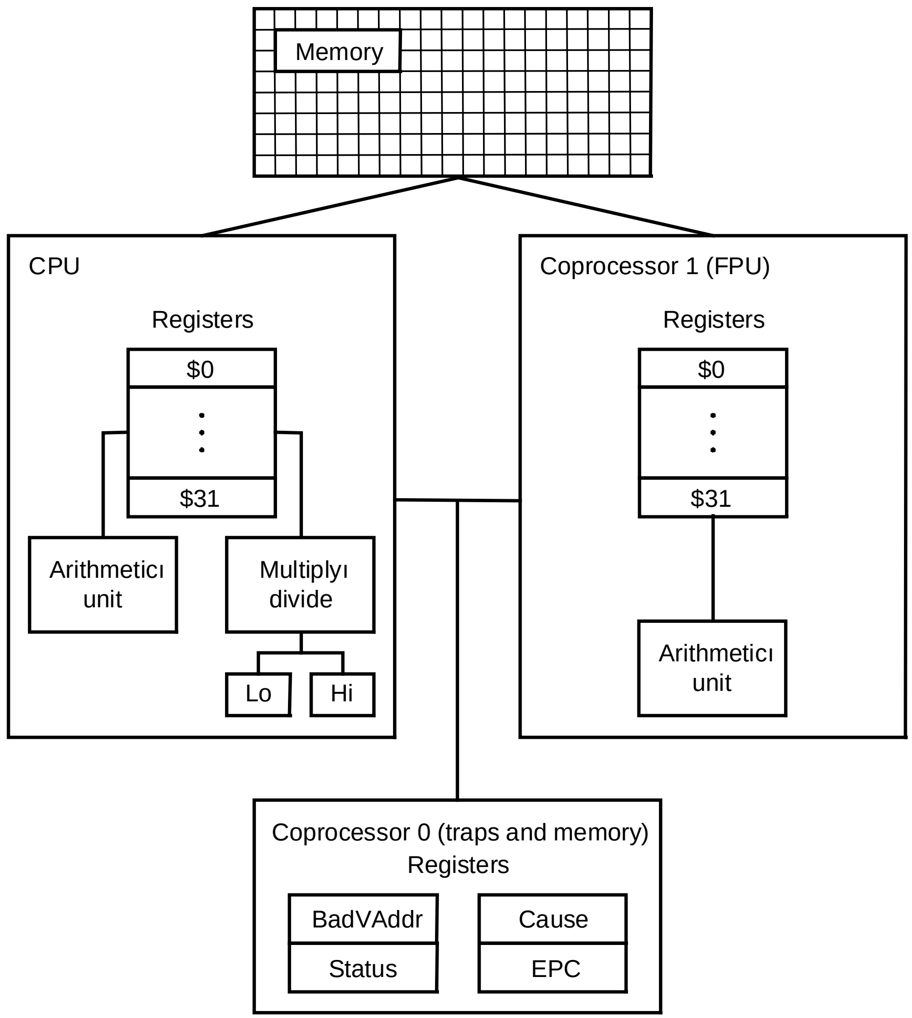
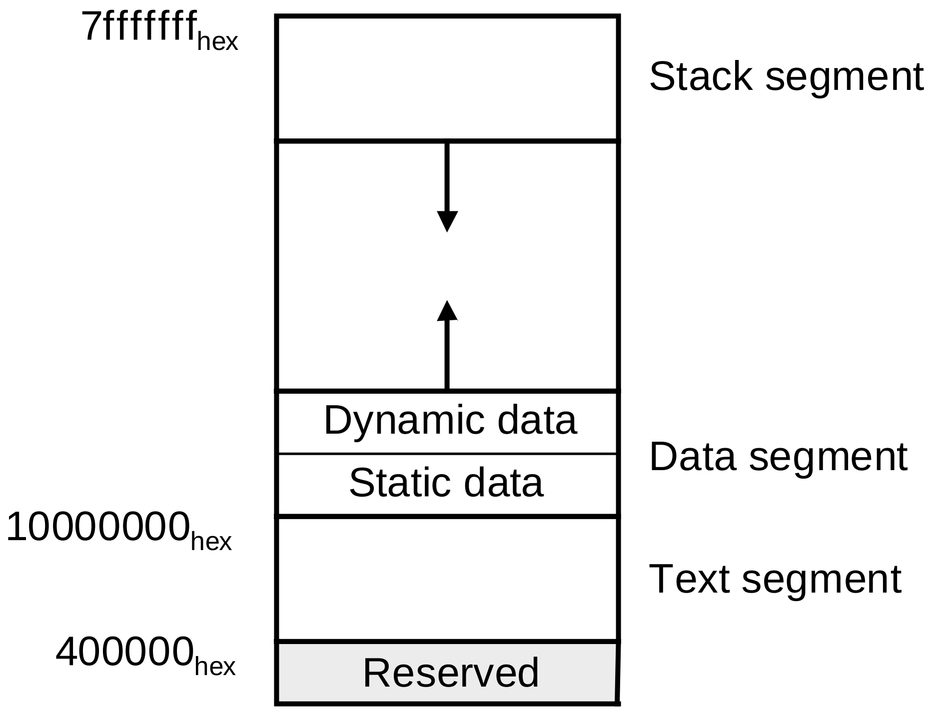
SPIM machine architecture



Memory usage in SPIM



General purpose registers

Name	Register number	Usage
$zero	0	the constant value 0
$v0-$v1	2-3	values for results and expression evaluation
$a0-$a3	4-7	arguments
$t0-$t7	8-15	temporaries
$s0-$s7	16-23	saved
$t8-$t9	24-25	more temporaries
$gp	28	global pointer
$sp	29	stack pointer
$fp	30	frame pointer
$ra	31	return address

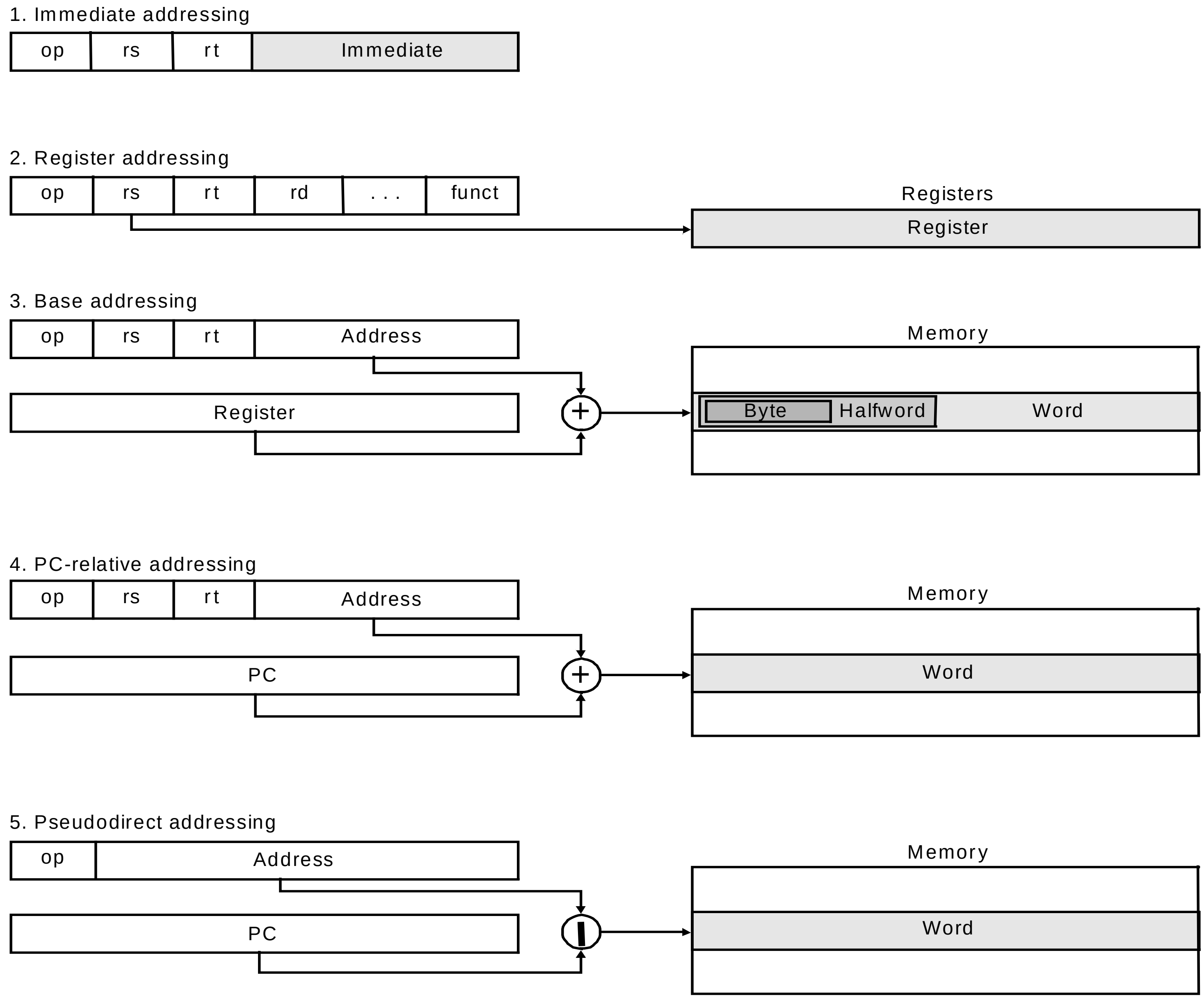
MIPS operands

Name	Example	Comments
32 registers	$s0-$s7, $t0-$t9, $zero, $a0-$a3, $v0-$v1, $gp, $fp, $sp, $ra, $at	Fast locations for data. In MIPS, data must be in registers to perform arithmetic. MIPS register $zero always equals 0. Register $at is reserved for the assembler to handle large constants.
2^{30} memory words	Memory[0], Memory[4], ..., Memory[4294967292]	Accessed only by data transfer instructions. MIPS uses byte addresses, so sequential words differ by 4. Memory holds data structures, such as arrays, and spilled registers, such as those saved on procedure calls.

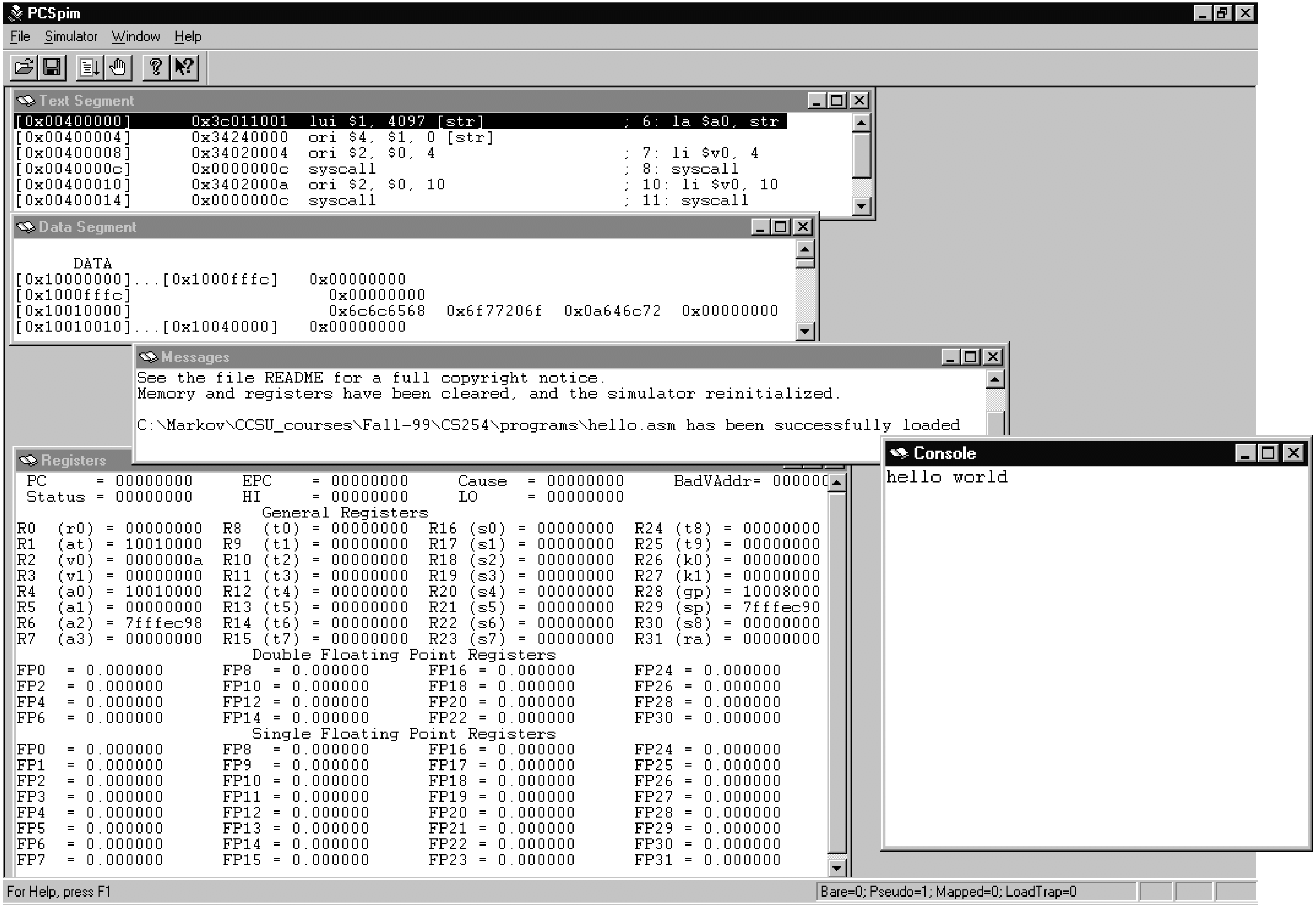
MIPS assembly language

Category	Instruction	Example	Meaning	Comments
Arithmetic	add	add $s1, $s2, $s3	$s1 = $s2 + $s3	Three operands; data in registers
	subtract	sub $s1, $s2, $s3	$s1 = $s2 - $s3	Three operands; data in registers
	add immediate	addi $s1, $s2, 100	$s1 = $s2 + 100	Used to add constants
Data transfer	load word	lw $s1, 100($s2)	$s1 = Memory[$s2 + 100]	Word from memory to register
	store word	sw $s1, 100($s2)	Memory[$s2 + 100] = $s1	Word from register to memory
	load byte	lb $s1, 100($s2)	$s1 = Memory[$s2 + 100]	Byte from memory to register
	store byte	sb $s1, 100($s2)	Memory[$s2 + 100] = $s1	Byte from register to memory
	load upper immediate	lui $s1, 100	$s1 = 100 * 2^{16}	Loads constant in upper 16 bits
Conditional branch	branch on equal	beq $s1, $s2, 25	if ($s1 == $s2) go to PC + 4 + 100	Equal test; PC-relative branch
	branch on not equal	bne $s1, $s2, 25	if ($s1 != $s2) go to PC + 4 + 100	Not equal test; PC-relative
	set on less than	slt $s1, $s2, $s3	if ($s2 < $s3) $s1 = 1; else $s1 = 0	Compare less than; for beq, bne
	set less than immediate	slti $s1, $s2, 100	if ($s2 < 100) $s1 = 1; else $s1 = 0	Compare less than constant
Unconditional jump	jump	j 2500	go to 10000	Jump to target address
	jump register	jr $ra	go to $ra	For switch, procedure return
	jump and link	jal 2500	$ra = PC + 4; go to 10000	For procedure call

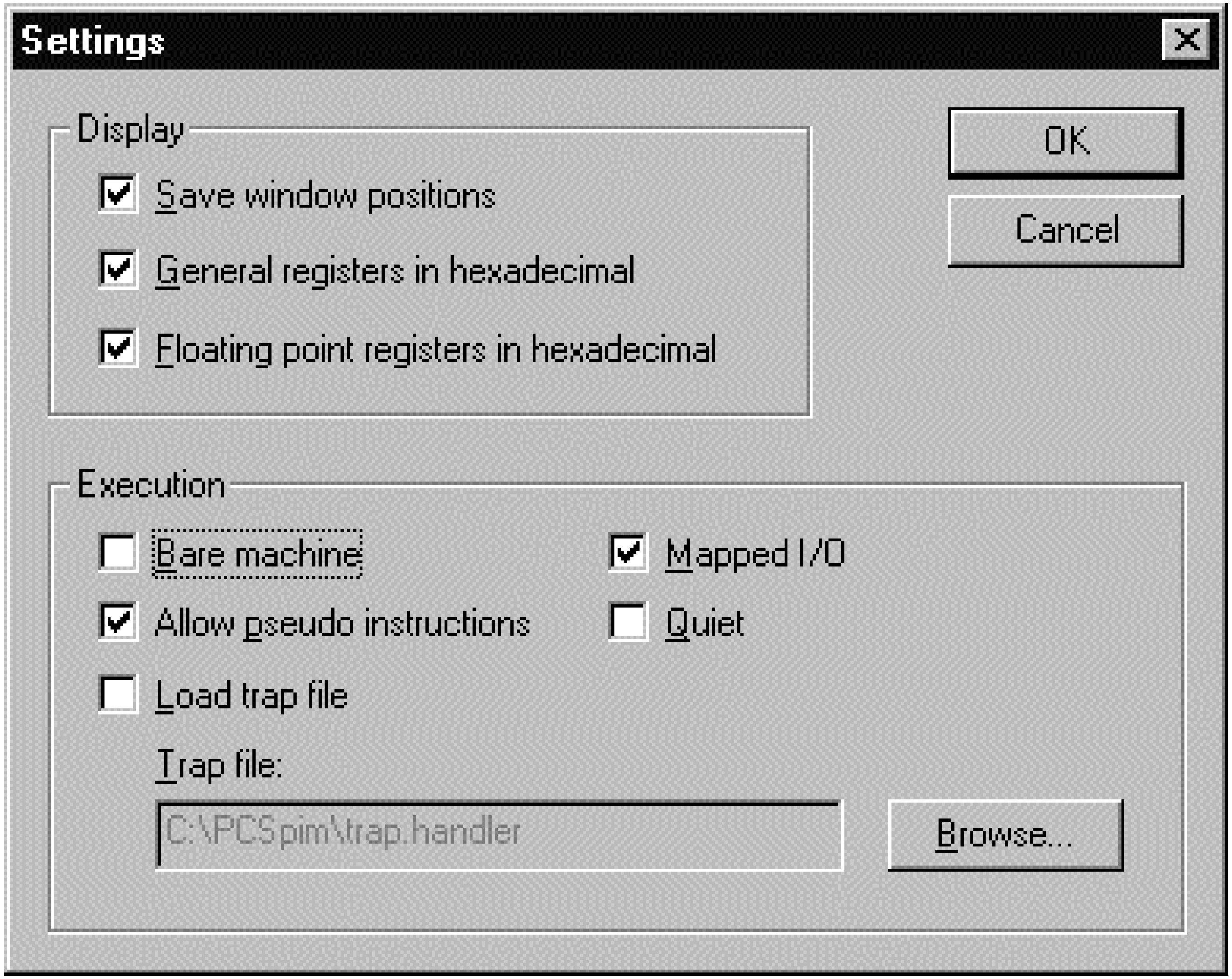
MIPS addresing modes



SPIM simulator - main window



SPIM simulator - the settings to run a program



Operating system services

Service	$v0	Input	Output
print_int 0	1	$a0 = integer	
print_float 0	2	$f12 = float	
print_double	3	$f12 = double	
print_string 0	4	$a0 = string	
read_int 0	5		integer in $v0
read_float 0	6		float in $f0
read_double	7		double in $f0
read_string 0	8	$a0 = buffer, $a1 = length	
sbrk 0	9	$a0 = amount	address (in $v0)
exit	10		

Example: print 25 on console

```
addi $v0, $0, 1          # load service code
addi $a0, $0, 25   # load argument
syscall                  # call the operating system
```