COSC230 Tutorials No. 1

(1) The procedure multiply in page 23 can be explained by using the following hand calculation.

```
          1 1 1     a=7
  1 0 1 0 1 0 1     b=85
-------------------------
          1 1 1     a * 1
        0 0 0     2 a * 0
      1 1 1       2 a * 1
    0 0 0         2 a * 0
  1 1 1           2 a * 1
0 0 0             2 a * 0
1 1 1             2 a * 1
-------------------------
1 0 0 1 0 1 0 0 1 1     595
```

The computation of while loop proceeds from top to bottom in this figure. In each iteration in the loop, a is doubled and b is halved. The least significant bit of b is tested. If it is 1, a is added to z. Explain procedure divide in the same page in a similar way.

(2) The following program multiply two numbers with addition and subtraction.

```
{x>=0}
a:=x; b:=y; z:=0;
while a>0 do begin
  z:=z+b; a:=a-1
end. {z=x*y}
```

Which multiply is more efficient? Give the reason.

(3) The following program divides x by y.

```
{y>0}
r:=x; q:=0; w:=y;
while w <= r do begin
  r:=r-w; q:=q+1
end.  {x=q*y+r and 0 <= r < y, q is quotient, r is remainder}
```

Which divide is more efficient? Give the reason.

(4) Trace procedure gcd in page 23 with x=84 and y=35.

(5) The procedure gcd in page 23 can be rewritten as follows:

```
procedure gcd;
  var f, g, h;
begin
  f:=x; g:=y;
  while g > 0 do begin
    h:=f mod g;
    f:=g;
    g:=h
  end
end.
```

Trace this procedure with the same x and y.

(6) This prcedure is further modified into

```
procedure gcd;
  var f : history of degree 1;
begin
  f:=x; f:=y;
  while f > 0 do f:=f<1> mod f
end.
{ f<1> = gcd(x, y) }
```

f has two words; one for the current value the other for the previous value. If a new value is assigned with f, the current value is moved to f<1> automatically.

Trace this procedure with the same x and y.

(7) Enhance the syntax chart of PL/0 with array declaration like

```
var a : array[lower .. upper];
```

where lower and upper are constants and array reference like a[i], a[i+j], etc.

(8) Enhance the chart with repeat statement.

(9) Enhance the chart with go to statement.

(10) Enhance the chart with if-then-else statement.
If you enhance the chart in this question, there will be ambiguity like

```
if B1 then if B2 then S1 else S2
if B1 then (if B2 then S1 else S2)
if B1 then (if B2 then S1) else S2
```

Semantically these two interpretations cause different results. Give such an example.

(11) Trace the object code in page 36 with x=3 and y=5. Trace the changes on the stack s.