www.regeo.uji.es
Technical Reports. Ref. 10/2016

Study on human perception of bilateral symmetry planes

Raquel Plumed, Pedro Company, Peter A.C. Varley

Department of Mechanical Engineering and Construction, Universitat Jaume I

Abstract
This Technical Report describes the experiment conducted to understand how human beings perceive the existence of bilateral symmetry in objects depicted in sketches. The document also reflects the conclusions of this study. Our final goal is to develop an algorithm that, from a single-view wireframe sketch, can replicate the human perception in detecting the existence of bilateral symmetry planes. For this reason, we need to propose and carry out experiments on humans. The issue of finding bilateral symmetry planes has already been addressed previously by others authors, the novelty here is that our algorithm tries to mimic human perception.

Key words: Computer-Aided Sketching, Bilateral symmetry, Symmetry perception

1. INTRODUCTION

The core of a Sketch-Based Modelling (SBM) application, the geometrical reconstruction engine, produces 3D geometric models from 2D drawings. The term *recognition* roughly encompasses the variety of different procedures (vectorisation, refinement, etc.) used to extract information from the sketch. In the most common case of line-drawing recognition from pen-sketches the input is a set of strokes, and the output is a plain line drawing.

Reviewing related work on sketch recognition, we shall conclude that some main aspects still need further improvement.

Most of the approaches are nearly exclusively based on geometrical considerations, while it is already well known that perceptual considerations are equally important. As Lamiroy [1] reports: "The goal of document image analysis is to achieve performance using automated tools that is comparable to what a careful human expert would achieve, or at least to do better than existing algorithms on the same task".

In addition, it is commonly realised that sketch recognition is a complex problem that should be disintegrated into multiple tasks. In this work we revisit one of these tasks, the problem of *early* detection of bilateral symmetry when the only available information is a flat sketch.

Our interest here is to apply perceptual criteria to solve the recognition problem of bilateral symmetry. But, to date studies in the field of visual perception rarely provide enough detailed information to develop an algorithmic approach to replicate human perception. So our purpose is an algorithm that outperforms existing algorithms. This implies reducing the *semantic gap* between algorithms and human perception. This concept is well defined by Smeulders at al. [2]: "The semantic gap is the lack of coincidence between the information that one can extract from the visual data and the interpretation that the same data have for a user in a given situation".

In other works, algorithms should accept what humans accept, should reject what humans reject, and should doubt where humans doubt.

We have proposed an approach for finding bilateral symmetry planes of polyhedral shapes sketched by way of single-view wireframes [3]. The approach takes advantage of the approach for finding skewed facial symmetry described in Piquer et al. [4], and improved by Zou and Lee. [5]. The novelty is studying and replicating how human beings apply their visual perception to recognise bilateral symmetry in objects represented by sketches.

To this end we performed the following experiment to identify which planes humans perceive as depicting symmetric planes, which they reject as symmetric planes, and how confident they are in their judgement.

2. EXPERIMENTS

The experiment was designed to validate or reject the following hypotheses:

1. Humans beings are able to perceive some bilateral symmetries of three-dimensional objects drawn freehand, regardless of their level of engineering training.

2. Our algorithm works as the algorithms studied from other authors, but it better replicates the human perception than them.

2.1 Hypothesis #1

Human beings have the ability to perceive some bilateral symmetries of three-dimensional (3D) objects drawn by sketches. When they are given a series of sketches which also include certain planes that divide the drawing into two opposite halves, human beings are able to classify such planes based on a better representation of a symmetry plane.

Type of prediction: This prediction is posed as a difference.

Significance test: Since we want to test whether there are differences in the perception of bilateral symmetry between different groups of subjects, it seems appropriate to consider an analysis of differences between samples. For this first hypothesis—with quantitative ordinal data—we use numerical analysis tests variables, such as an analysis of variance (ANOVA).

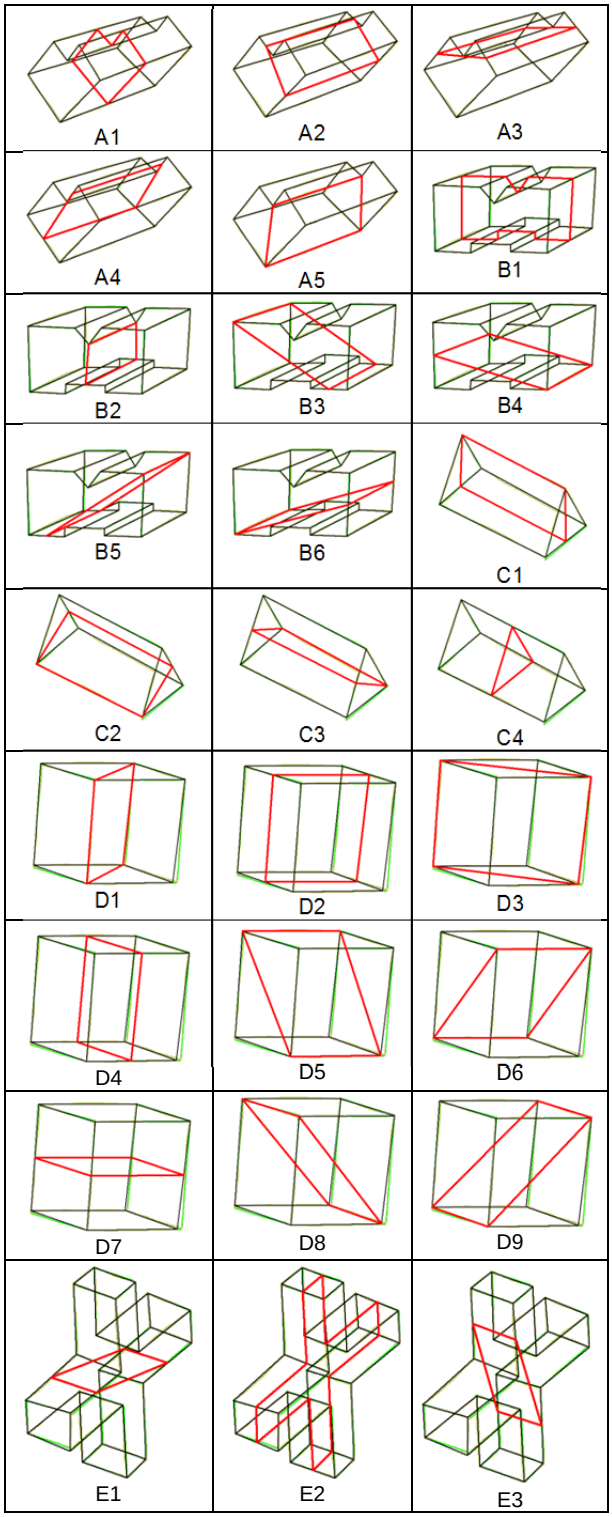
Measures of variables: As we do not know the frequencies with which each example is considered by humans as a symmetry plane, or not, we will try to obtain this information by means of this pilot experiment. To verify that the perception of symmetry planes is similar in any group, irrespective the engineering training of the subjects, we will apply an ANOVA analysis of a single factor. The dependent variable will be the engineering experience level of subjects, and the factor will be the perception of symmetry planes.

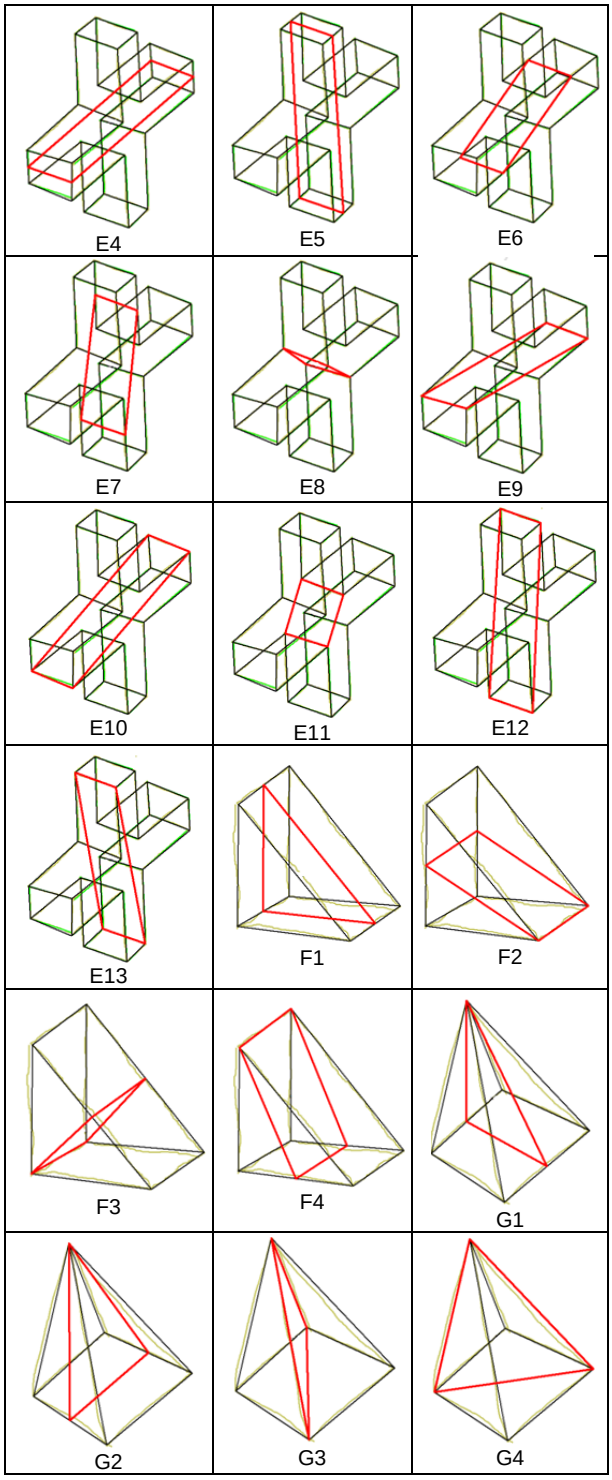
Experimental design: we start with a collection of 7 drawings of 3D wireframe models. For each model, the algorithm calculates candidate planes to represent symmetry planes; the planes are ordered by a figure of merit.

The subjects were given a set of A6 sheets containing one of the sketches (A,… G) plus one of its candidate symmetry planes (as detected by our algorithm) and were informed that the sketch depicted a 3D shape that was complemented with different planes displayed by its contours drawn with dashed lines. Subjects were also informed that those extra planes divided the shape in two halves. Subjects were asked to sort the sheets (which had been previously shuffled) based on the symmetry of their respective extra planes. They were also given a coloured sheet and instructed to use it to clearly separate the sheets in two groups: planes that (to some degree) could depict an actual symmetry plane, and planes that could never be considered to depict an actual symmetry plane.

The examples used in the A6 sheets are represented in Table 1. The frequencies (F) of perception for symmetry planes for each group are showed in Table 2. For a better visualization we have highlighted in bold those symmetry planes perceived by more than a half of the interviewed subjects.

TABLE 1: EXAMPLES USED IN THE EXPERIMENT





From this experiment we hope to obtain information about the frequency with which the planes are perceived as symmetry planes. We also want to obtain information on whether the classification made by humans is independent (there are no differences) from the origin of the human groups studied.

2.1.1 Data collection

Finally we interviewed a sample of 133 subjects (mainly engineering teachers and students, plus a few from other backgrounds).

The answers collected for each model are presented in the following attached at the end of the document.

The frequencies of perception for symmetric planes of each group are showed in Table 2. For a better visualization we have highlighted percentages greater than 50%. Column "parallel" points whether the example includes a plane oriented parallel to any main plane.

TABLE 2: FREQUENCY OF PERCEPTION

Example	High-school	Undergrad.	Master	Teachers
A1	**1,00**	**0,94**	**1,00**	**1,00**
A2	0,00	0,24	0,17	0,07
A3	0,06	0,24	0,17	0,07
A4	0,18	0,29	0,22	0,07
A5	**0,76**	**0,65**	**0,67**	**0,80**
B1	**1,00**	**1,00**	**1,00**	**1,00**
B2	**1,00**	**0,94**	**1,00**	**1,00**
B3	0,18	0,29	0,28	0,00
B4	0,06	0,24	0,11	0,00
B5	0,12	0,24	0,11	0,00
B6	0,06	0,29	0,11	0,00
C1	**0,88**	**1,00**	**1,00**	**0,93**
C2	**0,76**	**0,89**	**0,80**	**0,73**
C3	**0,82**	**0,89**	**1,00**	**0,87**
C4	**0,94**	**1,00**	**0,93**	**1,00**
D1	**0,82**	**1,00**	**0,89**	**1,00**
D2	**1,00**	**1,00**	**1,00**	**1,00**
D3	**0,88**	**0,94**	**0,78**	**1,00**
D4	**1,00**	**0,94**	**1,00**	**1,00**
D5	**0,88**	**0,94**	**0,83**	**0,93**
D6	**0,82**	**1,00**	**0,83**	**0,93**
D7	**1,00**	**1,00**	**1,00**	**1,00**
D8	**0,88**	**1,00**	**0,89**	**0,93**
D9	**0,94**	**0,94**	**0,83**	**0,93**
E1	**0,59**	**0,68**	0,20	0,33
E2	**0,94**	**1,00**	**0,87**	**1,00**
E3	**0,53**	**0,63**	0,13	0,27
E4	**1,00**	**0,95**	**0,93**	**1,00**
E5	**1,00**	**0,95**	**0,93**	**1,00**
E6	**0,59**	**0,68**	0,27	0,40
E7	**0,59**	**0,63**	0,13	0,27
E8	**0,88**	**0,79**	**0,93**	**0,73**
E9	**0,76**	**0,74**	0,27	0,33
E10	**0,88**	**0,74**	0,27	0,33
E11	**1,00**	**0,84**	**0,93**	**0,80**
E12	**0,88**	**0,63**	0,27	0,33
E13	**0,88**	**0,79**	0,27	0,33
F1	**0,94**	**0,95**	**1,00**	**1,00**
F2	**0,59**	**0,53**	**0,53**	0,20
F3	**0,82**	**0,89**	**0,93**	**0,93**
F4	0,41	0,47	0,47	0,13
G1	**1,00**	**0,94**	**0,89**	**1,00**
G2	**1,00**	**1,00**	**0,89**	**0,93**
G3	**0,71**	**1,00**	**0,94**	**0,93**
G4	**0,71**	**1,00**	**0,94**	**0,93**

We can see that, in general, the criterion for considering a symmetry plane is quite similar in all groups. Degree of

engineering training seems not to influence in adopting a classification criterion.

In the light of the results we can conclude that models with complicated geometries (A and B models), produce similar and quite categorical responses. Subjects, regardless of their engineering training, perceive as symmetrical those planes oriented parallel to main planes.

For models with simple, regular and well-known geometries (C, D, F and G models), subjects seem to be quite flexible and they recognise even oblique planes as planes of symmetry. In this case the preference for parallel planes to main planes is not so clear.

2.1.2 Analysis # 1

To verify the first hypothesis, we perform an ANOVA analysis for a single factor (perception of symmetry) among the groups was done (Table 3). The null hypothesis (H_0) was defined as: there is no difference between the perception of symmetry among the four groups.

TABLE 3: SUMMARY

Groups	*Count*	*Sum*	*Mean*	*Variance*
High-school	45	32.76	0.73	0.10
Undergrad.	45	34.74	0.77	0.07
Master	45	29.62	0.66	0.12
Teachers	45	29.47	0.65	0.15

VARIANCE ANALYSIS

Source of variations	*Sums of squares*	*DF*	*Mean square*	*F*	*Prob.*	*Critical value F*
Between groups	0.44	3	0.15	1.33	0.27	2.66
Within groups	19.27	176	0.11			
Total	19.71	179				

H_0 was accepted since the probability p = 0.27> 0.05 (significance level of α = 5% is the probability that the observed difference is the result of chance).

[56] -- *Wednesday, March 30, 2016 -- 21:36:02*
F tests – ANOVA: Fixed effects, special, main effects and interactions

Analysis:	Post hoc: Compute achieved power		
Input:	Effect size f	=	0.4
	α err prob	=	0.05
	Total sample size	=	180
	Numerator df	=	3
	Number of groups	=	4
Output:	Noncentrality parameter λ	=	28.8000000
	Critical F	=	2.6559389
	Denominator df	=	176
	Power (1-β err prob)	=	0.9971979

This analysis has a statistical power (1-β) of 99.72% (probability of rejecting H_0 when it is false).

2.2 Hypothesis #2

The second hypothesis states that our algorithm classifies the symmetry planes as previous algorithms would, but it better replicates the human perception.

Type of prediction: This prediction is posed as a difference.

Significance test: Since we want to test whether there are differences between the new algorithm, the algorithms proposed by other authors and the symmetry planes perceived by humans, we use tests for categorical variables analysis, such as contingency tables (the data is dichotomous ordinal qualitative data).

2.2.1 Input data

TABLE 4: SYMMETRY PLANES CLASSIFICATION

Example	Algorithm	Humans	Previous Authors
A1	1	1	1
A2	-1	-1	-1
A3	-1	-1	-1
A4	-1	-1	-1
A5	-1	1	1
B1	1	1	1
B2	-1	1	1
B3	-1	-1	-1
B4	-1	-1	-1
B5	-1	-1	-1
B6	-1	-1	-1
C1	1	1	1
C2	1	1	1
C3	1	1	1
C4	1	1	1
D1	1	1	-1
D2	1	1	1
D3	1	1	-1
D4	1	1	1
D5	1	1	-1
D6	1	1	-1
D7	1	1	1
D8	1	1	-1
D9	1	1	-1
E1	-1	-1	-1
E2	1	1	1
E3	-1	-1	-1
E4	1	1	1
E5	1	1	1
E6	-1	-1	-1
E7	-1	-1	-1
E8	-1	1	-1
E9	-1	1	-1
E10	-1	1	-1
E11	-1	1	-1
E12	-1	1	-1
E13	-1	1	-1

We take the examples of previous experiment which were analysed previously with the algorithms proposed by other authors in [ZL05] and [PCM03].

The results of models A to E are tabulated as follows:

- Planes are considered as symmetric for the new algorithm only if they were assigned a positive or null merit (value 1), are considered non-symmetric otherwise (value -1).
- Planes are considered as symmetric for humans if they were so perceived by more than a half of the interviewed subjects (F≥0.5 in Table 2).
- Planes included as symmetry planes by other authors are computed as such.

Results are shown in Table 4. For a better visualization, the background of cells labelled as non-symmetric (value -1) is greyed.

2.2.2 Analysis # 2

Using data in Table 4, we contrast the null hypothesis H_0: There is no difference between groups for the classification of planes of symmetry, by Pearson $\chi 2$.

Observed (count) and expected frequencies are shown in Table 5:

TABLE 5: CONTINGENCY TABLE

		Humans	Algorithm	Previous Authors	Total
Symmetry	Count	26	18	14	59
	Expected	19.67	19.67	19.67	59
Non-sym.	Count	11	19	23	52
	Expected	17.33	17.33	17.33	52
	Total	37	37	37	111

From Table 5, $\chi^2_2 = 8.09 > \chi^2_{0.05;2} = 5.99$, the observed statistic is greater than the expected statistical therefore the null hypothesis is rejected. We conclude that there are differences in the responses given by the three study groups, in other words, the classification methods exposed are not independent, and therefore the responses vary depending on the method used (Figure 1).

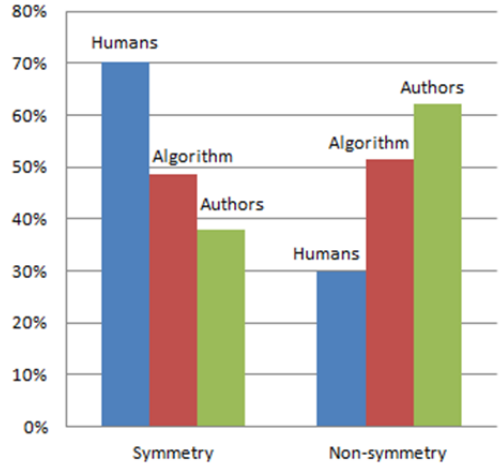


Figure 1: Differences in the perception of symmetry planes.

For an exhaustive analysis, we carry out a pairwise comparison between groups.

TABLE 6: CONTINGENCY TABLE HUMANS-ALGORITHM

		Humans	Algorithm	Total
Symmetry	Count	26	18	44
	Expected	22	22	44
Non-sym.	Count	11	19	30
	Expected	15	15	30
	Total	37	37	111

From Table 6, $\chi^2_2 = 3.59 > \chi^2_{0.05;2} = 3.841$, the observed statistic is smaller than the expected statistical therefore the null hypothesis: There is no difference between Human beings and our algorithm for the classification of planes of symmetry, is accepted.

TABLE 7: CONTINGENCY TABLE HUMANS-AUTHORS

		Humans	Previous Authors	Total
Symmetry	Count	26	14	40
	Expected	20	20	40
Non-sym.	Count	11	23	34
	Expected	17	17	34
	Total	37	37	74

From Table 7, $\chi^2_2 = 7.84 > \chi^2_{0.05;2} = 3.841$, the observed statistic is greater than the expected statistical therefore the null hypothesis: There is no difference between Human beings and algorithms of previous authors for the classification of planes of symmetry, is rejected.

TABLE 8: CONTINGENCY TABLE ALGORITHM-AUTHORS

		Algorithm	Previous Authors	Total
Symmetry	Count	18	14	32
	Expected	16	16	32
Non-sym.	Count	19	23	42
	Expected	21	21	42
	Total	37	37	74

From Table 8, $\chi^2_2 = 0.84 > \chi^2_{0.05;2} = 3.841$, the observed statistic is smaller than the expected statistical therefore the null hypothesis: There is no difference between our algorithm and algorithms of previous authors for the classification of planes of symmetry, is accepted. This means that our algorithm behaves similarly to the algorithms of others authors when classifying the planes of symmetry.

We can conclude that humans accept as symmetric some candidate planes that are classified as non-symmetric by previous approaches. This implies that dichotomist algorithms are stricter than humans. Our merit-algorithm reduces the Semantic Gap relative to previous algorithms, as it behaves quite similar to human judgement for planes clearly perceived as symmetric or non-symmetric. Although it is less strict than humans for dubious symmetry planes.

3. CONCLUSIONS

We have designed and implemented questionnaires to identify which examples humans perceive as depicting symmetry planes.

Conclusions from the experiment support that the algorithm scores the symmetry planes mostly as humans do for clearly perceived and for clearly not-perceived symmetry planes, while it is more prone than humans to accept dubious planes as true symmetry planes.

References

[1] Lamiroy B. 2013. Interpretation, Evaluation and the Semantic Gap...What if we Were on a Side- Track? GREC2013, LNCS 8746, pp.213- 226, 2014.

[2] Smeulders A.W.M., Worring M., Santini S., Gupta A. and Jain R. Content-Based Image Retrieval at the End of the Early Years. *IEEE Trans. Pattern Analysis and Machine Intelligence*, 22(12), pp. 1349-80, Jan. 2000.

[3] Plumed R., Company P., Varley P.A.C. 2016. Detecting mirror symmetry in single-view wireframe sketches of polyhedral shapes. *Computers & Graphics*, accepted paper.

[4] Piquer A., Company P. and Martin R.R. 2003. Skewed mirror symmetry in the 3D reconstruction of polyhedral models. *Journal of WSCG*, 11(3), 504-511.

[5] Zou H.L. and Lee Y.T. 2005. Skewed Mirror Symmetry Detection from a 2D Sketch of a 3D Model. *Proceedings GRAPHITE 2005. 3rd International Conference on Computer Graphics and Interactive Techniques in Australasia and Southeast Asia*, 69-76.

Next, it is shown the classification made by each subject for each model. Subjects are grouped by their level of engineering experience: High-School students, Undergraduated students, Master students and Teachers.

Negative signs reflect those planes classified by polled subjects like planes that could never be considered to depict an actual symmetry plane. That is to say, those examples situated behind the coloured sheet used to separate the A6 sheets.

Model A:

Origin	Subject	1º	2º	3º	4º	5º
Master	2	A1	A5	-A3	-A4	-A2
Master	5	A1	-A2	-A3	-A5	-A4
Master	6	A5	A1	-A3	-A4	-A2
Master	7	A1	A5	A2	A4	A3
Master	105	A5	A3	A2	A4	A1
Master	107	A1	A5	-A3	-A2	-A4
Master	110	A1	-A2	-A5	-A3	-A4
Master	112	A1	A5	-A4	-A2	-A3
Master	115	A1	A5	-A2	-A4	-A3
Master	116	A1	A4	A5	A2	A3
Master	117	A1	A5	-A2	-A3	-A4
Master	124	A1	A5	-A4	-A2	-A3
Master	125	A1	-A5	-A3	-A2	-A4
Master	127	A1	A4	-A5	-A2	-A3
Master	129	A1	-A2	-A4	-A5	-A3
Master	130	A1	-A3	-A2	-A5	-A4
Master	132	A1	A5	-A4	-A3	-A2
Master	133	A5	A1	-A4	-A2	-A3
Undergrad.	10	A5	A3	A1	A2	A4
Undergrad.	12	A1	-A5	-A2	-A4	-A3
Undergrad.	13	A1	-A2	-A3	-A4	-A5
Undergrad.	17	A5	A1	-A4	-A2	-A3
Undergrad.	18	A1	A5	-A3	-A4	-A2
Undergrad.	19	A1	A5	-A4	-A3	-A2
Undergrad.	23	A5	A1	-A2	-A4	-A3
Undergrad.	25	A1	-A5	-A4	-A2	-A3
Undergrad.	26	A1	A5	A4	A2	A3
Undergrad.	28	A1	A5	A4	A2	A3
Undergrad.	29	A1	-A3	-A2	-A4	-A5
Undergrad.	31	A4	A5	A2	A1	A3
Undergrad.	33	A1	A5	-A3	-A2	-A4
Undergrad.	37	A5	A1	-A4	-A2	-A3
Undergrad.	38	A4	A5	-A2	-A3	-A1
Undergrad.	42	A1	-A5	-A4	-A2	-A3
Undergrad.	43	A1	-A4	-A2	-A3	-A5
High-School	46	A1	A5	-A2	-A3	-A4

Model B:

Origin	Subject	1º	2º	3º	4º	5º	6º
Master	2	B2	B1	-B5	-B6	-B4	-B3
Master	5	B2	B1	-B5	-B3	-B6	-B4
Master	6	B2	B1	-B6	-B3	-B4	-B5
Master	7	B2	B1	-B3	-B5	-B4	-B6
Master	105	B2	B1	B3	B4	B5	B6
Master	107	B2	B1	-B4	-B5	-B3	-B6
Master	110	B1	B2	-B5	-B6	-B3	-B4
Master	112	B1	B2	-B3	-B5	-B6	-B4
Master	115	B1	B2	-B6	-B4	-B3	-B5
Master	116	B2	B1	B3	B5	B4	B6
Master	117	B2	B1	-B5	-B4	-B6	-B3
Master	124	B1	B2	-B5	-B3	-B4	-B6
Master	125	B1	B2	B3	-B6	-B5	-B4
Master	127	B3	B2	B1	-B6	-B5	-B4
Master	129	B1	B2	-B6	-B3	-B5	-B4
Master	130	B2	B1	B3	-B6	-B5	-B4
Master	132	B1	B2	-B6	-B4	-B5	-B3
Master	133	B2	B1	-B6	-B3	-B5	-B4
Undergrad.	10	B2	B4	B1	B5	B3	B6
Undergrad.	12	B2	B1	-B5	-B6	-B4	-B3
Undergrad.	13	B1	B2	-B3	-B6	-B4	-B5
Undergrad.	17	B1	B2	-B6	-B3	-B5	-B4
Undergrad.	18	B1	B2	B5	B3	B4	B6
Undergrad.	19	B1	B2	-B5	-B4	-B3	-B6
Undergrad.	23	B1	-B5	-B6	-B2	-B4	-B3
Undergrad.	25	B1	B2	-B3	-B4	-B6	-B5
Undergrad.	26	B1	B2	-B3	-B6	-B4	-B5
Undergrad.	28	B1	B2	B4	B3	B6	B5
Undergrad.	29	B1	B2	-B3	-B5	-B4	-B6
Undergrad.	31	B1	B2	B3	B5	B4	B6
Undergrad.	33	B1	B2	B6	-B3	-B5	-B4
Undergrad.	37	B2	B1	-B3	-B6	-B5	-B4
Undergrad.	38	B1	B3	B2	-B5	-B4	-B6
Undergrad.	42	B1	B2	-B6	-B4	-B5	-B3
Undergrad.	43	B2	B1	-B4	-B6	-B5	-B3
High-School	46	B2	B1	-B5	-B6	-B4	-B3

High-School	47	A5	A1	-A2	-A3	-A4
High-School	49	A1	-A3	-A2	-A4	-A5
High-School	52	A5	A1	-A3	-A2	-A4
High-School	53	A5	A1	-A2	-A3	-A4
High-School	55	A1	-A4	-A5	-A2	-A3
High-School	57	A5	A1	-A4	-A2	-A3
High-School	58	A1	-A4	-A2	-A5	-A3
High-School	59	A1	A5	A4	A3	-A2
High-School	61	A1	A5	-A3	-A2	-A4
High-School	63	A1	A5	A4	-A2	-A3
High-School	67	A1	A5	-A3	-A2	-A4
High-School	68	A1	A5	A4	-A3	-A2
High-School	70	A5	A1	-A2	-A3	-A4
High-School	71	A1	A5	-A3	-A2	-A4
High-School	73	A1	-A4	-A3	-A2	-A5
High-School	76	A5	A1	-A2	-A4	-A3
Teacher	79	A1	A5	-A3	-A4	-A2
Teacher	81	A1	A5	-A4	-A2	-A3
Teacher	82	A1	A5	-A2	-A3	-A4
Teacher	83	A5	A1	-A3	-A4	-A2
Teacher	85	A1	A3	A4	A2	A5
Teacher	90	A1	A5	-A4	-A2	-A3
Teacher	91	A1	A5	-A4	-A3	-A2
Teacher	92	A1	A5	-A4	-A3	-A2
Teacher	94	A1	A5	-A3	-A2	-A4
Teacher	96	A1	A5	-A2	-A4	-A3
Teacher	99	A1	-A5	-A3	-A4	-A2
Teacher	100	A1	-A2	-A4	-A3	-A5
Teacher	103	A5	A1	-A2	-A4	-A3
Teacher	118	A1	-A2	-A5	-A3	-A4
Teacher	120	A1	A5	-A3	-A4	-A2

High-School	47	B2	B1	-B4	-B5	-B6	-B3
High-School	49	B2	B1	-B5	-B6	-B4	-B3
High-School	52	B2	B1	-B3	-B5	-B4	-B6
High-School	53	B2	B1	B3	B6	B5	B4
High-School	55	B1	B2	-B4	-B5	-B3	-B6
High-School	57	B1	B3	B2	-B4	-B5	-B6
High-School	58	B1	B2	-B5	-B3	-B6	-B4
High-School	59	B3	B1	B2	-B4	-B6	-B5
High-School	61	B1	B2	B5	-B4	-B6	-B3
High-School	63	B2	B1	-B6	-B5	-B3	-B4
High-School	67	B2	B1	-B4	-B6	-B3	-B5
High-School	68	B1	B2	-B3	-B5	-B4	-B6
High-School	70	B2	B1	-B3	-B6	-B5	-B4
High-School	71	B2	B1	-B6	-B5	-B3	-B4
High-School	73	B2	B1	-B3	-B4	-B5	-B6
High-School	76	B2	B1	-B6	-B5	-B3	-B4
Teacher	79	B2	B1	-B6	-B4	-B5	-B3
Teacher	81	B1	B2	-B5	-B3	-B6	-B4
Teacher	82	B1	B2	-B3	-B5	-B6	-B4
Teacher	83	B1	B2	-B6	-B4	-B3	-B5
Teacher	85	B1	B2	-B3	-B5	-B6	-B4
Teacher	90	B2	B1	-B5	-B3	-B6	-B4
Teacher	91	B2	B1	-B6	-B4	-B5	-B3
Teacher	92	B1	B2	-B4	-B6	-B5	-B3
Teacher	94	B2	B1	-B3	-B4	-B5	-B6
Teacher	96	B1	B2	-B6	-B4	-B3	-B5
Teacher	99	B2	B1	-B6	-B4	-B5	-B3
Teacher	100	B1	B2	-B3	-B5	-B4	-B6
Teacher	103	B2	B1	-B6	-B5	-B3	-B4
Teacher	118	B2	B1	-B3	-B4	-B5	-B6
Teacher	120	B2	B1	-B3	-B4	-B5	-B6

Model C:

Origin	Subject	1º	2º	3º	4º
Master	1	C3	C2	C1	-C4
Master	3	C1	C3	C4	C2
Master	4	C4	C1	C3	-C2
Master	8	C4	C1	C3	-C2
Master	106	C1	C3	C2	C4
Master	108	C1	C4	C3	C2
Master	109	C2	C4	C1	C3
Master	111	C2	C4	C3	C1
Master	113	C2	C4	C3	C1
Master	114	C4	C1	C2	C3
Master	122	C2	C4	C1	C3
Master	123	C1	C3	C4	C2
Master	126	C4	C1	C3	-C2
Master	128	C1	C2	C4	C3
Master	131	C4	C2	C1	C3
Undergrad.	9	C1	C4	C2	C3
Undergrad.	11	C4	C2	C3	C1
Undergrad.	13	C4	C1	-C3	-C2
Undergrad.	14	C4	C1	C3	C2
Undergrad.	15	C4	C1	C3	C2
Undergrad.	16	C1	C2	C3	C4
Undergrad.	22	C1	C3	C2	C4
Undergrad.	24	C3	C2	C1	C4
Undergrad.	26	C4	C1	C2	C3
Undergrad.	27	C3	C1	C2	C4
Undergrad.	30	C2	C4	C3	C1
Undergrad.	32	C1	C3	C4	C2
Undergrad.	34	C4	C1	C2	C3
Undergrad.	35	C4	C2	C3	C1
Undergrad.	36	C3	C1	C2	C4

Model D:

Origin	Subject	1º	2º	3º	4º	5º	6º	7º	8º	9º
Master	2	D4	D2	D3	D1	D5	D6	D9	D8	D7
Master	5	D2	D7	D4	-D3	-D1	-D5	-D9	-D6	-D8
Master	6	D9	D5	D1	D3	D6	D8	D4	D2	D7
Master	7	D7	D2	D4	D3	D6	D8	D9	D1	D5
Master	105	D4	D7	D2	D8	D9	D6	D5	D3	D1
Master	107	D7	D9	D1	D6	D8	D5	D4	D3	D2
Master	110	D7	D2	D4	D5	D6	D9	D8	D1	D3
Master	112	D8	D1	D5	D7	D9	D6	D3	D2	D4
Master	115	D7	D4	D2	D9	D5	D1	D8	D6	D3
Master	116	D4	D2	D7	D6	D8	D9	D5	D1	D3
Master	117	D9	D1	D7	D2	D6	D8	D4	D5	D3
Master	124	D2	D7	D4	D1	-D6	-D3	-D5	-D8	-D9
Master	125	D8	D9	D6	D4	D7	D5	D2	D1	D3
Master	127	D7	D9	D1	D5	D8	D6	D4	D2	-D3
Master	129	D7	D8	D2	D4	-D6	-D3	-D9	-D5	-D1
Master	130	D3	D9	D5	D4	D2	D7	D8	D6	D1
Master	132	D3	D5	D4	D8	D6	D2	D7	D1	D9
Master	133	D1	D3	D6	D8	D5	D9	D4	D7	D2
Undergrad.	10	D7	D8	D6	D2	D1	D9	D3	D4	D5
Undergrad.	12	D7	D9	D8	D4	D2	D6	D3	D5	D1
Undergrad.	13	D9	D1	D8	D5	D3	D2	D7	D6	D4
Undergrad.	17	D7	D2	D4	D8	D6	D3	D1	D5	D9
Undergrad.	18	D8	D5	D6	D7	D3	D1	D9	D4	D2
Undergrad.	19	D2	D1	D4	D3	D7	D5	D6	D8	D9
Undergrad.	23	D7	D2	D4	D5	D9	D6	D8	D3	D1
Undergrad.	25	D2	D8	D6	D5	D3	D9	D4	D1	D7
Undergrad.	26	D7	D4	D2	D9	D5	D1	D6	D8	D3
Undergrad.	28	D2	D4	D8	D9	D1	D5	D3	D7	D6
Undergrad.	29	D7	D4	D2	D9	D8	D3	D6	D1	D5
Undergrad.	31	D7	D2	D4	D1	D9	D5	D8	D3	D6

Undergrad.	39	C4	C1	C2	C3
Undergrad.	40	C4	C3	C1	C2
Undergrad.	41	C4	C1	-C2	-C3
Undergrad.	44	C2	C4	C3	C1
High-School	45	C4	C1	C3	C2
High-School	48	C2	C1	C4	C3
High-School	50	C1	C4	-C2	-C3
High-School	51	C4	-C2	-C3	-C1
High-School	54	C4	C1	-C2	-C3
High-School	56	C4	C2	C3	C1
High-School	60	C1	C2	C3	C4
High-School	62	C2	C4	C3	-C1
High-School	64	C4	C3	C2	C1
High-School	65	C4	C2	C1	C3
High-School	66	C1	C4	C2	C3
High-School	69	C3	C2	C1	-C4
High-School	72	C4	C1	C3	-C2
High-School	74	C4	C3	C1	C2
High-School	75	C1	C4	C2	C3
High-School	77	C1	C4	C2	C3
High-School	102	C1	C3	C4	C2
Teacher	78	C4	-C2	-C1	-C3
Teacher	80	C4	C1	C3	C2
Teacher	84	C4	C3	C1	-C2
Teacher	86	C1	C4	C2	C3
Teacher	87	C4	C2	C1	C3
Teacher	88	C1	C2	C3	C4
Teacher	89	C1	C4	C2	C3
Teacher	93	C1	C3	C4	C2
Teacher	95	C4	C1	-C2	-C3
Teacher	97	C1	C4	C3	C2
Teacher	98	C1	C4	C2	C3
Teacher	101	C1	C4	C3	-C2
Teacher	104	C3	C4	C2	C1
Teacher	119	C4	C3	C1	C2
Teacher	121	C1	C3	C4	C2

Undergrad.	33	D5	D4	D9	D3	D2	D1	D7	D6	D8
Undergrad.	37	D6	D2	D4	D1	D3	D8	D9	D7	D5
Undergrad.	38	D6	D8	D7	D1	D2	-D3	-D4	-D5	-D9
Undergrad.	42	D6	D5	D9	D8	D7	D2	D3	D1	D4
Undergrad.	43	D5	D8	D3	D4	D1	D7	D2	D6	D9
High-School	46	D4	D2	D8	D9	D1	D5	D3	D7	D6
High-School	47	D9	D6	D2	D7	D1	D4	D3	D8	D5
High-School	49	D2	D4	D7	-D5	-D1	-D6	-D3	-D8	-D9
High-School	52	D3	D9	D5	D4	D2	D1	D7	D8	D6
High-School	53	D6	D2	D4	D1	D3	D8	D9	D7	D5
High-School	55	D3	D8	D6	D7	D1	D2	D9	D4	D5
High-School	57	D7	D2	D4	D5	D9	D1	D3	D6	D8
High-School	58	D3	D6	D8	D1	D9	D5	D4	D2	D7
High-School	59	D5	D1	D6	D9	D8	D3	D4	D2	D7
High-School	61	D7	D2	D4	D8	D9	D5	D1	D6	D3
High-School	63	D7	D2	D4	D5	D8	D9	D3	D1	D6
High-School	67	D4	D2	D9	D5	D7	-D1	-D8	-D6	-D3
High-School	68	D7	D4	D5	D2	D6	D9	D8	D1	D3
High-School	70	D7	D4	D2	D6	D5	D9	D8	D3	D1
High-School	71	D4	D7	D2	D8	D3	D9	-D1	-D5	-D6
High-School	73	D5	D6	D2	D4	D1	D3	D8	D9	D7
High-School	76	D6	D8	D4	D1	D9	D5	D2	D7	D3
Teacher	79	D7	D2	D5	D6	D9	D4	D8	D1	D3
Teacher	81	D7	D4	D2	D9	D5	D1	D8	D6	D3
Teacher	82	D7	D4	D2	D1	D8	D6	D5	D9	D3
Teacher	83	D7	D4	D2	D9	D3	D8	D1	D5	D6
Teacher	85	D7	D8	D2	D9	D4	D5	D1	D6	D3
Teacher	90	D3	D6	D8	D1	D9	D5	D4	D2	D7
Teacher	91	D5	D9	D3	D1	D8	D6	D7	D4	D2
Teacher	92	D2	D7	D4	D6	D3	D1	D5	D9	D8
Teacher	94	D4	D7	D2	D3	D1	D8	D6	D9	D5
Teacher	96	D2	D4	D7	D3	D1	D6	D5	D9	D8
Teacher	99	D4	D2	D7	D6	D5	D1	D8	D9	D3
Teacher	100	D7	D2	D4	D9	D6	D3	D1	D8	D5
Teacher	103	D5	D3	D9	D6	D8	D7	D1	D4	D2
Teacher	118	D3	D9	D5	D4	D2	D7	D1	D8	D6
Teacher	120	D2	D4	D1	D3	D7	-D5	-D6	-D8	-D9

Model E:

Origin	Subject	1º	2º	3º	4º	5º	6º	7º	8º	9º	10º	11º	12º	13º
Master	1	E8	E11	E6	E5	-E12	-E1	-E13	-E2	-E4	-E7	-E9	-E10	-E3
Master	3	E2	E4	E11	E8	E10	E9	E12	E13	-E7	-E6	-E3	-E5	-E1
Master	4	E5	E4	E2	E11	E8	-E10	-E6	-E12	-E3	-E7	-E1	-E13	-E9
Master	8	E2	E5	E4	-E3	-E13	-E12	-E9	-E10	-E7	-E1	-E6	-E11	-E8
Master	106	E4	E5	E2	E8	E11	-E10	-E9	-E13	-E12	-E7	-E1	-E3	-E6
Master	108	E2	E5	E4	E11	E8	-E12	-E13	-E9	-E10	-E7	-E3	-E6	-E1
Master	109	E5	E4	E2	E11	E8	-E7	-E6	-E10	-E9	-E12	-E13	-E3	-E1
Master	111	E5	E11	E8	E4	E2	-E1	-E6	-E7	-E3	-E10	-E12	-E13	-E9
Master	113	E4	E5	E8	E11	E2	-E12	-E13	-E9	-E3	-E1	-E10	-E6	-E7
Master	114	E8	E4	E5	E2	E12	E11	E13	E3	E10	E6	E9	E7	E1
Master	122	E4	E5	E2	E1	E3	E13	E7	E10	E11	E8	E12	E6	E9
Master	123	E8	E4	E11	E2	E5	-E1	-E7	-E9	-E6	-E10	-E3	-E13	-E12
Master	126	E5	E4	E2	E11	E8	-E13	-E12	-E9	-E6	-E10	-E1	-E7	-E3
Master	128	E11	E1	E8	E5	E4	E12	E6	E10	E9	E13	-E7	-E2	-E3
Master	131	E2	E5	E4	E8	E11	-E6	-E13	-E1	-E9	-E12	-E10	-E7	-E3
Undergrad.	9	E2	E5	E4	E12	E13	E9	E10	E6	E7	E8	E11	E1	E3
Undergrad.	11	E2	E5	E4	E10	E9	E6	E13	E12	-E7	-E3	-E1	-E11	-E8
Undergrad.	13	E8	E11	E4	E5	E2	-E3	-E13	-E12	-E9	-E10	-E7	-E1	-E6
Undergrad.	14	E5	E4	E8	E11	E9	E6	E3	E1	E13	E2	-E7	-E10	-E12
Undergrad.	15	E11	E4	E5	E8	E9	E12	E3	E10	E7	E13	E6	E1	E2
Undergrad.	16	E2	E4	E5	E8	E7	E9	E10	E11	E12	E13	E1	E3	E6
Undergrad.	22	E2	-E3	-E10	-E8	-E11	-E13	-E6	-E9	-E7	-E4	-E12	-E5	-E1
Undergrad.	24	E2	E6	E1	E5	E7	E10	E4	E9	E12	E11	E13	E3	E8
Undergrad.	26	E11	E8	E2	E4	E5	-E10	-E13	-E6	-E9	-E1	-E3	-E7	-E12

Undergrad.	27	E4	E5	E2	E13	E12	E11	E8	E7	E9	E6	E1	E3	E10
Undergrad.	30	E2	E8	E10	E7	E9	E6	E11	E12	E1	E13	E3	E4	E5
Undergrad.	32	E2	E5	E4	E12	E9	E8	E11	E1	E6	E13	E7	E10	E3
Undergrad.	34	E13	E10	E5	E4	E2	E8	E11	E7	-E3	-E1	-E9	-E6	-E12
Undergrad.	35	E3	E1	E2	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
Undergrad.	36	E7	E9	E13	E1	E3	E2	E8	E4	E10	E12	E6	E11	E5
Undergrad.	39	E3	E2	E10	E8	E11	E12	E6	E9	E7	E4	E13	E5	E1
Undergrad.	40	E11	E4	E5	E2	-E8	-E3	-E10	-E12	-E9	-E13	-E7	-E1	-E6
Undergrad.	41	E10	E13	E2	E5	E4	E12	E7	E9	E6	E1	E3	-E8	-E11
Undergrad.	44	E2	E10	E13	E1	E11	E8	E9	E4	E5	-E12	-E6	-E7	-E3
High-	45	E2	E5	E4	E7	E10	E9	E12	E3	E13	E1	E11	E6	E8
High-	48	E4	E5	E11	-E7	-E2	-E6	-E3	-E9	-E12	-E1	-E8	-E13	-E10
High-	50	E5	E4	E2	E10	E9	E13	E12	E11	E8	-E6	-E7	-E1	-E3
High-	51	E2	E4	E5	E3	E7	E6	E1	E9	E10	E11	E12	E13	E8
High-	54	E3	E2	E10	E8	E11	E13	E7	E4	E12	E5	E1	-E9	-E6
High-	56	E2	E4	E5	E11	E8	-E7	-E9	-E13	-E1	-E3	-E10	-E12	-E6
High-	60	E10	E9	E13	E5	E2	E4	E12	E11	E8	-E1	-E6	-E3	-E7
High-	62	E5	E2	E4	E11	E12	E9	E8	E13	E10	E6	-E3	-E7	-E1
High-	64	E8	E11	E4	E5	E2	E1	E6	E3	E7	E13	E12	E10	E9
High-	65	E2	E5	E4	E10	E12	E9	E13	E8	E11	E6	E7	E1	E3
High-	66	E2	E4	E5	E8	E11	E10	E12	E9	E13	E6	E1	E7	E3
High-	69	E10	E2	E12	E4	E5	E13	E11	-E7	-E8	-E9	-E3	-E1	-E6
High-	72	E4	E5	E11	E8	E10	E13	E12	E9	E2	E1	E6	E7	E3
High-	74	E2	E10	E8	E11	E13	E4	E5	E12	E9	E7	E6	E3	E1
High-	75	E5	E4	E2	E8	E11	E9	E13	E12	E10	E3	E7	E6	E1
High-	77	E11	E8	E5	E4	E2	E13	E10	E12	E9	E6	E1	E7	-E3
High-	102	E4	E5	E2	E10	E9	E13	E12	E11	E8	-E1	-E6	-E7	-E3
Teacher	78	E2	E4	E5	-E11	-E8	-E13	-E9	-E12	-E10	-E6	-E7	-E1	-E3
Teacher	80	E8	E11	E4	E5	E2	E10	E12	E13	E7	E9	E3	E1	E6
Teacher	84	E2	E5	E4	E11	E6	E8	-E9	-E10	-E12	-E13	-E1	-E3	-E7
Teacher	86	E5	E4	E2	E10	E9	E13	E12	E11	E8	E6	E1	E7	E3
Teacher	87	E5	E4	E2	E11	E8	-E12	-E1	-E9	-E3	-E7	-E13	-E6	-E10
Teacher	88	E10	E9	E13	E12	E11	E8	E2	E5	E4	E6	E1	E3	E7
Teacher	89	E4	E5	E8	E11	E2	E12	E6	E10	E3	E7	E1	E9	E13
Teacher	93	E5	E4	E2	E8	E11	-E12	-E6	-E10	-E1	-E9	-E3	-E7	-E13
Teacher	95	E2	E4	E5	E11	-E8	-E9	-E12	-E13	-E10	-E7	-E6	-E3	-E1
Teacher	97	E2	E5	E4	E11	E8	-E9	-E10	-E7	-E3	-E12	-E13	-E6	-E1
Teacher	98	E5	E4	E11	E8	E2	-E1	-E7	-E9	-E6	-E12	-E10	-E3	-E13
Teacher	101	E4	E5	E2	E11	E8	-E9	-E10	-E12	-E13	-E3	-E6	-E7	-E1
Teacher	104	E2	E8	E5	E4	E11	-E3	-E7	-E12	-E10	-E9	-E1	-E13	-E6
Teacher	119	E9	E5	E4	E12	E13	E2	E6	E10	E1	-E7	-E3	-E11	-E8
Teacher	121	E2	E4	E5	-E3	-E11	-E6	-E7	-E10	-E1	-E13	-E12	-E9	-E8

Model F:

Origin	Subject	1º	2º	3º	4º
Master	1	F3	F1	-F4	-F2
Master	3	F1	F4	F3	F2
Master	4	F3	F1	-F4	-F2
Master	8	F1	F3	F2	-F4
Master	106	F1	F3	-F4	-F2
Master	108	F1	F3	-F2	-F4
Master	109	F3	F1	F2	F4
Master	111	F1	F4	F3	F2
Master	113	F1	F3	F4	F2
Master	114	F1	F2	F4	F3
Master	122	F1	F3	-F2	-F4
Master	123	F3	F1	-F4	-F2
Master	126	F1	F3	-F2	-F4
Master	128	F1	F2	F4	-F3
Master	131	F1	F3	F4	F2
Undergrad.	9	F1	F3	F2	F4
Undergrad.	11	F2	F3	F1	-F4
Undergrad.	13	F1	F3	-F2	-F4
Undergrad.	14	F4	F1	F2	-F3

Model G:

Origin	Subject	1º	2º	3º	4º
Master	2	G2	G1	G4	G3
Master	5	G4	G3	-G2	-G1
Master	6	G3	G4	G2	G1
Master	7	G1	G3	G4	G2
Master	105	G2	G1	G3	G4
Master	107	G1	G2	G3	G4
Master	110	G4	G3	G2	G1
Master	112	G1	G2	G3	G4
Master	115	G1	G2	G4	G3
Master	116	G2	G1	G4	G3
Master	117	G3	G2	G4	G1
Master	124	G2	G1	-G4	-G3
Master	125	G1	G2	G3	G4
Master	127	G3	G4	-G1	-G2
Master	129	G1	G2	G3	G4
Master	130	G1	G2	G4	G3
Master	132	G1	G4	G2	G3
Master	133	G1	G2	G4	G3
Undergrad.	10	G4	G1	G2	G3

Undergrad.	15	F1	F2	F3	F4
Undergrad.	16	F1	F3	-F4	-F2
Undergrad.	22	F3	-F2	-F4	-F1
Undergrad.	24	F1	F4	F3	F2
Undergrad.	26	F3	F1	F4	F2
Undergrad.	27	F1	F3	F4	F2
Undergrad.	30	F1	F2	F4	F3
Undergrad.	32	F1	F2	F4	F3
Undergrad.	34	F1	F3	-F2	-F4
Undergrad.	35	F1	F3	-F4	-F2
Undergrad.	36	F2	F4	F1	F3
Undergrad.	39	F1	F3	-F4	-F2
Undergrad.	40	F3	F1	-F2	-F4
Undergrad.	41	F1	-F2	-F3	-F4
Undergrad.	44	F3	F1	-F2	-F4
High-School	45	F3	F1	F2	F4
High-School	48	F1	F2	-F3	-F4
High-School	50	F1	-F4	-F3	-F2
High-School	51	F1	-F4	-F2	-F3
High-School	54	F1	F3	-F4	-F2
High-School	56	F1	F3	-F2	-F4
High-School	60	F1	F3	-F4	-F2
High-School	62	F1	F3	-F4	-F2
High-School	64	F4	F2	F3	F1
High-School	65	F1	F3	-F2	-F4
High-School	66	F1	F2	F3	-F4
High-School	69	F3	F2	F4	-F1
High-School	72	F1	F3	F2	F4
High-School	74	F1	F3	F4	F2
High-School	75	F1	F3	F2	F4
High-School	77	F3	F1	F4	F2
High-School	102	F1	F2	F3	-F4
Teacher	78	F1	F3	F2	F4
Teacher	80	F1	F3	-F4	-F2
Teacher	84	F1	F3	-F4	-F2
Teacher	86	F1	F3	-F4	-F2
Teacher	87	F3	F2	F1	F4
Teacher	88	F3	F1	-F2	-F4
Teacher	89	F1	F3	-F4	-F2
Teacher	93	F1	F3	-F2	-F4
Teacher	95	F1	F3	-F4	-F2
Teacher	97	F1	-F3	-F2	-F4
Teacher	98	F1	F3	F2	-F4
Teacher	101	F1	F3	-F4	-F2
Teacher	104	F1	F3	-F2	-F4
Teacher	119	F1	F3	-F2	-F4
Teacher	121	F3	F1	-F4	-F2

Undergrad.	12	G3	G4	G1	G2
Undergrad.	13	G3	G1	G2	G4
Undergrad.	17	G1	G2	G4	G3
Undergrad.	18	G2	G4	G3	G1
Undergrad.	19	G4	G2	G3	G1
Undergrad.	23	G1	G2	G4	G3
Undergrad.	25	G2	G4	G3	G1
Undergrad.	26	G2	G1	G4	G3
Undergrad.	28	G2	G1	G4	G3
Undergrad.	29	G2	G4	G1	G3
Undergrad.	31	G1	G2	G3	G4
Undergrad.	33	G2	G1	G4	G3
Undergrad.	37	G3	G4	G2	G1
Undergrad.	38	G4	G2	G3	-G1
Undergrad.	42	G3	G1	G2	G4
Undergrad.	43	G1	G3	G2	G4
High-School	46	G4	G3	G2	G1
High-School	47	G2	G3	G1	G4
High-School	49	G1	G2	-G3	-G4
High-School	52	G4	G1	G3	G2
High-School	53	G3	G4	G2	G1
High-School	55	G2	G4	G1	G3
High-School	57	G1	G2	-G4	-G3
High-School	58	G4	G3	G2	G1
High-School	59	G1	G2	G4	-G3
High-School	61	G1	G2	G4	G3
High-School	63	G1	G2	G4	-G3
High-School	67	G1	G2	-G4	-G3
High-School	68	G2	G1	G3	-G4
High-School	70	G2	G1	G4	G3
High-School	71	G1	G2	G3	G4
High-School	73	G1	G2	G3	-G4
High-School	76	G1	G2	G4	G3
Teacher	79	G2	G1	G3	G4
Teacher	81	G1	G2	G4	G3
Teacher	82	G2	G4	G3	G1
Teacher	83	G3	G4	G1	G2
Teacher	85	G3	G2	G1	G4
Teacher	90	G4	G3	G1	G2
Teacher	91	G1	-G4	-G3	-G2
Teacher	92	G2	G1	G4	G3
Teacher	94	G3	G4	G1	G2
Teacher	96	G4	G1	G2	G3
Teacher	99	G1	G2	G3	G4
Teacher	100	G2	G4	G3	G1
Teacher	103	G4	G2	G3	G1
Teacher	118	G1	G2	G4	G3
Teacher	120	G1	G2	G3	G4