At the time this was assigned computer accounts and solution templates were not ready. If they become available they can be used for the solution, either way a paper submission is acceptable.

Problem 1: Write a MIPS assembly language program that copies and converts an array of integers to an array of doubles. Use the template below.

```
################################################################################
## cpy_w_to_dbl

        ## Register Usage
        #
        # $a0:  Procedure input: Address of start of integer array (to read).
        # $a1:  Procedure input: Length of integer array.
        # $a2:  Procedure input: Address of start of double array (to write).

        .globl cpy_w_to_dbl
cpy_w_to_dbl:
        # Your code can modify $a0-$a2 and $t registers.
        # A correct solution uses 8 instructions (not including jr, nop),
        #  a different number of instructions are okay.
        # Points will be deducted for obviously unnecessary instructions.
        #
        # Solution starts here.
        sll $a1, $a1, 2
        add $a1, $a1, $a0

LOOP:
        lwc1 $f0, 0($a0)
        cvt.d.w $f0, $f0
        sdc1 $f0, 0($a2)
        addi $a0, $a0, 4
        bne $a0, $a1, LOOP
        addi $a2, $a2, 8


        jr $ra
        nop
```

Problem 2: What do the Sun compiler `-xarch` and `-xchip` options as used below do, and what are the equivalent gcc 2.95 (GNU C compiler) switches.

```
 cc myprog.c -o myprog -xarch=v8 -xchip=super
```

See `http://gcc.gnu.org/onlinedocs/` for gcc and `http://docs.sun.com` for the Sun Forte C 6 / Sun Workshop 6 cc compiler.

Option `-xarch=v8` specifies that the compiler should emit v8 instructions. The closest equivalent gcc switch is `-mcpu=v8`. The `-xchip=super` option tells the compiler to select and arrange instructions for a supersparc chip. The equivalent gcc option is `-mtune=supersparc`.

Problem 3: In Sun's CINT2000 SPEC Benchmark disclosure for the Sun Blade 1000 Model 900 Cu they specify a `-xregs=syst` compiler flag for several of the benchmarks compiled under the peak rules. *Hint: Use a search engine to find this rare flag. Guess what many of the search hits are to?*

(*a*) What does this flag do?

It tells the compiler that it can use registers normally reserved for the system.

(*b*) How does it improve performance? *Hint: It affects one of the few low-level optimizations covered in class up to this point.*

It eases the register assignment problem. That is, because more registers are available for compiler use the compiler can leave more values in registers rather than writing and reading them from memory.

(*c*) How often could this option be used in the real world?

The Sun documentation explains that the option cannot be used when system libraries are used, which almost every program uses. So the option could not be used very often.

Problem 4: Benchmark suites are suites because a single program might run well on a processor that runs most other code poorly.

At `http://www.spec.org` find the fastest processors using the "result" numbers from the SPEC CINT2000 benchmarks in the following categories: The fastest two Pentium 4s, the fastest Athlon, and the fastest Alpha. (Figure out how to get a result-sorted list of machines that shows processor type.)

The solutions below are based on: Intel D850EMV2 motherboard (2.8 GHz, Pentium 4 processor) (`http://www.spec.org/osg/cpu2000/results/res2002q3/cpu2000-20020827-01581.html`), Intel D850EMV2 motherboard (2.67 GHz, Pentium 4 processor) (`http://www.spec.org/osg/cpu2000/results/res2002q3/cpu2000-20020827-01583.html`), HP AlphaServer ES45 68/1250 (`http://www.spec.org/osg/cpu2000/results/res2002q3/cpu2000-20020801-01512.html`), and the Epox 8KHA+ Motherboard, AMD Athlon (TM) XP 2600+ (`http://www.spec.org/osg/cpu2000/results/res2002q3/cpu2000-20020812-01551.html`). (Note, the links won't work forever.)

(*a*) What programs might an unfair Intel advocate want removed from the suite?

The Alpha outperforms the Pentium on the vpr and mcf benchmarks, so the unfair Intel advocate would want those removed. The Athlon outperforms the Pentium on crafty and eon, so the unfair person would want those removed too.

For the parts below consider the relative performance of the programs in the suite. (Put the bar graphs for two different systems side by side and note the difference in shape.)

(*b*) Why might one expect the top two Pentia to be very similar? Are they in fact very similar?

It appears from the name that they only differ in clock frequency. (This could be verified from the Processors' datasheets.) The internal design of the two processors are the same and so they would share the same strengths and weaknesses running programs. However, though the clock frequencies of the processor cores are different, other parts of the system, for example, the memory bus, are the same and so the performance of the faster chip will not be $\frac{2.8}{2.67}$ faster on every benchmark.

(*c*) Why might one expect the Athlon to be more similar to the Pentium than to the Alpha? Does it?

The Pentium and Athlon have similar ISAs, while the Pentium and Alpha have very different ISAs. If the instruction set was the only thing that determined performance then the Pentium and Athlon would be identical. If the instruction set had no impact on performance the Pentium would differ from the Athlon as much as it does from Alpha. The reality is between the two, the instruction set has some (perhaps relatively small) impact on performance.

The Athlon does appear more similar to the Pentium than the Alpha.