T-61.5010 Information Visualization Examination

March 5th, 2012

To pass the course you must also pass the term project (assignment). Results of this examination are valid for one year after the examination date. To get full points you must complete all of the problems 1–5. All of the problems have an equal weight. There are 50 points in this exam in total.

Answer in English. Please write clearly and leave a wide left or right margin. No extra material (calculator, lecture notes etc.) is allowed. Please write your answers preferably using a ballpoint pen, not a pencil.

PLEASE ANSWER EACH QUESTION ON A DIFFERENT SHEET!

Instructions for the essays: Write in full sentences and structure your answer in paragraphs. The essay should be written in a manner understandable to your fellow student (who would have the necessary prerequisite information to take this course, but has not taken it) who has asked you to tell him/her about the topic of the essay.

The results will be posted to the course Noppa home page on April 5th 2012, at latest. No other announcement will be made.

There are 10 (ten) pages in this examination. You can keep this paper.

1 Multiple choices questions

The following questions have each different proposed answers. Only one of them is correct. **You have to give your answer along with your confidence ("High" or "Low") for each answer.** Grading for each of these multiple choices questions is then:

- +2 if answer is right and confidence is high
- +1 if answer is right and confidence is low
- 0 if answer is missing
- -1 if answer is wrong and confidence is low
- -3 if answer is wrong and confidence is high

Write on your answer sheet the correct answer (A, B, C, D,...), along with the confidence you have (High, Low) for that question; e.g "A, Low" is a proper way of answering a question. **Missing confidence for a question will be treated as "Low". Total score for this question is between 0 and 10 (TOTAL SCORE OF THE EXAM IS ON 50).**

Question 1

The Latin alphabet is a set of

A) Sensory symbols

B) Arbitrary symbols

C) Sensory and Arbitrary symbols

D) None of the answers above is correct

Question 2

According to the CIE system of color standards, in the chromaticity diagram

A) Any set of three non-aligned colored lights specifies a triangle. Only points on the edges of the triangle can be represented as a mixture of the given lights

B) None of the realizable colors fall within the spectrum locus (the set of chromaticity coordinates representing single wavelength colors)

C) All the answers above are correct

D) None of the above answers is correct

Question 3

In the theory of pre-attentive features, the conjunction search of two pre-attentive attributes

A) is never pre-attentive

B) does not exist

C) is always pre-attentive

D) None of the above answers is correct

Question 4

The third and fourth principal components for PCA (Principal Component Analysis) in this figure (Figure 1) are given by:

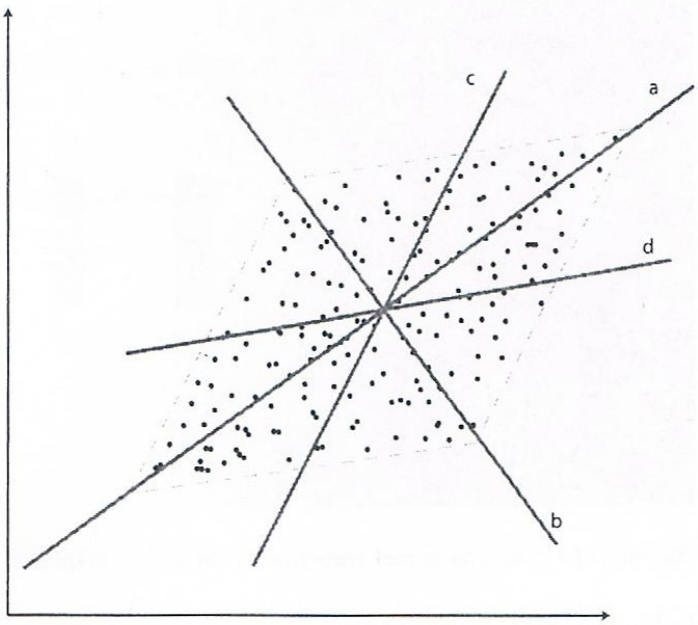

Figure 1: Which of the four lines are the third and fourth Principal Component ?

A) line a (third and fourth components are the same)

B) line b (third and fourth components are the same)

C) lines c and d

D) line d (third and fourth components are the same)

E) PCA cannot be computed for this type of data

F) None of the answers above is correct

Question 5

Which affirmation is correct ?

A) MDS (Multidimensional Scaling) preserves only small distances

B) CCA (Curvilinear Component Analysis) does not preserve small distances

C) For MDS, the stress is always increasing with the projection dimension

D) MDS requires the coordinates of the original data to project (distances are not enough)

E) None of the above answers is correct

2 Difference of Gaussians Model

Explain and describe the Difference of Gaussians model of the retinal ganglion cells. In addition, draw the response of the receptive field (modeled by the Difference of Gaussians) to the image given in Figure 2 (the response when passing over the grey vertical bands). You can use your drawing of the response to illustrate your explanations. Maximum 1 page.

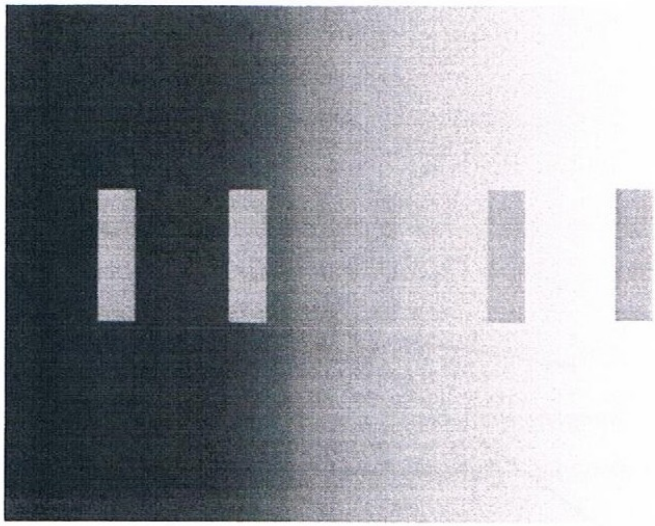

Figure 2: Plot the Difference of Gaussians model response to the above displayed bands in this gradient.

3 Concepts definitions

Define and explain in maximum 3 lines all of the following concepts:

- Gestalt laws
- Gibson's Affordance Theory
- Absolute Multidimensional Scaling
- Graphical Integrity
- Pre-attentive processing

4 Essay 1

In the following figures (Figures 3 to 7), you can find the description of a database containing variables related to the wealth of 172 countries. There is a total of 17 variables. In order to visualize these countries, a PCA is used to project the data set into a two-dimensional space (represented by Xp1 and Xp2 in Figures 4 to 7). The result of the PCA is represented in Figure 4, and several zooms are provided in order to see clearly different parts of the projection (Figures 5 to 7).

Using your knowledge about PCA, including its properties, provide a complete analysis of the given projection. For example, a few obvious conclusions that can be made about *similar* countries. Also, use some examples to show the limits (or errors) that can appear using a PCA. In your analysis, explain all the technical terms that you are using and show your understanding of the PCA.

Name of the 17 variables: Population, Total Wealth (TW), Net Foreign Assets (NFA), Produced Capital (PC), Natural Capital (NC), Intangible Capital (IC), Crop, Pasture Land, Forest - Timber, Forest – NTF (Non Timber Forest), Protected Areas, Oil, Natural Gas, Coal, Minerals, Subsoil Assets, Gross national savings (GNS), Consumption of Fixed Capital (CFC), Energy Depletion (ED), Mineral Depletion (MID), Net Forest Depletion (NFD).

Maximum 2 pages, explain all the technical terms that are used in your essay.

5 Essay 2

Present and discuss the five principles in Tufte's theory of data graphics, starting from the concepts of data-ink and graphical redesign. Maximum 2 pages, explain all the technical terms that are used in your essay.

NOTE: Both essays are compulsory !

4										
5		2005	2005 US$			# of countries: 152				
6	Economy	Code	Region	IncomeGr	Population	Total Wealth	Intangible Capital	Net Foreign Assets	Produced Capital	N
7	Afghanistan	AFG	South Asia	Low income	..	..	..	..	..	
8	Albania	ALB	Europe & Central Asia	Lower middle income	3,129,678	166,172,033,444	129,689,428,666	-1,208,992,942	21,829,247,188	
9	Algeria	DZA	Middle East & North Africa	Upper middle income	32,853,798	993,795,028,018	74,049,042,675	37,274,098,892	362,896,128,022	
10	American Samoa	ASM	East Asia & Pacific	Upper middle income	..	..	..	..	..	
11	Andorra	ADO	..	High income: nonOECD	..	..	..	..	..	
12	Angola	AGO	Sub-Saharan Africa	Lower middle income	15,941,392	223,050,109,561	-22,108,013,270	-16,153,985,214	46,184,347,123	
13	Antigua and Barbuda	ATG	..	High income: nonOECD	..	..	..	..	..	
14	Argentina	ARG	Latin America & Caribbean	Upper middle income	38,747,148	2,760,797,768,452	1,952,114,556,312	-8,171,328,825	419,044,406,171	
15	Armenia	ARM	Europe & Central Asia	Lower middle income	3,016,312	88,047,142,448	67,431,291,866	-1,476,107,281	12,624,519,290	
16	Aruba	ABW	..	High income: nonOECD	..	..	..	..	..	
17	Australia	AUS	..	High income: OECD	20,329,000	10,546,787,512,476	7,854,738,803,300	-390,828,055,437	2,270,155,118,943	
18	Austria	AUT	..	High income: OECD	8,233,300	4,698,367,590,057	3,761,165,147,857	-86,137,011,153	928,708,083,636	
19	Azerbaijan	AZE	Europe & Central Asia	Lower middle income	8,388,300	128,323,288,881	1,632,581,616	-9,346,661,744	38,037,728,313	
20	Bahamas, The	BHS	..	High income: nonOECD	..	..	..	..	..	
21	Bahrain	BHR	..	High income: nonOECD	728,617	145,660,958,279	43,060,103,341	11,301,338,320	31,509,403,654	
22	Bangladesh	BGD	South Asia	Low income	141,822,276	1,008,173,202,683	686,169,465,369	-18,561,601,709	142,829,706,536	
23	Barbados	BRB	..	High income: nonOECD	..	.	..	..	..	
24	Belarus	BLR	Europe & Central Asia	Upper middle income	9,775,591	467,159,523,743	318,921,021,245	-4,055,780,573	95,917,304,260	
25	Belgium	BEL	..	High income: OECD	10,478,650	5,892,809,269,415	4,699,349,416,689	116,256,919,260	1,035,516,382,761	
26	Belize	BLZ	Latin America & Caribbean	Lower middle income	291,800	18,828,887,961	10,480,362,591	-1,275,256,795	2,701,554,715	
27	Benin	BEN	Sub-Saharan Africa	Low income	8,438,953	80,375,305,575	50,989,472,413	-1,639,797,411	8,872,789,791	
28	Bermuda	BMU	..	High income: nonOECD	..	..	..	..	..	
29	Bhutan	BTN	South Asia	Lower middle income	637,013	10,461,909,257	-2,425,470,252	-58,995,167	4,025,181,511	
30	Bolivia	BOL	Latin America & Caribbean	Lower middle income	9,182,015	139,356,918,965	51,583,604,588	-7,860,451,840	18,362,636,037	
31	Bosnia and Herzegovina	BIH	Europe & Central Asia	Upper middle income	..	..	..	..	..	
32	Botswana	BWA	Sub-Saharan Africa	Upper middle income	1,764,926	103,946,076,298	49,323,919,763	8,014,029,188	37,041,646,758	
33	Brazil	BRA	Latin America & Caribbean	Upper middle income	188,404,913	14,752,395,057,893	10,171,915,645,037	-323,473,476,173	2,111,905,223,211	
34	Brunei Darussalam	BRN	..	High income: nonOECD	373,819	86,928,817,622	-54,660,564,813	45,474,648,960	27,599,244,145	
35	Bulgaria	BGR	Europe & Central Asia	Upper middle income	7,740,000	495,305,496,842	387,047,243,088	-12,789,503,127	78,013,561,478	
36	Burkina Faso	BFA	Sub-Saharan Africa	Low income	13,227,835	114,561,413,331	86,693,468,703	-1,476,746,022	11,629,318,965	
37	Burundi	BDI	Sub-Saharan Africa	Low income	7,547,515	16,539,393,843	-3,977,066,474	-1,092,123,435	1,249,948,019	
38	Cambodia	KHM	East Asia & Pacific	Low income						

Figure 3: Overview of the structure of the data for 172 countries, 17 variables.

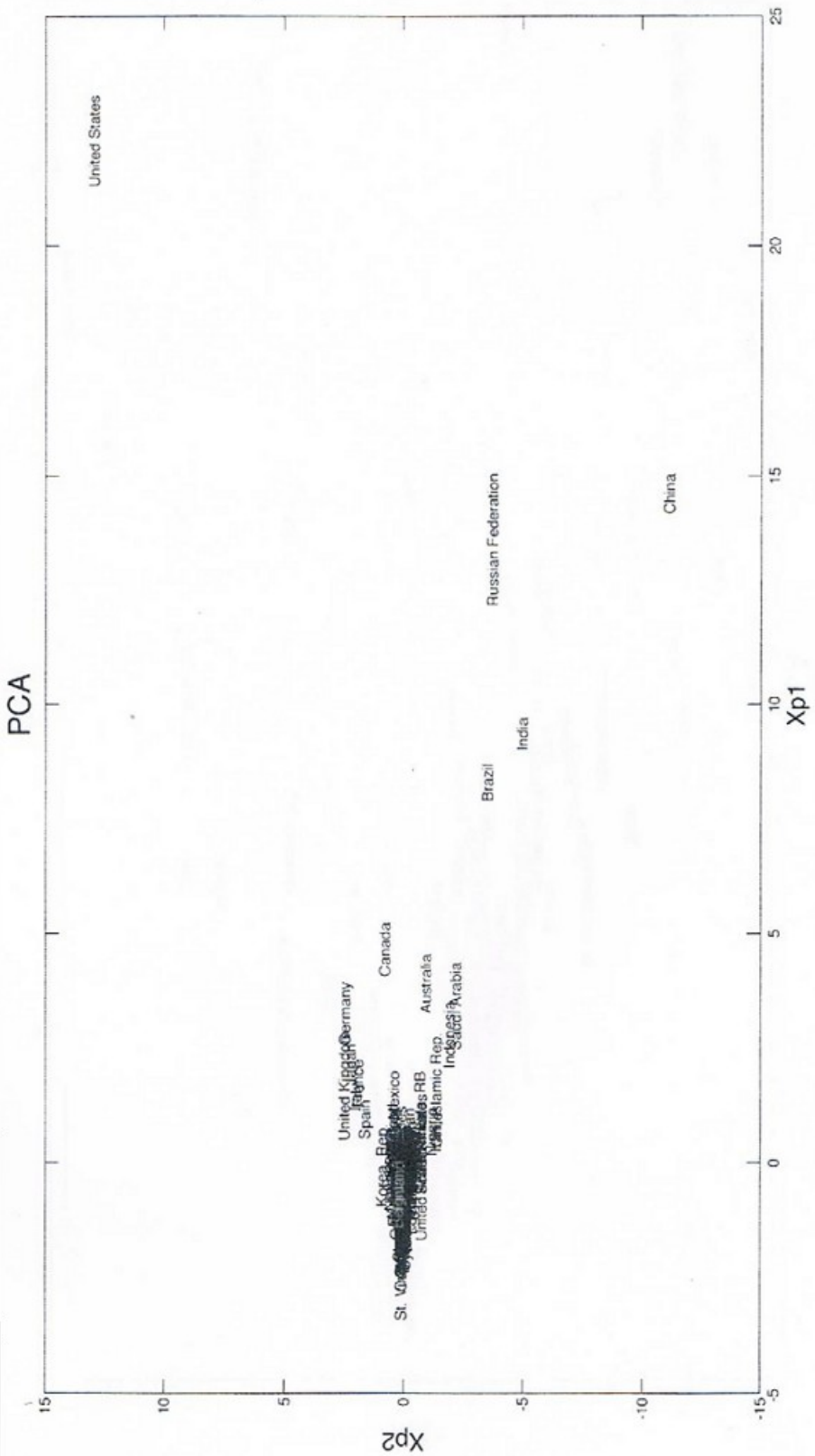

Figure 4: Overall view of the PCA.

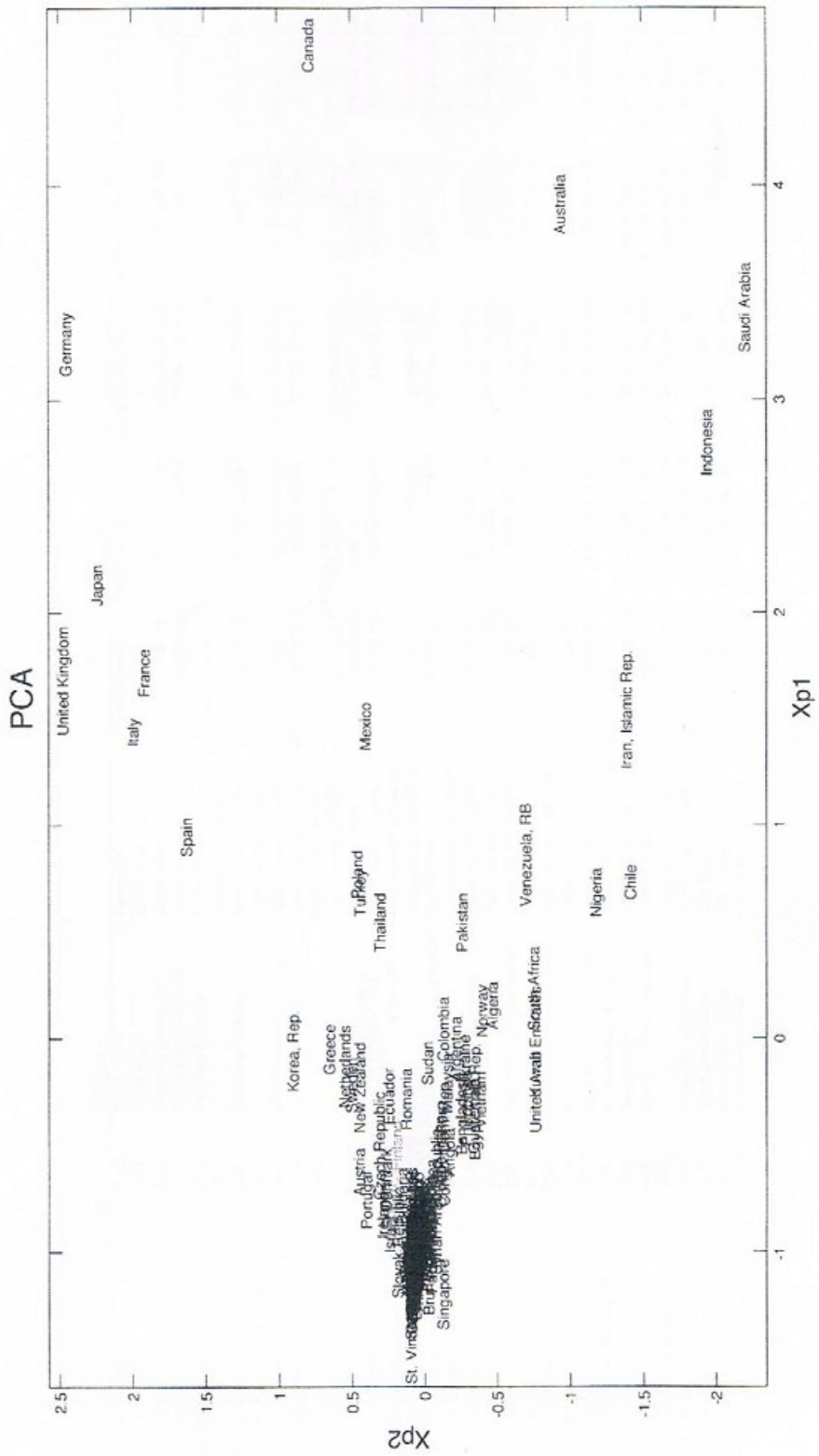

Figure 5: First zoom on the PCA of Figure 4.

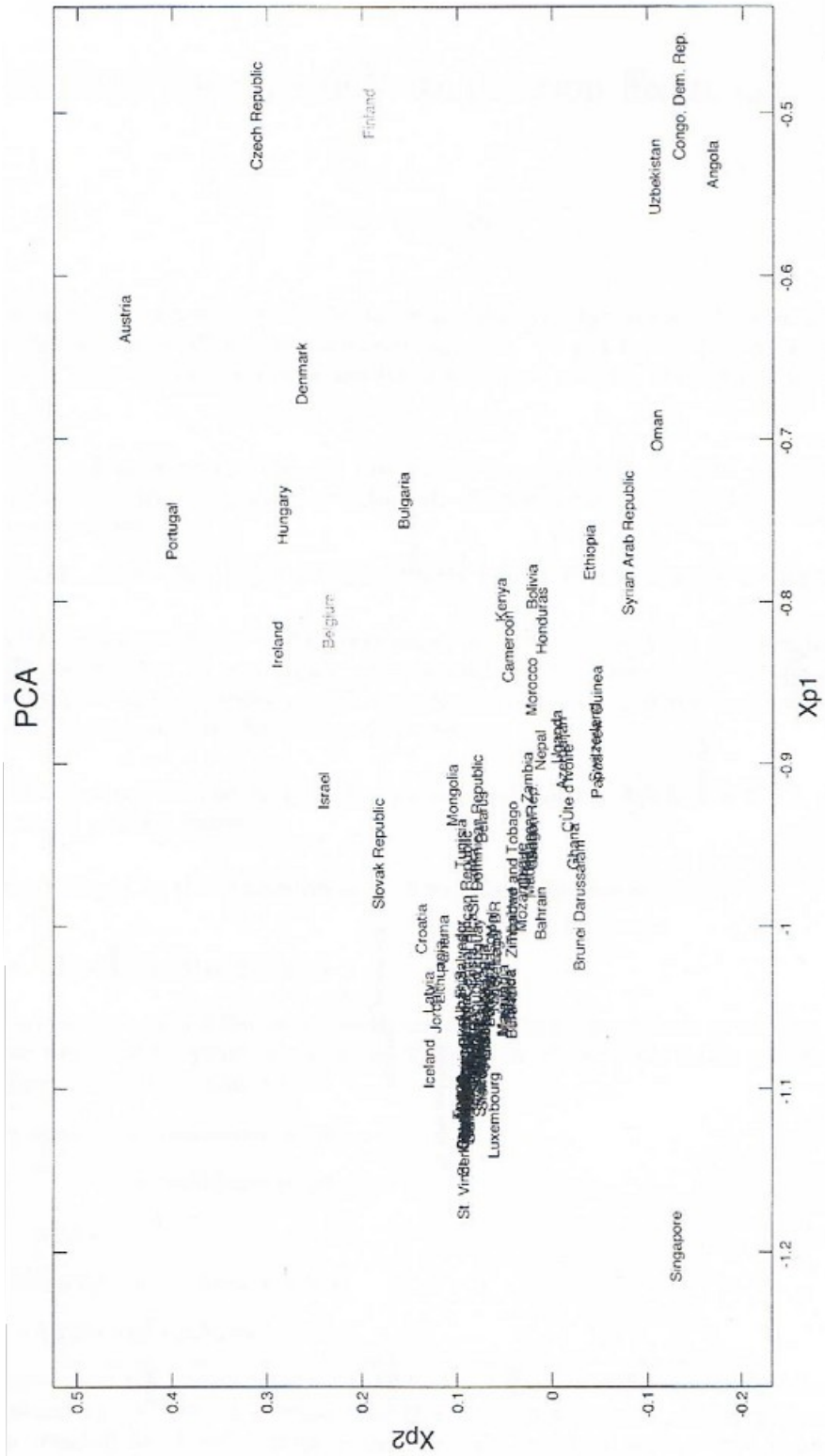

Figure 6: Further zoom on the PCA of Figure 5.

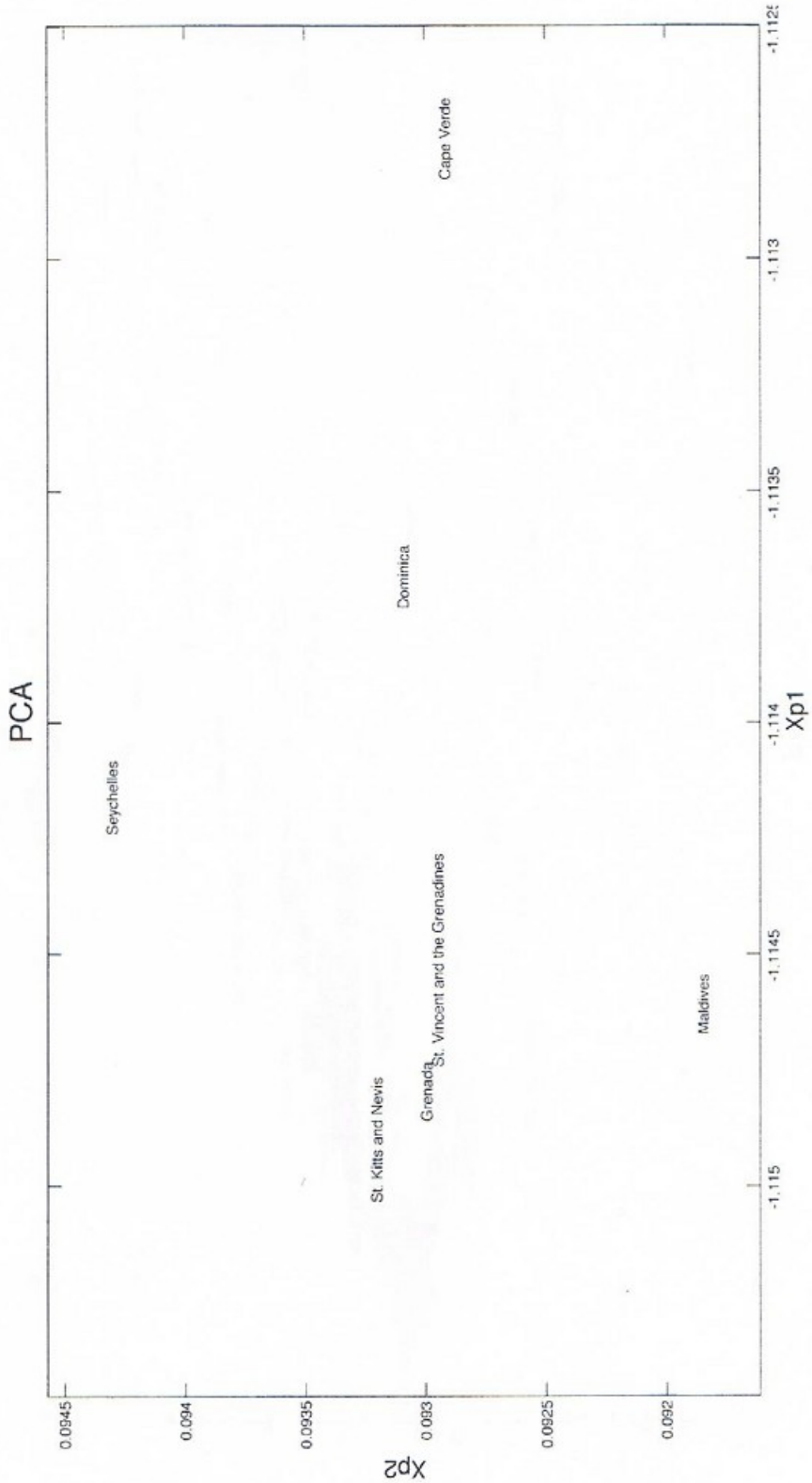

Figure 7: Further zoom on PCA of Figure 6.