

Solution to Attribute-Based Assignment Problems

A Primer to the University Timetabling Problem

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MTH/2014/014

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March 24, 2019



The Nature of Attributes

Definition

An Attribute is any characteristic of a group of objects that can serve as a basis for classification

Example

- Age
- State of Origin
- Courses offered in current Semester
- Body mass
- O'Level Results
- etc...



Partitions

Definition

A Partition, is a classification of objects based on an ideal value of one or more attributes

Example

- Teens, Young Adults,... (based on the Age attribute of objects)
- Hausa, Igbo, Yoruba,... (based on the State of Origin attribute)
- etc...



Constraints

Definition

A Constraint function, μ , matches the Ideal value of a partition, p_i , to the attribute value of an object, u_j , and assigns a membership value viz:

$$\mu(p_i, u_j) \mapsto [0, 1] \quad i, j \in \mathbf{Z}$$



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Example

NYSC: No student should be posted to their State of Origin.

ANALYSIS: Students should be posted as far as possible from their States of Origin

ATTRIBUTE: The distance of each state from a common point



Classes of Constraints

Definition

- **Binary Constraints** assign a membership value $v \in \{0, 1\}$ to each object
- **Continuous Constraints** assign a membership value $v \in [0, 1]$ to each object

Definition

- **Inclusion Constraints** admit objects based on proximity to the ideal value
- **Exclusion Constraints** admit objects based on distance from the ideal value



The NYSC Posting Problem

Given a number of graduates, we seek to post them to Service States under the following constraints:

- 1 No students should be posted to their State of Origin
- 2 No students should be posted to their States of study
- 3 The maximum capacity of each state must not be exceeded
- 4 All students should be assigned



The States - Partitions

Serial	State	Capacity
1	Osun State	3
2	Kwara State	2
3	Enugu State	1
4	Akwa-Ibom State	5
5	Kano State	1



The Graduates - Objects

Serial	Name	State of Origin	University
u_1	GR01	Kwara(2)	OAU(1)
u_2	GR02	Kwara(2)	BUK(5)
u_3	GR03	Kwara(2)	NSUKKA(3)
u_4	GR04	Kwara(2)	UNILORIN(2)
u_5	GR05	Akwa-Ibom(4)	OAU(1)
u_6	GR06	Akwa-Ibom(4)	BUK(5)
u_7	GR07	Akwa-Ibom(4)	NSUKKA(3)
\vdots	\vdots	\vdots	\vdots
u_{16}	GR16	Kano(5)	AKSU(4)
\vdots	\vdots	\vdots	\vdots
u_{20}	GR20	Enugu(3)	AKSU(4)



Constraint A, $\mu_A: u \mapsto [0, 1]$

Constraint A, μ_A : No student should be posted to their State of Origin

Illustration

$$\mu_{A_j}(u_i) = \frac{(j - s_A(u_i))^2}{1 + (j - s_A(u_i))^2}$$

Example

$$\begin{aligned}\mu_{A_1}(u_1) &= \frac{(1 - s_A(u_1))^2}{1 + (1 - s_A(u_1))^2} \\ &= \frac{(1 - 2)^2}{1 + (1 - 2)^2} \\ &= 0.5 \\ &\vdots\end{aligned}$$



Constraint B, $\mu_B: u \mapsto [0, 1]$

Constraint B, μ_B : No student should be posted to their State of studies

Illustration

$$\mu_{B_j}(u_i) = \frac{(j - s_B(u_i))^2}{1 + (j - s_B(u_i))^2}$$

Example

$$\begin{aligned}\mu_{B_1}(u_1) &= \frac{(1 - s_B(u_1))^2}{1 + (1 - s_B(u_1))^2} \\ &= \frac{(1 - 1)^2}{1 + (1 - 1)^2} \\ &= 0 \\ &\vdots\end{aligned}$$



The Solution

Name	S. of Origin	University	Posting	Membership
GR06	Akwa-Ibom	BUK, Kano	Osun	85%
GR16	Kano	AKSU, Akwa-Ibom	Osun	84%
GR04	Kwara	UNILORIN, Kwara	Akwa-Ibom	64%
GR01	Kwara	OAU, Osun	Akwa-Ibom	45%
GR03	Kwara	NSUKKA, Enugu	Kano	88%
GR05	Akwa-Ibom	OAU, Osun	Kano	47%
GR07	Akwa-Ibom	NSUKKA, Enugu	Kano	45%
GR20	Enugu	AKSU, Akwa-Ibom	Kano	40%
⋮	⋮	⋮	⋮	⋮



The Presentation

Thank You!