Menory heirarchy [Typewritten portrons of these notes are copied verbation from the Powerpoint slides provided by the textback authors] All computers use a heirarchy of hardware for storing data, ranging from (fast, expensive storage) (slow, change storage) e.g. cache memory e.g. hard drive

lupes of main memory " random all's main nemon nemo" ("read with ROM (read-only RAM remor world be this is also random access, SRAM flash so 'RAM' is a misleocling DRAM (dynamiz nAm (static RAM medium term. , faster speed z · stowner wst · expensive · deaper - hotter ·denser ·cooler retails data without good for small fixed loses data when programs e.g. for power povered off bosting a device good for good for good compromise mail wennon cache when power isn't always available e.g. smatphone, USB stick

Menoy heirarchy From textbook : More Costly Access Times Registers 1ns -> 2ns 3ns → 10ns Level 1 Cache 25ns -> 50ns Level 2 Cache System 30ns → 90ns Main Memory Online Less Costly Nearline 5ms -> 20ms Fixed Rigid Disk 100ms -> 5s * Optical Disk (Jukeboxes) 10s → 3m * Magnetic Tape (Robotic Libraries) If volume is mounted. The heirarchy uses the concept of caching: store information that is likely to be needed room in a place where it can be accessed quickly. When searching for a given piecer of data, start from the top and more down until it is found. A simplified version of the above pyramid is:

storage type	tupical access	tranical amount	
	time	available	
register	hs	50 bytes	
cache	10 ns	SMB	
mail memory	100 ns	5 GB	
hard drive	10000 hs for random	100 GB	
	access		

Definitions from textbook authors' slides:

- A *hit* is when data is found at a given memory level.
- A *miss* is when it is not found.
- The *hit rate* is the percentage of time data is found at a given memory level.
- The *miss rate* is the percentage of time it is not.
- Miss rate = 1 hit rate.
- The *hit time* is the time required to access data at a given memory level.
- The *miss penalty* is the time required to process a miss, including the time that it takes to replace a block of memory plus the time it takes to deliver the data to the processor.

Detow : Experted value Recall that the expected value of an event with probabilities proprand outcomes VI, UZ is just piv, + pvz e.g. blased coin with prob (head) = 0.7 play gave where head whos \$10, tail wine \$2. Mat is expected value of playing once? Answer: exercise Similar formula for many outcomer: piv,+ prv2+--+pnvn. Expected access fine (EAT) Above formula applies when calculating expected access time for a piece of data. e-g. 2-level heirarchy with 70% hit rate. Access files are 10ns and 100ns for the two levels. What is the GAT? Answer: exercise Minulas: Le look at results from CacheTiver.java and estimate size of cache on lab machines.