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Part I

Data Science, Foundations and Applications

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Introduction to chapter ??

by Daniel Bennequin and Fionn Murtagh

The Continuous and the Discrete. We will skip discussions in antiquity of the continuous and the discontinuous (Democritus, Epicurus and others who were proponents of atomism and the Stoic counter-argument based on the continuous). It has been mostly atomism that has prevailed since Boltzmann. That does not prevent mechanics, field theory and other domains being presented nowadays as based on a continuous vector field, from which discontinuities are deduced and not vice versa. Hence one can say that modern day thinkers who seek to start with a discrete model still have work on their hands as they pursue that vantage point.

Perhaps, all the same, it is necessary to cite Maxwell's cogwheel model. Consider the challenges of mobility in Maxwell that Gilles Chatelet laid out very well in his book, *Figuring Space* [?].

This point of view of a discrete origin of space, of time and of fields is adopted – often between the lines – by one of the inventors of strings and superstrings (that could even be viewed as a paradox), A.M. Polyakov [?]. See the first pages of his book *Gauge Fields and Strings* on “excitations of some complicated medium”. Even if it is especially in verbally communicated presentations that Polyakov takes up this question of the discrete origin, he presents Yang-Mills on a network, or strings as random surfaces with polymers that flatten themselves down. Furthermore he sees renormalization as a continuous limit of a statistical network, the details of which are unknown, and what is thereby described is nothing other than continuous “effective theories”.

Starting with the discrete is also however what underlies the approach of Wilson, Nobel Prize winner for his theories on networks. In fact, these researchers (Polyakov, Wilson, Kadanoff, 't Hooft) get their inspiration from the fundamental (and mysterious) correspondence between statistical systems (temperature) and quantum field theories (with time).

Finally in the same direction we should cite (even if it seems often to be in conflict with such a perspective) the work of “quantum gravity” and in particular Ashtekar and Rovelli (e.g. [?]). We may also refer to the work of Ambjørn on causal dynamical triangulation, relating to the origin of a fourth dimension.

One sees therefore that in this article J.P. Benzécri is not alone, even if his approach is an original one.

Between Physics and Computer Science. Arising out of computer science rather than physics, Wolfram's *New Kind of Science* [?] seeks to provide a computational theory of the universe through cellular automata. Patterns of all manner grow through having rules, or algorithms. J.P. Benzécri's *grains* and *spikes* are in a way reminiscent of such a computational or algorithmic framework.

The interface between physics and computation has become quite diffuse. As Nielsen and Chuang [?] remark, “Quantum computation and quantum information has taught us to *think physically about computation* ... we can also learn to *think computationally about physics*”.

Even more generally, computational models and algorithms for the modeling of physical or chemical – or social or artistic or whatever – processes are discrete just because they are implemented on digital and not analog computers.

In the chapter to follow, discrete origins are laid out in terms of pre-orders. The heart of J.P. Benzécri's presentation in his chapter comes later. This culmination of his presentation is how he derives a continuous space from finite sets, and more particularly from the correspondence between such finite sets.

Introduction to Chapters 7 to 11

by B. Goldfarb and C. Pardoux

These chapters are devoted to the presentation of five methodologies, illustrated in a wide area of applications (genomics, credit risk, energy production, ecology, semantics, ...).

Chapter 7 (Mariadassou and Bar-Hen) deals with the reconstruction and the validation of phylogenetic trees with a special focus on robustness. Their approach is based on several means: bootstrap or jackknife, influence function, Taxon influence index.

In chapter 8 (Demeyer and al.), a Bayesian approach of Structural Equation Models (SEM) is proposed, in which the use of posterior draws allows to model expert knowledge. A particular attention is also given to identifiability for which they use a parameter expansion.

In chapter 9 (Hand), the measures of accuracy in classification are reanalysed with a new look on a widely used measure, the so-called Area Under the ROC Curve (AUC index). Using mathematical reassessments, the author points out the source of its weaknesses and proposes a new performance measure, named H.

In chapter 10 (Da Silva, Lechevallier, and Seraoui), the special features of time-changing data streams are investigated; a clustering approach is presented for monitoring numerous time-changing data streams, and illustrated by real data from electric power production.

In chapter 11 (Fionn Murtagh), a framework for the analysis of semantics is developed through Correspondence Analysis, separating the context (the collection of all interrelationships) and the hierarchy tracks anomaly. There are numerous potential applications like business strategy and planning, education and training, science technology and economic development policy, although the methods are illustrated here with semantics of film script.

Introduction to chapter 12

This chapter, devoted to geometric Data Analysis (GDA) in social science, especially in the Pierre Bourdieu's work, is introduced by Brigitte Le Roux.

Since the very beginnings, Geometric Data Analysis (GDA) has been applied to a large range of domains, such as medicine, lexicology, market research, satisfaction surveys, econometrics and social sciences. In this latter domain, the work of the French social scientist Pierre Bourdieu is exemplary of the "elective affinities" between the spatial conception of social space and GDA representations [33]. These affinities led Bourdieu and his school to use Correspondence Analysis (CA) – especially Multiple Correspondence Analysis – consistently in the 1970s, 1980s, and 1990s [13, 6, 9]. It is commonplace to view CA as "Bourdieu's statistical method". This is rightly so, since Bourdieu's work has provided exemplary use of CA. In fact, beyond CA, a constant concern for Bourdieu was to substantiate his theories by statistical data and analyses. This essential aspect of Bourdieu's work has not been covered in detail so far by those who have written about Bourdieu's theories.

In chapter ??, Frédéric Lebaron deals with this particular domain of application of GDA techniques. He provides some landmarks concerning Bourdieu and statistics, from traditional statistics to GDA. Then he highlights the powerful link between geometry and the construction of social space – "Social reality is multidimensional" – as well as the investigation of the notion of "field" in Bourdieu's theory. On the basis of several examples, he shows the relevance of these techniques to discover the structures of social spaces.

Bourdieu passed away in 2002, but the interest of sociologist reseachers in the statistical methods that he had used, especially GDA, is increasing more and more, worldwide, as evidenced by the publishing of the book [?] on CA in 2005 and of the monograph on MCA [?] in 2010.

Throughout in all these chapters, the reader may appreciate the strength of the concept of Data Science, as well as the considerable extent of its applications.





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Geometric Data Analysis in a Social Science Research Program: The Case of Bourdieu's Sociology.

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12.1 Introduction

There is an essential aspect of Pierre Bourdieu's work that has been somewhat neglected by those who have written about his theory, that is his constant concern for quantifying his data material and for putting his thinking in mathematical terms¹. This chapter provides landmarks for this aspect, and outlines the solution that was retained by Bourdieu, at least from *La distinction* [6] onward: namely the Geometric Modeling of Data, based on Geometric Data Analysis.

As Bourdieu firmly expressed: "I use Correspondence Analysis very much, because I think that it is essentially a relational procedure whose philosophy fully expresses what in my view constitutes social reality. It is a procedure that 'thinks' in relations, as I try to do it with the concept of field" (Foreword of the german issue of *Le Métier de sociologue*, 1991). Bourdieu's program for quantification is not an arbitrary result of historical contingencies, but the logical consequence of a set of critical experiences and reflections about the shortcomings of dominant quantitative approaches in social sciences, which led him to a conscious and systematic move toward a geometric frame-model more adapted to his conception of the social world.

In a first part, we rapidly describe Bourdieu's life-long commitment into statistics (that is both quantification and formalization), which lead him to the choice of geometric modeling of data through the use of Correspondence Analysis (CA) and Multiple Correspondence Analysis (MCA). In a second part, we stress the role of multidimensionality in this process, with the example of *L'anatomie du goût* [13] and *La Distinction* [6]. In a third part, we show that the notion of field as it is developed by Bourdieu is constantly made operational through GDA, with the example of an article called *Le patronat* [14] (French company

¹A version of the first part of this text has been published in Karen Robson and Chris Sanders (eds) 2008 [30].

leaders). Then, in a last paragraph, after the examination of his last empirical work about French publishers, we try to infer from Bourdieu's practice a general Sociological Research Program based on the use of Geometric Data Analysis.

12.2 Bourdieu and Statistics

As early as the “Algerian times” (the second half of the 1950s, Bourdieu, 1958), Bourdieu cooperated with statisticians of the French National Institute of Statistics and Economic Studies (INSEE). He particularly did it in large-scale labor force surveys undertaken during the period of the liberation war (around 1960). Bourdieu applied his anthropological perspective to the sociological interpretation of survey data, especially the statistics of unemployment (Bourdieu, Sayad, Darbel & Seibel 1963 [16]; Garcia 2003 [22]; Seibel 2005 [35]; Yassine, 2008 [36]).

This collaboration continued in the 1960s at the Centre de Sociologie Européenne (then directed by Raymond Aron), as reflected in the contribution to *Les héritiers* by the statistician Alain Darbel (Bourdieu, Passeron, 1964 [15]). Darbel is associated with the epoch-making calculation of the chances of access to university for the various social class categories. In *L'amour de l'art*, Bourdieu and Darbel (1966 [12]) publish equations of the demand for cultural goods, where cultural capital measured according to the level of diploma, is the main variable explaining inequalities in access to museums. But, since that time, Bourdieu has been in quest for a more structural conception.

This early² need for a more structural conception relates to the influence of structuralism in French social sciences in the 1960s, especially with the models of linguistics and of anthropology around Claude Levi-Strauss. For Bourdieu, it is also based on the opposition between “substantialist” and “relational” conceptions of reality, developed by the philosopher of science Ernst Cassirer. This need is also rooted, though not explicitly, in the dynamics of mathematics under the influence of Bourbaki, who was also an implicit reference-frame for specialists of the human and social sciences. Bourdieu himself often referred to the need for scientific instruments which would be capable at grasping the relational dimension of social reality. Meanwhile, the geometric approach of data analysis developed by Jean-Paul Benzécri and his school around Correspondence Analysis was emerging (see Le Roux & Rouanet 2004 [25]; Rouanet 2006 [32]). Bourdieu had been aware of it since the 1960s.

In a chapter of *Le partage des bénéfices*, collective book written with statisticians and economists (Darras 1966 [17]), Bourdieu and Darbel evoke the limits of regression techniques in social sciences. They explicitly refer to quasi-collinearity as an important shortcoming, but they develop a more epistemological critique. Social causality amounts to the global effects of a complex structure of interrelations, which is not reducible to the combination of the “pure effects” of independent variables. As Bourdieu firmly states in *La distinction* ([6] p.103): “the particular relations between a dependent variable (political opinion) and so-called independent variables such as sex, age and religion, tend to dissimulate the complete system of relations that make up the true principle of the force and form specific to the effects recorded in such and such particular correlation”.

²A first version of the famous text about *La maison kabyle* strongly influenced by Levi-Strauss is written in 1960.

12.3 From Multidimensionality to Geometry

Bourdieu very soon referred to what he calls diverse species of capital: economic, cultural, social and symbolic. His scientific objective, with this theoretical apparatus, was to counter-balance a purely economic vision of society (symbolized by microeconomists trying to expand the validity of economic man like Gary Becker). It was also, at the same time, to contest a purely idealistic vision of the cultural domain developed in cultural anthropology, structural linguistics, literary studies or philosophy, by introducing an economy of symbolic goods. He tried to integrate different dimensions of social life in the perspective of a “general economy of practices” in line with the Durkheimian project (Lebaron 2003 [29]).

At the end of the 1960s, Bourdieu turned to Data Analysis, being the method most in “elective affinities” with his own theory (Rouanet et al. 2000 [33]). He developed the idea that if “quantification” is to take place in sociological research, it has to be multidimensional and to aim as a first step at making operational each of the basic dimensions of social space, namely the various types of capitals, e.g. economic, cultural, social and symbolic; the next step being to combine them so as to provide a geometric model of data.

L'anatomie du goût (Bourdieu & Saint-Martin 1976 [13]) is the first published application of Geometric Data Analysis methods in Bourdieu's work, republished in 1979 in *La distinction*. The data were collected through a survey done on two complementary samples, using the same basic questionnaire. The scientific objective of the work was first to provide a synthetic vision of the French social space as a global structure, and to study two sub-sectors more in-depth: the space of the dominant classes and the space of the middle-classes (“petite-bourgeoisie”), each study being based on the analysis of an Individuals×Variables table (taken from the respective sub-population). As can be seen on the Figures 12.1 (p.14) and 12.2 (p.15), the main elements of the geometric modeling of data were already present in this work, as Henry Rouanet, Werner Ackermann and Brigitte Le Roux have precisely shown in an article of the *Bulletin de méthodologie sociologique* (Rouanet et al. 2000 [33]).

CA was applied to an Individuals×Variables table, which was a common practice at the time, when the use of MCA was not yet developed. The choice of active and supplementary variables was subtle: questions on a large number of tastes and cultural practices were taken as active variables; socio-demographic and occupational information were used as supplementary elements; in the first publication, they were figured on a transparent which could be superposed to the first principal plan resulting from the CA. This technique of visualization gives an intuition of the sociological relations between the space of tastes (lifestyles) and the space of social positions.

The *cloud of individuals* was present in the published analysis: for specific fractions of the dominant classes the dispersion of individuals was made obvious through the contours of various subclouds (patrons, professions libérales) drawn by hand. This is what will be called later “structuring factors”: the cloud of individuals is systematically structured by external factors in line with the methodology of Structured Data Analysis (Le Roux & Rouanet 2004 [25]). Species of capital are “fundamental dimensions” of the space to investigate; their combination, the first principal dimensions which are interpreted, is a specific result of each analysis. The resulting global social space described in *La distinction* is three-dimensional: the first three dimensions are interpreted in terms of the volume of capital, composition of capital, and seniority in the class.

When referring to the space of the dominant classes or the “petite-bourgeoisie” (a then bi-dimensional space, the “volume” dimension being controlled), the first two axes are interpreted in terms of capital composition (Axis 1) and seniority in the class (Axis 2). The analysis results in a strong sociological statement about the existence of a structural

homology between the “space of lifestyles” and the “space of social positions”, both being interpreted as two aspects of the same social reality³. In the first principal plan of the CA of the dominant classes (Figure 12.1), one finds a first opposition between an economic and an intellectual poles (Axis 1) and a second one related to age and indicators of seniority in the class.

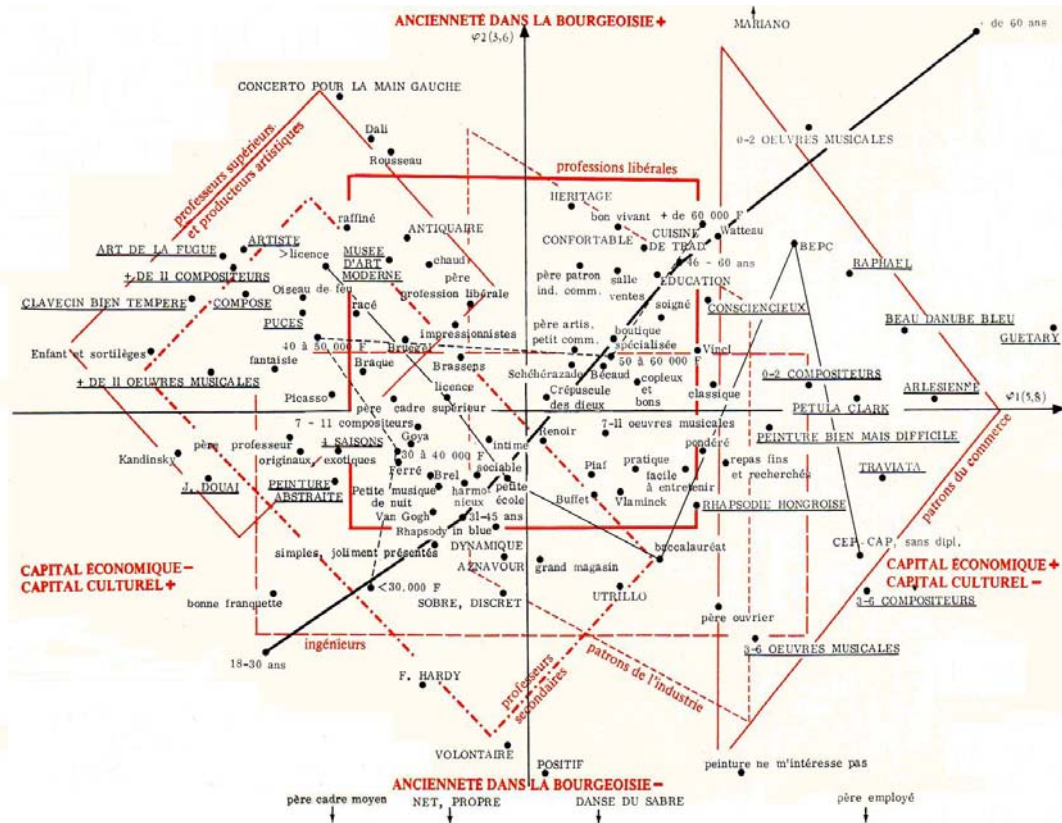


FIGURE 12.1

The space of the French dominant classes. Modalities and structuring factors (plane 1-2), in *La distinction* (Bourdieu 1979 [6]).

12.4 Investigating Fields

The “geometric modeling of data” was a practical way to combine objectification through quantitative data in a synthesis of statistical information, which is relatively close to the use of classical factor analysis, and the notion of field .

³Among today’s research questions following this classical analysis we can mention here the problem of the universality of these results in other (national or historical) contexts. For scholars like Lennart Rosenlund (2009 [31]), this configuration seems to be an invariant in developed capitalist societies, where the opposition between economic capital and cultural capital has become more pronounced.

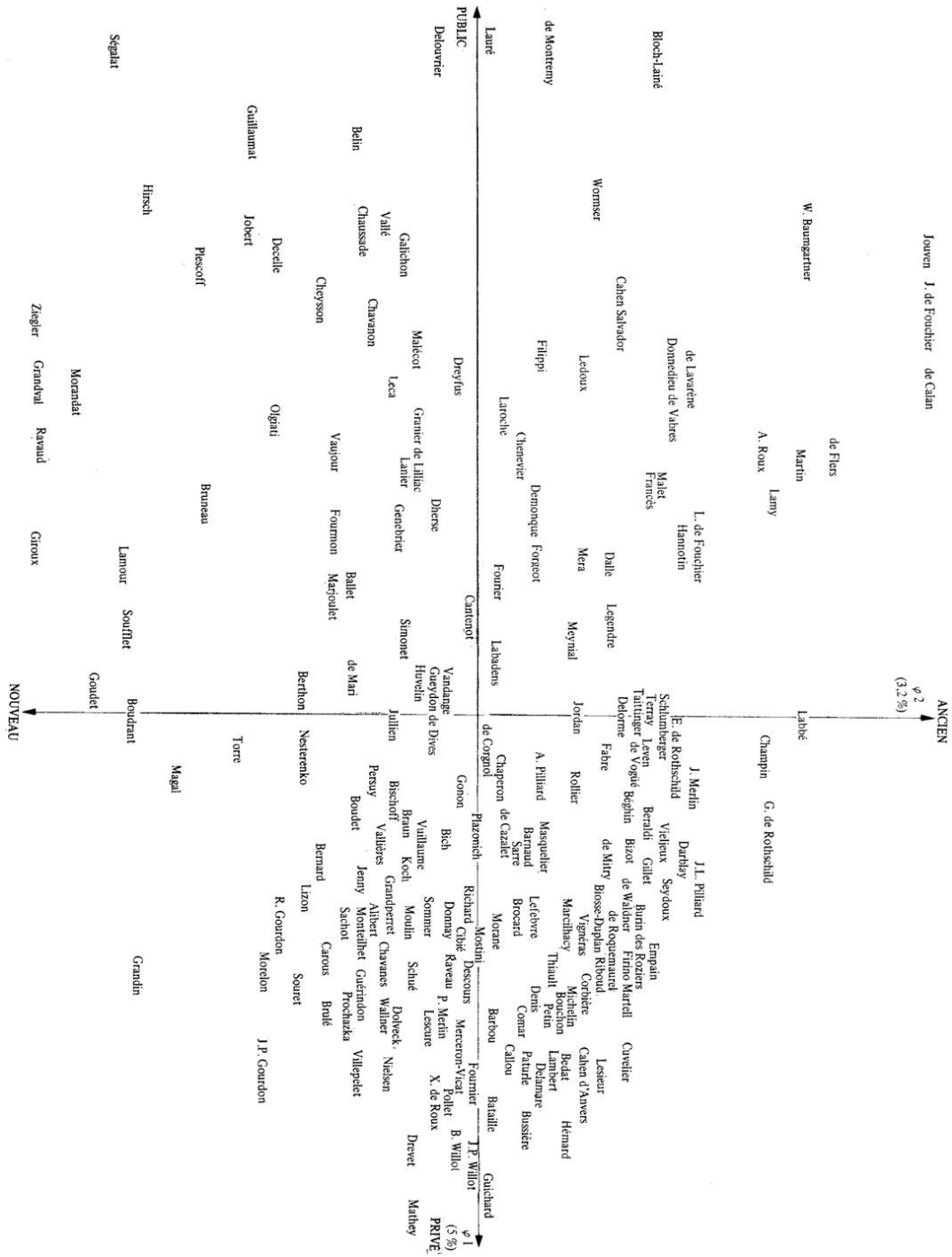


FIGURE 12.2

The space of the French CEOs. Individuals (plane 1-2), in “Le patronat” (Bourdieu & de Saint-Martin 1978 [14])

As early as in the middle of the 1960s, Bourdieu formulated the concept of “field”, which systematically addresses the relational aspects of social reality (Bourdieu 1966 [4]). He more completely developed his “theory of fields” in the beginning of the 1970s (Bourdieu 1971 [5]). A field is a small locus inside the global social space, which is defined by its degree of relative autonomy from other fields and the global society, its structure, related to a specific configuration of agents, and its dynamics. Agents in a field, even without any direct interaction, are put into objective relations, defined by the distribution of their specific resources and by a corresponding process of domination, which is distinct from the global process of social domination between classes.

The novelty of these analyses first lies in the type of data which were used in research about fields. Biographical data were collected in various biographical sources (directories, *Who’s who*, etc.), in a collective process directly inspired by growing scientific practices in social history (“prosopography”, coming from ancient and medieval history).

The second occurrence of a use of GDA by Bourdieu is a well-known article where Bourdieu and de Saint-Martin studied a population of economic elites ($n = 216$) with the help of MCA. In this article, the authors justify the central use of MCA as a way to discover and reveal a hidden relational reality which is not conscious, but nevertheless “more real” than the partial and practical perceptions of the agent (GDA as “rupture instrument” in Bachelard’s tradition). They use the program MULTM from L. Lebart, who is thanked for his help in a footnote. Active modalities were selected from a set of biographical data, defining the various species of capital at stake. The modalities were grouped into different headings (groups of questions), with an important number of modalities referring to social properties (from demographic characteristics to educational trajectory) and some of them to more specific assets in the economic field (positions in boards, distinctions, etc.). In particular, were considered:

- Demographic properties: place and date of birth, number of children, place of residence;
- Social and familial origin: profession of the father, seniority in class, presence in the *Bottin Mondain* (a directory of social elites);
- Educational trajectory (i.e. “grand lycée parisien”);
- Professional career: (i.e. “grand corps”);
- Specific positions in the field: economic power positions, membership to councils, etc.;
- Indicators of symbolic capital: official distinctions, decorations, etc.;
- Indicators of membership to mobilized groups (like associations).

The cloud of individuals in the first principal plane was published, with the names of economic elite members, helping the reader who “knew” some agents to have a direct intuition of the social structure of the field (Figure 12.2 p.15). The interpreted space (Figure 12.3 p.17) is two-dimensional (a third axis is rapidly evoked). The first Axis is opposing “public” to “private” positions and trajectories, the field being then dominated by technocratic managers coming from *Ecole nationale d’administration* or *Polytechnique*. The second Axis, again related to time, opposes “newcomers” and “established”. This analysis provides a view of the structure of the field of economic elites as being defined by the relation to the State (bureaucratic capital) and by a process of dynamic competition between fractions, first defined by their seniority in the field. The new “generation” in the field is for example more often trained in private business schools, or certain engineer schools. An explanatory perspective was also present in this analysis, which aimed at understanding

the space of managerial strategies (for example human resources strategies) in relation to their positions in the field, and more largely “reproduction strategies” (marriage, fertility, etc.). In *La noblesse d’Etat* [8], where this article is reproduced, this analysis was combined to a study of structural homologies between the field of power in which the economic elite is included, and the field of “grandes écoles” (higher education institutions).

Since the late 1970s, geometric modeling has been the basis of all empirical work conducted along Bourdieu’s line. It has allowed Bourdieu himself to explore the major hypotheses of his theory such as: “the positions [in a field] command the position-takings”. Two other uses of GDA techniques took place in a prosopographical study about academics in France around 68 (Bourdieu 1984 [7]) and in an economic–sociological study about the field of private housing (Bourdieu 2000 [10]). In his last lecture at the Collège de France, in 2001, Bourdieu reiterated ([11] p.70): “Those who know the principles of multiple correspondence analysis will grasp the affinities between this method of mathematical analysis and the thinking in terms of field”. To be complete, one should add that Bourdieu’s colleagues and followers have made an intensive use of GDA methods since the middle of the 1970s. Luc Boltanski (on managers and “dénonciation”), Remi Lenoir (demographers, family policy), Patrick Champagne (French peasants), Monique de Saint-Martin (nobility), Annie Verger (artists), among others, have published chapters of books or articles based on MCA during the 1980s and the first half of the 1990s.

A new generation of research based on GDA in the 1990s was made visible by an article of Gisèle Sapiro about the field of French writers under German occupation published in *Actes de la recherche en sciences sociales* in 1996. In parallel, Swedish sociologists of education around Donald Broady and Mikael Börjesson, inspired by Bourdieu’s work, were intensively using CA and MCA since the end of the 1980s. Lennart Rosenlund [31] was simultaneously replicating Bourdieu’s results about lifestyles in Stavanger and Norway in the 1990s. In 1998, a conference in Cologne (Germany) gave way to a strong new alliance between Bourdieu, sociologists referring to Bourdieu’s sociological theory and statisticians interested in Bourdieu’s theory like Henry Rouanet and Brigitte Le Roux. Among the outcomes of this cooperation was the analyses published in *Actes de la recherche en sciences sociales* about the field of publishers mentioned and illustrated below, and an article by Hjellbrekke et al. (2007 [23]) putting into practice recent theoretical and technical innovations in GDA. One can also add several articles and books by Lebaron (2001 [28]), Duval (2004 [21]), and doctoral theses by Denord (2003 [18]), Börjesson (2005 [2]), Hovden (2008 [24]) among many other applications (which could be the object of another chapter about Bourdieu’s school and quantification in recent years). Recently, an article about lifestyles in the UK using specific MCA, concentration ellipses was published by Brigitte Le Roux in cooperation with a group of sociologists including Mike Savage and Alan Warde (Le Roux et al. 2008 [27]).

12.5 A Sociological Research Program

One can infer from Bourdieu’s practice a general program based on the use of GDA in sociology. The example of his article “Une révolution conservatrice dans l’édition” (Bourdieu 1999 [9]) can be seen as the more up-to-date version of this underlying program. It is the last publication using GDA methods by Bourdieu himself. The analysis were realized in collaboration with Brigitte Le Roux and Henry Rouanet; this work was just following the Cologne conference on the “Empirical Investigation of Social Spaces” in 1998, after which a co-operation between both groups of researchers began.

The geometric analysis was based on prosopographical data collected on a set of companies publishing literary books in French, including translations from foreign languages ($n = 56$ active individuals). The main method used was *specific MCA*, at that time programmed in ADDAD by Brigitte Le Roux and Jean Chiche. This technique, derived from MCA, allows to put some modalities of active questions (for example no-information or “junk” modalities) as “passive” modalities of active questions, without destroying the fundamental properties of MCA (Le Roux & Rouanet 2004 [25], 2010 [26]). As active questions ($Q = 16$), Bourdieu chose various indicators of capital (i.e. symbolic, economic and specific editorial assets, like the importance of foreign literature). As a general rule, one can state here that the sociologist has to produce the most exhaustive list of theoretically fundamental dimensions of the social resources at stake in the studied field or space.

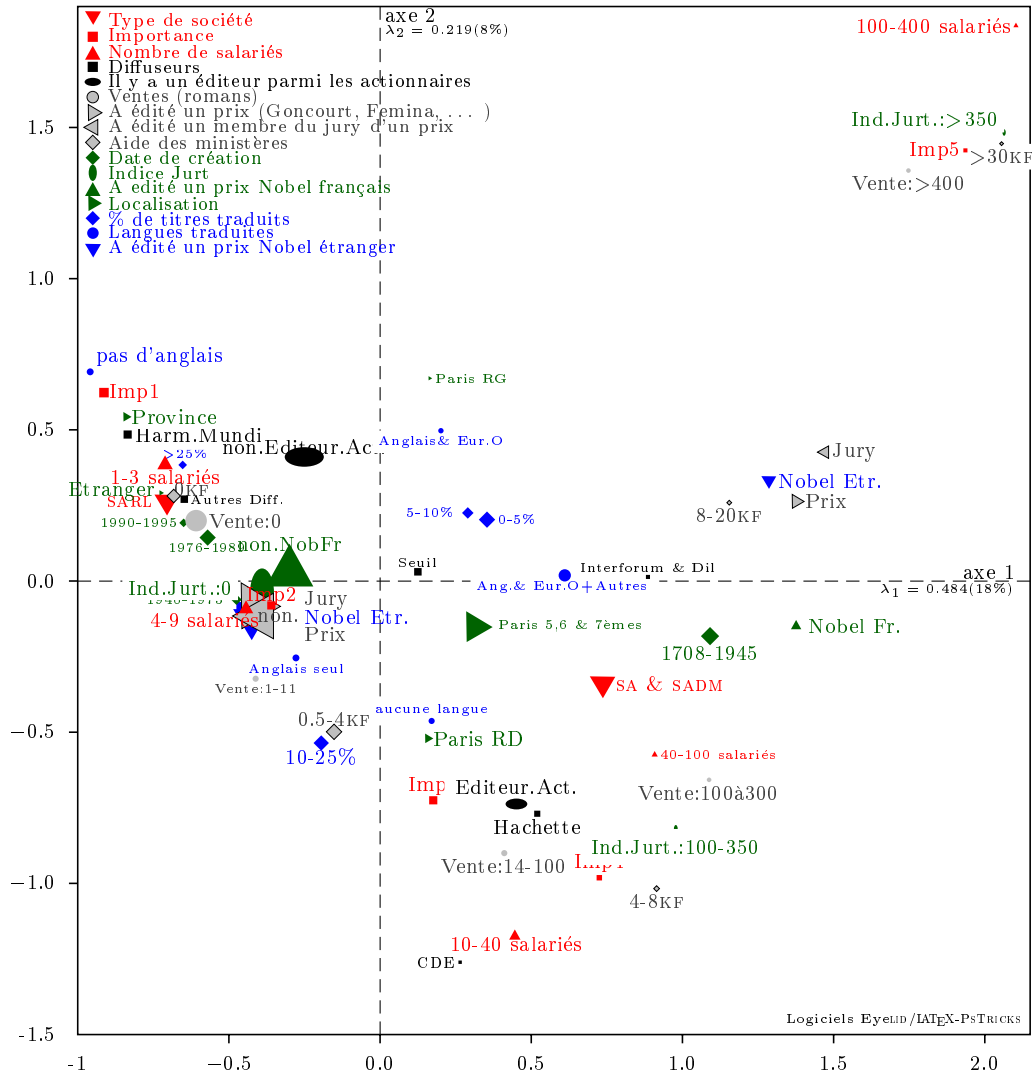


FIGURE 12.4
The space of French publishers. Cloud of modalities in plane 1-2 (Bourdieu 1999 [9]).

A *Euclidean clustering* was performed in order to characterize sub-groups of publishers, and to “forecast” (on a qualitative basis) the future dynamics of the market (for example the

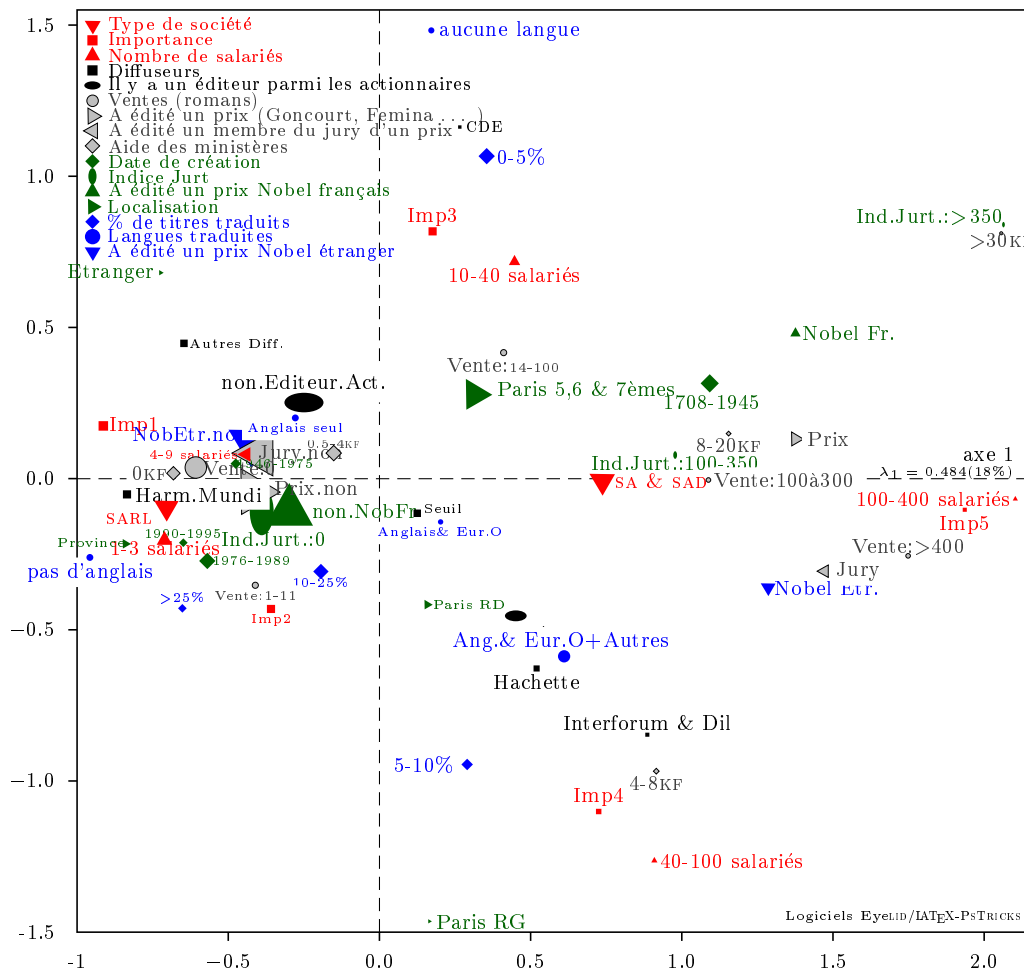


FIGURE 12.5
The space of french Publishers. Cloud of modalities in plane 1-3 (Bourdieu 1999 [9]).

concentration processes which would reduce the number of actors, the growing domination of the economically aggressive commercial publishers).

The *sociological interpretation* insisted on the “chiasmatic” structure of the field of publishers, with a first opposition between big and small companies, and a second one between a commercial pole and a literary legitimate pole. This second Axis appears to be in homology with the classical composition Axis found in previous analyses (the classical economy vs culture Axis). The third Axis refers more to the specific importance of translations and separates two fractions of the commercial pole. Sociological interpretations assessed the relations existing between positions (related to the specific configuration of resources) and “position-takings” (editorial choices here — but it could also be political, literary or scientific choices, strategies or contents); in this article, this was mainly based on qualitative comments based on the cloud of individuals .

A research program based on this perspective would aim at:

- Showing the structure of a field or more largely of a specific social space configuration; from a statistical point of view, descriptive procedures always come first and inference only in a second time;

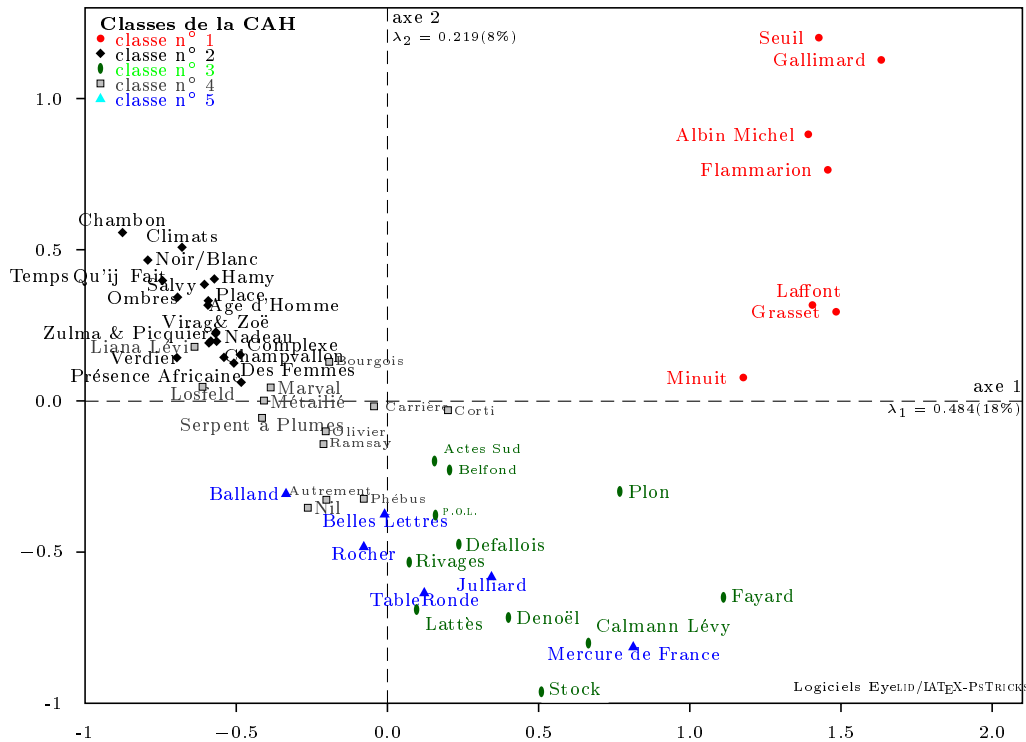


FIGURE 12.6

The space of French publishers. Cloud of individuals in plane 1-2 (Bourdieu 1999 [9]).

- Showing structural homologies between different fields or social spaces, which has to be based on appropriate statistical and sociological interpretations of axes; Data Analysis can be seen here as an interpretative practice where statistical and sociological comments must converge. There is a need for more sociological meta-studies in order to cumulate converging or diverging results;
- Determining the relative autonomy of fields or social spaces, which relates to the use of comparison procedures and of "causal" sociological hypotheses, e.g. about the relations between fields or spaces;
- Studying sub-spaces inside a more global space; for this purpose, class specific MCA (CSA) can be an appropriate instrument (Le Roux & Rouanet 2010 [26]);
- Explaining social practices (e.g. position takings) ; to quote Henry Rouanet quoting himself Ludovic Lebart and others, one should admit that "statistics doesn't explain anything, but gives some possible elements of explanation" (help finding "candidates" for sociological explanation);
- Assessing the importance of various effects, especially field effects; it could still be very much developed, given the possibility of an integration of Variance Analysis and Regression techniques into the frame of GDA, more appropriate to the context of observational data;
- Studying the dynamics of a field; it could be very much developed through Euclidean classification and/or an appropriate use of supplementary elements or, even better, structuring factors of the cloud of individuals .

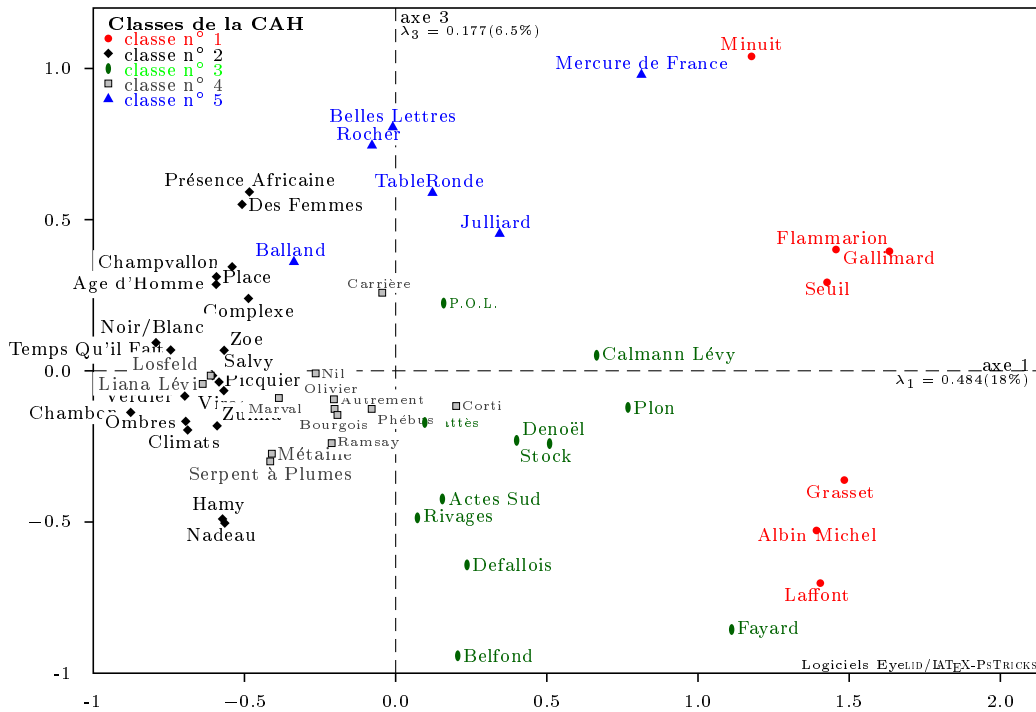


FIGURE 12.7

The space of French publishers. Cloud of individuals in plane 1-3 (Bourdieu 1999 [9]).

12.6 Conclusion

Bourdieu was not only conscious of the shortcomings of the dominant quantitative methods in social sciences (especially regression methods), which he discovered with Alain Darbel as early as in the 1960s. He consciously found an alternative to these methods with the geometric modeling of data, which he practised around 30 years, from the beginning of the 1970s until the late 1990s.

Bourdieu did not approve nor practice the usual rhetoric of scientific publications, presented in terms of hypotheses, empirical data and results confirming—or failing to confirm—hypotheses. Neither did he always clearly separate between sociological and statistical interpretations, nor did he completely formalize his theory of fields and his sociological interpretation of statistical analysis. Probably, the way his statistical practice was integrated into his sociological writing did not encourage dialogue with other quantitative traditions and the clear understanding of what he did from a statistical point of view. Many researchers may find this to regrettable.

But Bourdieu was clearly in search for a general geometric formalization ; he was enthusiastic about the possibility of future integration of regression into the framework of geometric data analysis.

Bourdieu's adoption of the geometric modeling of data has therefore opened a space for a strong empirical sociological research program.

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