Optimization for a Better Education

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Question: How many professors should our school hire?

Constraints

Ratio

Best Student-to-Teacher ratio

Class

Number of Classes Needed per Semester

Budget

Budget for Professor Salary

Non-Zero Integers

Can't have part of a professor
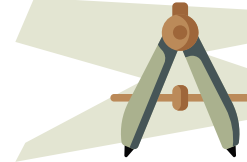
Methods

Ratio

Studies have shown that the most effective student to teacher ratio is 18:1

Class

According to the census, there are different number of classes needed to be taught in each school

Budget

We estimate that CU Denver has set aside $180,000,000 for professor salaries

Formulation

Sets:

S = the schools in CU Denver {business, architecture and planning, liberal arts and sciences, arts and media, education and human development, engineering, public affairs}

Decision Variables:

x_i = # of teachers hired in each school i, $\forall i \in S$

Parameters:

s_i = # students in each school i

r = maximum ratio willing to accept

p_i = average salary of professors in each school i

max_budget = maximum budget for the entire university

c_i = avg. # of classes each professor has to teach in each school i

a_i = minimum # of classes required for each school

Formulation

Objective Function:

Minimize $\sum x_i$

Constraints:

$r * x_i \geq s_i$ (Ratio Constraint)

$\sum p_i * x_i$ max_budget (Salary Budget Constraint)

$c_i * x_i \geq a_i$ (Class Constraint)

$x_i \geq 0$ (Non-negativity)

Our Data

Students:

14,509 total

- 3.1% in Architecture
- 9.6% in Arts and Media
- 16.6% in Business
- 8.8% in Engineering
- 3.4% in Public Affairs
- 56.8% in Liberal Arts and Sciences
- 1.7% in Education and Human Development

Ratio: 18:1

Average Salary:

- $95k in Architecture
- $70k in Arts and Media
- $101k in Business
- $109k in Engineering
- $84k in Public Affairs
- $92k in Liberal Arts and Sciences
- $73k in Education and Human Development

Our Data

Max Budget: $180 million

Average Classes to Teach:

- 2 in Architecture
- 3 in Arts and Media
- 2 in Business
- 3 in Engineering
- 1 in Public Affairs
- 3 in Liberal Arts and Sciences
- 1 in Education and Human Development

Minimum Classes to Teach:

- 96 in Architecture
- 246 in Arts and Media
- 307 in Business
- 154 in Engineering
- 231 in Public Affairs
- 1151 in Liberal Arts and Sciences
- 69 in Education and Human Development

Results

Total Number

1113 Professors

Engineering

71 Professors

Architecture

48 Professors

Public Affairs

231 Professors

Arts + Media

82 Professors

Liberal Arts

458 Professors

Business

154 Professors

Education

69 Professors

Conclusion and Further Work

Reasonable results:

- Architecture (3.1:4.3)

- Arts and Media (9.6:7.4)

- Business (16.6:13.8)

- Engineering (8.8:6.4)

- Public Affairs (3.4:20.8)

- Liberal Arts and Sciences (56.8:41.2)

- Education and Human Development (1.7:6.2)

Future study:

- Run our program for different universities and compare results

- Add more complexity to the problem to more accurately represent it (i.e. Part time and Graduate students/professors)

Questions?