BANA 7020

OPTIMIZATION

*Section - 2*

Optimization in Fantasy Sports

*A case study*

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# 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.

# 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

# Constraints

Constraints for selecting the entry are:

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

# Mathematical Formulation

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

***Decision Variables:***

***Parameters:***

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

***Objective function:***

***Constraints***

# 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

# Problem Statement 2

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

# Mathematical Formulation

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

***Decision Variables:***

***Parameters:***

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

***Objective function:***

***Constraints***

# 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.

# Problem statement 3

Our third challenge is to define some measure of diversity for the entries and formulate the problem of selecting the second entry as a linear integer program enforcing the measure of diversity proposed.

The measure of diversity that we defined is as following-

Aggregated salary of first team is at least 25% greater than aggregated salary of second team.

# Mathematical Formulation

The mathematical formulation is same as before with an additional constraint -

***Additional Constraints***

# 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 |
| LeSeanMcCoy | 1 | RB | 11862 | 23 |
| 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 |
| MarkIngram | 2 | RB | 5929 | 24 |
| DeSeanJackson | 2 | WR | 5545 | 21 |
| GarrettGilbert | 2 | QB | 5748 | 20 |
| Charles Clay | 2 | TE | 6260 | 16 |
| Vikings | 2 | DST | 10432 | 25 |

Value of Objective function is 266.

# 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

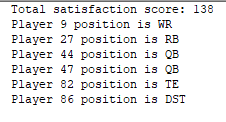
writeln("Player ", l," position is ",Position(l))

end-if

end-do

end-model

*Solution Obtained*



*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

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

if(getsol(y(l))>0) then

writeln("Player ",l," position is ",Position(l))

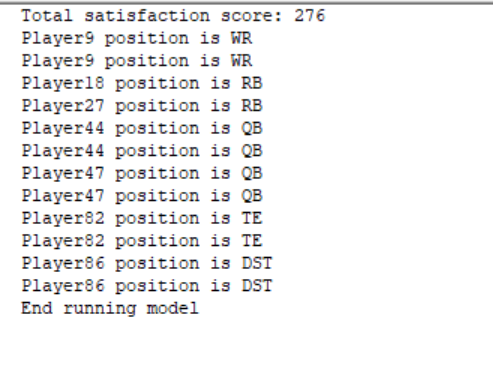
end-if

end-do

writeln("End running model")

end-model

*Solution Obtained*



*Code for Problem Statement 3*

Addional constraint –

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

*Solution Obtained*

