123   int t;
124   unsigned int A,B,C,D,E,TEMP;
125
126   for (t = 16; t <= 79; t++)
127     ctx->W[t] =
128       SHA_ROT(ctx->W[t-3] ^ ctx->W[t-8] ^ ctx->W[t-14] ^ ctx->W[t-16], 1);
129
130   A = ctx->H[0];
131   B = ctx->H[1];
132   C = ctx->H[2];
133   D = ctx->H[3];
134   E = ctx->H[4];
135
136   for (t = 0; t <= 19; t++) {
137     TEMP = SHA_ROT(A,5) + (((C^D)&B)^D)     + E + ctx->W[t] + 0x5a827999;
138     E = D; D = C; C = SHA_ROT(B, 30); B = A; A = TEMP;
139   }
140   for (t = 20; t <= 39; t++) {
141     TEMP = SHA_ROT(A,5) + (B^C^D)           + E + ctx->W[t] + 0x6ed9eba1;
142     E = D; D = C; C = SHA_ROT(B, 30); B = A; A = TEMP;
143   }
144   for (t = 40; t <= 59; t++) {
145     TEMP = SHA_ROT(A,5) + ((B&C)(D&(BC))) + E + ctx->W[t] + 0x8f1bbcdc;
146     E = D; D = C; C = SHA_ROT(B, 30); B = A; A = TEMP;
147   }
148   for (t = 60; t <= 79; t++) {
149     TEMP = SHA_ROT(A,5) + (B^C^D)           + E + ctx->W[t] + 0xca62c1d6;
150     E = D; D = C; C = SHA_ROT(B, 30); B = A; A = TEMP;
151   }
152
153   ctx->H[0] += A;
154   ctx->H[1] += B;
155   ctx->H[2] += C;
156   ctx->H[3] += D;
157   ctx->H[4] += E;
158 }
```

Chapter 6

Java

6.1 命令行java

编辑文件

code/test0001.java

```
public class test{
        public static void main(String args[]){
                System.out.println("A new jdk test!");
        }
}
```

然后在终端执行`$ javac test0001.java`生成class文件test0001.class. 然后在终端执行`$ java test0001`便可执行class文件了.

6.2 Java计算日期间的天数

code/date0001.java

```java
import java.text.ParseException;
import java.text.SimpleDateFormat;
import java.util.Calendar;
import java.util.Date;

public class test16 {

    /**
     * @param args
     * @throws ParseException
     */
    public static void main(String[] args) throws ParseException {
        // TODO Auto-generated method stub
        SimpleDateFormat sdf=new SimpleDateFormat("yyyy-MM-dd HH:mm:ss");
        Date d1=sdf.parse("2012-09-08 10:10:10");
        Date d2=sdf.parse("2012-09-15 00:00:00");
        System.out.println(daysBetween(d1,d2));

        System.out.println(daysBetween("2012-09-08 10:10:10","2012-09-15 00:00:00"));
    }

    /**
     * 计算两个日期之间相差的天数
     * @param smdate 较小的时间
     * @param bdate  较大的时间
     * @return 相差天数
     * @throws ParseException
     */
    public static int daysBetween(Date smdate,Date bdate) throws ParseException
    {
        SimpleDateFormat sdf=new SimpleDateFormat("yyyy-MM-dd");
        smdate=sdf.parse(sdf.format(smdate));
        bdate=sdf.parse(sdf.format(bdate));
        Calendar cal = Calendar.getInstance();
        cal.setTime(smdate);
        long time1 = cal.getTimeInMillis();
        cal.setTime(bdate);
        long time2 = cal.getTimeInMillis();
        long between_days=(time2-time1)/(1000*3600*24);

        return Integer.parseInt(String.valueOf(between_days));
    }

    /**
    *字符串的日期格式的计算
    */
    public static int daysBetween(String smdate,String bdate) throws ParseException{
        SimpleDateFormat sdf=new SimpleDateFormat("yyyy-MM-dd");
        Calendar cal = Calendar.getInstance();
        cal.setTime(sdf.parse(smdate));
        long time1 = cal.getTimeInMillis();
        cal.setTime(sdf.parse(bdate));
        long time2 = cal.getTimeInMillis();
        long between_days=(time2-time1)/(1000*3600*24);

        return Integer.parseInt(String.valueOf(between_days));
    }

```

```
59 }
```

6.3 Bloom Filter

There's a whole theory on good hash functions that are close to random in suitable ways. what is random hash function? Hashing themes repeat? Why Bloom Filters Are Not Taught in Algorithms 101?