

Application of Supersaturated Design to Study the Spread of Electronic Games

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Abstract A supersaturated design is an important method that relies on factorial designs whose number of factors is greater than experiments' number. The analysis of supersaturated designs is challenging due to the complexity of the design matrix. This problem is challenging due to the fact that the design matrix has a complicated structure. Identification of the variable including the active factor plays an essential role when supersaturated design is used to analyse the data. A variable selection technique to screen active effects in the SSDs and regression analysis are applied to our case study. This study set out to examine the actual reasons for the spread of electronic games statistically such as Saudi society. An online survey provided quantitative data from 200 participants. Respondents were randomly divided into two conditions (Yes+, No-) and asked to respond to one of two sets of the causes of electronic games. The responses was analysed using contrast method with supersaturated designs and regression methods using the SPSS computer software to determine the actual causes that led to the spread of electronic games. The findings indicated that because of their constant preoccupation, some parents resort to such games in order to get rid of the child's inconvenience and insufficient awareness among parents of the dangers of these games, and excessive pampering is the factor that led to the spread of electronic games in Saudi society statistically. On this basis, it is recommended that Saudi government professionals develop an operational plan to study these causes to take actions. In future investigations, no recent studies address the external environmental aspects that could influence gaming among individuals, and hence further research is required in this field.

Keywords Electronic Games, Supersaturated Designs, Contrast Method, Linear Model, Screening Design, Data Analysis.

1 Introduction

Electronic games have spread across all marketplaces and entered all homes, taking over much of children's and adults' time. They have spread very quickly among Arab society in general, and Saudi Arabia in specific. The digital revolution and a availability of internet have been helped spread electronic game. Within the technological revolution in which we are living and the spread of desktop and laptop computers and various smart devices, electronic games have become more present in the our lives. The impact of technology on daily living activities is a significant determinant of the future livelihoods of all individuals worldwide. Gaming has increased among the people of all ages across the world over recent years with an impact by culture. The development of video games continues to grow alongside the Internet expansion. In Saudi Arabia, approximately 63.7% of the population are internet users, while is more than tenfold higher than in 2001. These days, about 400 dollars spent on electronic games by a Saudi child annually [2]. Both positive and negative outcomes have been attributed to this trend. The spread of electronic games is influenced by diverse factors, including competition for rewards, need for entertainment, motivation and addiction, and its ability to nurture talent and

develop one's intelligence. An objective of this study is to find the actual causes that led to-electronic games in Saudi society. To achieve this goal, this investigation utilised quantitative data to determine the actual reasons for the spread of electronic games in Saudi society using Supersaturated designs (SSD). This paper begins by the previous research on the spread of electronic games in the country.

Supersaturated design has been widely applied in several studies. The construction of supersaturated designs has been originally proposed by ([12], [4]). An algorithm to construct systematic supersaturated designs suggested by ([12], [4]). Several methods of the construction of supersaturated designs have been widely investigated by ([9], [15], [5], [10] [11] [14]). Some analysis methods were proposed in literature for the analysis of supersaturated designs in recent years. stepwise regression was used to select p active factors by [9]. The identifiability of supersaturated designs was explored by [6]. A Bayesian variable-selection method was suggested by [13]. In addition, [13] proposed forward selection test technique and the effect sparsity hypothesis. The researcher [3] suggested a two-stage Bayesian model selection procedure for supersaturated designs. An approach based on penalised least squares for identifying the active effects in supersaturated designs was proposed [8]. A procedure of finding active factors based on the idea of staged dimensionality reduction was proposed by [11]. A contrast variance approach for analysing data from supersaturated designs was proposed by [7]. The problem of supersaturated designs in identifying the active factors was addressed by [10].

2 Method

The aim of this section is to present a procedure for analysing supersaturated designs. In this paper, the linear main effects model is used:

$$y = x\beta + \epsilon$$

where y is the vector of n responses from the experiment, β is the vector of the m unknown coefficients, X is the $n * m$ design matrix, and ϵ is the random error vector with $(\epsilon_1, \epsilon_2, \dots)$ and $\epsilon \sim N(0, \sigma^2)$, for $i = 1, 2, \dots$. Before present the models, we portray the strategies investigation for contrast strategy. This systems were applied by [7], who presented a strategy for breaking down SSDs that utilizing another agreements based technique. Assume there are p dynamic out of m components. The methodology as is depicted in [7] is as per the following.

A: Discover all factor separates through

$$M = X^T Y, \tag{1}$$

and Y is the reaction and X is the plan model lattice. At that point, ascertain the supreme qualities and arrange factors outright contracts.

B: Start with $i = 0$, then, use $p = N/2$, where N is the

number of trails.

C: Find the following

$$uml_i = |m_k| - t_{k-1, \alpha/2} \sigma_p \tag{2}$$

and

$$lml_i = -|m_k| + t_{k-1, \alpha/2} \sigma_p, \tag{3}$$

where $t_{k-1, \alpha/2}$ is the percent of the t- test.

D: Eliminate the greatest worth $|m_{k-i}|$ and subsequently set $i = i + 1$.

E: Find σ_p for the p biggest supreme differences utilizing the leftover qualities only.

F: From conditions(2) and (3), if the fluctuation in E is more modest than the difference that found before C, go to Step E in any case stop, and close the dynamic components from the differentiations falling external the basic district

More details about this method can be found in [1]. In order to address these ethical concerns, the following example are taken.

3 Data collection and Method

3.1 Written questionnaires and surveys

The main technique used to recognize that included the consequences of study questions requested that members decide the spread of electronic games in Saudi society. Two of the most well-known strategies for veritable data were used :1/How many daily hours do you spend or spend around you playing electronic games. 2/understudy surveys were driven by spreading13-question reviews to understudies. The target masses was 200 individuals.

3.2 Completing the trial and gathering information

From setp 1, by then become familiar with the accomplishment levels for the focused on understudy utilizing the reasonable model. This is shown in Table 1, which explains the data accumulated. Information were introduced to backslide assessments and the agreements structure methodology, with the tracking down that the fundamental driver of spread of electronic games in Saudi society.

3.3 Picking the example and ensuring in the event that it suits the various variables

A pre-design consisting of 13 factors and 8 trials is selected. This design is considered in all the data that has been put in the previous steps and in case of obtaining the whole design is placed the value of the response and the number of the person who answered the questionnaire. The design chosen in the previous step is analysed using contrast method with supersaturated designs and regression methods. If the factors that we get from contrast method are the same as the regression method, these factors are the actual causes of electronic games in Saudi society.

Table 1. Notes to be considered about the tables of information

Factor	signal	Description
Some children or young people resort to these games in order to escape the real reality to the virtual world	+	Yes
	–	No
Insufficient awareness among parents of the dangers of these games, and excessive pampering	+	Yes
	–	No
Because of their constant preoccupation, some parents resort to such games in order to get rid of the child's inconvenience	+	Yes
	–	No
Some games offer bonuses so children and young people continue to play long	+	Yes
	–	No
Love to brag and boast that their children have a lot of modern technological tools, and their ability to deal with them quickly.	+	Yes
	–	No
Children imitate a parent, there are some parents addicted to these games	+	Yes
	–	No
Lack of communication between parents and children, which makes the child resort to such games in order to fill the gap suffered	+	Yes
	–	No
The financial return as a result of improved family income and the ability of children and young people to acquire modern equipment and access to the Internet and play these games	+	Yes
	–	No
The absence of the social role of social institutions such as clubs and school activities, all of which occupied the time of students or youth, which led to resort to the practice of electronic games to fill their free time	+	Yes
	–	No
The gap between generation and generation increased significantly	+	Yes
	–	No
Blaming one parent for the other	+	Yes
	–	No
Impressed, admired and emulated by foreign cultures	+	Yes
	–	No
Lack of media role on awareness of the dangers of these games	+	Yes
	–	No
Y(Response)	Number	The number of hours to spend playing electronic games

Table 2. Supersaturated design for Example 1.

Run	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	Y
1	-1	1	1	1	-1	1	1	1	1	1	1	-1	-1	5
2	-1	1	1	1	1	1	-1	-1	1	1	-1	-1	-1	1
3	-1	1	1	1	1	1	1	1	1	1	1	1	1	5
4	1	1	1	-1	-1	1	1	-1	1	1	1	1	1	15
5	1	-1	-1	1	-1	-1	-1	-1	1	-1	-1	1	-1	5
6	-1	-1	1	1	1	-1	-1	1	1	1	1	1	-1	0.3
7	-1	1	1	1	1	1	1	1	1	1	1	1	-1	3
8	1	1	1	1	1	1	1	-1	1	-1	-1	1	1	16

Table 3. Arranged supreme differentiations esteems for example 1 .

<i>j</i>	1	2	3	4	5	6	7	8
<i>x_n</i>	<i>x₉</i>	<i>x₃</i>	<i>x₂</i>	<i>x₆</i>	<i>x₁₂</i>	<i>x₇</i>	<i>x₈</i>	<i>x₁</i>
<i>c(j)</i>	50.3	40.3	39.7	39.7	38.3	37.7	23.7	21.7
<i>j</i>	9	10	11	12	13			
<i>x_n</i>	<i>x₁₃</i>	<i>x₄</i>	<i>x₁₀</i>	<i>x₁₁</i>	<i>x₅</i>			
<i>c(j)</i>	21.7	20.3	8.3	6.03	0.3			

Table 4. Step by step figurings for the examination model 1

<i>i</i>	σ_i^2	<i>uml_i</i>	<i>lml_i</i>	σ_i^2 more than σ_{i-1}^2
0	27.12	38.95	-38.95	
1	0.72	38.43	-38.43	No
2	1.02	37.44	-37.44	Yes

4 Data Analysis

The performance of contrast method with supersaturated designs methods is assessed in terms of their ability to define the active value. More details about this method can be found in [1]. In order to address these ethical concerns, the following example are taken.

Example 1.

In this example, we assume $n = 13$ that shown in Table 2. The aforementioned analysis methods were performed respectively. We portray the systems examination for super-saturated design in Table 2. All factor contrasts calculate the absolutes using Equation 1, and sort these values in Table 3. Then, start with $i = 0$ and figure the difference of the p biggest total agreements using $p = N/2$, where N is the number of trials. The result is in Table 4.

We see that σ_2^2 is more than σ_1^2 , and subsequently we pause and track down the dynamic components. The final values for A are:

$$uml_i = 38.43, \quad lml_i = -38.43 \quad \text{and} \quad \sigma_1^2 = 0.72.$$

Accordingly, there are actives factors outside the basic area: x_9, x_3, x_2 and x_6 . Examination of these information (Forward determination) with programming bundle SPSS, uncovers as dynamic factors x_1 and x_3 , an expected straight model is:

$$y = 3.930 + 6.320x_1 + 5.320x_3 + \epsilon.$$

Investigation of these information (utilizing regression) with programming bundle SPSS, uncovers as dynamic factors x_1, x_3 and x_7 , an expected direct model is:

$$y = 4.677 + 5.58x_1 + 3.40x_3 + 1.84x_7 + \epsilon.$$

The robust contrast method result in four active factors x_9, x_3, x_2 and x_6 and the regression analysis method result in three active factors x_1, x_3 and x_7 . Thus, there is a single active factor x_3 (because of their constant preoccupation, some parents resort to such games in order to get rid of the child's inconvenience) with a linear contribution.

Example 2. In this example, the same procedures used in example 1 with $n = 13$, analysis for contrast method depict in Table 5.

The sorted absolute contrast values are depicted in sort these values in Table 6.

The resulting variance of the p largest absolute contracts is shown in Table 7.

The detecting of the active factors were stopped as σ_1^2 is more than σ_0^2 . The final values for A are:

$$uml_i = 56.28, \quad lml_i = -56.28 \quad \text{and} \quad \sigma_0^2 = 16.$$

This result in five actives factors outside the critical region: x_2, x_7, x_9, x_2 and x_{10} . The active variable based on analysis in this case is x_3 with the following estimated linear model:

$$y = 12.35 - 5.64x_3 + \epsilon.$$

For convenience, regression method also used to detect the active variable, which result in x_3 as active variable with linear model:

$$y = 12.35 - 5.64x_3 + \epsilon.$$

Based on above analysis, we conclude that there is no an active factor with a linear contribution.

Example 3. The supersaturated design for this example are depicted in Table 8.

The sorted absolute contrast values are shown in Table 9.

Table 10 shown the result from calculating the variance of the p largest absolute contracts.

The result from calculating the lower and upper limits on critical region are:

$$uml_i = 30.37, \quad lml_i = -30.37 \quad \text{and} \quad \sigma_1^2 = 12,$$

which show that there are actives factors outside the basic district: x_{13}, x_5, x_2 and x_9 .

Table 5. Supersaturated design for Example 2.

Run	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	Y
1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
2	1	1	1	-1	-1	1	1	1	1	1	1	-1	1	9
3	1	1	1	1	-1	-1	1	-1	1	1	1	1	-1	6
4	1	1	-1	-1	1	1	1	-1	1	1	-1	-1	1	18
5	1	-1	1	-1	-1	-1	1	-1	1	-1	-1	-1	-1	4
6	1	1	1	1	1	1	1	1	1	1	1	1	1	4
7	1	1	1	1	1	1	1	-1	1	1	1	1	1	8
8	1	1	1	1	1	1	1	1	1	1	1	1	1	12

Table 6. Arranged supreme differentiations esteems for example 2 .

j	1	2	3	4	5	6	7	8
x_n	x_2	x_7	x_9	x_2	x_{10}	x_6	x_{13}	x_3
$ c(j) $	65	65	65	57	57	45	45	29
j	9	10	11	12	13			
x_n	x_5	x_{11}	x_8	x_4	x_{12}			
$ c(j) $	27	21	7	3	3			

Table 7. Figurings for the examination model 2.

i	σ_i^2	uml_i	lml_i	σ_i^2 more than σ_{i-1}^2
0	16	56.28	-56.28	
1	21.33	54.83	-54.83	Yes

Table 8. Supersaturated design for Example 3.

Run	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	Y
1	1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	3
2	1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	3
3	1	1	1	-1	-1	1	1	-1	1	-1	1	1	1	3
4	1	1	1	1	1	-1	1	1	1	1	1	-1	1	3
5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	-1	1	6
6	-1	1	-1	1	-1	1	1	-1	1	1	-1	1	1	4
7	-1	1	1	1	-1	-1	-1	1	1	-1	-1	-1	1	10
8	-1	1	1	1	-1	-1	-1	1	1	-1	-1	-1	1	12

Table 9. Arranged supreme differentiations esteems for example 3 .

j	1	2	3	4	5	6	7	8
x_n	x_{13}	x_5	x_2	x_9	x_{10}	x_3	x_1	x_6
$ c(j) $	44	38	32	32	30	24	20	18
j	9	10	11	12	13			
x_n	x_{12}	x_4	x_7	x_{11}	x_8			
$ c(j) $	18	14	12	8	6			

Investigation of these information utilizing Forward determination uncovers that the dynamic factors are x_2 and x_7 and assessed direct model is:

$$y = 4.600 + 2.500x_2 - 3.900x_7 + \varepsilon.$$

We then perform regression analysis, which result in two active variables x_2, x_7 . The obtained linear model is:

$y = 4.600 + 2.500x_2 - 3.900x_7 + \varepsilon$. The robust contrast method result in four active factors x_{13}, x_5, x_2 and x_9 while the regression analysis method gives two active factors

Table 10. Figurings for the examination model 3 .

i	σ_i^2	uml_i	lml_i	σ_i^2 more than σ_{i-1}^2
0	33	31.48	-31.48	
1	12	30.37	-30.37	No
2	14.33	23.56	-23.56	Yes

Table 11. Supersaturated design for Example 4.

Run	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	Y
1	-1	1	1	1	-1	1	-1	-1	1	1	1	-1	1	6
2	1	1	1	1	1	1	1	1	1	1	1	1	-1	24
3	1	1	1	1	1	-1	1	1	1	1	1	1	1	3
4	1	1	1	1	1	-1	1	-1	1	1	-1	-1	1	10
5	1	1	1	1	1	1	1	1	1	1	1	-1	1	3
6	1	1	1	1	-1	-1	1	-1	1	1	1	-1	1	0
7	1	1	1	1	1	1	1	1	1	1	1	1	1	2
8	1	-1	1	1	1	-1	1	-1	1	-1	1	1	1	3

Table 12. Arranged supreme differentiations esteems for example 4 .

j	1	2	3	4	5	6	7	8
x_n	x_3	x_4	x_9	x_2	x_{10}	x_1	x_5	x_7
$ c(j) $	51	51	51	45	45	39	39	39
j	9	10	11	12	13			
x_n	x_{11}	x_6	x_8	x_{12}	x_{13}			
$ c(j) $	31	19	13	13	3			

Table 13. Figurings for the examination model 4 .

i	σ_i^2	uml_i	lml_i	σ_i^2 more than σ_{i-1}^2
0	9	44.46	-44.46	
1	12	43.37	-43.37	Yes

x_2 and x_7 . In this case, there is only one active factor x_2 (which is insufficient awareness among parents of the dangers of these games, and excessive pampering) with a linear contribution.

Example 4.

The results from performing the same procedure are shown in Table 11.

At that point we discover all factor differences from condition 1, compute the absolutes and arrange these qualities. The outcome is appeared in Table 12.

Start with $i = 0$ and figure the change of the p biggest supreme agreements use $p = N/2$, where N is the number of trials. The outcome is appeared in Table 13.

We see that σ_1^2 is more than σ_0^2 , and consequently we pause and track down the dynamic elements. The last qualities for A are

$$uml_i = 44.46, \quad lml_i = -44.46 \quad \text{and} \quad \sigma_0^2 = 9.$$

cordingly, there are actives factors outside the basic locale: x_3, x_4, x_9, x_2 and x_{10} . Investigation of these information dependent on forward choice is bring about two dynamic factors x_{11} and x_{13} . The assessed straight model:

$$y = 17 - 3.58x_{11} - 10.58x_{13} + \varepsilon.$$

Analysis of these information utilizing relapse bring about two dynamic elements x_{11} and x_{13} , the acquired direct model:

$$y = 17 - 3.58x_{11} - 10.58x_{13} + \varepsilon.$$

In view of the above examination, we infer that there is no dynamic factor with a direct commitment.

5 Conclusions

This paper examined the actual causes that led to the spread of electronic games in Saudi society using contrast method analysis and the regression analysis. A pre-design consisting of 13 factors and 8 trials is selected to performance of contrast method with supersaturated designs methods is assessed in terms of their ability to define the active value. This examples illustrates that supersaturated design and regression model method are very effective for screening effect. The result show that the factor (because of their constant preoccupation, some parents resort to such games in order to get rid of the child’s inconvenience and insufficient awareness among parents of the dangers of these games), and excessive pampering are the factors that led to the spread of electronic games in Saudi society statistically. On this premise, it is suggested that Saudi government experts build up an operational arrangement to consider these causes to make moves. In future examinations, no new investigations address the outer natural viewpoints that could impact gaming among people, and thus further exploration

is needed in this field. Moreover, there is a prerequisite for more examination contemplates that address various pieces of electronic games , for instance, the degree of this wonder with three levles (+,0,-).

Abbreviations:

SPSS: Statistical package for social sciences

5.1 Ethics approval and consent to participate

Not applicable

5.2 Availability of data and material

The data supports the finding of this study are available within the article and its supplementary material.

5.3 Competing interests

Not applicable

5.4 Funding

Not applicable

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