3/25

1、 1 = cheesecake　　2. Black Forest

min. $320x_{11} + 330x_{12} + 360x_{13} + 230y_{11} + 270y_{12} + 300y_{13} + 0.5(x_{11} + x_{12} + x_{13} + y_{11} + y_{12} + y_{13})$

s.t.

$x_{11} + 20 - 45 = y_{11}$

$y_{11} + x_{12} - 30 = y_{12}$

$y_{12} + x_{13} - 10 = y_{13}$

$x_{21} + 20 - 25 = y_{21}$

$y_{21} + x_{22} - 35 = y_{22}$

$y_{22} + x_{23} - 20 = y_{23}$

$x_{ij} \geq 0,\ y_{ij} \geq 0 \quad \forall i = 1,2,\ \forall j = 1,2$

2,

min $8x_1 + 12x_2 + 13x_3 + 15x_4$

s.t. $x_1 + x_2 + x_3 + x_4 = 1000$

$0.04x_1 + 0.06x_2 + 0.1x_3 + 0.11x_4 \geq 50$

$0.02x_1 + 0.05x_2 + 0.03x_3 + 0.09x_4 \geq 40$

$0.01x_1 + 0.01x_2 + 0.03x_3 + 0.04x_4 \geq 20$

$x_2 \geq 100$

$x_1, x_3, x_4 \geq 0$

3、 shifts x_{12}. x_{13}. x_{14} x_{23} x_{24} x_{34}

min. $9600(x_{12} + x_{23} + x_{34} + x_{14}) + 12000(x_{13} + x_{24})$

s.t. $x_{12} + x_{13} + x_{14} \geq 12$

$x_{12} + x_{23} + x_{24} \geq 6$

$x_{13} + x_{23} + x_{34} \geq 14$

$x_{14} + x_{24} + x_{34} \geq 17$

$x_{ij} \geq 0 \quad \forall i = 1 \ldots 3,\ j = i+1 \ldots 4$

5.

min $3w$

s.t. $x_1 + 2x_2 \geq 5$

$x_1 + 2x_2 \geq x_1 + x_2$

$2x_1 + 3x_2 = 4$

$w \geq x_2 - 5$

$w \geq 5 - x_2$

$x_i = 0 \quad \forall i = 1,2$

3/25

4. 6.

(a) x_t = products produced

y_t = inventory remained

$$\max \sum_{t=1}^{T} P_t D_t - \sum_{t=1}^{T} x_t C_t - H \sum_{t=1}^{T} y_t$$

s.t. $y_0 = 0$

$y_{t-1} + x_t - D_t = y_t \quad \forall t = 1 \dots T$

$x_t \le k_t \quad \forall t = 1 \dots T$

$x_t \ge 0, \quad y_t \ge 0 \quad \forall t = 1 \dots T$

(b) w_t = the number sold.

$$\max \sum_{t=1}^{T} w_t P_t - \sum_{t=1}^{T} x_t C_t - H \sum_{t=1}^{T} y_t$$

s.t. $y_0 = 0$.

$y_{t-1} + x_t - w_t = y_t \quad \forall t = 1 \dots T$

$x_t \le k_t \quad \forall t = 1 \dots T$

$w_t \le D_t \quad \forall t = 1 \dots T$

$x_t \ge 0, \quad y_t \ge 0, \quad w_t \ge 0 \quad \forall t = 1 \dots T$

7. x_t = product produced.

y_t = inventory remained

$$\max \sum_{t=1}^{T} D_t P_t - \sum_{t=1}^{T} x_t C_t - H \sum_{t=1}^{T} \max\{y_t, 0\} - S \sum_{t=1}^{T} \max\{-y_t, 0\}$$

s.t. $y_0 = 0$

$y_{t-1} + x_t - D_t = y_t \quad \forall t = 1 \dots T$

$x_t \le k_t \quad \forall t = 1 \dots T$.

$x_t \ge 0 \cdot y_t$ urs. $\forall t = 1 \dots T$

(linearized)

$$\Rightarrow \max \sum_{t=1}^{T} D_t P_t - \sum_{t=1}^{T} x_t C_t - H \sum_{t=1}^{T} y_t^{+} - S \sum_{t=1}^{T} y_t^{-}$$

s.t. $y_0 = 0$

$y_{t-1} + x_t - D_t = y_t \quad \forall t = 1 \dots T$

$y_t^{+} \ge y_t \quad \forall t = 1 \dots T$

$y_t^{+} \ge 0$

$y_t^{-} \ge -y_t \quad \forall t = 1 \dots T$

$y_t^{-} \ge 0$.

$x_t \le k_t \quad \forall t = 1 \dots T$.

$x_t \ge 0 \cdot y_t$ urs. $\forall t = 1 \dots T$

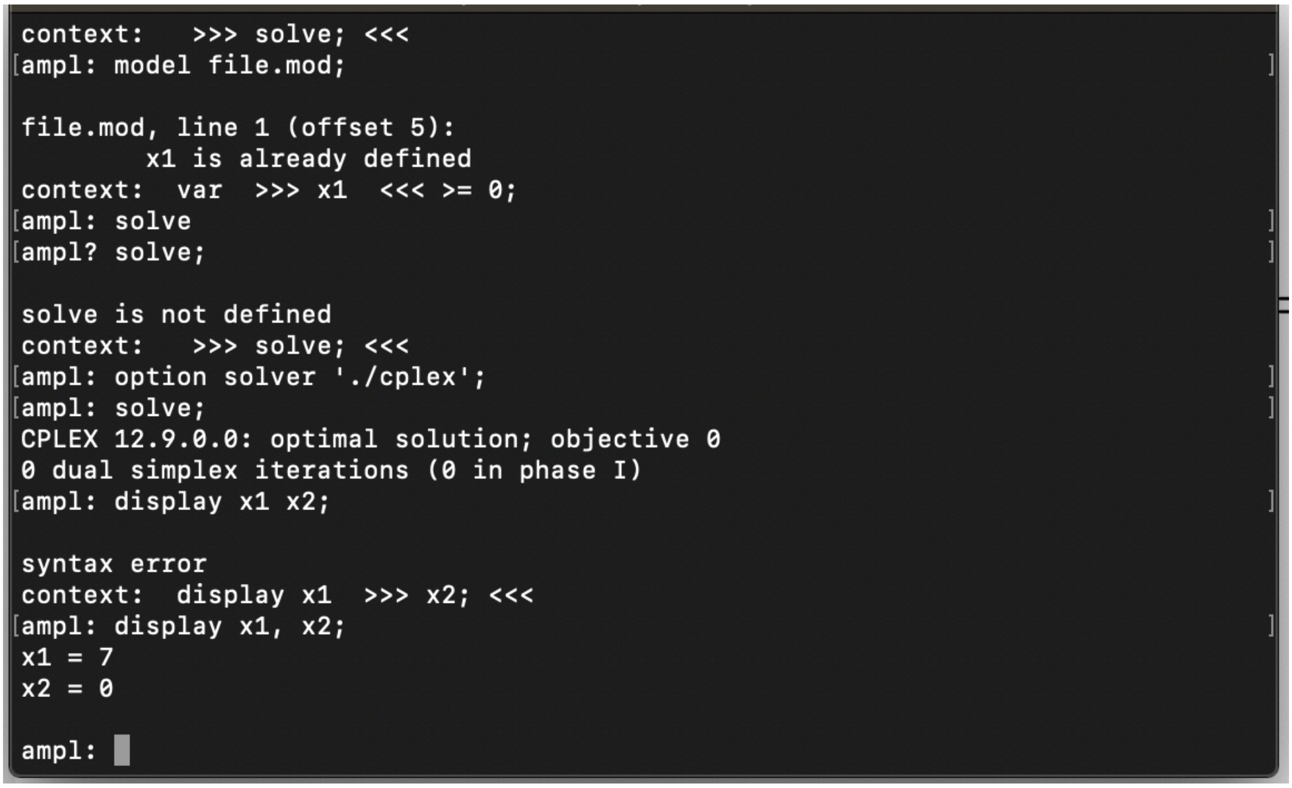
9. The model file contains

```
var x1 >= 0;
var x2 >= 0;

minimize obj: 3 * x2;

subject to constraint1:     x1 + 2 * x2 >= 6;
subject to constraint2: 2 * x1 + 3 * x2 = 14;
```

An optimal solution is $(x_1^*, x_2^*) = (7, 0)$. The associated objective value is $z^* = 0$.



```
context:   >>> solve; <<<
[ampl: model file.mod;

file.mod, line 1 (offset 5):
        x1 is already defined
context:  var  >>> x1  <<< >= 0;
[ampl: solve
[ampl? solve;

solve is not defined
context:   >>> solve; <<<
[ampl: option solver './cplex';
[ampl: solve;
CPLEX 12.9.0.0: optimal solution; objective 0
0 dual simplex iterations (0 in phase I)
[ampl: display x1 x2;

syntax error
context:  display x1  >>> x2; <<<
[ampl: display x1, x2;
x1 = 7
x2 = 0

ampl: 
```

10. The model file contains

```
param N;
param T;

param H;
param K;
param I{i in 1..N};
param D{i in 1..N, t in 1..T};
param C{i in 1..N, t in 1..T};

var x{i in 1..N, t in 1..T} >= 0;
var y{i in 1..N, t in 0..T} >= 0;

minimize cost: sum{i in 1..N, j in 1..T} (C[i, t] * x[i, t] + H * y[i, t]);

subject to capacity{j in 1..T}: sum{i in 1..N} x[i, t] <= K;
subject to inv{i in 1..N, t in 1..T}: y[i, t - 1] + x[i, t] - D[i, t] = y[i, t];
subject to initInv{i in 1..N}: y[i, 0] = I[i];
```


The data file contains

```
param N := 2;
param T := 3;
param K := 60;
param H := 0.5;
param I :=
   1  20
   2  20;
param D :
      1   2   3 :=
   1  45  30  10
   2  25  35  20;
param C :
       1    2    3 :=
   1  320  330  360
   2  230  270  300;
```