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The Evaluation of Child Capacity by Machine Learning According to the Region

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Abstract

Mongolian territory is 1.5 million square kilometers, there are 1.439 kindergartens that include 263.333 children. Mongolia has 5 regional zones. The research was made on selected provinces such as Sukhbaatar district from Ulaanbaatar region, Huvsgul aimag from Khangai region, Umnu-gobi from Central region, Dornod aimag from Eastern region and Bayan-Ulgii from Western region. Total 450 preschool children at age of 3 - 5 years old (30 children at every 3, 4 and 5 years old) were selected randomly, they performed 5 tasks of Math according to the curriculum. The classification of age, sex and region was made under cluster analyses of children's mathematical ability using research method. The purpose of the research is classification of province zone, determination of inequality and difference between rural and urban areas. It is made support for developer's policy and decision makers of education under the base of financing and sharing kindergarten budget, specialization, retraining of teachers and children, developing, elaboration and planning curriculum.

Keywords

Data Mining, Machine Learning, Clustering HCPC, R Programming

1. Introduction

Result of increasing usage of mobile gadgets such as computer, tablet and smart phones in the word's countries with progressive development of computer science and technology in XXI century, we have to study requirement of customer depending on their age, sex and growing environment. Most of the requirements are

related to common customers who are adults no caring above mentioned customers. Under requirement it, Child and Cognitive, Child and Computer Interaction are developed intensively throughout the world.

2. Related Work

Due to demand, devices dedicated to age classification are developed sharply in software. The main objective of the research is to determine the developmental appropriateness of apps for young children and its effects on children's responses through a content analysis of 318 apps and a test of a subset of them (N = 25) with a sample of 53 children aged 3 - 5 [1] research work. It is required to use software programs that based on new methods of research, smart devices and latest children's software programs in the Child and Cognitive training system.

Strategy of Mongolian regional development concept 2010. According to the new general plan of Ulaanbaatar approved by Government, it will be developed as an independent region. It said that the connections of society, culture, economy and institutions for the interprovince will be improved [2]. It was approved assessment procedure of development progress, ability and skills for preschool children [3]. It is intended to study mathematical ability by age classification under the base of selected cities and provinces from regional zone [4] (**Figure 1**).

Lowing the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

3. Methodology

3.1. Research Data Collection

Mongolian provinces are divided into 5 regions, researches were made by sample survey for children of Bayan Ulgii province from Western region, children of Dornod province from Eastern region, children of Umnu Gobi province from Central region, children of Khuvsgul province from Khangai region and children of Sukhbaatar District from Ulaanbaatar city.

Figure 1. 4 and 5 years old participant who perform tasks.

Policy of Mongolian regional development [5] (Figure 2).

3 - 5 years old children of selected provinces and city who participated in the research (Table 1).

The datas were collected by mail and online from teachers of kindergardens from selected regions. Due to COVID-2019, all education system has transferred to online.

The research has started on the 7 January 2021, Mathematics was selected from the preschool education curriculum following "Music and Fine Arts", "Mathematics", "Nature and Social Environment", "Language", "Movement and Health" and "Development of Socializing".

Research data were based on performance of the children according to 5 tasks of the Mathematics [6]. Following are:

Task 1: sorting one and plural;

Task 2: sorting items by size and naming;

Task 3: sorting items by similarity, nominating and connecting;

Task 4: using and recognizing position words;

Task 5: using and recognizing time expressions: now and after.

Task evaluation: it was evaluated such as "very good-5 scores", "good-4 scores", "satisfied-3 score", "bad-3 score", "very bad-3 score". The survey wasn't done due to corona, schools and kindergartens were locked down. Each child performance of the tasks 1 - 5. Tasks 1 - 5 are indicated such as: q1, q2, q3, q4, q5 (Table 2).

Figure 2. Mongolian regional development concept.

Table 1. Chosen participants.

Age, month	Bayan-Ulgii	Dornod	Umnu-Govi	Khuvsgul	UB-SB, District	Total
3 ages	30	30	30	30	30	150
4 ages	30	30	30	30	30	150
5 age	30	30	30	30	30	150
			Total			450

Table 2. Initial 10 components of Bayan-Ulgii.

kidID	Age, month	q1	q2	q3	q4	q5	Aimag
001	3.5	4	3	3	4	2	Bayan-Ulgii
002	3.5	3	2	3	2	2	Bayan-Ulgii
003	3.11	3	2	3	2	2	Bayan-Ulgii
004	3.4	2	1	2	1	1	Bayan-Ulgii
005	3.7	4	2	3	3	4	Bayan-Ulgii
006	3.2	3	3	4	3	2	Bayan-Ulgii
007	3.3	4	3	4	3	3	Bayan-Ulgii
008	3.1	4	3	4	3	3	Bayan-Ulgii
009	3.9	2	1	2	2	1	Bayan-Ulgii
010	3.2	2	1	3	1	1	Bayan-Ulgii

3.2. Research Methodology

Analysis of the Data mining of the Hierarchical Clustering on Principal Components—HCPC is possible to calculate by algorithms of methods PCA, MCA, MFA in program R [4] [7]. Evaluation mathematical ability of the children is measured by next four formulas.

There are as follows, where $|p - p'|$ is the distance between two objects or points, p *and* p'; m_i are the mean for cluster, C_i; and n_i is the number of objects in C_i.

Minimum distance:

$$dist\left(c_i, c_j\right) \min_{p \in c_i, p' \in c_j} \left\{\left|p - p'\right|\right\}_{\min} \tag{3.1}$$

Maximum distance:

$$dist\left(c_i, c_j\right) \max_{p \in c_i, p' \in c_j} \left\{\left|p - p'\right|\right\}_{\max} \tag{3.2}$$

Mean distance:

$$dist_{\text{mean}}\left(c_i, c_j\right) = \left|m_i - m_j\right| \tag{3.3}$$

Average distance:

$$dist_{\min}\left(C_i, C_j\right) = \frac{1}{n_i n_j} \sum_{p \in c_i, p \in c_j} \left|p - p'\right| \tag{3.4}$$

Hierarchical Clustering on Principal Components

The formula was made classification of each cluster depending distance to the nearest cluster center.

$$\max_{i \in q} \min_{q' \neq q} d\left(i, C_{q'}\right) \tag{3.5}$$

$C_{q'}$ to cluster center q' distance, it is classified maximum and minimum mean of the nearest and farthest distance and different means.

Using this formula and calculation, it is described difference of it result of

cluster analysis on age classification for children according to the regional zone.

3.3. Processing

Cluster analysis were made on database at 3 years old participants of kindergarden from selected provinces and urban zone according to the Mongolian regional zone. Formula (3.3). Three divisions of the Cluster analyses on the Hierarchical Clustering on Principal Components. It was used fviz_dend() function of the method HCPC [7] (**Figure 3**). According to regional zone, data of 3 years old participants at age of 3 - 5 years old were included in 3 clusters by cluster analyses.

In (**Figure 3**) 3 divisions of the cluster analysis involving total 3 years old participants. Hierarchical Clustering on Principal Components are divided into 3 clusters, it is described different means that the nearest and farthest point of the central point. Formulas (3.1)-(3.5).

The result of the analysis of the Hierarchical Clustering on Principal Components, using algorithms (MFA) of methods HCPC, it is described different means that the nearest and farthest point of the each cluster (**Figure 4**).

Total 3 years old children of the cluster task performance are 76.6%, distance to the cluster center is 8.1%.

Here (**Figure 5**). It is 0.25 mean that green the nearest distance to the cluster center, 0.50 mean is blue middle and 0.75 mean is red far [8]. Algorithm (PCA) of the method HCPC.

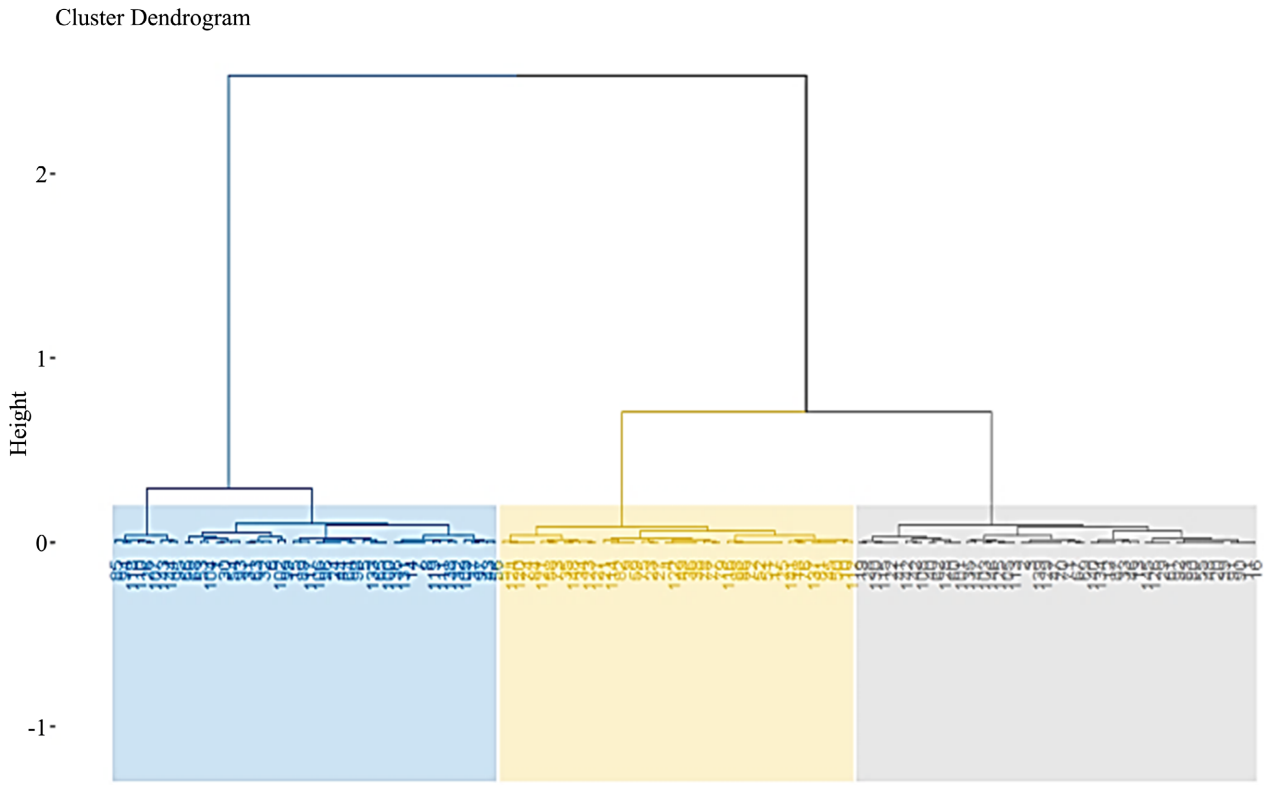

Figure 3. The division of the cluster analysis involving total 3 years old participants.

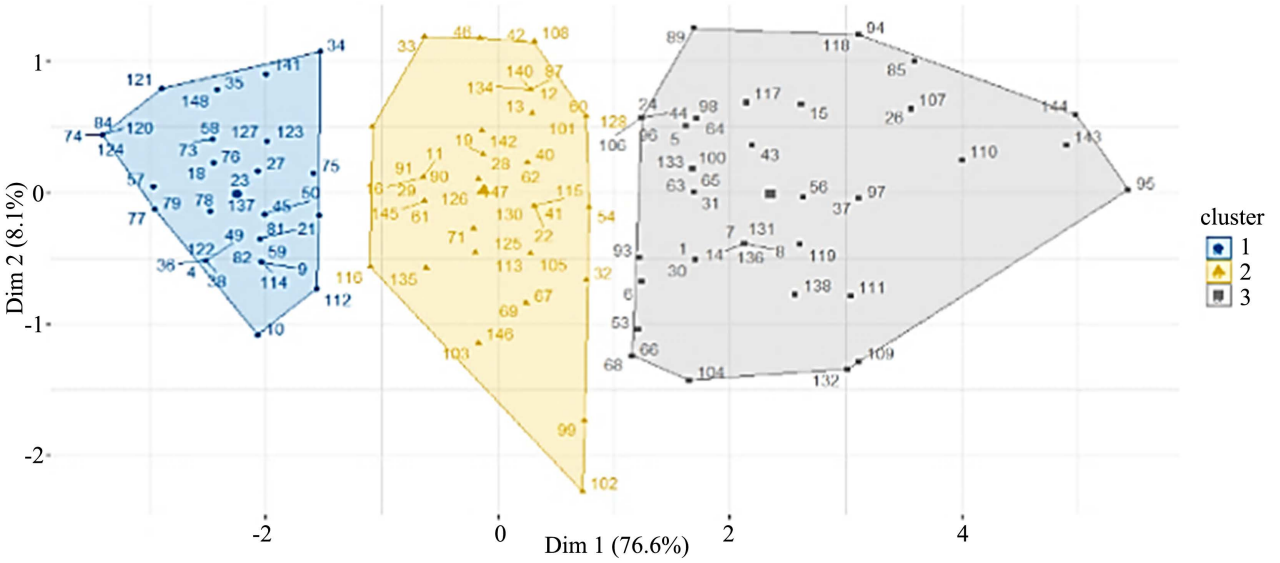

Figure 4. Total 3 years old participants, the values of each clusters.

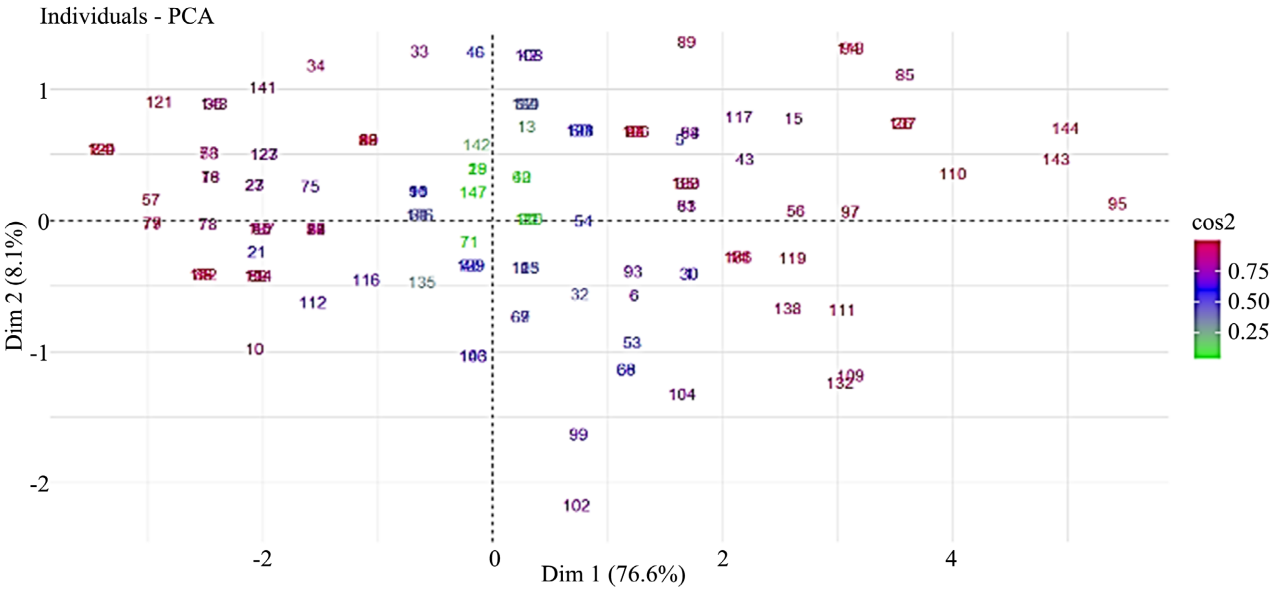

Figure 5. Total 3 years old participants, tasks 1 - 5, result of the clusters.

The task performance 1 - 5 for the total 3 years old participants of each cluster is 76.58%, result of each cluster.

4. Results

Ability of Total Children

Involving total 3 - 5 years old children selected from regional zones, the results of cluster analyses on the task to define mathematical ability of 3 years old children were shown on **Table 3**, the nearest mean to the cluster center is 0.6, the farthest mean is 5.6; others are same distance provinces and urban regional zone.

Table 3. Total 3 years old participants, task result of the each cluster.

Kid-id	Age, month	Task 1	Task 2	Task 3	Task 4	Task 5	Aimag
Cluster 1/Close mean to the central distance of the cluster 0.8/							
4	3 years old 4 months	2	1	2	1	1	Bayan-Ulgii
45	3 years old 5 months	2	2	2	1	1	Dornod
50	3 years old 2 months	2	2	2	1	1	Dornod
81	3 years old 4 months	2	2	2	1	1	Khuvsgul
137	3 years old 11 months	2	2	2	1	1	Ulaanbaatar, Sukhbaatar
Cluster 1/remote mean to the central distance of the cluster 3.3/							
74	3 years old 8 months	1	1	1	1	1	Khuvsgul
84	3 years old 1 months	1	1	1	1	1	Khuvsgul
120	3 years old 1 months	1	1	1	1	1	Ulaanbaatar, Sukhbaatar
124	3 years old 6 months	1	1	1	1	1	Ulaanbaatar, Sukhbaatar
121	3 years old 7 months	1	2	1	1	1	Ulaanbaatar, Sukhbaatar
Cluster 2/Close mean to the central distance of the cluster 0.6/							
3	3 years old 11 months	3	2	3	2	2	Bayan –Ulgii
47	3 years old 8 months	3	2	3	2	2	Dornod
70	3 years old 10 months	3	2	3	2	2	Khuvsgul
129	3 years old 8 months	3	2	3	2	2	Ulaanbaatar, Sukhbaatar
139	3 years old 3 months	3	2	3	2	2	Ulaanbaatar, Sukhbaatar
Cluster 2/remote mean to the central distance of the cluster 3.1/							
42	3 years old 10 months	3	3	2	2	3	Dornod
46	3 years old 4 months	2	2	2	3	3	Dornod
71	3 years old 9 months	4	2	2	2	2	Khuvsgul
99	3 years old 3 months	4	3	4	2	1	Umnu-Govi
102	3 years old 10 months	3	2	5	3	1	Umnu-Govi
Cluster 3/Close mean to the central distance of the cluster 0.7/							
7	3 years old 3 months	4	3	4	3	3	Bayan-Ulgii
8	3 years old 10 months	4	3	4	3	3	Bayan-Ulgii
14	3 years old 10 months	4	3	4	3	3	Bayan-Ulgii
131	3 years old 8 months	4	3	4	3	3	Ulaanbaatar, Sukhbaatar
136	3 years old 2 months	4	3	4	3	3	Ulaanbaatar, Sukhbaatar
Cluster 3/remote mean to the central distance of the cluster 5.6/							
85	3 years old 6 months	4	5	4	3	4	Khuvsgul
95	3 years old 7 months	5	5	5	5	4	Umnu-Govi
110	3 years old 8 months	5	4	4	4	4	Umnu-Govi
143	3 years old 4 months	5	4	5	4	5	Ulaanbaatar, Sukhbaatar
144	3 years old 5 months	5	5	4	5	4	Ulaanbaatar, Sukhbaatar

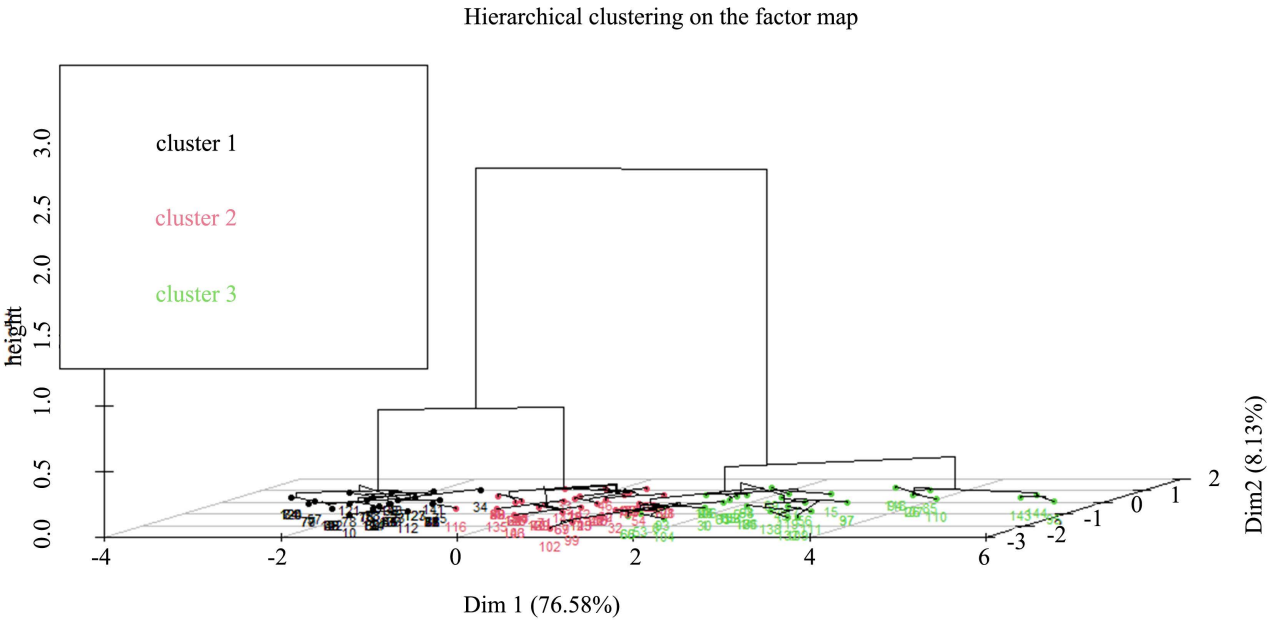

Figure 6. Total 3 years old participants of each cluster task performance 1 - 5, result of each cluster.

Table 4. Total 3 years old participants, task 1 - 5 result of the clusters.

q_id	Performance	Height
Task 4	0.72%	4.6
Task 1	0.67%	3.1
Task 5	0.65%	2.9
Task 3	0.62%	2.6
Task 2	0.59%	1.9

It is described the closest and remote mean of the distance to the center of the 3 years old cluster.

Seeing 3 years old participants of each cluster task, the cluster task performance 1 - 5; it has different result task 1 in the cluster 1 (mean 1.7, overall mean 2.8).

Tasks 1 - 5 of the total 3 years old participants, performance of the clusters (**Figure 6**).

Under cluster analyses on performance 1 - 5 tasks to define mathematical ability of total 3 years old children, task 4 performed more efficiently, it's were shown on **Table 4**.

5. Conclusions

Comparing result of Hierarchical Clustering on Principal Components for total 3 years old participants from 3 - 5 years old participants of the selected district, cities and provinces according to Mongolian regional zone, it was described:

- Ulaanbaatar of central zone that is cluster 2 distance is 0.6 the nearest

(Figure 4) to each cluster center. Cluster 3 is farthest distance 5.6 Umnu-Gobi from central region, Ulaanbaatar from urban zone.

- Total 3 years old participants' who are close to the distance of the clusters performing task 4 is 0.72, farthest distance rate is 4.6.

It is concluded that total 3 years old participants from 3 - 5 years old participants of the total provinces, cities and districts performed task 4 more efficient. Also, children from Ulaanbaatar and Sukhbaatar district from urban zone, Umnu-Gobi from central region that are selected according to the regional zone, have more ability.

Combination using of training and game program with data visualization are made accuracy of the result.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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