www.optimyar.com



# دوره جامع آنلاین بهینه‌سازی استوار و برنامه‌ریزی در شرایط عدم‌قطعیت همراه با کدنویسی در نرم‌افزار(GAMS)

## Decision-Making under Uncertainty (Robust Optimization - Stochastic Programming - Fuzzy Programming)

**مدرس:**

**دکتر علی پاپی (Ali Papi)**

تخصص شاخص: بهینه‌سازی و تحقیق در عملیات، علم تحلیل داده، تکنیک‌های تجزیه و روش‌های حل دقیق، بهینه‌سازی استوار داده‌محور، هوش محاسباتی و الگوریتم‌های فرابتکاری، نظریه بازی، بهینه‌سازی چندهدفه و تصمیم‌گیری چندمعیاره

**Optimization & Operations Research, Data Analytics, Computational Intelligence & Metaheuristics, Decomposition Techniques & Exact Methods, Data-Driven Robust Optimization, Game Theory, Multi Criteria Decision Making**

## کدهای نرم‌افزاری

SCND_pRobust

SCND_Mulvey

SCND_YuLe

SCND_SemiVar

SCND_CCP

SCND_EVPI

SCND_VSS

# SCND_pRobust

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/
;
```

A(s)  = uniform(1000,1500);

f(d)  = uniform(2000,3000);

b(s)  = uniform(5,10);

trSD(s,d)= uniform(1,2);

trDC(d,c)= uniform(0.5,0.7);

p  = 15;

capD(d)  = uniform(500,1000);

capS(s)  = uniform(1000,2000);

dem(c,'w1')  = uniform(50,100);

dem(c,'w2')  = (1+0.8)*dem(c,'w1') ;

dem(c,'w3')  = (1+0.2)*dem(c,'w1') ;

dem(c,'w4')  = (1-0.2)*dem(c,'w1') ;

dem(c,'w5')  = (1-0.3)*dem(c,'w1') ;

dem_N(c)= sum(w,prob(w)*dem(c,w));

Display

A

f

b

trSD

trDC

p

capD

capS

dem

dem_N

;

**********

Free Variable

Z(w)

EB

;

Binary Variables

y(s)

x(d)

v(w)

;

Scalar bigM;

bigM=sum(c,dem_N(c));

Positive Variable

u(s,w)

QSD(s,d,w)

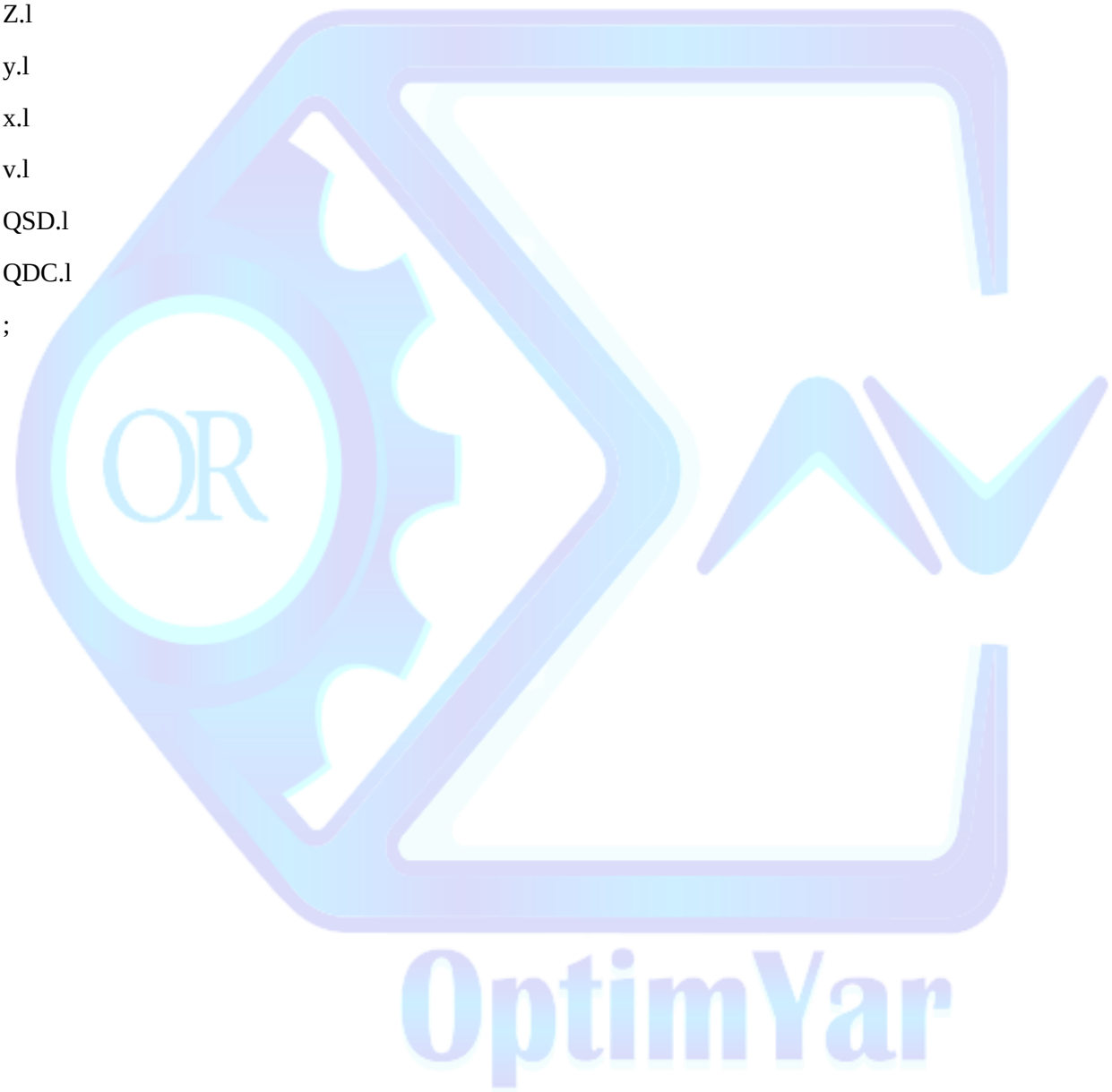
QDC(d,c,w)

;

```
Equations
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consprobust
;


obj_RNSSP..      EB =e= sum(w,Prob(w)*Z(w));


obj_Scenario(w) ..      z(w) =e=   p*sum({d,c},QDC(d,c,w)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) + sum({s,d},trSD(s,d)*QSD(s,d,w))
                                        + sum({d,c},trDC(d,c)*QDC(d,c,w)) + sum(s,b(s)*u(s,w))) ;


cons1(s,w)..       u(s,w) =L= capS(s)*y(s);


cons2(d,w)..       sum(S,QSD(s,d,w))=L= capD(d)*x(d);


cons3(s,w)..       u(s,w) =e= sum(d,QSD(s,d,w));


cons4(d,w)..       sum(s,QSD(s,d,w)) =e= sum(c,QDC(d,c,w));


cons5(c,w)..       sum(d,QDC(d,c,w)) =l= dem(c,w);
```

```
cons6(c,w)..      sum(d,QDC(d,c,w)) =g= 0.5*dem(c,w) - (1-v(w))*bigM;


scalar pay /0.9/;


consprobust..     sum(w,Prob(w)*v(w))=g=pay;



Model SCND
/
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consprobust
/
;


Options
mip = CPLEX
reslim =100
optcr = 0
;
```

```
Solve SCND us mip max EB;


Display
EB.l
Z.l
y.l
x.l
v.l
QSD.l
QDC.l
;
```



# SCND_Mulvey

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/


;
```

```
A(s)     = uniform(1000,1500);
f(d)     = uniform(2000,3000);
b(s)     = uniform(5,10);
trSD(s,d)= uniform(1,2);
trDC(d,c)= uniform(0.5,0.7);
p        = 15;
capD(d)  = uniform(500,1000);
capS(s)  = uniform(1000,2000);



dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;


dem_N(c)= sum(w,prob(w)*dem(c,w));



Display
A
f
b
trSD
trDC
p
```

capD

capS

dem

dem_N

;

**********

Free Variable

Z_Mulvey

Z(w)

EB

;

Binary Variables

y(s)

x(d)

v(w)

;

Scalar bigM;

bigM=sum(c,dem_N(c));

Positive Variable

Var

PCV "constraint violations"

phi(w)

```
u(s,w)
QSD(s,d,w)
QDC(d,c,w)
;

Equations
obj_Mulvey
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consVar
consP
;

Scalar
lamda
Say
;

lamda=0.0001;
Say=1/10;

obj_Mulvey..     Z_Mulvey=e=  EB  -lamda*Var - Say*PCV;
```

obj_RNSSP.. EB =e= sum(w,Prob(w)*Z(w));

obj_Scenario(w) .. z(w) =e= p*sum({d,c},QDC(d,c,w)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) + sum({s,d},trSD(s,d)*QSD(s,d,w))
+ sum({d,c},trDC(d,c)*QDC(d,c,w)) + sum(s,b(s)*u(s,w))) ;

cons1(s,w).. u(s,w) =L= capS(s)*y(s);

cons2(d,w).. sum(S,QSD(s,d,w))=L= capD(d)*x(d);

cons3(s,w).. u(s,w) =e= sum(d,QSD(s,d,w));

cons4(d,w).. sum(s,QSD(s,d,w)) =e= sum(c,QDC(d,c,w));

cons5(c,w).. sum(d,QDC(d,c,w)) =l= dem(c,w);

cons6(c,w).. sum(d,QDC(d,c,w)) =g= 0.5*dem(c,w) - phi(w);

consVar.. Var =g= sum(w,Prob(w)*(EB-Z(w))*(EB-Z(w)));

consP.. PCV =e= sum(w,Prob(w)*phi(w));

Model SCND

/

```
obj_Mulvey
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consVar
consP
/
;


Options
MIQCP = CPLEX
reslim =100
optcr = 0
;



Solve SCND us MIQCP max Z_Mulvey;


Display
EB.l
Var.l
PCV.l
Z.l
y.l
```

x.l

QSD.l

QDC.l

;

# SCND_YuLe

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/
;
```

```
A(s)     = uniform(1000,1500);
f(d)     = uniform(2000,3000);
b(s)     = uniform(5,10);
trSD(s,d)= uniform(1,2);
trDC(d,c)= uniform(0.5,0.7);
p        = 15;
capD(d)  = uniform(500,1000);
capS(s)  = uniform(1000,2000);


dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;

dem_N(c)= sum(w,prob(w)*dem(c,w));


Display
A
f
b
trSD
trDC
p
```

capD

capS

dem

dem_N

;

**********

Free Variable

Z_YuLe

Z(w)

EB

;

Binary Variables

y(s)

x(d)

v(w)

;

Scalar bigM;

bigM=sum(c,dem_N(c));

Positive Variable

SD

PCV "constraint violations"

phi(w)

teta(w)

u(s,w)

```
QSD(s,d,w)
QDC(d,c,w)
;

Equations
obj_YuLe
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consSD
consP
consteta
;

Scalar
lamda
Say
;

lamda=0.0001;
Say=1/10;

obj_YuLe..     Z_YuLe=e=  EB  -lamda*SD - Say*PCV;
```

```
obj_RNSSP..      EB =e= sum(w,Prob(w)*Z(w));

obj_Scenario(w) ..      z(w) =e=   p*sum({d,c},QDC(d,c,w)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) + sum({s,d},trSD(s,d)*QSD(s,d,w))
                                    + sum({d,c},trDC(d,c)*QDC(d,c,w)) + sum(s,b(s)*u(s,w))) ;

cons1(s,w)..       u(s,w) =L= capS(s)*y(s);

cons2(d,w)..       sum(S,QSD(s,d,w))=L= capD(d)*x(d);

cons3(s,w)..       u(s,w) =e= sum(d,QSD(s,d,w));

cons4(d,w)..       sum(s,QSD(s,d,w)) =e= sum(c,QDC(d,c,w));

cons5(c,w)..       sum(d,QDC(d,c,w)) =l= dem(c,w);

cons6(c,w)..       sum(d,QDC(d,c,w)) =g= 0.5*dem(c,w) - phi(w);

consSD..          SD =g= sum(w,Prob(w)*(2*teta(w)-(EB-Z(w))));

consP..           PCV =e= sum(w,Prob(w)*phi(w));

consteta(w)..       teta(w) =g=  EB-Z(w);

Model SCND
/
```

obj_YuLe

obj_RNSSP

obj_Scenario

cons1

cons2

cons3

cons4

cons5

cons6

consSD

consP

consteta

/

;

Options

MIP = CPLEX

reslim =100

optcr = 0

;

Solve SCND us MIP max Z_YuLe;

Display

EB.l

SD.l

PCV.l

Z.l

y.l

x.l

QSD.l

QDC.l

;

# SCND_SemiVar

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/
;
```

```
A(s)     = uniform(1000,1500);
f(d)     = uniform(2000,3000);
b(s)     = uniform(5,10);
trSD(s,d)= uniform(1,2);
trDC(d,c)= uniform(0.5,0.7);
p        = 15;
capD(d)  = uniform(500,1000);
capS(s)  = uniform(1000,2000);


dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;

dem_N(c)= sum(w,prob(w)*dem(c,w));


Display
A
f
b
trSD
trDC
p
```

capD

capS

dem

dem_N

;

**********

Free Variable

Z_SV

Z(w)

EB

;

Binary Variables

y(s)

x(d)

v(w)

;

Scalar bigM;

bigM=sum(c,dem_N(c));

Positive Variable

SV

Gama(w)

u(s,w)

```
QSD(s,d,w)
QDC(d,c,w)
;

Equations
obj_SV
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consSV
consGama
;

Scalar
lamda
Say
;

lamda=0.0001;


obj_SV..     Z_SV=e=  EB  - lamda*SV ;
```

```
obj_RNSSP..      EB =e= sum(w,Prob(w)*Z(w));


obj_Scenario(w) ..      z(w) =e=   p*sum({d,c},QDC(d,c,w)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) +
sum({s,d},trSD(s,d)*QSD(s,d,w))
                                    + sum({d,c},trDC(d,c)*QDC(d,c,w)) + sum(s,b(s)*u(s,w))) ;


cons1(s,w)..       u(s,w) =L= capS(s)*y(s);


cons2(d,w)..       sum(S,QSD(s,d,w))=L= capD(d)*x(d);


cons3(s,w)..       u(s,w) =e= sum(d,QSD(s,d,w));


cons4(d,w)..       sum(s,QSD(s,d,w)) =e= sum(c,QDC(d,c,w));


cons5(c,w)..       sum(d,QDC(d,c,w)) =l= dem(c,w);


cons6(c,w)..       sum(d,QDC(d,c,w)) =g= 0.5*dem(c,w) ;


consSV..          SV =g= sum(w,Prob(w)*power(Gama(w),2));


consGama(w)..      Gama(w) =g= EB - z(w);




Model SCND

/

obj_SV
```

```
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
cons6
consSV
consGama
/
;


Options
MIQCP = CPLEX
reslim =100
optcr = 0
;



Solve SCND us MIQCP max Z_SV;


Display
EB.l
SV.l
Z.l
y.l
x.l
QSD.l
```

QDC.l

;

# SCND_CCP

Sets

S /s1*s10/

D /d1*d20/

C /c1*c30/

w /w1*w5/

;

Parameters

A(s)

f(d)

b(s)

trSD(s,d)

trDC(d,c)

p_L

P_U

*P= price is a unifoem RV

Lamda_capS(s)

*CapS = Capacity of suppliers is exponetial RV

dem(c,w)

dem_N(c)

capD(d)

Prob(w)

/

w1 0.2

w2 0.3

w3 0.1

w4 0.2

w5 0.2

/

;

A(s) = uniform(1000,1500);

f(d) = uniform(2000,3000);

b(s) = uniform(5,10);

trSD(s,d)= uniform(1,2);

trDC(d,c)= uniform(0.5,0.7);

p_L = 10;

p_U = 20;

capD(d) = uniform(500,1000);

Lamda_capS(s) = 1/uniform(1000,2000);

```
dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;

dem_N(c)= sum(w,prob(w)*dem(c,w));
```

**********

```
Free Variable
Z;

Binary Variables
y(s)
x(d)
;

Positive Variable
u(s)
QSD(s,d)
QDC(d,c)
;

Equations
obj
cons1
```

```
cons2
cons3
cons4
cons5
;



Scalars
alfa1 /0.8/
alfa2 /0.3/
;


obj..    z =l=  (P_L + (1-alfa1)*(P_U-P_L))*sum({d,c},QDC(d,c)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s))
+ sum({s,d},trSD(s,d)*QSD(s,d))
                                        + sum({d,c},trDC(d,c)*QDC(d,c)) + sum(s,b(s)*u(s))) ;


cons1(s)..       u(s) =L=-Log(alfa2)/Lamda_capS(s)*y(s);


cons2(d)..       sum(S,QSD(s,d))=L= capD(d)*x(d);


cons3(s)..       u(s) =e= sum(d,QSD(s,d));


cons4(d)..       sum(s,QSD(s,d)) =e= sum(c,QDC(d,c));


cons5(c)..       sum(d,QDC(d,c)) =l= dem_N(c);
```

```
Model SCND
/
obj
cons1
cons2
cons3
cons4
cons5
/
;


Options
mip = CPLEX
reslim =100
optcr = 0
;



Solve SCND us mip max Z;


Display
Z.l
y.l
x.l
QSD.l
QDC.l
;
```

# SCND_EVPI

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
dem_w(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/
;
```

```
A(s)     = uniform(1000,1500);
f(d)     = uniform(2000,3000);
b(s)     = uniform(5,10);
trSD(s,d)= uniform(1,2);
trDC(d,c)= uniform(0.5,0.7);
p        = 15;
capD(d)  = uniform(500,1000);
capS(s)  = uniform(1000,2000);



dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;


dem_N(c)= sum(w,prob(w)*dem(c,w));



Display
A
f
b
trSD
trDC
```

p

capD

capS

dem

dem_N

;

**********

Free Variable

AR

RR

Z_w

Z(w)

EB

WB

;

Binary Variables

y(s)

x(d)

;

Positive Variable

u(s,w)

QSD(s,d,w)

QDC(d,c,w)

u_w(s)

QSD_w(s,d)

QDC_w(d,c)

;

Equations

obj_AR

obj_RNSSP

obj_RASSP

obj_Scenario

obj_w

cons1

cons2

cons3

cons4

cons5

cons1_w

cons2_w

cons3_w

cons4_w

cons5_w

;

**********

obj_w .. Z_w =e= p*sum({d,c},QDC_w(d,c)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) + sum({s,d},trSD(s,d)*QSD_w(s,d))

+ sum({d,c},trDC(d,c)*QDC_w(d,c)) + sum(s,b(s)*u_w(s))) ;

```
cons1_w(s)..      u_w(s) =L= capS(s)*y(s);

cons2_w(d)..      sum(S,QSD_w(s,d))=L= capD(d)*x(d);

cons3_w(s)..      u_w(s) =e= sum(d,QSD_w(s,d));

cons4_w(d)..      sum(s,QSD_w(s,d)) =e= sum(c,QDC_w(d,c));

cons5_w(c)..      sum(d,QDC_w(d,c)) =l= dem_w(c);
**********

Model SCND_W
/
obj_w
cons1_w
cons2_w
cons3_w
cons4_w
cons5_w
/
;

Options
Optcr=0;
```

```
Parameters
ZS(w);

Loop(w,

dem_w(c)=dem(c,w) ;
Solve SCND_w us mip max Z_w;

ZS(w)= Z_w.l;

);
*end of loop

Display  ZS;


Scalar PIV,EVPI ;

PIV=  sum(w,prob(w)*ZS(w));

EVPI= PIV - 6763.496;

Display EVPI;
```

# SCND_VSS

```
Sets
S       /s1*s10/
D       /d1*d20/
C       /c1*c30/
w       /w1*w5/
;


Parameters
A(s)
f(d)
b(s)
trSD(s,d)
trDC(d,c)
p
dem(c,w)
dem_N(c)
capD(d)
capS(s)
Prob(w)
/
w1      0.2
w2      0.3
w3      0.1
w4      0.2
w5      0.2
/


;
```

```
A(s)     = uniform(1000,1500);
f(d)     = uniform(2000,3000);
b(s)     = uniform(5,10);
trSD(s,d)= uniform(1,2);
trDC(d,c)= uniform(0.5,0.7);
p        = 15;
capD(d)  = uniform(500,1000);
capS(s)  = uniform(1000,2000);



dem(c,'w1')   = uniform(50,100);
dem(c,'w2')   = (1+0.8)*dem(c,'w1') ;
dem(c,'w3')   = (1+0.2)*dem(c,'w1') ;
dem(c,'w4')   = (1-0.2)*dem(c,'w1') ;
dem(c,'w5')   = (1-0.3)*dem(c,'w1') ;


dem_N(c)= sum(w,prob(w)*dem(c,w));



Display
A
f
b
trSD
trDC
p
```

capD

capS

dem

dem_N

;

**********

Free Variable

Z(w)

EB

;

Binary Variables

y(s)

x(d)

;

*Nominal

y.fx(s)=0;

y.fx('s1')=1;

y.fx('s3')=1;

x.fx(d)=0;

x.fx('d7')=1;

x.fx('d15')=1;

x.fx('d17')=1;

Positive Variable

u(s,w)

QSD(s,d,w)

QDC(d,c,w)

;

Equations

obj_RNSSP

obj_Scenario

cons1

cons2

cons3

cons4

cons5

;

obj_RNSSP.. EB =e= sum(w,Prob(w)*Z(w));

obj_Scenario(w) .. z(w) =e= p*sum({d,c},QDC(d,c,w)) - (sum(d,f(d)*x(d)) + sum(s,A(s)*y(s)) + sum({s,d},trSD(s,d)*QSD(s,d,w))

+ sum({d,c},trDC(d,c)*QDC(d,c,w)) + sum(s,b(s)*u(s,w))) ;

cons1(s,w).. u(s,w) =L= capS(s)*y(s);

cons2(d,w).. sum(S,QSD(s,d,w))=L= capD(d)*x(d);

```
cons3(s,w)..      u(s,w) =e= sum(d,QSD(s,d,w));

cons4(d,w)..      sum(s,QSD(s,d,w)) =e= sum(c,QDC(d,c,w));

cons5(c,w)..      sum(d,QDC(d,c,w)) =l= dem(c,w);



Model SCND
/
obj_RNSSP
obj_Scenario
cons1
cons2
cons3
cons4
cons5
/
;

Options
mip = CPLEX
reslim =100
optcr = 0
;


Solve SCND us mip max EB;
```

Scalar VSS;

VSS= 6763.496-EB.l;

Display

EB.l

Z.l

y.l

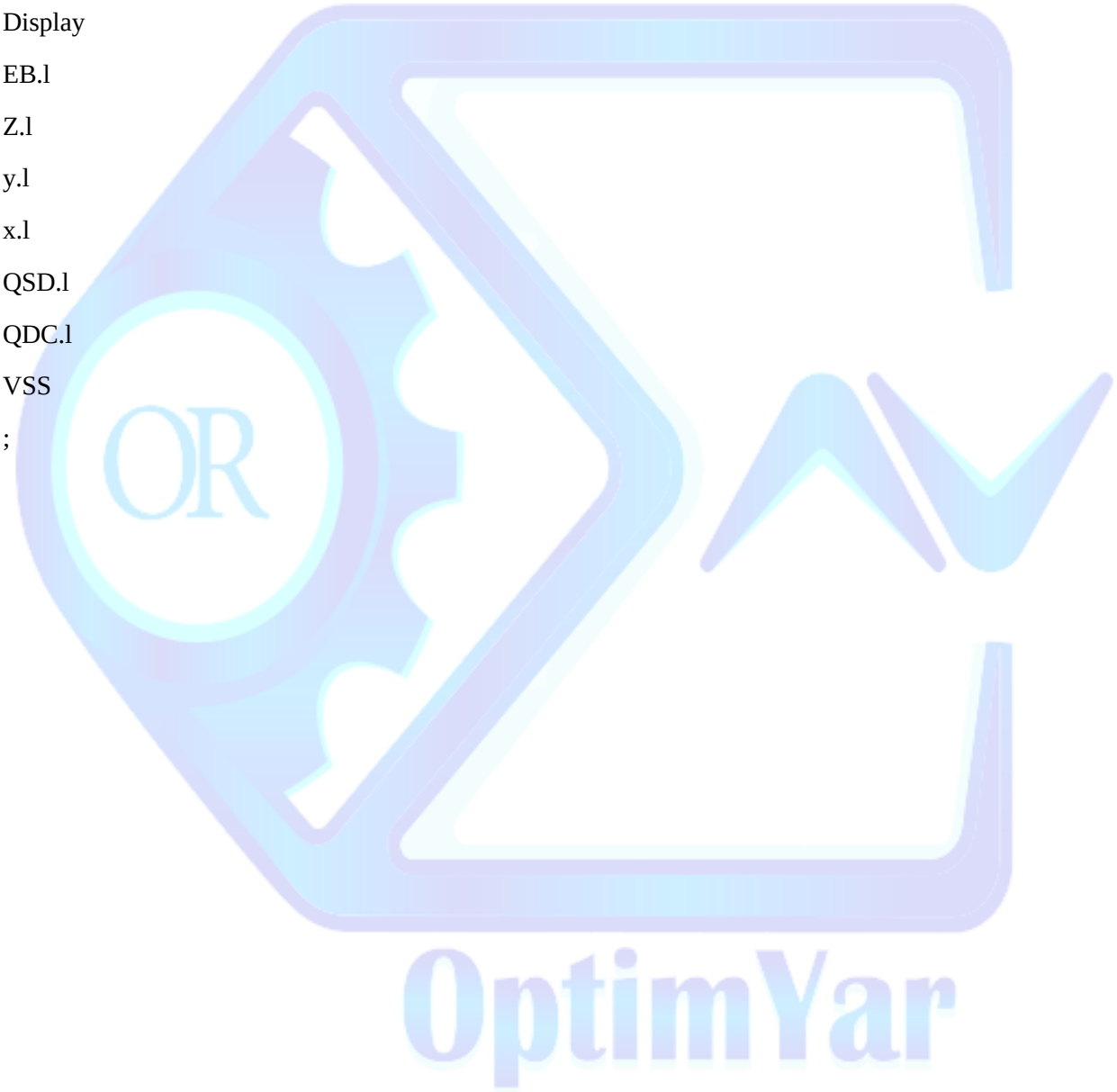
x.l

QSD.l

QDC.l

VSS

;



www.optimyar.com

دوره جامع آنلاین بهینه‌سازی استوار و برنامه‌ریزی در شرایط عدم‌قطعیت همراه با کدنویسی در نرم‌افزار(GAMS)

**Decision-Making under Uncertainty (Robust Optimization - Stochastic Programming - Fuzzy Programming)**

**مدرس:**

**دکتر علی پاپی (Ali Papi)**

**تخصص شاخص:** بهینه‌سازی و تحقیق در عملیات، علم تحلیل داده، تکنیک‌های تجزیه و روش‌های حل دقیق، بهینه‌سازی استوار داده‌محور، هوش محاسباتی و الگوریتم‌های فراابتکاری، نظریه بازی، بهینه‌سازی چندهدفه و تصمیم‌گیری چندمعیاره

**Optimization & Operations Research, Data Analytics, Computational Intelligence & Metaheuristics, Decomposition Techniques & Exact Methods, Data-Driven Robust Optimization, Game Theory, Multi Criteria Decision Making**