Exercise 3

Objective function: Max: Z = x1 + 2 x2

subject to:

$2x_1 + 4x_2 \leq 20$

$x_1 + x_2 \leq 8$

and $x_1 \quad x_2 \geq 0$

$Z - x1 - 2x2 = 0$

$2x_1 + 4x_2 + S1 \leq 20$

$x_1 + x_2 + S2 \leq 8$

and $x_1 \quad x_2 \quad S1 \quad S2 \geq 0$

Solving with the SIMPLEX:

			z	x1	x2	s1	s2	RHS	racio
	R0	z	1	-1	-2	0	0	0	-
*R1*1/4*	R1	s1	0	2	4	1	0	20	5
	R2	s2	0	1	1	0	1	8	8

			z	x1	x2	s1	s2	RHS	racio
*R0-(-2)*R1*	R0	z	1	0	0	0.5	0	10	-
	R1	x2	0	0.5	1	0.25	0	5	10
*R2-(1)*R1*	R2	s2	0	0.5	0	-0.25	1	3	6

non-basic variables: x1 s1 **basic variables:** x2 s2

Having a non-basic variable with a coeff of zero in R0 is indicative of multiple solutions.
Solution A: (x1, x2) = (0, 5) and Z= 10. If we now force x1 to enter the basis we'll see that the solution will lead to the same Z value

			z	x1	x2	s1	s2	RHS
	R0	z	1	0	0	0.5	0	10
*R1-(0.5)*R2*	R1	x2	0	0	1	0.5	-1	2
*R2*2*	R2	x1	0	1	0	-0.5	2	6

Solution B: (x1, x2, s1, s2) = (2, 6, 0, 0) and Z= 10

Solution A: (x1, x2, s1, s2) = (0, 5, 0,3) and Z= 10.

Exercise 4

Objective function: Max: $Z = x_1 + x_2$

subject to:

$x_1 + x_2 \leq 4$

$2x_1 + x_2 \leq 6$

$x_1 + 2x_2 \leq 6$

and $x_1 \; x_2 \geq 0$

$Z - x1 - x2 = 0$

$x1 + x2 + S1 \leq 4$

$2x1 + x2 + S2 \leq 6$

$x1 + 2x2 + S3 \leq 6$

and $x_1 \; x_2 \; S1 \; S2 \; S3 \geq 0$

Tie in leaving variable leads to a basic variable =0 in the next tableau (S3), thus we're in the presence of a degenerate solution

Solving with the SIMPLEX:

Tie in entering variable: arbitrairy choice - let's choose x1

			z	x1	x2	s1	s2	s3	RHS	racio
	R0	z	1	-1	-1	0	0	0	0	-
	R1	s1	0	1	1	1	0	0	4	4
	R2	s2	0	2	1	0	1	0	6	3
	R3	s3	0	1	2	0	0	1	6	6

			z	x1	x2	s1	s2	s3	RHS
	R0	z	1						
	R1	s1	0						
*R2*1/2*	R2	X1	0	1	0.5	0	0.5	0	3
	R3	s3	0						

Tie in leaving variable: arbitrairy choice - let's choose s1

			z	x1	x2	s1	s2	s3	RHS	racio
	R0	z	1	0	-0.5	0	0.5	0	3	-
	R1	s1	0	0	0.5	1	-0.5	0	1	2
	R2	X1	0	1	0.5	0	0.5	0	3	6
	R3	s3	0	0	1.5	0	-0.5	1	3	2

			z	x1	x2	s1	s2	s3	RHS
	R0	z	1						
*R1*2*	R1	X2	0	0	1	2	-1	0	2
	R2	X1	0						
	R3	s3	0						

			z	x1	x2	s1	s2	s3	RHS
*R0-(-0.5)*R1*	R0	z	1	0	0	1	0	0	4
	R1	X2	0	0	1	2	-1	0	2
*R2-(0.5)*R1*	R2	X1	0	1	0	-1	1	0	2
*R3-(1.5)*R1*	R3	s3	0	0	0	-3	1	1	0

Exercise 5

Objective function: Max: $Z = x_1 + x_2$

subject to:

$x_1 \leq 10$

$x_1 - 3x_2 \leq 15$

$x_1 - x_2 \leq 20$

and $x_1 \; x_2 \geq 0$

Z - x1 - x2 = 0

x1 + S1 ≤ 10

x1 - 3 x2 +S2 ≤ 15

x1 - x2 +S3 ≤ 20

and $x_1 \; x_2$ S1 S2 S3 ≥ 0

Solving with the SIMPLEX:

Tie in entering variable: arbitrairy choice - let's choose x1

			z	x1	x2	s1	s2	s3	RHS	racio
	R0	z	1	-1	-1	0	0	0	0	-
	R1	X1	0	1	0	1	0	0	10	10
	R2	s2	0	1	-3	0	1	0	15	15
	R3	s3	0	1	-2	0	0	1	20	20

			z	x1	x2	s1	s2	s3	RHS	racio
*R0-(-1)*R1*	R0	z	1	0	-1	1	0	0	10	-
	R1	x1	0	1	0	1	0	0	10	-
*R2-(1)*R1*	R2	s2	0	0	-3	-1	1	0	5	-1.7
*R3-(1)*R1*	R3	s3	0	0	-2	-1	0	1	10	-5

The 2nd entering variable is x2 (please note all coeff. in this column are either negative or zero, a sign we might have problems with the min racio test. Then we confirm we do not meet the min racio test criteria: choosing the smallest positive value (all values are either zero or negative). Thus we are in the presence of an ilimited solution and we say we have an unbound problem

Exercise 6

Objective function: Min: $Z = 2x_1 - 3x_2 - 4x_3$

subject to:

$x_1 + 5x_2 - 3x_3 \leq 15$

$x_1 + x_2 + x_3 \leq 11$

$5x_1 - 6x_2 + x_3 \leq 4$

and $x_1\ x_2\ x_3 \geq 0$

Z - 2 x1 + 3 x2 + 4 x3 = 0

x1 + 5 x2 - 3 x3 + S1 ≤ 15

x1 + x2 + x3 + S2 ≤ 11

5 x1 - 6 x2 + x3 + S3 ≤ 4

and $x_1\ x_2\ x_3$ S1 S2 S3 ≥ 0

Please note we will solve this as minimization problem, thus we'll have to reverse the optimality and entering var. criteria

In forestry problems it is not common to get a negative value for the objective function, but it is not impossible. After the class I got thinking and the problem could be, for example, related to the minimizing the temperature so that a certain bacteria wouldn't be able to replicate.

Solving with the SIMPLEX:

Because the problem is soved as a minimization problem, we'll choose as entering variable the one with the biggest positive value (x3).If we were maximizing the choice would fall on the one with the smallest negative value. The criteria for the min racio test remains unchanged!

			z	x1	x2	x3	s1	s2	s3	RHS	racio
*R0-(-1)*R1*	**R0**	z	1	-2	3	4	0	0	0	0	-
	R1	s1	0	1	5	-3	1	0	0	15	-5
*R2-(1)*R1*	**R2**	s2	0	1	1	1	0	1	0	11	11
*R3-(1)*R1*	**R3**	s3	0	**5**	**-6**	**1**	**0**	**0**	**1**	**4**	**4**

			z	x1	x2	x3	s1	s2	s3	RHS	racio
*R0-(4)*R3*	**R0**	z	1	-22	27	0	0	0	-4	-16	-
*R1-(-3)*R3*	**R1**	s1	0	16	-13	0	1	0	3	27	-2
*R2-(1)*R3*	**R2**	s2	**0**	**-4**	**7**	**0**	**0**	**1**	**-1**	**7**	1
	R3	x3	0	5	-6	1	0	0	1	4	-1

The next entering variable is X2 (biggest positive value) and the leaving var is S2

			z	x1	x2	x3	s1	s2	s3	RHS
	R0	z	1							
	R1	s1	0							
*R2*1/7*	**R2**	x2	0	**-0.6**	**1**	**0**	**0**	**0.1**	**-0.1**	**1**
	R3	x3	0							

			z	x1	x2	x3	s1	s2	s3	RHS
*R0-(27)*R2*	**R0**	z	1	-6.6	0	0	0	-3.9	-0.1	-43
*R1-(-13)*R2*	**R1**	s1	0	8.6	0	0	1	1.9	1.1	40
	R2	x2	0	-0.6	1	0	0	0.1	-0.1	1
*R3-(-6)*R2*	**R3**	x3	0	1.6	0	1	0	0.9	0.1	10

There are no more positive coeff in R0, thus we've reached the optimal solution is (x1, x2, x3, S1, S2, S3) = (0, 1, 10, 40, 0, 0) and Z = -43. All resources were used for s2 and s3 but 40 resource units were left unused for the resource represented by constraint 1 (S1 = 40)

Exercise 7

Objective function: Max: $Z = 10x1 + 30x2$

subject to:

$x_1 \leq 15$

$x_1 - x_2 \leq 20$

$-3x_1 + x_2 \geq -30$

and $x_1 \geq 0 \quad x2 \leq 0$

solve the negative RHS:

$3x_1 - x_2 \leq 30$

solve the nonpositive x2:

$x2' = -x2$ with $x2' \geq 0$

the new problem will be:

Objective function: Max: $Z = 10x1 - 30x2'$

subject to:

$x_1 \leq 15$

$x_1 + x_2' \leq 20$

$3x_1 + x_{2'} \leq 30$

and $x1 \quad x2' \geq 0$

the standard problem for the new model:

$Z - 10x1 + 30x2'$

$x_1 + S1 \leq 15$

$x_1 + x_2' + s2 \leq 20$

$3x_1 + x_2' + S3 \leq 30$

and $x1 \quad x2' \quad S1 \quad S2 \quad S3 \geq 0$

Solving with the SIMPLEX:

			z	x1	x2'	s1	s2	s3	RHS	racio
*R0-(-1)*R1*	**R0**	z	1	-10	30	0	0	0	0	-
	R1	s1	0	1	0	1	0	0	15	15
*R2-(1)*R1*	**R2**	s2	0	1	1	0	1	0	20	20
*R3-(1)*R1*	**R3**	s3	0	3	1	0	0	1	30	10

			z	x1	x2'	s1	s2	s3	RHS
	R0	z	1						
	R1	s1	0						
	R2	s2	0						
*R3*1/3*	**R3**	x1	0	1	0.3	0	0	0.3	10

			z	x1	x2'	s1	s2	s3	RHS
*R0-(-10)*R3*	**R0**	z	1	0	33.3	0	0	3.3	100
*R1-(1)*R3*	**R1**	s1	0	0	-0.3	1	0	-0.3	5
*R2-(1)*R3*	**R2**	s2	0	0	0.7	0	1	-0.3	10
	R3	x1	0	1	0.3	0	0	0.3	10

There are no more negative coeff in R0, thus we've reached the optimal solution is (x1, x2', S1, S2, S3) = (10, 0, 5, 10, 0) and Z =100. Please note that since x2' = -x2 thus x2 =0. All resources were used for constraint 3, but 5 and 10 resource units were left unused for the resources represented by constraints 1 and 2 (S1 = 5, S2 = 10)

Solution to the real problem (x1, x2, S1, S2, S3) = (10, 0, 5, 10, 0), Z = 100

Exercise 8

Objective function: Max: Z = - x2

subject to:

$x_1 + x_2 + x_3 \le 100$

x1 - 5 X2 ≤ 40

$x_3 \ge -10$

and $x_1 \ge 0$ x2 ≤ 0 x3 unbounded

solve the negative RHS:

$-x_3 \le 10$

solve the nonpositive x2:

x2' = -x2 with x2' ≥ 0

solve the unbounded x3:

$x3 = X3^+ - X3^-$

the standard problem for the new model:

Z + x2 -> Z -x2' = 0

$x1 - x2' + X3^+ - X3^- + S1 = 100$

x1 + 5 x2' + S2 = 40

$- X3^+ + X3^- + S3 = 10$

and $x1\ x2'\ x3^+\ X3^-\ S1\ S2\ S3 \ge 0$

Solving with the SIMPLEX:

The entering variable is X2' (negative value) and the leaving var is S2

		z	x1	x2'	$x3^+$	$x3^-$	s1	s2	s3	RHS	racio
R0	z	1	0	-1	0	0	0	0	0	0	-
R1	s1	0	1	-1	1	-1	1	0	0	100	-100
R2	s2	0	1	5	0	0	0	1	0	40	8
R3	s3	0	0	0	-1	1	0	0	1	10	-

			z	x1	x2'	x3+	x3-	s1	s2	s3	RHS	
	R0	z	1									
	R1	s1	0									
*R2*1/5*	R2	s2	0	0.2	1	0	0	0	0.2	0	8	8
	R3	s3	0									

			z	x1	x2'	x3+	x3-	s1	s2	s3	RHS
*R0-(-1)*R2*	R0	z	1	0.2	0	0	0	0	0.2	0	8
*R1-(-1)*R2*	R1	s1	0	1.2	0	1	-1	1	0.2	0	108
	R2	x2'	0	0.2	1	0	0	0	0.2	0	8
	R3	s3	0	0	0	-1	1	0	0	1	10

There are no more negative coeff in R0, thus we've reached the optimal solution:

(x1, x2', X3+, X3-,S1, S2, S3) = (0, 8, 0, 0, 108, 0, 10) and Z =8

Please note that: since x2' = -x2 and X3 = x3+ - x3-, then x2 = -8 and X3 = 0; the solution for the original problem is:

(x1, x2, X3,S1, S2, S3) = (0, -8, 0, 108, 0, 10) and Z = -X2, Z = -(-8) => Z = 8

Not all resources were used for constraints 1 and 3 (108 and 10 units of each resource were respectively left unused: S1 =108 and S3 = 10)

Exercise 9

Objective function: Min: $Z = 4x1 + 2x2$

subject to:

$2x1 - x2 \geq 4$

$x1 + x2 \geq 5$

and $x_1 \; x2 \geq 0$

$Z = 4x_1 + 2x_2 + Ma_1 + Ma_2$

$2x_1 - x_2 - S_1 + a_1 = 4$

$x_1 + x_2 - S_2 + a_2 = 5$

and $x_1, x_2, S_1, S_2, a_1, a_2 \geq 0$

Where *a1 = 4 - 2 x1 + x2 + S1*

a2 = 5 - x1 - x2 + S2

Replacing in the OF: ⇒

Min $Z = 4x_1 + 2x_2 + M(4 - 2x_1 + x_2 + S_1) + M(5 - x_1 - x_2 + S_2)$

Min $Z = 4x_1 + 2x_2 + 4M - 2Mx_1 + Mx_2 + MS_1 + 5M - Mx_1 - Mx_2 + MS_2$

Min $Z = 4x_1 - 2Mx_1 - Mx_1 + 2x_2 + Mx_2 - Mx_2 + MS_1 + MS_2 + 4M + 5M$

Min $Z = 4x_1 - 3Mx_1 + 2x_2 + MS_1 + MS_2 + 9M$

Min $Z = (4 - 3M)x_1 + 2x_2 + MS_1 + MS_2 + 9M$

$Z - (4 - 3M)x1 - 2x2 - MS1 - MS2 = 9M$

Solving with the SIMPLEX:

Because this is a minimization problem the selection criteria for the entering variable is finding the biggest positive value in R0, thus X1 is the entering variable. The criteria for the leaving variable remains unaltered

		z	x1	x2	s1	s2	a1	a2	RHS	racio
R0	Min z	1	3M - 4	-2	-M	-M	0	0	9M	-
R1	a1	0	2	-1	-1	0	1	0	4	2
R2	a2	0	1	1	0	-1	0	1	5	5

			z	x1	x2	s1	s2	a1	a2	RHS
	R0	Min z								
*R1*1/2*	R1	x1	0	1	-0.5	-0.5	0	0.5	0	2
	R2	a2	0							

			z	x1	x2	s1	s2	a1	a2	RHS
*R0-(3M - 4)*R1*	R0	Min z	1	0	-4 +3/2M	1/2M - 2	-M	-3/2M + 2	0	3M +8
*R1*1/2*	R1	x1	0	1	-0.5	-0.5	0	0.5	0	2
*R2-(1)*R1*	R2	a2	0	0	1.5	0.5	-1	-0.5	1	3

*R0-(3M - 4)*R1:*

x1 (3M - 4) - (3M - 4)*1 = 0 3M-4-3M+4 = 3M-3M-4+4=0

x2 -2-(3M - 4)*(-0.5) = -2 -(- 3/2M + 2) = -4 +3/2M

s1 -M - (3M -4)* (-0.5) = -M -(-3/2M + 2) = -M +3/2M -2 = 1/2M - 2

s2 -M - (3M -4)* (0) = - M

a1 0 - (3M - 4) *(0.5) = -3/2M + 2

a2 0 -(3M - 4) *(0) = 0

RHS 9M - (3M - 4)*(2) = 9M - 6M + 8 = 3M +8

We haven't reached the optimal solution because there are still 2 positive coeff (x2 and S1), so we *choose the biggest positive one*

Exercise 9 (cont.)

Solving with the SIMPLEX:

		z	x1	x2	s1	s2	a1	a2	RHS	racio
R0	Min z	1	0	-4 +3/2M	1/2M - 2	-M	-3/2M + 2	0	3M +8	-
R1	x1	0	1	-0.5	-0.5	0	0.5	0	2	-4
R2	a2	0	0	1.5	0.5	-1	-0.5	1	3	2

			z	x1	x2	s1	s2	a1	a2	RHS
	R0	Min z	1							
	R1	x1	0							
*R2*2/3*	R2	x2	0	0	1	0.3	-0.7	-0.3	0.7	2

			z	x1	x2	s1	s2	a1	a2	RHS
*R0-(-4+3/2M)*R2*	R0	Min z	1	0	0	-0.66667	-8/3	-M+2/3	8/3-M	16
*R1-(-0.5)*R2*	R1	x1	0	1	0	-0.3	-0.3	0.3	0.3	3
	R2	x2	0	0	1	0.3	-0.7	-0.3	0.7	2

*R0-(3M - 4)*R1:*

x1 0

x2 0

s1 (1/2M - 2) - (-4+3/2M)*1/3 = 1/2M-2 -(-4/3+ 2/3M*1/3) = (-6 + 4)/2 = -2/3

s2 - M - (-4+3/2M)*(-2/3) = -M - ((4*2)/3 - 3/2*2/3M) = -M - 8/3 +M = -8/3

a1 -3/2M + 2 - (3/2M - 4)*(-1/3) = -3/2M + 2 - (-3/2*1/3M + 4/3) = -3/2M + 2 + 1/2M - 4/3 = -M + 2/3

a2 0 - (3/2M - 4)*(2/3) = -(3/2*2/3M-4*2/3) = -(M-8/3) = 8/3-M

RHS 3M +8 - (3/2M-4)*(2) = 3M +8 - (3M -8) = 3M - 3M + 8 + 8 =16

There are no more positive coeff in R0, thus we've reached the optimal solution:

(x1, x2, S1, S2) = (3, 2, 0, 0) and Z = 16

Exercise 11

Max: $Z = 3x_1 + 2x_2$
Subject to: $2x_1 + x_2 \leq 9$
$x_1 + 2x_2 \leq 9$

$x_1, \geq 0$; x_2 unbounded

$x2 = x2' - x2''$ $\quad$ $x1, x2', x2'' \geq 0$

Max: $Z = 3x_1 + 2(x_2'-x_2'')$
Subject to: $2x_1 + (x_2'-x_2'') \leq 9$
$x_1 + 2(x_2'-x_2'') \leq 9$

$x_1\ x_2'\ x_2'' \geq 0$

Max: $Z = 3x_1 + 2x_2' - 2x_2''$
Subject to: $2x_1 + x_2' - x_2'' \leq 9$
$x_1 + 2x_2' - 2x_2'' \leq 9$

$x_1\ x_2'\ x_2'' \geq 0$

Max: $Z - 3x_1 - 2x_2' + 2x_2''$
Subject to: $2x_1 + x_2' - x_2'' + S1 = 9$
$x_1 + 2x_2' - 2x_2'' + S2 = 9$

$x_1\ x_2'\ x_2''\ S1\ S2 \geq 0$

entering (x1)

	basic var	z	x1	x2'	x2''	s1	s2	RHS		
	z	1	-3	-2	2	0	0	0		
leaving	s1	0	2	1	-1	1	0	9	4.5	
	s2	0	1	2	-2	0	1	9	9	A: (x1,x2)= (0,0)

(x1, x2',x2'',s1,s2) = 0,0,0,9,9)
z= 0

entering (x2')

	basic var	z	x1	x2'	x2''	s1	s2	RHS		
	z	1	0	-0.5	0.5	1.5	0	13.5		
	x1	0	1	0.5	-0.5	0.5	0	4.5	9	
leaving	s2	**0**	**0**	**1.5**	**-1.5**	**-0.5**	**1**	**4.5**	3	B: (x1,x2)= (4.5,0)

(x1, x2',x2'',s1,s2) = (4.5,0,0,0,4.5)
z= 13.5

basic var	z	x1	x2'	x2''	s1	s2	RHS	
z	1	0	0	0	1.3333	0.3333	15	
x1	0	1	0	0	0.6667	-0.333	3	optimal solution ! C: (x1,x2)= (3,3)
x2'	0	0	1	-1	-0.333	0.6667	3	

(x1, x2',x2'',s1,s2) = (3,3,0,0,0)
z= 15

Solution to the real problem

x2=x2'-x2''
x2=3-0

(x1, x2,s1,s2) = (3,3,0,0)

Exercise 12

Max: $Z = 3x_1 + 4x_2$

Subject to:

$x_1 + x_2 \leq 10$

$5x_1 + 12x_2 \leq 60$

$x_1 + 3x_2 \leq 15$

$x_2 \leq 5$

$x_1, x_2 \geq 0$

Max: $Z - 3x_1 - 4x_2$

$x_1 + x_2 + s1 = 10$

$5x_1 + 12x_2 + s2 = 60$

$x_1 + 3x_2 + s3 = 15$

$x_2 + s4 = 5$

x_1, x_2 S1 s2 s3 s4 ≥ 0

entering: x2

	basic var	z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	-3	-4	0	0	0	0	0	
	s1	0	1	1	1	0	0	0	10	10
leaving	s2	0	5	12	0	1	0	0	60	5
	s3	0	1	3	0	0	1	0	15	5
	s4	0	0	1	0	0	0	1	5	5

1, x2,s1,s2, s3,s4) = (0,0,10,60,15,5)

z= 0

A:

(x1,x2)= (0,0)

entering: x1

	basic var	z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	-1.333	0	0	0.333	0	0	20	
leaving	s1	0	0.583	0	1	-0.083	0	0	5	8.57143
	x2	0	0.417	1	0	0.083	0	0	5	12
	s3	0	-0.25	0	0	-0.25	1	0	0	-
	s4	0	-0.417	0	0	-0.083	0	1	0	-

1, x2,s1,s2, s3,s4) = (0,5,5,0,0)

z= 20

B:

(x1,x2)= (0,5)

basic var	z	x1	x2	s1	s2	s3	s4	RHS
z	1	0	0	2.286	0.143	0	0	31.4
x1	0	1	0	1.714	-0.143	0	0	8.6
x2	0	0	1	-0.714	0.143	0	0	1.4
s3	0	0	0	0.429	-0.286	1	0	2.1
s4	0	0	0	0.714	-0.143	0	1	3.6

1, x2,s1,s2, s3,s4) = (8.6,1.4,0,0,2.1,3.6)

z= 31.428571

C:

(x1,x2)= (8.6,1.4)

optimal solution!!

When facing the tie in the leaving variable for the 1st table if we add chosen a different leaving variable it would have taken us longer (more tables) to solve the problem. I´ve chosen to take out the slack corresponding to the binding constraint (one of the two constraints that determine the optimal cornerpoint). Of course I only knew this because I looked at the graph. For more complex problems when graphing is not possible we choose arbitrarily.

Exercise 12 (cont.)

chosing a different leaving variable:

entering (x2)

		z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	-3	-4	0	0	0	0	0	
	s1	0	1	1	1	0	0	0	10	10
	s2	0	5	12	0	1	0	0	60	5
	s3	0	1	3	0	0	1	0	15	5
leaving	s4	0	0	1	0	0	0	1	5	5

1, x2,s1,s2, s3,s4) = (0,0,10,60,15,5)

z= 0

A:

(x1,x2)= (0,0)

look what happens if we force s2 or s3 to leave the basis (despite these have ratios of 0, shouldn't even be candidates to leave):

entering (x1)

		z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	-3	0	0	0	0	4	20	
	s1	0	1	0	1	0	0	-1	5	5
	s2	0	5	0	0	1	0	-12	0	0
leaving	s3	0	1	0	0	0	1	-3	0	0
	x2	0	0	1	0	0	0	1	5	-

1, x2,s1,s2, s3,s4) = (0,5,5,0,0,0)

z= 20

B:

(x1,x2)= (0,5)

degenerate solution because we have 2 basic variables =0!

Still at point B

entering (s4)

		z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	0	0	0	0	3	-5	20	
	s1	0	0	0	1	0	-1	2	5	2.5
leaving	s2	0	0	0	0	1	-5	3	0	0
	x1	0	1	0	0	0	1	-3	0	0
	x2	0	0	1	0	0	0	1	5	5

1, x2,s1,s2, s3,s4) = (0,5,5,0,0,0)

z= 20

B:

(x1,x2)= (0,5)

degenerate solution because we have 2 basic variables =0!

Still at point B

entering (s3)

		z	x1	x2	s1	s2	s3	s4	RHS	
	z	1	0	0	0	1.667	-5.333	0	20	
leaving	s1	0	0	0	1	-0.667	2.333	0	5	2.14286
	s4	0	0	0	0	0.333	-1.667	1	0	0
	x1	0	1	0	0	1	-4	0	0	0
	x2	0	0	1	0	-0.333	1.667	0	5	3

1, x2,s1,s2, s3,s4) = (0,5,5,0,0,0)

z= 20

B:

(x1,x2)= (0,5)

degenerate solution because we have 2 basic variables =0!

Still at point B

Exercise 12 (cont.)

	z	x1	x2	s1	s2	s3	s4	RHS
z	1	0	0	2.286	0.143	0	0	31.4
s3	0	0	0	0.429	-0.286	1	0	2.1
s4	0	0	0	0.714	-0.143	0	1	3.6
x1	0	1	0	1.714	-0.143	0	0	8.6
x2	0	0	1	-0.714	0.143	0	0	1.4

1, x2,s1,s2, s3,s4) = (8.6,1.4,0,0,2.1,3.6)

z= 31.428571

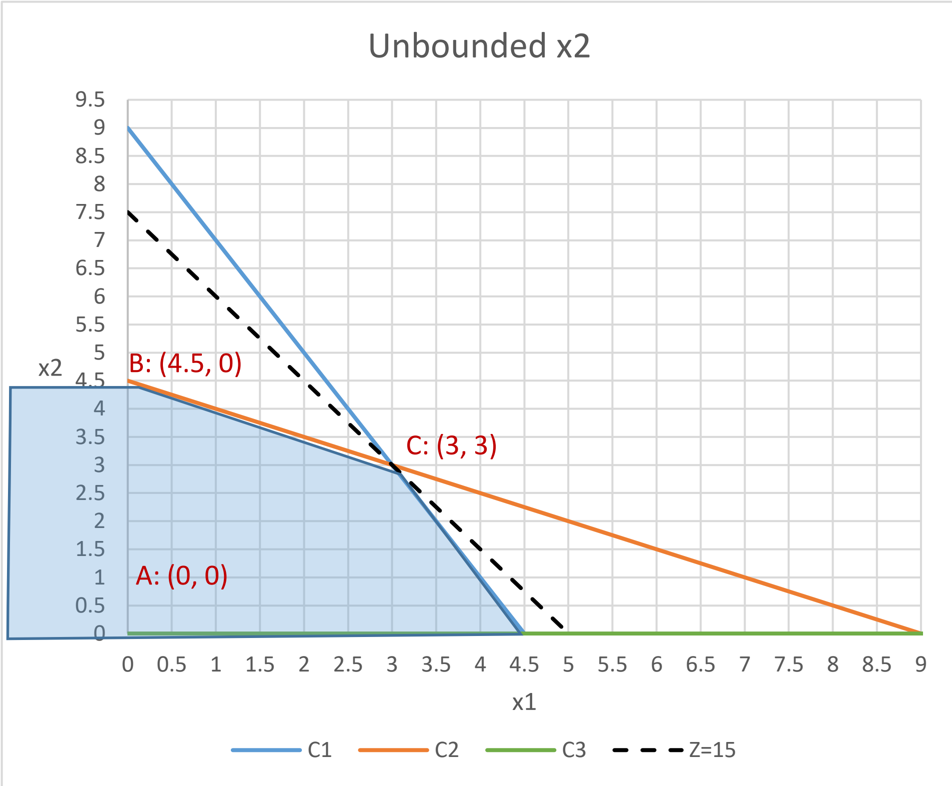
C:

(x1,x2)= (8.6,1.4)

optimal solution!!

Exercise 11

max	**z=**	**3 x1**	**+**	**2 x2**			
Z=15	15	0		7.5			
		5		0			
C1		2 x1	+	1 x2	=	9	
		0		9			
		4.5		0			
C2		1 x1	+	2 x2	=	9	
		0		4.5			
		9		0			
C3		X1			=	0	
		10		0			
		0		0			



Exercise 12

	max	**z=**	**3 x1**	**+**	**4 x2**	
	Z=31.4	35	0		8.8	
			12		0	
		39	1.4		8.6	
C1			1 x1	+	1 x2	= 10
			0		10	
			10		0	
C2			5 x1	+	12 x2	= 60
			0		5	
			12		0	
C3			1 x1	+	3 x2	= 15
			0		5	
			15		0	
C4					X2	= 5
			0		5	
			15		5