



How to streamline your life (lessons from computer architecture).

COS 116, Spring 2010

Guest: Szymon Rusinkiewicz

Lesson 1: Caching

(and the 80-20 rule)



Customer Rating



4.7 out of 5

XPS 420

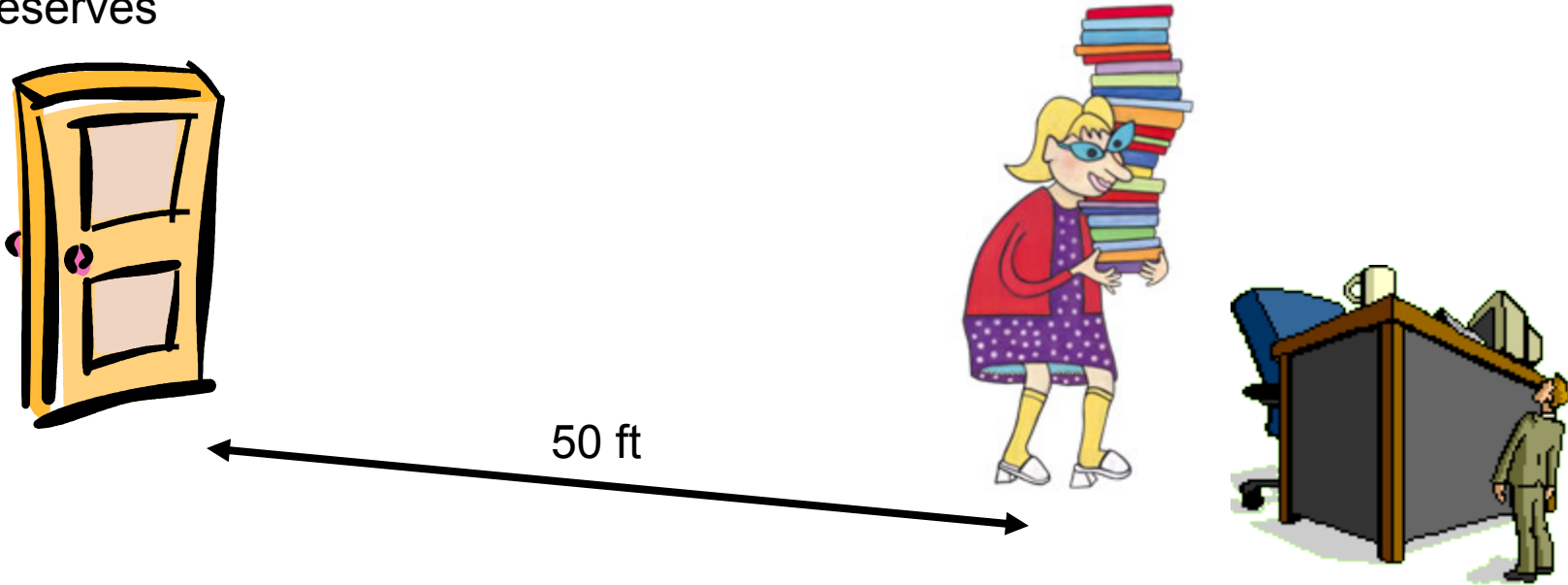
Intel® Core™2 Q6600

Quad-Core (8MB L2


cache, 2.4GHz, 1066FSB)

The Tired Librarian

Reserves



- 1000 checkouts/returns per day
- Distance covered = $50 \times 2 \times 1000 = 100,000$ feet
~ 20 miles
- Please help!!!

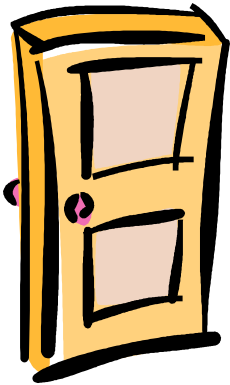


80-20 “Rule”

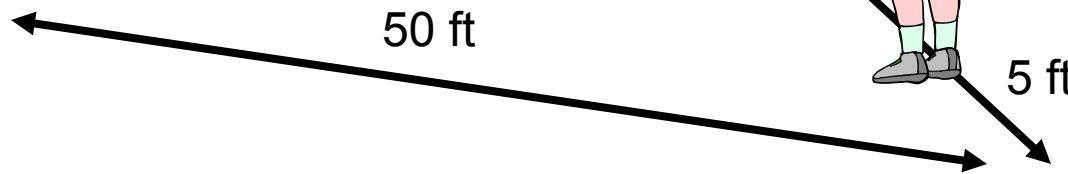
- Pareto [1906]: 20% of the people own 80% of the wealth
- Juran [1930's]: 20% of the organization does 80% of the work

Better Arrangement

Reserves



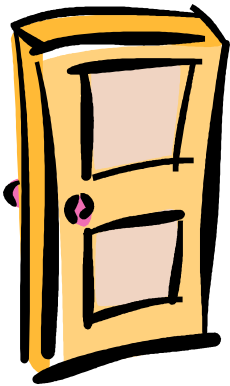
“Most popular” shelf:
20% most popular
books



- Distance covered per day?

Even better arrangement?

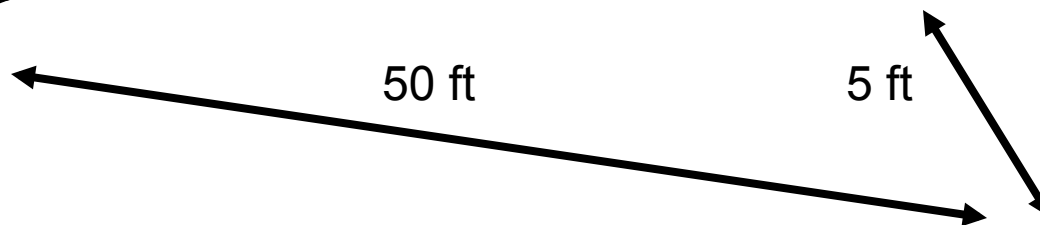
Reserves



“Most popular” shelf:
20% most popular
books



Top 4%



- Distance covered per day?



Discussion Time



- Is the librarian's problem solved?



How to predict the 20% most popular books for next day?

- In general, no easy solution
- In practice, use rules of thumb
 - Example: “Least Recently Used”. When you need to create space on the desk (or shelf), move out the book that was used least recently
 - Many others (LRU is computationally expensive)

New and improved

		
<p>XPS 600 Raw Power Unleashed</p>	<p>XPS 200 Small, But Mighty</p>	<p>X TI</p>
<p>+ SPECIAL OFFERS</p>		
<p>- Processor Intel® Pentium® 4 Processor 640 with HT (3.20GHz, 800 FSB, 2MB L2 cache) up to Pentium® Extreme Edition Dual Core</p>		
<p>- Operating System Genuine Windows® XP Media Center Edition 2005</p>		



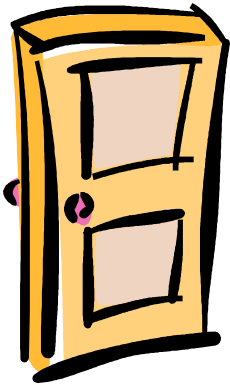
Connection to Computer Organization

- Speed vs cost of various memories

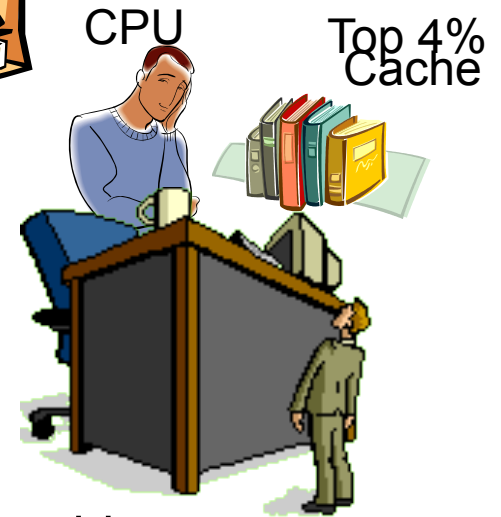
	Cost: \$ / GB	Speed: GB/s
Hard drive	0.10	0.1
Flash (e.g., SSD, USB stick)	2	0.25
RAM	10	10
On-chip memory for CPU (L2 Cache)	40000	20

Computer ~~Librarian~~ arrangement

Disks
Reserves



“Most popular” shelf:
20% most popular
books Memory



Often, today's computers have even more levels of caching



Moral

- Performance:

- Speed is close to that of fastest memory (cache)
- Overall capacity is that of largest memory (disk)

Question



- How does the same program (.exe file) run on different PCs with different memory configurations?
- Answer: “Virtual Memory”
 - All programs live a fiction: allowed to pretend they each have 2^{32} or 2^{64} bytes of memory
 - Illusion is preserved by hardware

Lesson 2: Multitasking

- “The Multitasking Generation”



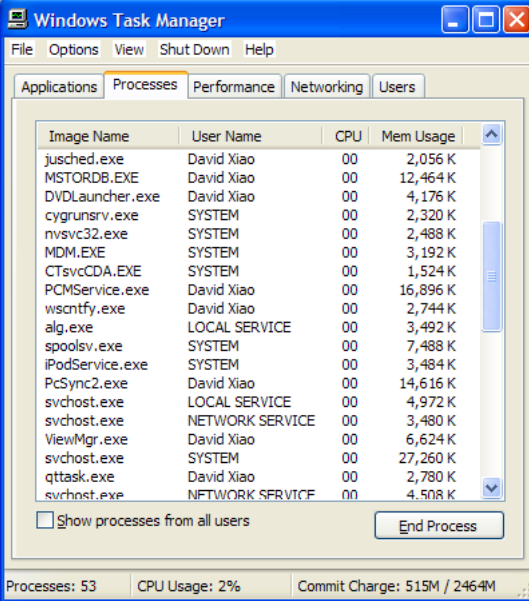
An Evening's Tasks for a Gen-M'er

- Homework
- Listen to music
- Instant Messaging
- Call Mom (goes to bed by 11 PM!)
- Answer phone
- Read a bit more of Joyce's *Ulysses*
- Watch the Daily Show
- How do you do it all?



Tasks done by my PC last night

- Word processing
- Play CD
- Download news updates
- Download email
- Run clock
- Hidden tasks: handle network traffic, manage disk and RAM traffic, scheduler, etc.



The screenshot shows the Windows Task Manager window with the 'Processes' tab selected. It displays a list of running processes with columns for Image Name, User Name, CPU usage, and Mem Usage. The status bar at the bottom indicates 53 processes, 2% CPU usage, and a commit charge of 515M / 2464M.

Image Name	User Name	CPU	Mem Usage
jusched.exe	David Xiao	00	2,056 K
MSTORDB.EXE	David Xiao	00	12,464 K
DVDLauncher.exe	David Xiao	00	4,176 K
cygrunsrv.exe	SYSTEM	00	2,320 K
nsvsc32.exe	SYSTEM	00	2,488 K
MDM.EXE	SYSTEM	00	3,192 K
CTsvcCDA.EXE	SYSTEM	00	1,524 K
PCMSvc.exe	David Xiao	00	16,896 K
wscntfy.exe	David Xiao	00	2,744 K
alg.exe	LOCAL SERVICE	00	3,492 K
spoolsv.exe	SYSTEM	00	7,488 K
iPodService.exe	SYSTEM	00	3,484 K
PcSync2.exe	David Xiao	00	14,616 K
svchost.exe	LOCAL SERVICE	00	4,972 K
svchost.exe	NETWORK SERVICE	00	3,480 K
ViewMgr.exe	David Xiao	00	6,624 K
svchost.exe	SYSTEM	00	27,260 K
qtask.exe	David Xiao	00	2,780 K
svchost.exe	NETWORK SERVICE	00	4,508 K

Managed by “Operating System”
(WinXP, Linux, MacOS, etc.)



Multitasking versus Parallel Processing

Multitasking: A single CPU handles many tasks by switching rapidly among them.
(e.g., all Wintel machines since early 1990s; all Unix machines since the 1970s)


Parallel Processing: Multiple CPUs that do the work of a single CPU. (But, 4 CPUs do not necessarily mean 4x speed.)

XPS 420

Intel® Core™2 Q6600

Quad-Core (8MB L2

cache, 2.4GHz, 1066FSB)



Scheduler's objectives

- Fairness
- Timeliness
- Critical tasks processed promptly
- Low overhead

How can one achieve these
(often conflicting) goals?