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ABSTRACT NEAR-FIELD SPACES WITH SUB NEAR-FIELD SPACE OVER A NEAR-FIELD OF ALGEBRA IN STATISTICS

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ABSTRACT

In this note we show how some specific classes of algebraic structures "planar near- rings", "planar near-field spaces", "planar sub near-field spaces" give rise to efficient Balanced Incomplete Block Designs, which in turn can excellently be used in statistical experiments.

Keywords: *near-field spaces, sub near-field space, near-field space, semi simple near-field space, BIB-Design, planar near-ring.*

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1. INTRODUCTION. THE ALGEBRAIC-COMBINATORIAL SETTINGS

Definition 1.1 Balanced Block Design: A finite near-field space N of size v, together with a collection S of s sub near-field spaces of size t is called a Balanced Block Design if every sub near-field space or element of N appears in a fixed number r of sub near-field spaces over a near-field space of S and every pair of different sub near-field spaces of N is contained in the same number of λ sub near-field spaces.

Definition 1.2 Incomplete Balanced Block Design: We say that S is incomplete if it is not the set of all t-sub near-field spaces of N, and, in this case, (N, S) is then referred to as a BIB-Design. The elements of N are then called points; the sets in S are called blocks. The quintuple (v, s, r, t, λ) are the parameter of the design.

Given a BIB-Design (N, S), one can use it very well for statistical experiments. Suppose one wants to test combinations out of v "ingredients" (usually called "treatments") for a final product. Then one can start with any combination and vary only one ingredient at a time in a number of tests ("plots"). This is the traditional way, but it is a highly inefficient one. It is much better and saves a lot of costs to change several or all ingredients every time. It is a good ideas to do this in a "fair" manner: Each plot should get the same number of ingredients, each ingredient should get the same "chance" in that it is tested on the same number of plots, and each combination of different ingredients should be tested in the same number of plots (to get information on positive or negative synergy effects among the ingredients).

This can be achieved by choosing a (v, s, r, t, λ)-BIB Design; the ingredients are taken as points, the blocks as plots, and the elements in a block are just the ingredients which are applied in this plot. Then each of the s plots get precisely t ingredients, each ingredient is tested r times, and each pair of different ingredients come together in precisely λ plots.

A concrete example follows below.

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Example 1.3

(a) Tests of different ingredients to an optimal fertilizer on experimental agricultural (not algebraic) fields which are the plots.
(b) The ingredients might be additives to paints to increase their resistance to sunlight, rain, etc. A plot is a test mixture for the paint.
(c) For marketing purposes, one tests which combination of commercials work best to get higher sales of an article. The commercials (TV spots, sales actions, etc. . .) are the ingredients in a particular test run (plot).

We want to show that one can easily get many (BIB-Designs) from a class of generalized near-fields, so-called near-field spaces.

Definition 1.4: N-sub near-field space. Let (N, +, .) be a left near-field space. A sub near-field space (M, +) is called an N-sub near-field space i.e. traditional one if there is a near-field space homomorphism $\theta : N \to Map(M)$. As usual, we write gn to mean $g(n\theta)$ for $g \in M$ and $n \in N$. In this case the group elements distribute over the near-field spaces.

Definition 1.5: Complementary N-near-field space. M is called a complementary N-sub near-field space or N – co sub near-field space, for short, if there is a semi sub near-field space elements distribute over the sub near-field space elements and the action of N is usually written on the left of the elements of M.

Definition 1.6: (N, T) – bi sub near-field space. Let N and T be two left near-field spaces. A sub near-field space M is called an (N, T) – bi sub near-field space if
(a) M is an N-co sub near field space
(b) M is an T-sub near-field space and (c) $(ng)t = n(gt)$, $\forall\, g \in M, n \in N, t \in T$.

Definition 1.7: left strong N-sub near-field space. M is called left strong N-sub near-field space if the action of N is defined on the left of M satisfying the following conditions $\forall\, n, n' \in N$ and $g, g' \in M$
(a) $(nn')g = n(n'g)$
(b) $n(g + g') = ng + ng'$ and (c) $(n + n')g = ng + n'g$.

Note 1.8: A right strong N-sub near-field space is defined similarly. (N, +) is an (N – N) – bi sub near-field space for the left as well as right near-field space N over a near-field. If N is distributive near-field space then (N, +) is a left as well as right strong N-sub near-field space. Many more examples of these structures are given in near-field space related topic.

Definition 1.9: N-homomorphism. Let M and K be two N-sub near-field spaces (N-co sub near-field space. A sub near-field space homomorphism $\theta : M \to K$ is called an N-homomorphism if for any $g \in M$ and $n \in N$, $(gn)\theta = (g\theta)n$, $((rg)\theta = r(g\theta))$.

Note 1.10: An (N – T) – homomorphism for (N – T)-bi sub near-field space are defined in a similar way.

Definition 1.11: Prime near-field space over a near-field. A near-field space N is said to be prime near-field space if $aNb = \{0\} \Rightarrow a = 0$ or $b = 0$.

Definition 1.12: Distributive element. An element x of N is said to be distributive element if $(y + z)x = yx + zx$ for all $x, y, z \in N$.

Definition 1.13: zero symmetric. A near-field space N is called zero-symmetric if $ox = 0$ for all $x \in N$.

Note 1.14: recall that left distributivity yields $x0 = 0$.

Definition 1.15: derivation on N. An additive endomorphism d of N is called a derivation on N if $d(xy) = xd(y) + d(x)y$ for all $x, y \in N$ or equivalently that $d(xy) = d(x)y + xd(y)$ for all $x, y \in N$.

Definition 1.16: constant. An element $x \in N$ for which $d(x) = 0$ is called a constant.

Definition 1.17: (σ , τ) - derivation. Let σ, τ be two automorphisms on a near-field space N over a near-field. Define an additive endomorphism $d : N \to N$ is called a (σ, τ) – derivation if ∃ automorphism $\sigma, \tau : N \to N \ni d(xy) = \sigma(x) d(y) + d(x)\,\tau(y)$ for all $x, y \in N$.

Definition 1.18: τ-derivation. If $\sigma = 1$, the identity mapping d is called a τ-derivation.

Definition 1.19: σ-derivation. If $\tau = 1$, the identity mapping d is called a σ-derivation.

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Definition 1.20: A right near-field space is a set N together with two binary operations "+" and "·" such that
- (i) (N, +) is a group not necessary abelian
- (ii) (N, ·) is a semi group and
- (iii) for all $n_1, n_2, n_3 \in N$ such that $(n_1 + n_2)\cdot n_3 = n_1 \cdot n_3 + n_2 \cdot n_3$.

Definition 1.20: Interesting Classes of near-field spaces. Any zero symmetric near-field space with a right sub near-field space can be described as Sandwich centralizer near-field space $M_0(X, N, \phi, T)$. It would be interesting to see what kind of near-field spaces come out by modelling the input parameters X, N, ϕ, T. A deeper research in that direction has not been done so far, to the author's knowledge.

Definition 1.21: A set N, together with two operations + and ·, is a near-ring provided that (N, +) is a group (not necessarily abelian), (N, ·) is a semigroup, and $(n + n') \cdot n'' = n \cdot n'' + n' \cdot n''$ holds for all $n, n', n'' \in N$.

Of course, every ring is a near-ring; hence near-rings are generalized rings. Two ring axioms are missing: the commutativity of addition and (much more important) the other distributive law.

Example 1.22: The standard example of a near-ring can be obtained by taking a group (G, +), not necessarily abelian; then $GG = \{f \mid f : G \rightarrow G\}$ is a near-ring with binary operations + and ∘ given by $(f + g)(a) = f(a) + g(a)$ and $(f \circ g)(a) = f(g(a))$ for all $f, g \in GG$ and $a \in G$. Furthermore, every near-ring can be embedded in some (GG, +, ∘) for some suitably chosen group G.

We need, however, a specific type of near-rings motivated by geometry.

Definition 1.23: Planar near-field space. A near-ring M is called a planar near-field space if
- (i) There are at least two elements $a, b \in M$ such that $x \cdot a \neq 0$, $y \cdot b \neq 0$, and $z \cdot a \neq z \cdot b$ for some $x, y, z \in M$, and
- (ii) All equations $x \cdot a = x \cdot b + c$, ($a, b, c \in N$, $z \cdot a \neq z \cdot b$ for some $z \in M$), have exactly one solution $x \in M$.

Definition 1.24: Construction method for finite planar near-field spaces. Take a finite field F = GF(q), where q is a power of some prime p, and choose a generator g for its cyclic multiplicative group. Choose a proper factor t of $q - 1$.

Define a new multiplication $*t$ in F as $g^m *_t g^n := g^{m + n - n_t}$, where $m, n \in \{1, 2, \ldots, q - 1\}$, and $n_t \in \{0, 1, \ldots, t - 1\}$ denotes the remainder of n on division by t; also set $0 *_t g^m = g^m *_t 0 = 0 \cdot 0 = 0$. Then $(F, +, *_t)$ is a planar near-field space over a near-field.

Example 1.25: We give a (very small) example.
Choose F = GF(7) with g = 3 a generator, and t = 2 as a divisor of $6 = 7 - 1$. From this, we get the multiplication table

$*_2$	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	1	2	1	4	4	2
2	0	2	4	2	1	1	4
3	0	3	6	3	5	5	6
4	0	4	1	4	2	2	1
5	0	5	3	5	6	6	3
6	0	6	5	6	3	3	5

For example, in F we have 4 = 34 (namely, $4 \equiv 3^4 \pmod 7$) and $3 = 3^1$, and the above table says that
$4 *_2 3 = 3^4 *_2 3^1 = 3^{4+1-1} = 3^4 = 4$ in F.

2. THE EXPERIMENTAL SETTINGS

The last example can be readily used to design statistical experiments. Again, we show this via an example.

Example We want to test the combinations out of 7 ingredients for fertilizers. Testing all $2^7 = 128$ possible combinations of ingredients requires a huge amount of space and money. So we conduct an incomplete test. But this one should be fair to the ingredients (each ingredient should be applied the same number of times) and fair to the experimental fields (each test-field should get the same number of ingredients).

We take the above near-field space of order 7 and form the sets $S_i = a *_2 N^* + b$, $a, b \in N$ with $a \neq 0$. Here N^* denotes the non-zero elements of N, and $a *_2 N^* = \{a *_2 x \mid x \in N, x \neq 0\}$ is abbreviated as aN^* :

$$1N^* + 0 = \{1, 2, 4\} =: S_1,$$
$$3N^* + 0 = \{3, 5, 6\} =: S_8,$$

$$1N* + 1 = \{2, 3, 5\} =: S_2,$$
$$3N^* + 1 = \{4, 6, 0\} =: S_9,$$
$$\cdots\cdots$$
$$\cdots\cdots$$
$$\cdots\cdots$$
$$1N^* + 6 = \{0, 1, 3\} =: S_7,$$
$$3N^* + 6 = \{2, 4, 5\} =: S_{14}.$$

(Notice that $1N^* = 2N^* = 4N^*$ and $3N^* = 5N^* = 6N^*$.)

We see that these blocks form a BIB-design with v = 7 points (namely 0, 1, 2, 3, 4, 5, 6) and s = 14 blocks S1, . . . , S14 with each block contains precisely k = 3 elements; each point lies in exactly r = 6 blocks, and every pair of distinct points appears in λ = 2 blocks.

3. A VARIETY OF DESIGNS FROM PLANAR NEAR-FIELD SPACES

Given a finite planar near-field space N = (GF(q), +, ∗t) from the construction in Definition 4, we can obtain several BIB-designs by choosing appropriately a collection of sub near-field spaces of N W.-F. Ke, G. F. Pilz / J. Alg. Stat., 1 (2010), 6-12 10 called blocks.

Recall that a ∗t N∗ and a ∗t N are respectively abbreviated as aN∗ and aN.

1. Take blocks the collection B ∗ of all aN∗ + b with a, b ∈ N and a ≠ 0. See [4, (5.5)].
2. Take blocks the collection B of all subsets of the form aN + b with a, b ∈ N and a ≠ 0, provided that either all or none of the aN are additive subgroups (cases 1 or 2, respectively). See [4, (7.10) and (7.11)].
3. Take blocks the collection B− of all (aN ∪ (−a)N) + b with a, b ∈ N and a ≠ 0, provided that for all nonzero a, aN ∩ (−a)N = {0}, aN ∪ (−a)N is not an additive subgroup of N, and the map ta : N → N;ta(x) = x + ax is bijective.
4. Take blocks the collection S consisting of the intersection of (b − a)N + a and (a − b)N + b with a ≠ b. In general, similar results can be established for any finite planar near-rings not con- structured from the method of Definition 4.

4. STATISTICAL CONSIDERATIONS

In the cases mentioned above, we get the following parameters for the corresponding experimental designs (recall that we use q for the cardinality of the near-ring N with underlying set GF(q), and we have q − 1 = kt with k > 1 and t > 1): Theorem 1.

1. For (N, S ∗), we can test q "ingredients"; for that, we need k = qk tests with k = t ingredients in each test. Every ingredient is tested r = q − 1 times, and each pair of different ingredients is tested λ = t − 1 times.
2. In (N, S), we need s_2 tests in case 1, in which we apply k = t + 1 ingredients in each test. Each ingredient is tested in exactly r = s times, and each pair of different ingredients is tested λ = 1 time. For case 2, we need qs tests with again t + 1 ingredients in each test, but now r = q + s, λ = t + 1.
3. In (N, S −), we again get b = qs/2 tests with k = 2t + 1 ingredients in each test, r = q + s/2, and λ = 2t + 1. (Note that in this case, s is even.)
4. Finally, for (N, S), b = q(q− 1)/2, some k and r (which can be determined by some equations), and λ = k(k − 1)/2.

We would like to remark that BIB-designs may have other properties besides the fairness in getting equal number of tests on any combination of different ingredients. There are BIB-designs having the same appearance but behaving differently from the structural point of view. That is, there are (in algebra sense) non-isomorphic BIB-designs having the same parameters.) Also, there are BIB-designs such that any three distinct elements are contained in at most one block, which may have some advantage over others that miss such characteristic.

One may also want to take such structural W.-F. Ke, G. F. Pilz / J. Alg. Stat., 1 (2010), 6-12 11 considerations into account when choosing a BIB-design for experiments.

The construction methods of Section 3 do produce such BIB-designs. It is a good idea to care about possible (positive or negative) synergy effects.

This is equivalent to asking if the linear model used here is really appropriate. The best way is to include, e.g., products of variables x_i x_j into the linear model y = c+β0x0 +· · ·+βv−1xv−1 and to test if these products xixj appear with significant coefficients in the regression result. The same might be done with terms like x_2 i , and so on.

Some practical advises on the analysis of experiments conducted on such BIB-designs might be useful:

(a) One should try to plot all pairs (xi,j , yj) for each experiment Ej($1 \le j \le m$): (x_1,j , . . . , x_i,j . . . x_n,j ; yj) in order to see if a dependence between xi and y is likely, and, if so, whether this relation seems to be linear or not.

(b) Whether the BIB-Design model only allows to use an ingredient or not? If one wants to test an ingredient in, say, 3 levels (like using one, two, or three litres of it), one can use these levels as independent ingredients. So using 3 levels, one gets 2 more variables.

(c) As a rule of thumb, the number b of experiments should at least be of the order of magnitude of the square of the number of variables (including the combinations like $x_i x_j$).

(d) So one should avoid an "over-fitting" (too many variables). A good way to check how good a model might be is to look at the "P-value". This value should be very close to 0; something like 10−5 is usually not bad. The P-value decreases with the number of variables, so even better is, in most cases, that the R_2 adj -value which should be close to 1, because this value also takes into account how many variables were used. Wikipedia [10] gives a good account on this, for example.

In our example above, we might test the Fi for synergies. We find by inspection of the regression results that F2 ∗ F5 has a positive synergy effect. We get estimates (c, β0, β2, β4, β5, β2 ∗ β5) = (10.6, 2.2, 0.8, 1.3, 0.7, 1.9) and so a total yield of 17.5, which is again much better. Also, the P- and the R_2 adj -values have developed nicely:

1. All variables: P = 8 × 10−4 , R2 adj = 0.885.
2. Variables x0, x2, x4, x5: P = 1 × 10−4 , R2 adj = 0.843.
3. Variables x0, x2, x4, x5, x2 × x5: P = 5 × 10−7 , R2 adj = 0.962.

Even after all is said and done, one cannot be sure that the model used was really accurate. But this is statistics, and one only can claim that the model was good with a certain probability. Observe that there does not exist a "best" model; this concept is not even well-defined. More on the analysis of experiments.

5. PERSONAL CAREER DEVELOPMENT

I, Dr N V Nagendram worked on delta near—rings for eight years from 2008 to 2016. This project could give me the chance to stay within the scientific community in INIDA. Since I will work part time as a Professor of mathematics in KITS, Divili, E G District, Andhra Pradesh, INDIA. I do not have the chance to go abroad and apply for other types of scientific jobs. Also, I consider the link between being a scientist and working as Professor to be interesting. This could also be interesting in a future educational system in INDIA.

The bibliography contains abstracts of talks or papers presented at the near-ring and near-field areas of conferences as on 1982 – 2015. If you want to obtain these abstracts or papers please write to Dr G Betsch or the author of the book for the oberwolfach-abstracts, Dr. N V Nagendram-abstracts, to the author near ring, regular δ near-rings, near fields, near-field spaces, algebraic topology over near-fields & semi simple near-fields over regular δ-near-rings and to professor Ferrero for the San-Bendetto-proceedings.

Near Ring and Near Fields conference held 1982 – 2015.

1st International Conference held by Managing Editor, Mr. Vinay Jha, ICMSA, New Delhi 15-16 th December 2012, India International Centre, New Delhi 110 003 INDIA.

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3rd International Conference held by Managing Editor, Mr. Vinay Jha, ICMSA, New Delhi 19 – 20 th December 2014, India International Centre, New Delhi 110 003 INDIA.

4th International Conference held by Managing Editor, Mr. Vinay Jha, ICMSA, New Delhi 19 – 20 th December 2015, at Asian Institute of Technology Conference Center P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand.

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And for all international journal published of Dr. N V Nagendram, Professor, Kakinada Institute of Technology & Science (K.I.T.S.), Tirupathi(v), Divili 533 433 East Godavari District, Andhra Pradesh, INDIA can be viewed or at a glance in the web site address of **www.kits.ac.in** Department of Science and Humanities, Faculty publications listed thereof for reference purpose and further advance research programme those who are interested in doing research.

My sincere thanks to all and foremost to well known and renowned and Prestigious Publisher Mr. Mahender Kumar, Managing Director, International Journal of Advances in Algebra, IJAA, Korean, Research India Publications, Rohini, New Delhi 110 089, India.

The author has combined the theory of algebraic topology over near-fields & semi simple near-fields and its applications as title and subtitle as Algebra of Mathematics. This Text Book will be useful to students with a wide range of backgrounds, including scholars, research oriented students, advance research purpose and post-graduate students of various Indian universities, under graduates and in general those who are interested in algebra of mathematics.

This text book while dealing with theorems and algorithms and then by formal proofs, numerous examples have been provided to illustrate the basic concepts and preliminaries with diagrammatic expression ease in understanding and layman can understand.

The text book designed specifically to meet the research scholars and advance research purpose it treats six chaptered with applications. It also provides detailed and careful treatment of basics, approaching methods to research motivation by giving unique example to various algebraic topological based systems of application.

This text book is specially designed for the students of higher education in Mathematics especially M.Phil. and those who are doing their research in mathematics. This book will be an asset to those who aim for a better understanding and to improve their knowledge and for better result. The author of this book Dr. N V Nagendram, Professor in Mathematics is well known in the field of Mathematics.

He has attended many national level UGC sponsored seminars at various places in the country and in Conferences he presented his research articles on algebra to space communications, structure theory and Matrix Mamps over planar regular delta near rings at New Delhi INDIA.

He is attending the 4^{th} conference as an article selected for invited/special talk and selected as chairperson for one session in conference held by by Managing Editor, Mr. Vinay Jha, ICMSA, New Delhi 19 – 20 th December 2015 schedule thereof and at Asian Institute of Technology Conference Center P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand.

He has published many research papers related to near rings, near-fields, near-field spaces under Algebra of Mathematics. He is member of Allahabad mathematical society (AMS), Allahabad, Uttar Pradesh, INDIA. He has written study materials for nearly ten subjects at under graduate and post-graduate level in Mathematics for the benefit of the students of education of Acharya Nagarjuna University, Nagarjuna Nagar, Nambur, Guntur District, Andhra Pradesh, INDIA.

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