L5

- performance of many apps (29 as of 2006 spec) compressed into a single number
- spec uses geometric mean (GM)
  - $\sqrt[n]{sr_1 * sr_2 * ....sr_n}$,

  where sr is exec time/refernce time
  reference time is the time taken to exec the program on the SPEC benchmark system
- Arithmetic mean is also popular but not good
- Weighted A.M. is better.

Execution time after improvement

- Execution time unaffected (which is part of the program that cannot be parallelised) + {Exec time Affected/ Rate of improvement}
- If a certain part of a program eg. multiply has 80% of the exec time, we can't achieve - like a 5 fold enhancement, if 80% can't be parallelized

Amdahl's law says
Let,

> T_b -> execution before improvement
> f -> fraction that can be improved
> T_a -> After improvement
> s_f -> Speedup factor

$T_b = (1-f)T_b + fT_b$
$T_a = (1-f)T_b + f\frac{T_b}{s_f}$
$1 = (1-f)s_o + fs_o/s_f$
where $s_o = T_b/T_a$

$$s_o = \frac{1}{((1-f)+f/s_f)}$$

max speedup will go to 1/(1-f)
sf α 1/(no. of cores) in theory, but actually its performance is lesser

the theoretical usage drops after some time and is shown by the amdahl's law graph

Instructions

mIPS - million instructions per second
MIPS - Microcomputer without interlocked pipelined stages

- John L. Hennessy at Stanford University developed MIPS
    - inspired most architectures since the 80s
- Arithmetic
- Data transfer
- logical
- conditional branch
- conditional jump

32 registers -> $0 to $31

register no.	register name	functionality
$0	$zero	hardwired to 0
$1	$at	• reserved by the assembler • used to handle large constants
$2,$3	$v0, $v1	function return args, values of temp results and expo values
$4 - $7	$a0- $a3	argument passing regs to the function
$8 - $15	$t0 - $t7	temporary regs
$16 - $23	$s0 - $s7	• saved registers, used for calling one fn to another, • preserved across call
$24-$25	$t8 - $t9	temporary
$26 - $27	$k0 - $k1	reserved by OS for exception handling
$28	$gp	storing global variables
$29	$sp	stack pointer
$30	$fp	frame pointer
$31	$ra	return address