

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

COS 116, Spring 2010

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Lesson 1: Caching

(and the 80-20 rule)



Customer Rating



4.7 out of 5

XPS 420

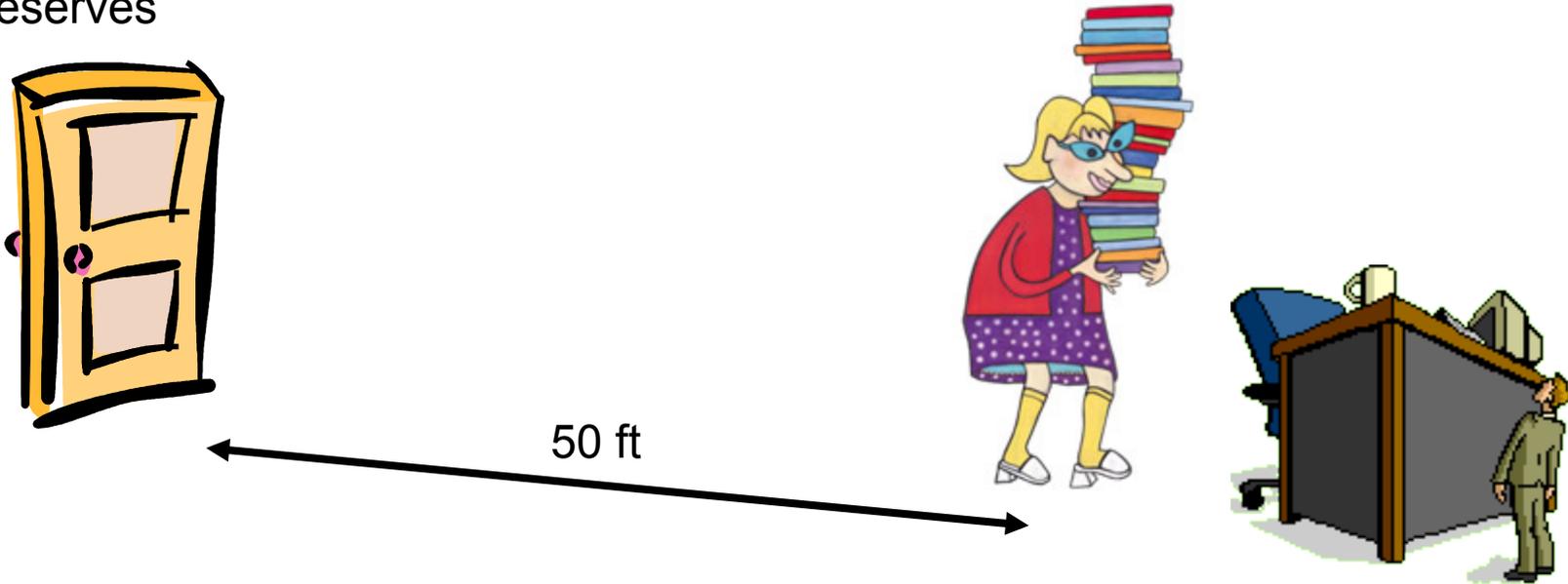
Intel® Core™2 Q6600

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!!!

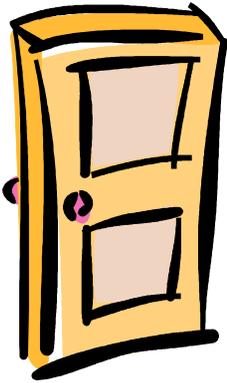


80-20 “Rule”

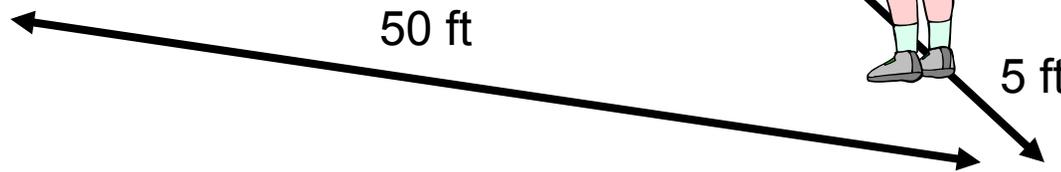
- Pareto [1906]: 20% of the people own 80% of the wealth
- Juran [1930's]: 20% of the organization does 80% of the work

Better Arrangement

Reserves



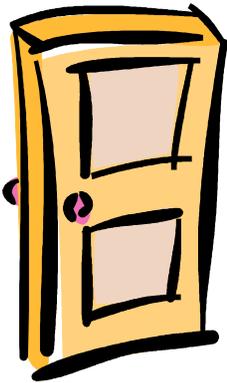
“Most popular” shelf:
20% most popular
books



- Distance covered per day?

Even better arrangement?

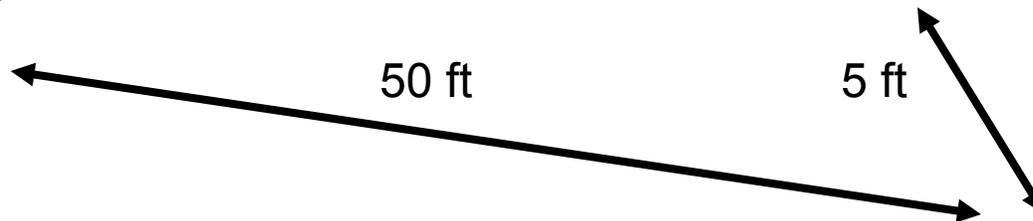
Reserves



“Most popular” shelf:
20% most popular
books



Top 4%



- Distance covered per day?



Discussion Time

- Is the librarian's problem solved?

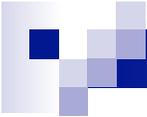


How to predict the 20% most popular books for next day?

- 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

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



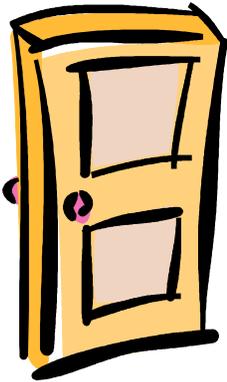
Connection to Computer Organization

- Speed vs cost of various memories

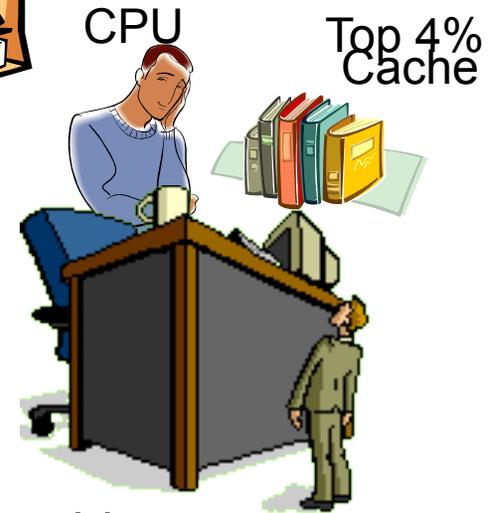
	Cost: \$ / GB	Speed: GB/s
Hard drive	0.10	0.1
Flash (e.g., SSD, USB stick)	2	0.25
RAM	10	10
On-chip memory for CPU (L2 Cache)	40000	20

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”



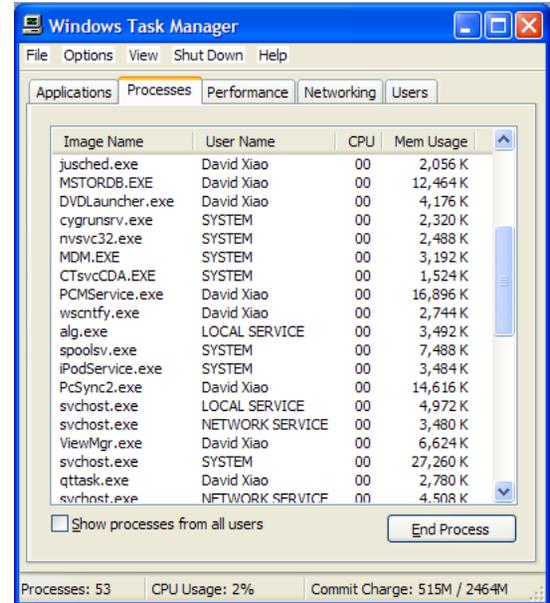
An Evening's Tasks for a Gen-M'er

- 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

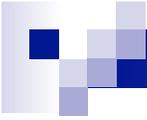
- Word processing
- Play CD
- Download news updates
- Download email
- Run clock
- Hidden tasks: handle network traffic, manage disk and RAM traffic, scheduler, etc.



The screenshot shows the Windows Task Manager window with the 'Processes' tab selected. The window title is 'Windows Task Manager' and it has a menu bar with 'File', 'Options', 'View', 'Shut Down', and 'Help'. Below the menu bar are tabs for 'Applications', 'Processes', 'Performance', 'Networking', and 'Users'. The 'Processes' tab is active, displaying a list of running processes with columns for 'Image Name', 'User Name', 'CPU', and 'Mem Usage'. The status bar at the bottom indicates 'Processes: 53', 'CPU Usage: 2%', and 'Commit Charge: 515M / 2464M'. There is an 'End Process' button at the bottom right of the list.

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

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Scheduler's objectives

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

How can one achieve these
(often conflicting) goals?