BANA 7020
OPTIMIZATION
Section - 2

Optimization in Fantasy Sports

A case study

Submitted by

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1. INTRODUCTION

Fantasy sports is a multibillion dollar industry that gathers players from around the world. The competition consists in selecting virtual or fantasy teams composed by players from a pool of games. The virtual teams are ranked according to the real score achieved by the players in the team. Contestants compete for money or other prizes usually via webpages like DraftKings or FanDuel.

This report presents the modeling and implementation of a computational solution for a challenging case study on Fantasy Sports.

2. PROBLEM STATEMENT 1

Consider a fantasy football competition in which each contestant can participate with at most one fantasy team or entry. Each player has a salary that must be paid to get the player into the entry, a projected score that is an estimation of how many points will the player achieve, and a corresponding position: Quarterback (QB), Running Back (RB), Wide Receiver (WR), Tight End (TE), Defense (DST). Objective is to select an entry with the maximum projected score.

Data for the players is in the attached file

2.1.CONSTRAINTS

Constraints for selecting the entry are:

a. Each entry consists of 6 players
b. The total combined salary of the selected players is at most 50,000
c. There must be at least 1 player for each position
d. The sixth player is a flexible player that can be either a RB, WR, or TE

2.2.MATHEMATICAL FORMULATION

This problem is modeled as an integer linear program as follows:

Decision Variables:

$$x_i = 1, if\ player\ i\ is\ selected; 0, otherwise$$

Parameters:

$$Salary_i = Salary\ of\ i^{th}\ player$$

$$ProjectedScore_i = Projected\ Score\ of\ i^{th}\ player$$

$$K = \{QB, RB, WR, TE, DST\}$$

Objective function:

$$Maximize \sum_{i=1}^{100} ProjectedScore_i * x_i$$

Constraints

$$\sum_{i=1}^{100} x_i \ = 6$$

$$\sum_{i=1}^{100} Salary_i * x_i \leq 50000$$

$$\sum_{i \in K} x_i \geq 1 \quad for\ all\ K$$

2.3.SOLUTION

The solution to the problem is computed using FICO Xpress IVE Version 1.24.26. Refer to Appendix for code.

Selected fantasy team as per the solution obtained:

Name	Position	Salary	Projected Score
A.J. Green	WR	5831	23
Mark Ingram	RB	5929	24
Lamar Jackson	QB	6442	25
Brandon Weeden	QB	8891	25
Charles Clay	TE	6260	16
Vikings	DST	10432	25

Value of Objective function is 138

3. PROBLEM STATEMENT 2

Our second challenge is to select a second team which is not exactly same as the first team already selected.

3.1.MATHEMATICAL FORMULATION

This problem is modeled as an integer linear program as follows:

Decision Variables:

$$x_i = 1, if\ player\ i\ is\ selected\ in\ entry\ 1; 0, otherwise$$
$$y_i = 1, if\ player\ i\ is\ selected\ in\ entry\ 2; 0\ otherwise$$
$$w_i = 1, if\ player\ i\ is\ in\ both\ entries; 0\ otherwise$$

Parameters:

$$Salary_i = Salary\ of\ i^{th}\ player$$

$$ProjectedScore_i = Projected\ Score\ of\ i^{th}\ player$$

K = {QB, RB, WR, TE, DST}

Objective function:

$$Maximize \sum_{i=1}^{100} ProjectedScore_i * x_i \ + \sum_{i=1}^{100} ProjectedScore_i * y_i$$

Constraints

$$\sum_{i=1}^{100} x_i \ = 6$$

$$\sum_{i=1}^{100} Salary_i * x_i \leq 50000$$

$$\sum_{i \in K} x_i \geq 1 \quad for\ all\ K$$

$$\sum_{i=1}^{100} y_i \ = 6$$

$$\sum_{i=1}^{100} Salary_i * y_i \leq 50000$$

$$\sum_{i \in K} y_i \geq 1 \quad for\ all\ K$$

$$\sum_{i=1}^{100} w_i \leq 5$$

$$w_i \geq x_i + y_i - 1\ for\ all\ i = 1, \ldots..100$$
$$w_i \leq y_i \ \ for\ all\ i = 1, \ldots..100$$
$$w_i \leq x_i\ for\ all\ i = 1, \ldots\ldots..100$$

3.2.SOLUTION

The solution to the problem is computed using FICO Xpress IVE Version 1.24.26. Refer to Appendix for code.

Selected fantasy team as per the solution obtained:

Name	Entry	Position	Salary	Projected Score
A.J. Green	1	WR	5831	23
Mark Ingram	1	RB	5929	24
Lamar Jackson	1	QB	6442	25
Brandon Weeden	1	QB	8891	25
Charles Clay	1	TE	6260	16
Vikings	1	DST	10432	25
A.J. Green	2	WR	5831	23

Joe Mixon	2	RB	8405	24
Lamar Jackson	2	QB	6442	25
Brandon Weeden	2	QB	8891	25
Charles Clay	2	TE	6260	16
Vikings	2	DST	10432	25

Value of Objective function is 276.

4. APPENDIX

Code for Problem Statement 1

```
!@encoding CP1252
model CoolName
uses "mmxprs"; !gain access to the Xpress-Optimizer solver

!sample declarations section
declarations
    N = 1..100
    Name: array(N) of string
    Position: array(N) of string
    Salary: array(N) of integer
    ProjectedScore: array(N) of integer
    x: array(N) of mpvar
    num_dst=0
    num_QB=0
    num_RB=0
    num_TE=0
    num_WR=0
end-declarations
 forall(i in N) do
    x(i) is_binary
 end-do

initializations from 'PlayerData.txt'
    Name
    Position
    Salary
    ProjectedScore
end-initializations

Objective:= (sum(i in N) x(i) * ProjectedScore(i))

sum(i in N) Salary(i)*x(i) <= 50000
sum(i in N) x(i) =6

 x(3)+ x(5)+ x(6)+ x(8)+ x(9)+ x(12)+
x(14)+ x(20)+ x(23)+ x(26)+ x(29)+ x(32)+
x(35)+ x(38)+ x(41)+ x(46)+ x(50)+ x(54)+
x(69)+ x(72)+ x(73)+ x(74)+ x(75)+ x(77)+
```

```
x(78)+ x(79)+ x(80)+ x(81)+ x(83)+ x(84)+
x(88)+ x(91)+ x(95)+ x(96)>=1

x(13)+ x(37)+ x(56)+ x(76)+ x(82)+ x(99)+
x(100)>=1

x(1)+ x(2)+ x(4)+ x(7)+ x(11)+ x(15)+
x(18)+ x(19)+ x(22)+ x(24)+ x(27)+ x(30)+
x(40)+ x(43)+ x(49)+ x(52)+ x(53)+ x(59)+
x(60)+ x(62)+ x(63)+ x(64)+ x(68)+ x(85)+
x(87)+ x(89)+ x(90)+ x(92)+ x(93)+ x(94)+
x(98)>=1

x(10)+ x(16)+ x(17)+ x(21)+ x(25)+ x(28)+
x(31)+ x(33)+ x(34)+ x(36)+ x(39)+ x(42)+
x(44)+ x(45)+ x(47)+ x(48)+ x(51)+ x(55)+
x(57)+ x(58)+ x(61)+ x(65)+ x(66)+ x(67)+
x(70)>=1

x(71)+ x(86)+ x(97)>=1

 maximize(Objective)

 writeln("Total satisfaction score: ", getobjval)
  forall(l in N) do
  if(getsol(x(l))>0) then
    writeln("Player ", l," position is ",Position(l))
   end-if
   end-do
end-model
```

Solution Obtained

```
 Total satisfaction score: 138
 Player 9 position is WR
 Player 27 position is RB
 Player 44 position is QB
 Player 47 position is QB
 Player 82 position is TE
 Player 86 position is DST
```

Code for Problem Statement 2

```
!@encoding CP1252
model ModelName
uses "mmxprs"; !gain access to the Xpress-Optimizer solver
declarations
    N = 1..100
    Name: array(N) of string
    Position: array(N) of string
    Salary: array(N) of integer
    ProjectedScore: array(N) of integer
    x: array(N) of mpvar
    y: array(N) of mpvar
    w: array(N) of mpvar

end-declarations
```

```
 forall(i in N) do
    x(i) is_binary
 end-do

 forall(i in N) do
    y(i) is_binary
 end-do

  forall(i in N) do
    w(i) is_binary
 end-do

initializations from 'PlayerData.txt'
    Name
    Position
    Salary
    ProjectedScore
end-initializations

Objective:= (sum(i in N) x(i) * ProjectedScore(i)) + (sum(i in N) y(i) *
ProjectedScore(i))

sum(i in N) Salary(i)*x(i) <= 50000
sum(i in N) Salary(i)*y(i) <= 50000
sum(i in N) x(i) =6
sum(i in N) y(i) =6

 x(3)+ x(5)+ x(6)+ x(8)+ x(9)+ x(12)+
x(14)+ x(20)+ x(23)+ x(26)+ x(29)+ x(32)+
x(35)+ x(38)+ x(41)+ x(46)+ x(50)+ x(54)+
x(69)+ x(72)+ x(73)+ x(74)+ x(75)+ x(77)+
x(78)+ x(79)+ x(80)+ x(81)+ x(83)+ x(84)+
x(88)+ x(91)+ x(95)+ x(96)>=1

x(13)+ x(37)+ x(56)+ x(76)+ x(82)+ x(99)+
x(100)>=1

x(1)+ x(2)+ x(4)+ x(7)+ x(11)+ x(15)+
x(18)+ x(19)+ x(22)+ x(24)+ x(27)+ x(30)+
x(40)+ x(43)+ x(49)+ x(52)+ x(53)+ x(59)+
x(60)+ x(62)+ x(63)+ x(64)+ x(68)+ x(85)+
x(87)+ x(89)+ x(90)+ x(92)+ x(93)+ x(94)+
x(98)>=1

x(10)+ x(16)+ x(17)+ x(21)+ x(25)+ x(28)+
x(31)+ x(33)+ x(34)+ x(36)+ x(39)+ x(42)+
x(44)+ x(45)+ x(47)+ x(48)+ x(51)+ x(55)+
x(57)+ x(58)+ x(61)+ x(65)+ x(66)+ x(67)+
x(70)>=1

x(71)+ x(86)+ x(97)>=1

y(3)+ y(5)+ y(6)+ y(8)+ y(9)+ y(12)+
y(14)+ y(20)+ y(23)+ y(26)+ y(29)+ y(32)+
y(35)+ y(38)+ y(41)+ y(46)+ y(50)+ y(54)+
y(69)+ y(72)+ y(73)+ y(74)+ y(75)+ y(77)+
y(78)+ y(79)+ y(80)+ y(81)+ y(83)+ y(84)+
y(88)+ y(91)+ y(95)+ y(96)>=1
y(13)+ y(37)+ y(56)+ y(76)+ y(82)+ y(99)+
y(100)>=1
y(1)+ y(2)+ y(4)+ y(7)+ y(11)+ y(15)+
y(18)+ y(19)+ y(22)+ y(24)+ y(27)+ y(30)+
y(40)+ y(43)+ y(49)+ y(52)+ y(53)+ y(59)+
```

```
y(60)+ y(62)+ y(63)+ y(64)+ y(68)+ y(85)+
y(87)+ y(89)+ y(90)+ y(92)+ y(93)+ y(94)+
y(98)>=1
y(10)+ y(16)+ y(17)+ y(21)+ y(25)+ y(28)+
y(31)+ y(33)+ y(34)+ y(36)+ y(39)+ y(42)+
y(44)+ y(45)+ y(47)+ y(48)+ y(51)+ y(55)+
y(57)+ y(58)+ y(61)+ y(65)+ y(66)+ y(67)+
y(70)>=1
y(71)+ y(86)+ y(97)>=1

sum(i in N) w(i) <=5
forall(i in N) do
w(i)>=x(i)+y(i)-1
w(i)<=y(i)
w(i)<=x(i)
end-do

!sum(i in N)x(i)*Salary(i)>= 1.25*(sum(i in N)y(i)*Salary(i))

 maximize(Objective)

  writeln("Total satisfaction score: ", getobjval)
  forall(l in N) do
  if(getsol(x(l))>0) then
    writeln("Palyer ", l," position is ",Position(l))
   end-if
   if(getsol(y(l))>0) then
    writeln("Player ",l," position is ",Position(l))
   end-if
   end-do
writeln("End running model")

end-model
```

Solution Obtained

```
Total satisfaction score: 276
Palyer 9 position is WR
Player 9 position is WR
Palyer 18 position is RB
Player 27 position is RB
Palyer 44 position is QB
Player 44 position is QB
Palyer 47 position is QB
Player 47 position is QB
Palyer 82 position is TE
Player 82 position is TE
Palyer 86 position is DST
Player 86 position is DST
End running model
```