Synchronising sequences: an analytic approach to explore relationships between events and temporal patterns[1]

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Abstract

Sequence data is most of the time analysed in calendar time (historical periods, daily schedules) or in age-based process time. However, many social processes unfold according to event-related time patterns and need other time references to be studied. This paper presents a simple analytical approach, called sequence synchronisation, which allows studying social processes that are strongly linked to specific events. The key operation consists in defining the time axis of the sequences according to the time preceding or elapsed after a specific event. The event chosen for synchronising sequence data can be either endogenous or exogenous to the sequence alphabet. Two empirical case studies are presented in order to support the usefulness of sequence synchronisation: the analysis of functional differentiation in British academia, and the analysis of class mobility of French back-migrants. The strengths and weaknesses of sequence synchronisation are assessed against three different methods: Event history analysis, Multichannel sequence analysis and Multiple sequence alignment. We argue that sequence synchronisation is a simple and efficient means to study the interaction between events and temporal patterns, and provides new opportunities to operationalise concepts like turning point and differentiation using sequence data. It thereby contributes to reducing the methodological gap between Event history analysis and Sequence analysis.

Introduction

Advocates of sequence analysis often emphasise on its holistic approach, as opposed to event history modelling (Abbott et Hrycak 1990, 147; Robette 2010, 3). This results from the fact that sequence analysts have mainly focussed on structural patterns, while devoting less interest on events. Most existing studies based on sequence data have indeed concentrated on measuring resemblance in order to identify typical careers (Blair-Loy 1999) or household trajectories (Elzinga et Liefbroer 2007), whereas most endeavours of event history analysts were geared to uncover and measure causal relationships (Blossfeld et Rohwer 2002).

Despite some pleas for articulating these two statistical methods (Lemercier 2005, 17), their antagonistic development has translated into a substantial methodological gap: structural patterns and events are most of the time studied separately. As a consequence, few sequence analysts have satisfactorily explored the relationships between events (for example getting married) and structural patterns (for example employment history), and vice versa[2].

[1] Authors would like to thank the participants and organisers of the LaCOSA conference, from which they received stimulating comments and feedback.

[2] Exceptions are recent works building on multi-channel sequence analysis, which are discussed in part three of this paper.

Particularly striking is the fact that this type of question is deeply rooted in sociological research. For example, the concept of "turning point", which accounts for the transition between sequences (Hughes 1996 [1950]) or, in Abbott's words, "between different probability regimes" (1997, 92), is, paradoxically, largely overlooked by sequence analysis.

This paper provides a simple analytic solution that enables combining events and larger patterns in sequence analysis. The key operation of this method consists in synchronising sequence data according to idiosyncratic events. This means that each sequence (*e.g.* job positions) is positioned according to an event that takes place in a particular time for each individual (*e.g.* getting married). The operation therefore does not require applying optimal matching or similar algorithms, nor does it preclude them either.

This operation has been used, as far as we know, in very few existing studies (Blanchard 2010; Giudici et Gauthier 2009). By alternatively referring to these studies and our research experience, we argue that sequence synchronisation 1) contributes to the pluralisation of social times in sociological analysis, 2) opens up potential opportunities to operationalise the concepts of turning point and differentiation with sequence data, 3) invites to reduce the methodological gap between holistic and event history approaches, 4) could potentially be replicated in other fields of social science. Hence the need of understanding the theoretical meaning and implications of the operation, as well as clarifying its added value in comparison with other approaches.

Two empirical cases taken from our respective ongoing research will illustrate the heuristics of this practice of sequence analysis. The first one shows how the division of academic labour in the UK is tied to career patterns (Paye 2010). Sequences of functional mobility of 122 individuals are synchronised at the date of access to the permanent workforce. Sequence visualisation shows that before this date, academic careers tend to converge towards polyvalent jobs, and then diverge anew towards monovalent jobs. Division of labour in academia appears as a result of functional differentiation. The second case explores the impact of international mobility on social mobility. Class sequences of French individuals from the "Histoire de vie 2003" survey (Insee, 2003) are synchronised according to the period of expatriation. Sequence visualisation reveals that class mobility reaches a peak during the expatriation period, as compared to those who do not experience international mobility.

The first section of this paper details the operation of synchronisation and considers a number of practical as well as methodological issues. The next section presents the two illustrative cases and their contribution to their respective research fields. In section three, the added value of sequence synchronisation is discussed with reference to three existing methods that can be used for the same purpose: Event history analysis, Multichannel sequence analysis and Multiple sequence alignment. A short conclusion comes back to the initial problem and opens up a number of questions that would deserve further attention.

1. Synchronising sequence data

Details of the operation

Sequence data is, most of the time, either displayed in calendar time (Blair-Loy 1999, 1358) or in age-relative time (Robette et Thibault 2009). The first option has the advantage to conserve historical context, while the second one is useful for analysing life course processes, especially those which display, because of highly institutionalised temporal norms, little age variance (i.e. leaving compulsory education).

Another process time than age-based reference can be used by taking as reference a specific event that occurs in a given point in one's career, *i.e.* an *idiosyncratic event*. Marriage or childbirth are example of such events. This has been done, for example, by Philippe Blanchard, in an analysis of 502 aids activists' careers (2010, 95), and by Giudici and Gauthier's study of professional trajectories as they interact with parenthood (2009). Only the

first author quickly provides an account of what synchronisation can bring forth for the visualisation of sequences. According to him, index plots of synchronised sequences best illustrate two phenomena: 1) individual contrasts in terms of order and duration of commitment experiences into aids activism, and 2) the brevity of aids activism compared to more lengthy related experiences in other spheres of life, such as sociosexual trajectories (Blanchard 2010, 19-20).

The justification for the use of sequence synchronisation can also be theoretical: some social processes unfold more according to event-related time patterns than age-based time or historical time. Therefore their study needs other time references. Incarceration or emigration seem to be events influential enough to consider using time axes defined according to their date of occurrence.

Figure 1 provides one example of the operation of sequence synchronisation with a sample of five individuals taken from the "Histoire de Vie 2003" survey. Sequences of employment status are plotted in three different ways: left-aligned, right-aligned and synchronised according to the date of the first marriage:

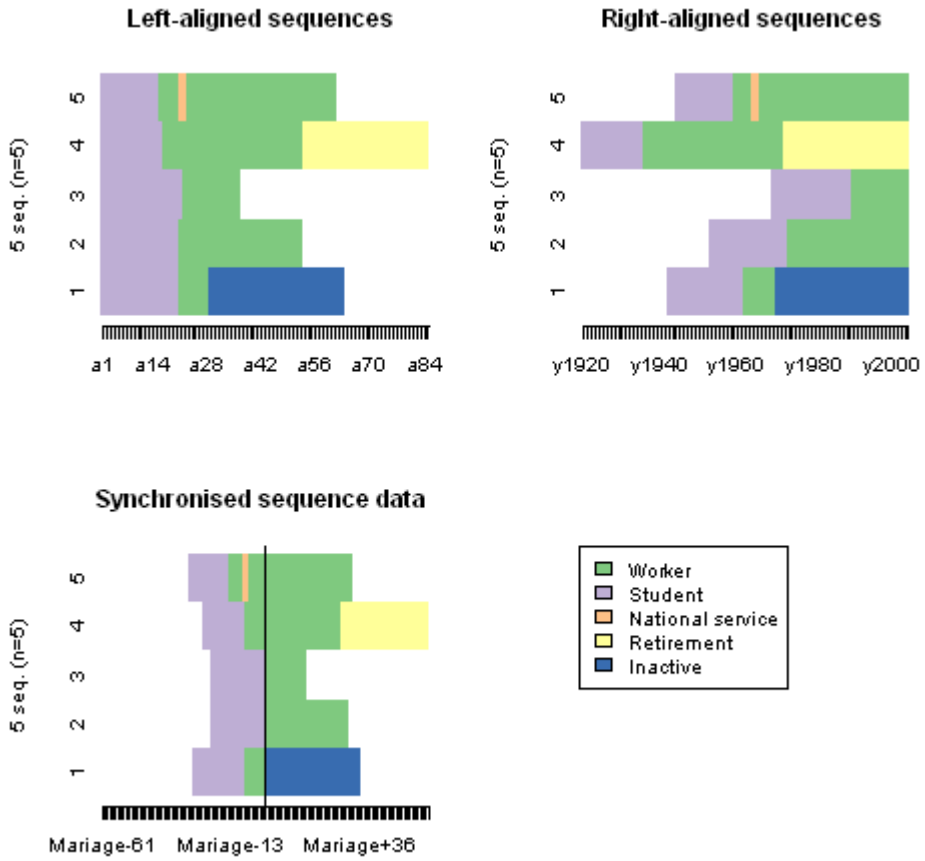


Figure 1: Sequences left-aligned, right-aligned and synchronised according to the year of first marriage

Sequence synchronisation allows to see that individual 1 leaves the labour market as soon as he (or she) gets married. It also help pinpointing that none of the 5 individuals gets married while studying: this could mean, for example, that marriage was "postponed" until studies are completed, or alternatively that marital life entailed leaving the studies.

In this case, "marriage" *is not an element of the sequence alphabet*. It is interesting to distinguish between exogenous and endogenous events, and assess their respective heuristic

potential. The event chosen to synchronise sequences can be either *endogenous* or *exogenous* to the sequence alphabet. We provide two examples using the "Histoires de vie 2003" survey.

Exogenous events

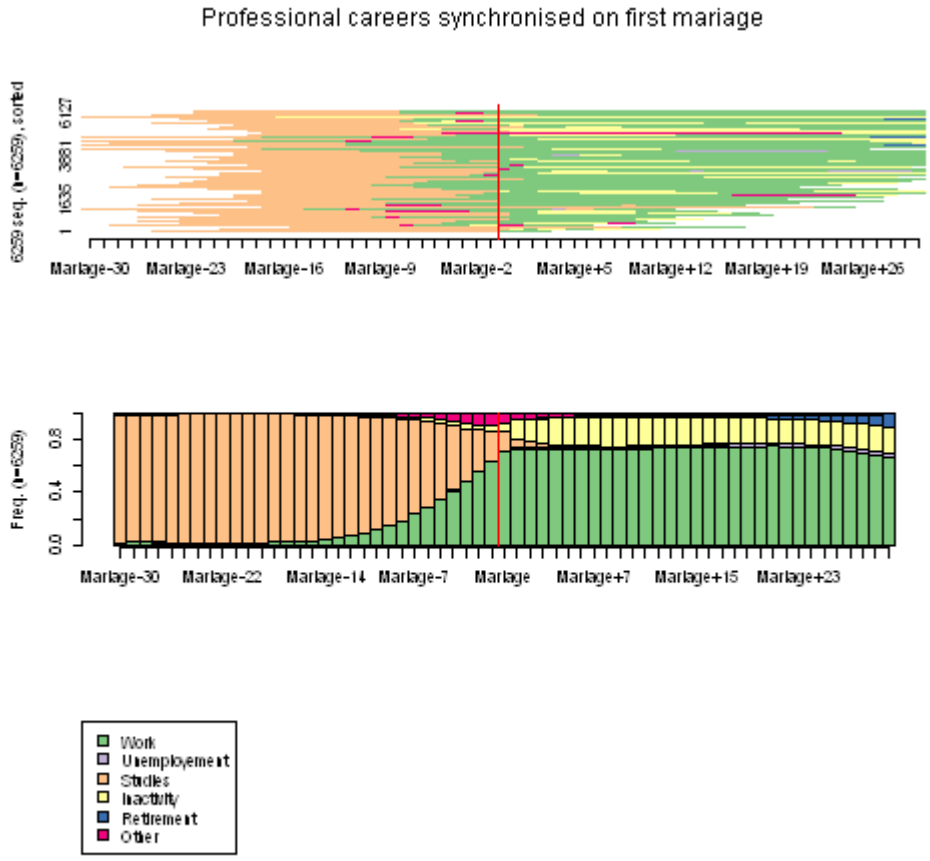


Figure 2: An example of alignement on an exogenous event: marriage

This first example is an *exogenous* synchronisation: in this case, the event is not an element of the alphabet of sequence data. Figure 2 provides index[3] and frequency plots. Time axis has been left-truncated at "marriage – 30" and right-truncated at "marriage + 30" so as to reduce interpretive pitfalls due to a high level of missing values.

With no surprise, we observe that marriage corresponds to an important transitory period in professional careers. Moreover, inactive states mostly appear after marriage, while the relative amount of work situation within the population suddenly stabilises at about 70%.

The comparison between different generations yields further results (Figure 3 & Figure 4). Individuals from earlier generations are less likely to work before their first marriage (probably a consequence of longer studies) are more likely to work after instead of became inactive (probably a consequence of women employment). Marriage increasingly coincides with a sharper turning point in people's lives, a result which is somewhat counter-intuitive.

[3] In the index plot, sequences are sorted by age: younger individuals are on the bottom.

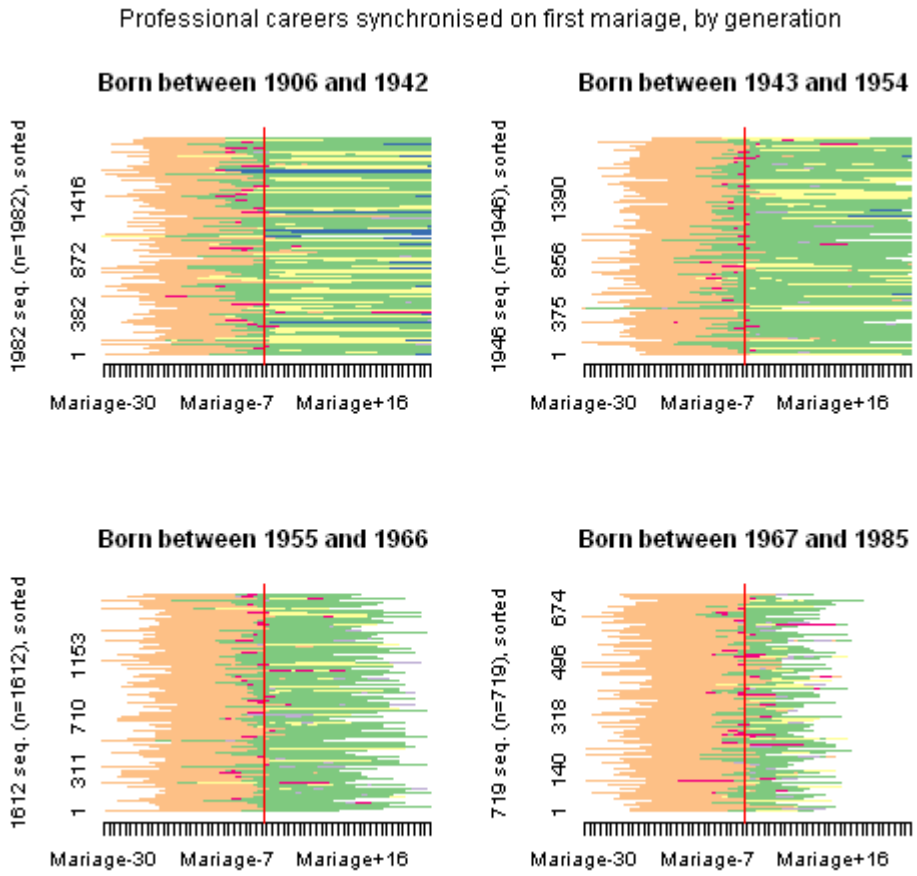


Figure 3 : An example of alignement on an exogenous event: comparison between different generations (index plots)

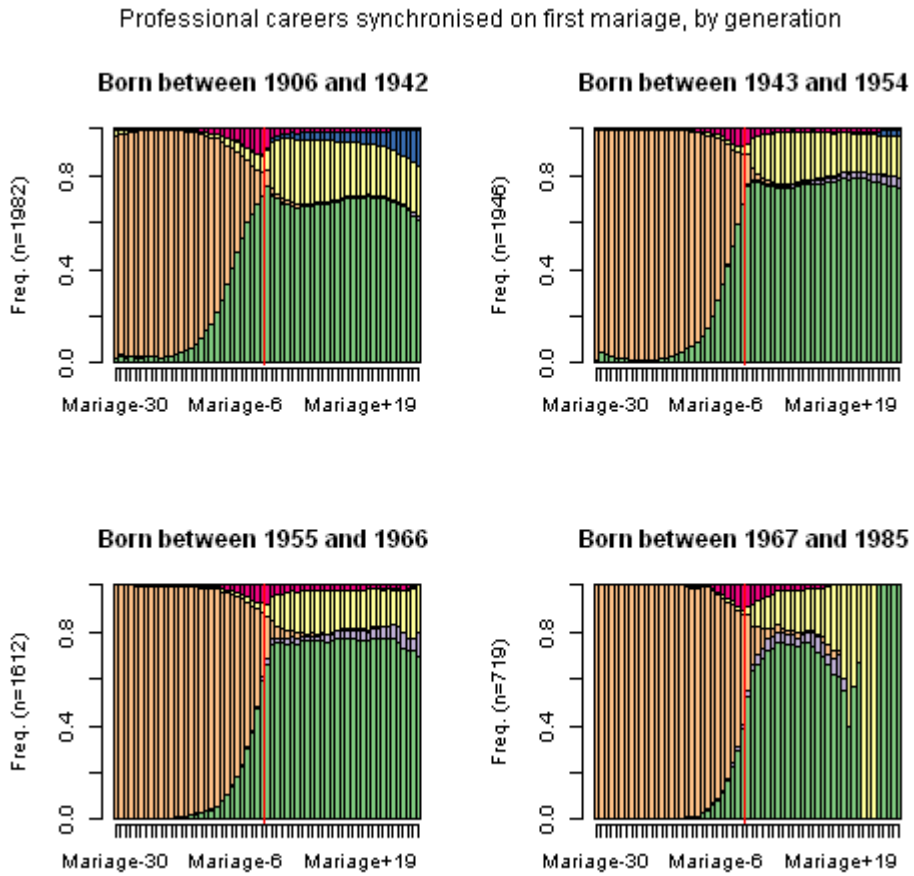


Figure 4: An example of alignement on an exogenous event: comparison between different generations (frequency plots)

Endogenous events

Sequence synchronisation can also be done according to an event that is *endogenous* to the sequence alphabet. The example below (Figure 5) displays employment careers synchronised according to the first year of unemployment[4], an information which is embedded in the sequences:

[4] Careers displaying no unemployment episode state are not represented.

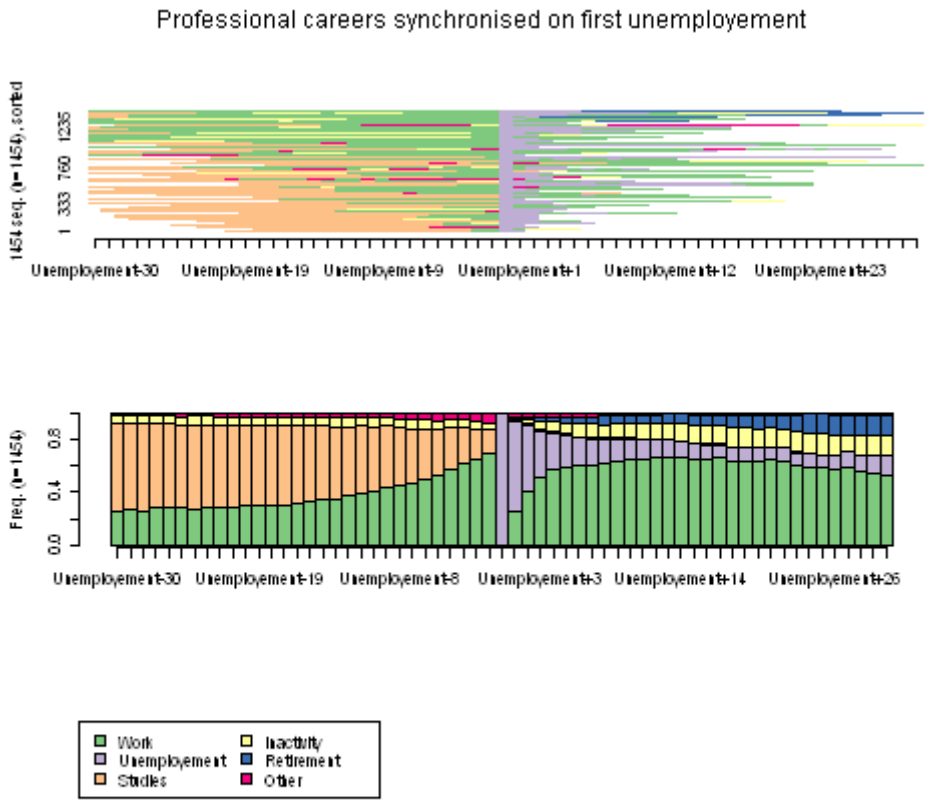


Figure 5: An example of alignement on an endogenous event: unemployment

In the index plot, individuals are sorted by age. This allows identifying an age-based trend: very few people of the oldest generations experience unemployment at a young age, contrary to individuals belonging to the youngest generations. Another interesting outcome relates to the situation preceding first unemployment: most individuals actually occupy a job, and rare are those who transit directly from studies to unemployment, although this case seems to happen more frequently within the youngest generation.

A comparison between men and women's careers is also insightful (Figure 6). Unemployment appears more likely to be linked to inactivity episodes within the female population, although this trend seems to disappear, as index plots ranged by age show.

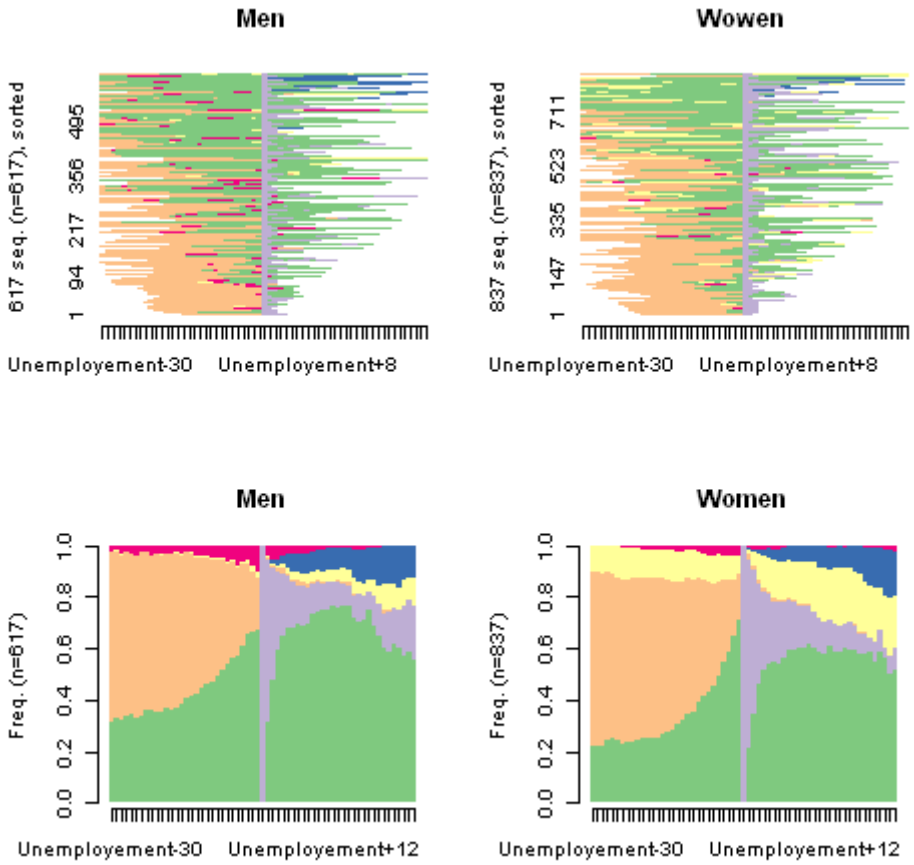


Figure 6: Professional carreers centered on first unemployement: comparison between men and women

Exogenous synchronisation, because it incorporates more contextual information, seems to have a better heuristic potential than endogenous synchronisation. Nevertheless, endogenous synchronisation also allows identifying interactions between events and temporal patterns.

2. *Two illustrative cases*

We now present and discuss two illustrative cases taken from our respective ongoing research. The first one is an analysis of the division of teaching and research labour within a population of British academics. This analysis is part of a PhD research on the principles of career differentiation within the academic profession. The second case is an exploration of consequences of employment abroad for French high-skilled workers. This analysis is part of a PhD on international mobility and professional careers.

Case 1: How division of academic labour is tied to career patterns

The division of academic labour in British universities is a puzzling phenomenon. It is mostly accounted for as a consequence of the proliferation of casual jobs (most of them being "teaching-only" and "research-only" positions). But monovalent labour also exists within the permanent workforce. Division of academic labour therefore needs different explanations according to whether it occurs in a external labour market of temporary jobs or in a internal market in which job allocation follows rules of career advancement. While it is straightforward to understand the origin of division of labour in a secondary market of temporary jobs ("as specialised jobs increase, division of labour increases"), the same is much more intricate in a primary market. To understand how division of academic labour occurs within the permanent workforce, I propose to look into the process of career differentiation. It

starts after securing the first permanent position, which is, most of the time, a polyvalent job. Professional profiles tend to diverge through a sequence of career transitions, which has the effect of increasing the overall level of division of labour. To do so, synchronising academic careers appears to be a useful means of establishing the result exposed above. To see whether permanentship (*i.e.* getting the first permanent position in one's career) influences research and teaching specialisation, sequences of job positions are aligned at the year in which individuals get access to their first permanent position. This operation is a synchronisation of sequences according to an idiosyncratic event: the date of entry into permanent workforce is indeed specific to each individual. Visualisation allows identifying the trend of functional specialisation that occurs after permanentship.

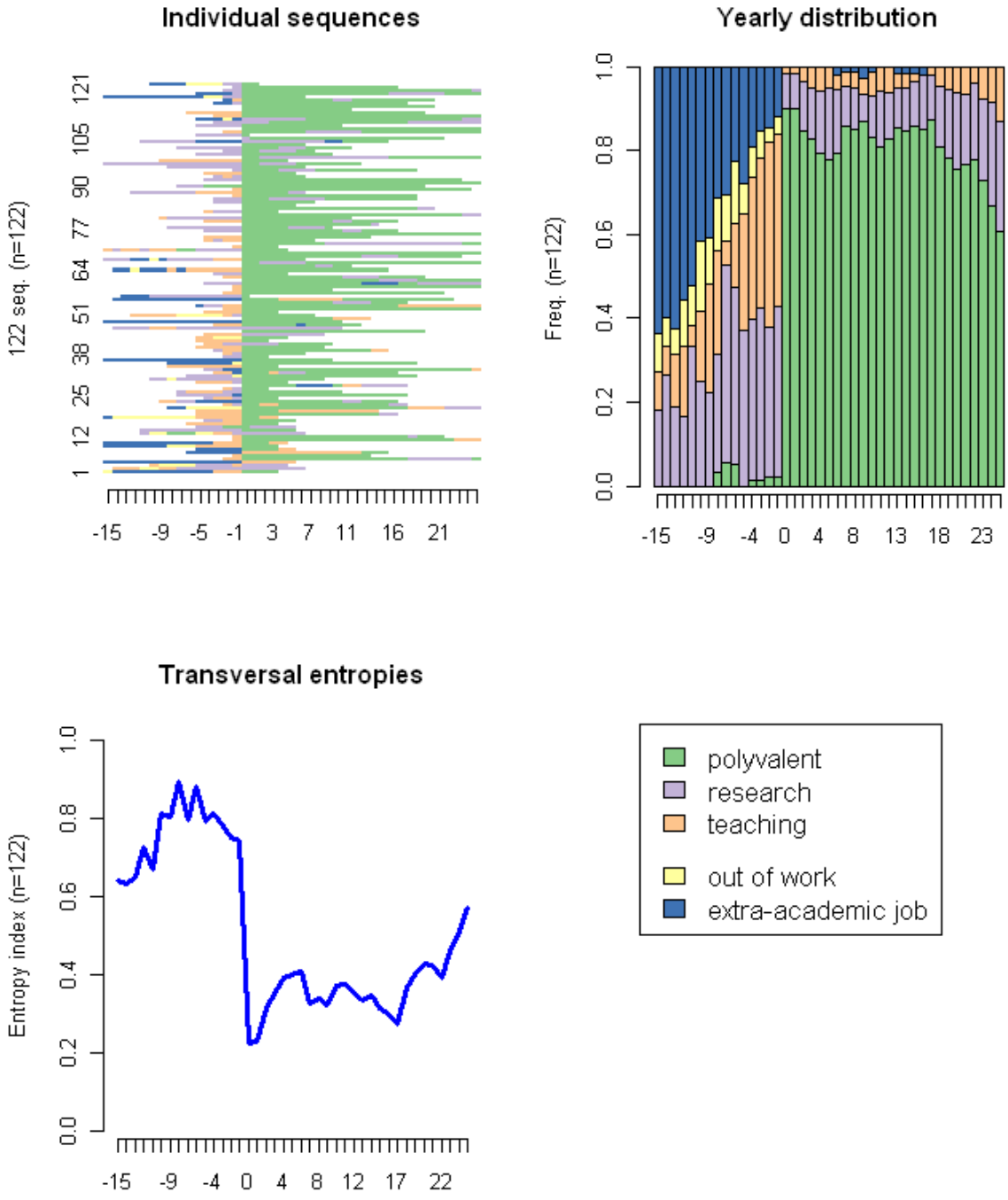


Figure 7: Visualisation of functional differentiation within the academic workforce

The index and frequency plots of yearly employment functions show a tendency of functional differentiation: as time elapses, the proportion of monovalent jobs increases. The entropy plot accounts for the divergence that occurs following permanentship.

Without synchronisation, this research outcome would have been difficult to identify. The following graphs allow comparing index, frequency and entropy plots with right-aligned, left-aligned and synchronised time axes.

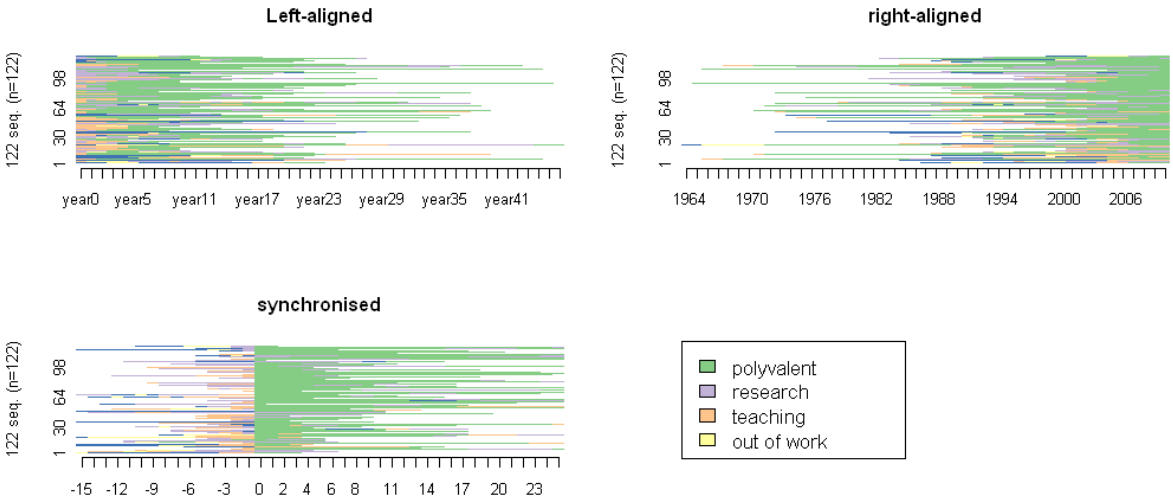


Figure 8: Comparison of index plots with different time axes

Figure 9: Comparison of frequency plots with different time axes

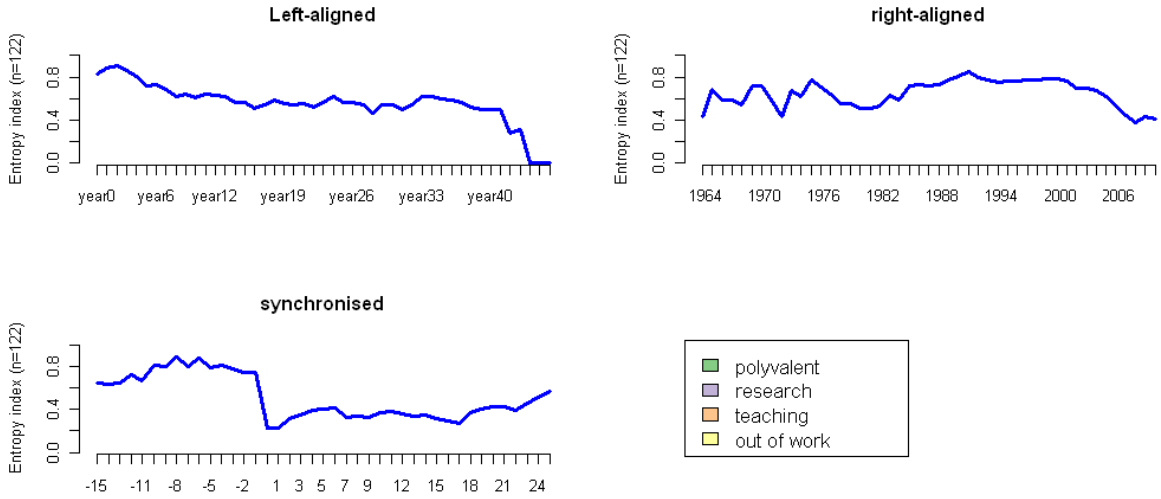


Figure 10: Comparison of entropy plots with different time axes

Observability of the phenomenon is highly dependent on the definition of the time axis. Without synchronising sequences, visualisation cannot account for any clear tendency of functional differentiation.

More standard methods such as event history analysis are also costly ways to arrive at the same result. Survival curves would have allowed analysing the probability of one specific event (*e.g.* moving from a research job to a teaching job) occurring after a previous event (*e.g.* moving from a teaching job to a research job job). Figure 7 Provides a more comprehensive account since it displays all possible transitions at once. This is hardly possible using event history modelling, unless with "competing risks" models. These models, also called « multiple destination models », are designed to deal with one origin state and multiple destination states (Blossfeld et Rohwer 2002, 101-107). However, they do not fully account for all the possible transitions within the state space. If the model includes three competing risks, only three transitions are accounted for.

The alphabet of sequence data includes 5 categories of employment function. Therefore, no less than 25 different transitions are theoretically possible and all appear to be empirically realised, as the table of functional flows shows:

	[→ P]	[→ R]	[→ T]	[→ U]	[→ X]
[P →]	115	36	15	1	3
[R →]	60	67	12	3	5
[T →]	43	22	54	4	2
[U →]	5	4	5	11	4
[X →]	12	7	6	10	25

Multiple risks modelling doesn't help in dealing with such categorical complexity. Multichannel sequence analysis without synchronisation would equally hardly lead to observe anything clear[5].

Synchronisation appears as the simplest way to identify what appears as one of the most structuring patterns of academic careers in the UK: functional differentiation after the entrance into the permanent workforce.

Case 2: How employment abroad facilitate upward class mobility

This second application deals with the complex links between international and social mobility. A core question in the related literature is whether international mobility fosters

[5] This argument is developer in section I.3. of this paper.

social mobility (Wagner 1998). The analysis focuses on 346 French "expatriates", *i.e.* workers who leave France to occupy a job abroad and then come back to France.

The "Histoire de Vie 2003" survey (Insee, 2003) is used to study the interaction between international mobility and social mobility in the trajectory of these individuals. In this sub-population, the majority are white-collar workers (30,4%, 115 individuals), classified as "cadres et professions intellectuelles supérieures": 10,5% of this class have experienced international mobility (as compared to 4,2% on the whole population).

Applied to their case, the core question can be formulated as such: is it because they go to work abroad that they become "cadres et professions intellectuelles supérieures"? Or is it because they belong to that upper class that they have more chances to experience international mobility?

Order is crucial in the treatment of this question: if international mobility has an impact on social mobility, people should have more chances to join the upper class after their expatriation than before. The comparison between "expatriates" and the reference population is therefore a simple way to see whether social mobility is more likely to happen if international mobility has occurred.

Figure 11 displays class careers using the "groupes socio-professionnels" scheme of the Insee. It uses a specific synchronisation technique that takes into account two dates instead of one. Graphs on the top display expatriates' careers centred on the year of expatriation (left graph) and on the year of return to France (right graph)[6]. On the bottom, equivalent frequency plots for the whole population are aligned on the mean age of first expatriation (left) and on the mean age of first return (right)[7].

[6] Multiple expatriation rarely happened within the population of the dataset: only 49 individuals on 376.

[7] This synchronisation according to mean ages allows comparing "expatriates" with the reference population. Comparability is justified if the variance of mean ages (migration and return) is low. Here, 75% of expatriation occurs before age 28, and 75% of the returns before age 35. Standard error is 6,6 for departure and 8,5 for return.

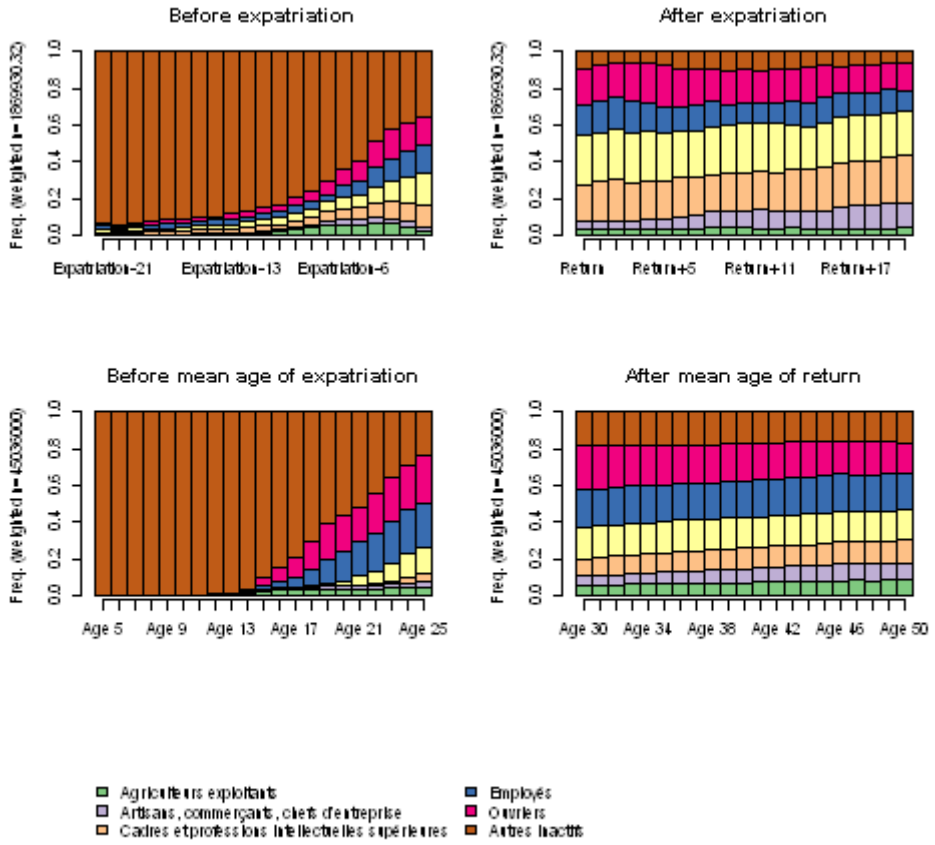


Figure 11: Comparison between "expatriates" and the whole population

Expatriates are less likely to be inactive after expatriation than the whole population, but the composition of the different classes does not change significantly. Figure 12 focuses on "cadres et professions intellectuelles supérieures". It shows that the proportion of people who belong to the upper-class *before* expatriation is significantly lower than the proportion *after* expatriation, a difference which is less noticeable when looking at the reference population Expatriates therefore experience more often upward class mobility during their migratory episode than the reference population of the same age range. Expatriation could be seen as a turning point as it operates a clear shift between probability regimes of class mobility .

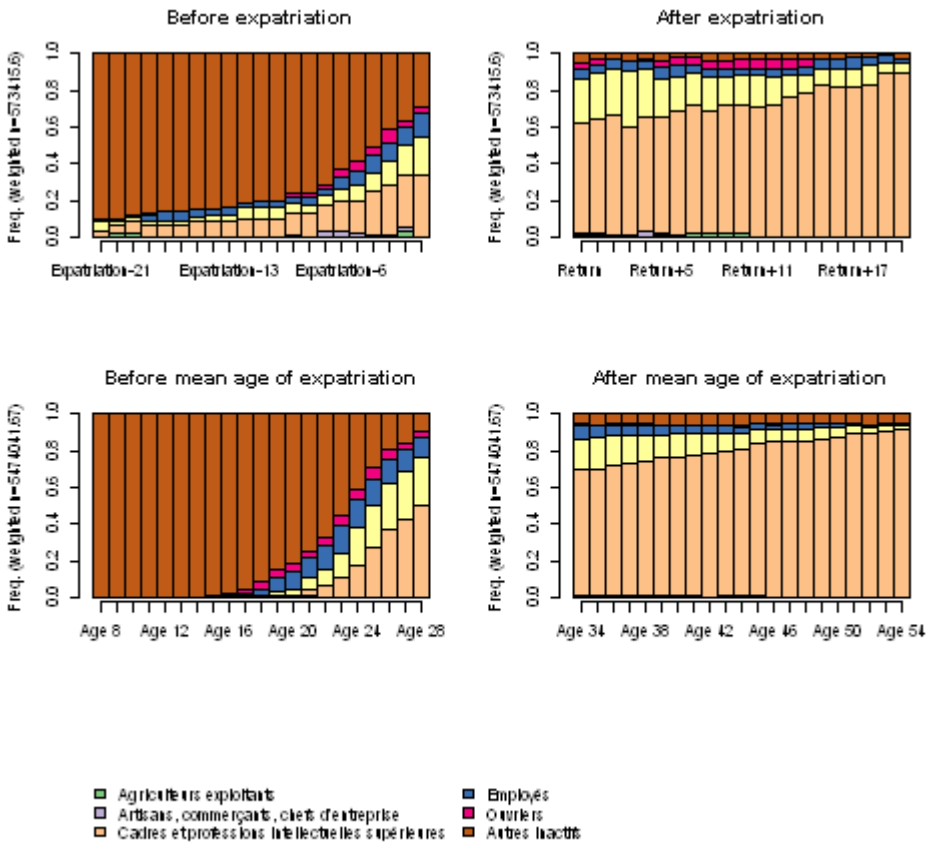


Figure 12: Comparison between upper-class "expatriates" and the whole population of upper-class

This effect is even more important within the female population (Figure 13). Expatriates have less chances to be part of the upper-class before expatriation and more after than the whole population of upper-class women. The reasons for this gender sensibility could relate to the more difficult experiences of women in the labour market or on their least participation in the upper-class (8,3% of women and 16,3% of men are "cadres et professions intellectuelles supérieures").

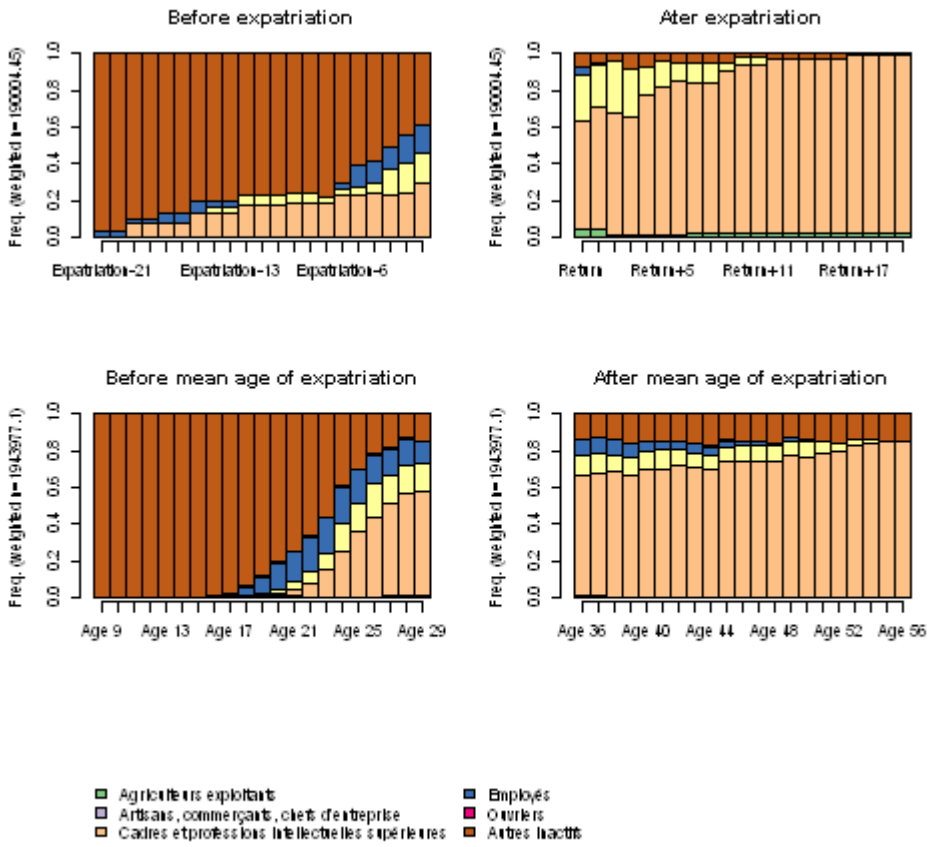


Figure 13: Comparison between upper-class expatriates women and the whole population of upper-class women

This short example shows the interest of this type of sequence representation: it allows the analysis to take account of order and events in social mobility studies. Expatriation seems to correspond to a shift in the probability regime for access to the upper-class. Further analysis is needed to examine whether this regime shift is an effect of the expatriation itself: the anticipation of a social mobility toward upper-class could indeed explain international mobility.

3. Sequence synchronisation compared

In this last section, we turn to discuss some of the strengths, pitfalls and weaknesses of sequence synchronisation with regard to three other ways of analysing longitudinal data: Event history analysis, Multichannel sequence analysis, and Multiple sequence alignment.

Let us start with the main strength: synchronising sequences allows comparing between sequences processes that happen before, during and after a specific event. This is useful for who wants to pinpoint transversal patterns around a particular event. One can thereby visualise trends that could be interpreted as constitutive of turning points or diverging or converging patterns.

A major shortcoming relates to missing data. Aligning sequences according to idiosyncratic events entails expanding the time axis considerably. This means ending up with more missing data than before the operation on the extreme left and right of the time axis. Figure 14 shows a standard index plot with historical time axis and a synchronised index plot with a time axis relative to the first year of activism:

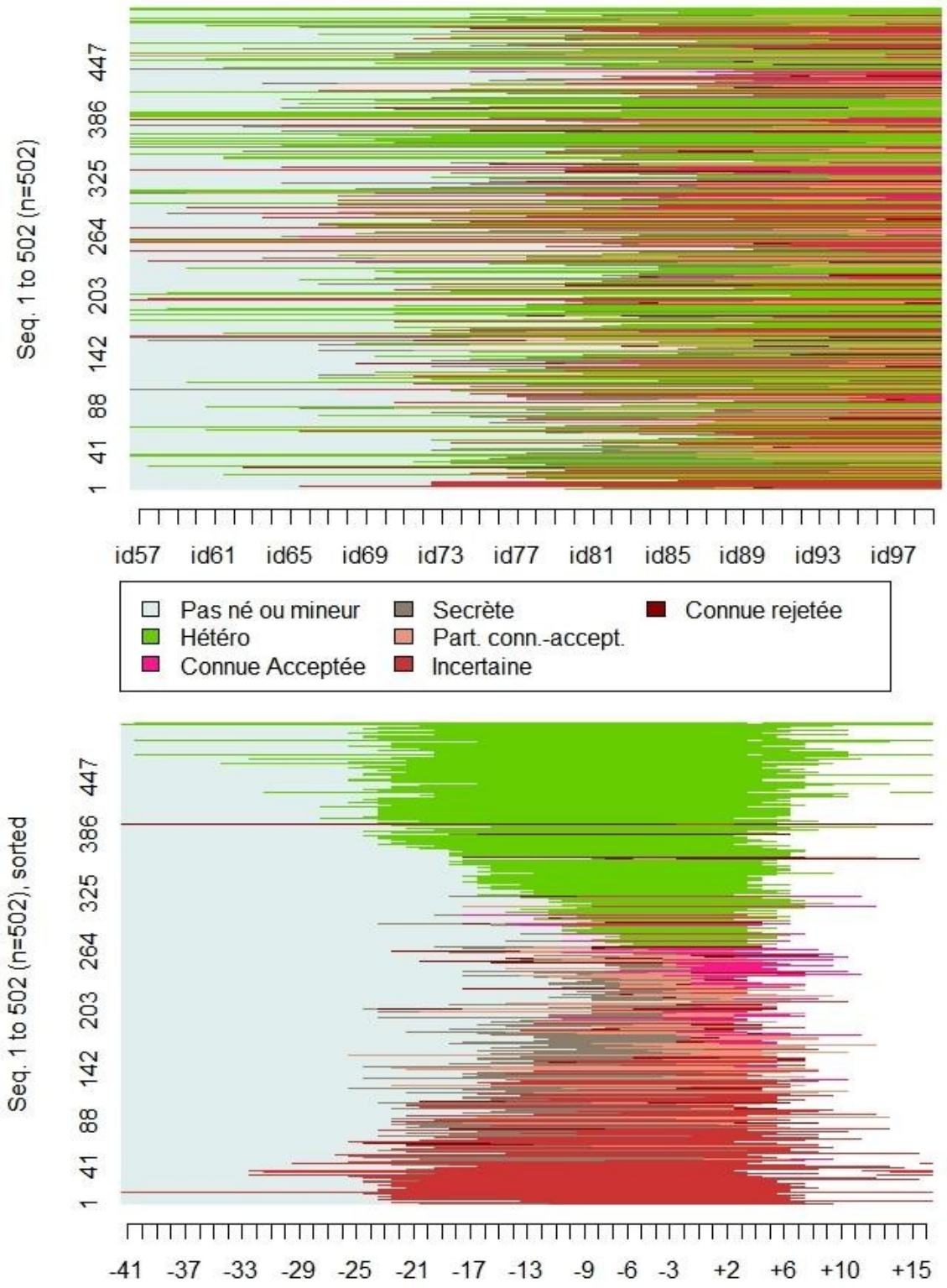


Figure 14: Comparison between normal index plot and synchronised index plot (Philippe Blanchard data, pp.32-33)

These two graphs clearly show that after the operation, missing data is high after year "+6". This drawback is less noticeable – but equally problematic – when working with sequences of varying length.

The strengths and limitations of sequence synchronisation can be put in relation with the three other ways of of analysing longitudinal data. We summarize this comparison in the following table and discuss in detail the different cases:

	Event history analysis	Multichannel sequence analysis	Multiple sequence alignment	Sequence synchronisation
Identifying turning points (exogenous)	yes, but limited	no	no	yes
Identifying turning points (endogenous)	no	yes, but not very accurate	yes	yes
Identifying converging/diverging trends	no	yes, but not very accurate	yes	yes
ontology	events	states	states	states and events

Event history analysis

Event history analysis is the most obvious solution to study relationships between events. According to Blossfeld and Rohwer's definition, event history modelling is geared to "discover the causal relationships among events and to assess their importance." (2002, 3). Survival curves allow visualising elapsed time between two given events.

As Lemercier puts it, "if event history analysis can include, in theory, any past event of the individual or any historical event of the past in general, as an element of causality of the movement under scrutiny (taking thereby into account, in a way, the entire trajectory), its primary unit of analysis is the event." (2005, 17).

Sequence synchronisation precisely allows to study relationships between an event and entire temporal patterns. The strength of event history techniques lies in that they easily authorize statistical tests of causality assessment. However they appear far less useful than sequence synchronisation for more exploratory uses, as they need strong hypotheses about which event counts and which events do not count.

Multichannel sequence analysis

By defining different "careers" per individual (*i.e.* occupational, housing, marital status, etc.) and comparing their patterns, multichannel sequence analyses are a useful way to explore resonances between spheres of life (Pollock 2007; Gauthier et al. 2010; Blanchard 2010). They can therefore show how a given trajectory in one "career" (*e.g.* housing career) can be reflected in another (*e.g.* friendship career). One example from a study led by Gauthier, Widmer, Bucher & Notredame (2010) provides insights on the readability of one event interacting with temporal patterns (Figure 15):

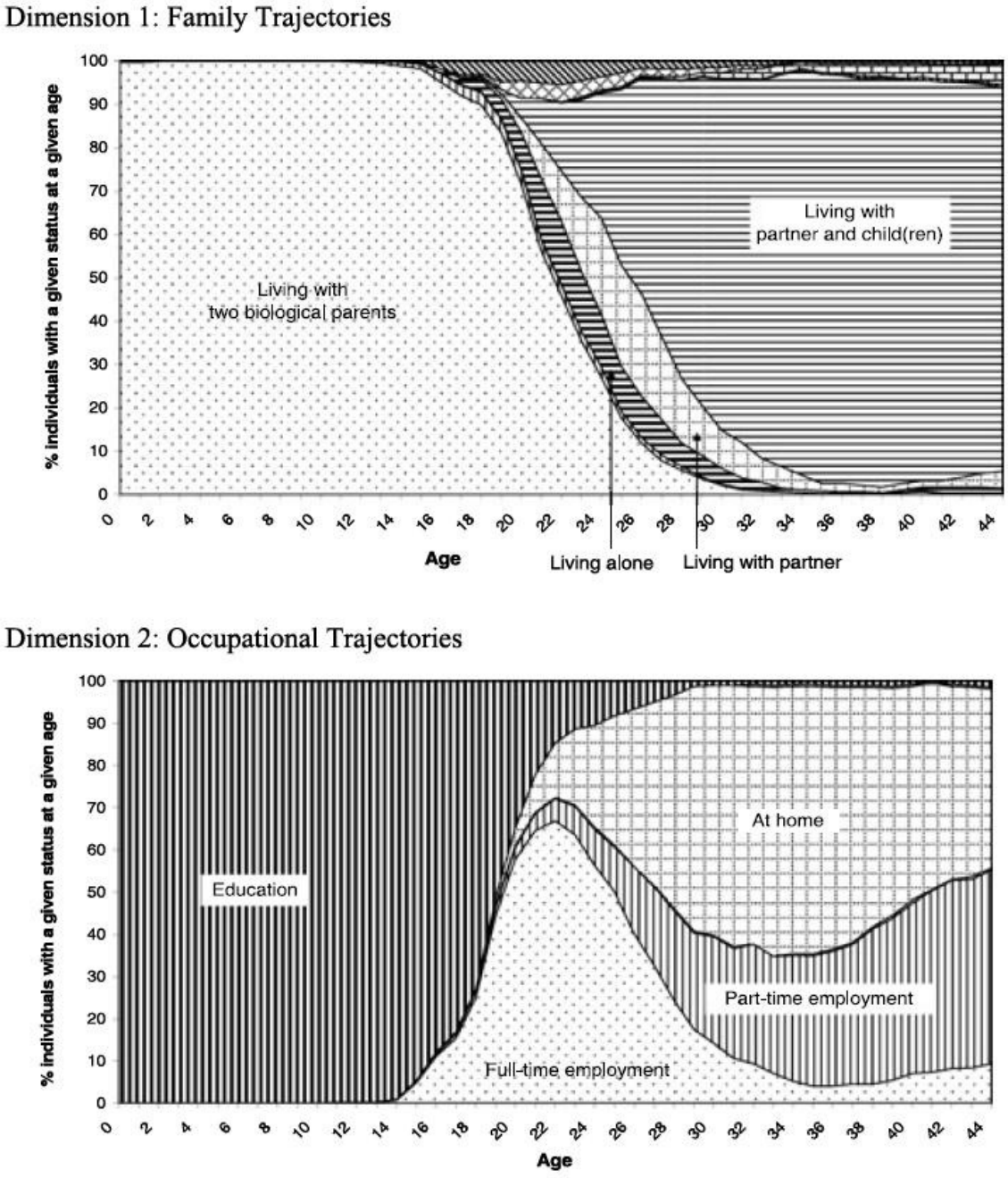


Figure 15: Resonances between family and occupational trajectories (Gauthier et al. 2010, p.14)

These frequency plots reveal that in both channels, substantial shifts occur between age 18 and 28. Their visualisation does not, however, allow to put in relation one specific transition in one channel (*i.e.* from education to full-time employment) with temporal patterns in family trajectories.

By remaining bound to one class of object (temporal patterns), Multichannel sequence analysis without synchronisation does not allow exploring actual relationships between events in one sphere and temporal patterns in another. The best conclusion that can be drawn from the examination of frequency plots are "resonances" between processes in one channel and processes in another channel.

Multiple sequence alignment

Gauthier's PhD thesis provides an interesting overview of the potentialities of this method of data representation (Gauthier 2007, 144-167).

"[It] aims at aligning not only a pair, but a whole set of sequences at the same time. The multiple sequence alignment procedure attempts the optimal alignment of a set of sequences so that homologous or identical symbols appear together in the same columns. For social science data, homology must be understood in a structural sense. It corresponds to the fact that the same status is present at about the same point in life for two or more individuals." (2007, 144)

Its use is rather geared to identify what is common in a set of sequences:

"MSA allows the identification of regions of sequences that are more or less identical. In a sociological perspective, such conserved regions may be seen as a configuration where, at some given points of the life course, the same social status (e.g. education, full-time or part-time paid work, housework, retirement) is held by a large number of the individuals belonging to a certain type. Thus, MSA helps to reveal conserved subsequences throughout the dataset or specific common patterns specific to some types of trajectories." (2007, 145)

This method requires using the OMA as a first step, to produce a metric that is later used to align the sequences at various points in time: "By aligning the sequences, the algorithm optimizes the vertical alignment of identical or homologous symbols, while minimizing the structural distortion of the original sequences." (2007, 146)

Gauthier claims that this approach of sequence visualisation has promising applications:

"By indicating the intensity at which some social statuses are shared among individuals and also the age range at which the common versus less common patterns occur, the multiple sequence alignment perspective definitely brings something essential to the display and to the interpretative tool box available for analyzing sequential data." (2007, 147)

Amongst the opportunities for sequence visualisation offered by Multiple sequence alignment, the one that is of interest to us is what he calls "Multi-aligned individual trajectories" (2007, 153-166). According to Gauthier, "we expect such graphs to highlight some less visible feature of typical individual trajectories, once they have been processed in order to optimize conserved regions among the members of that type." (2007, 153)

One major problem is that the obtained index plot has some distorting effect on the time scale, as it inserts gaps (missing values) to some of the sequences. But this is the trade-off inherent to multi-align the sequences. If these gaps expand too much the time scale, one option is to" delete columns according to the percentage of gaps they contain." (2007, 154). Yet again, this means loosing data.

Another limit of this method is that it is less useful when applied to sequences showing important variability (2007, 164). The dataset has to be particularly stable, and this is far to be the case in many social processes.

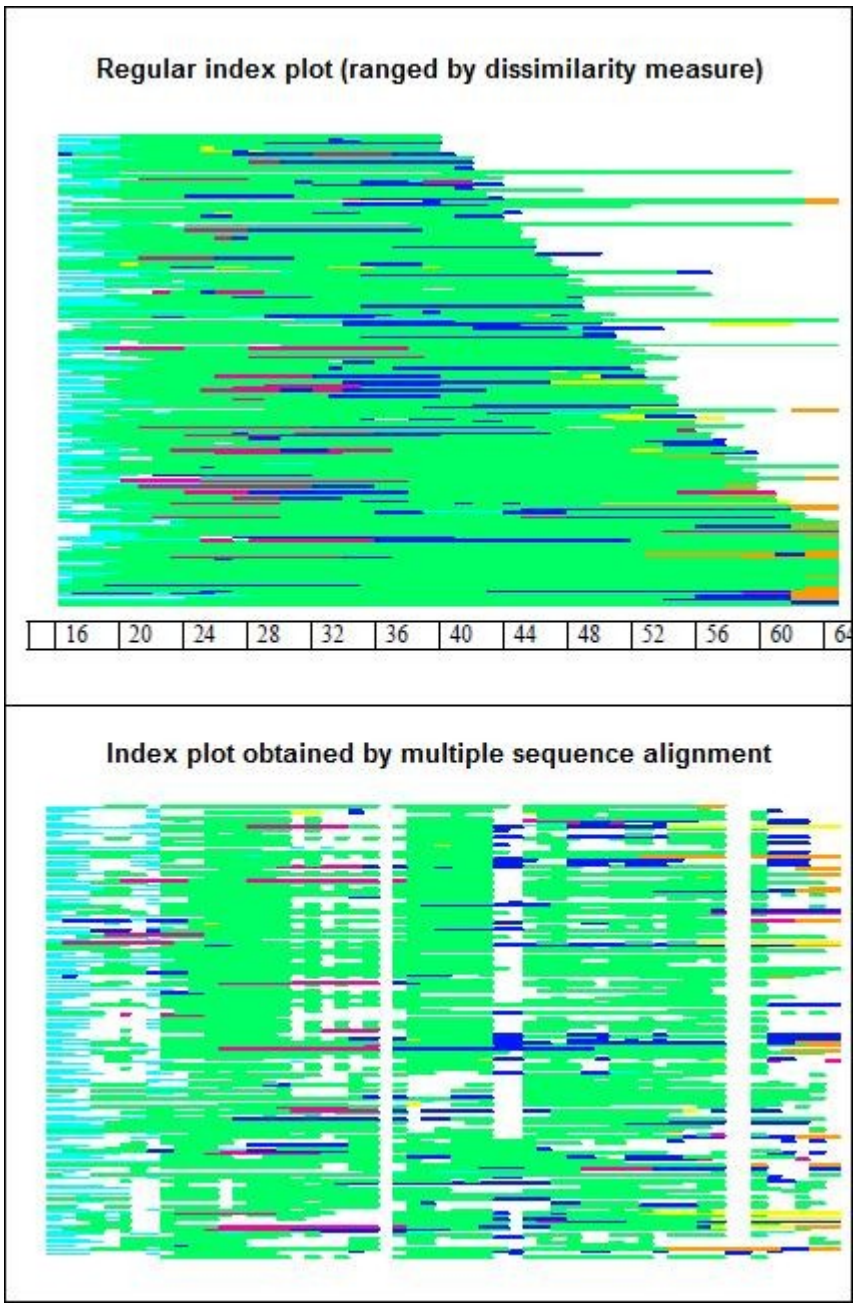
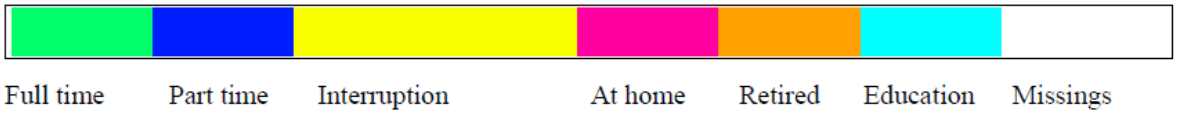


Figure 16: Comparison between standard index plot and MSA index plot with sequences with less than 50% missing values (Gauthier, 2007, p.159)



What can be said from the examination of Figure 16? Not much more than the fact that many sequences go through the typical subsequence education – full-time job – part-time job – retirement. In fact, this visualisation shows what is common to an important number of sequences (this number increasing as the percentage of missing values raises), but looses information related to heterogeneity.

Multiple Sequence Alignment can therefore be performed parallely to synchronisation as it allows to identify diverging or converging trends as well as states or subsequences that are shared by many individuals. It seems however less useful for identifying turning points as it is limited to the states included in the sequence alphabet.

Conclusion

Sequence synchronisation appears to be a useful analytic approach to explore the articulations between events and temporal patterns. Its main strength is that it allows studying both how events are conditioned by previous sequences of states, and how in turn events reconfigure the range of possibilities within subsequent temporal patterns. It therefore complements existing methods such as Event history analysis, Multichannel sequence analysis and Multiple sequence alignment.

As regard to theory, the synchronising approach seems consistent with two traditional concepts in sociology and social sciences in general: turning point, defined as probability regime shifts; and homogenisation/differentiation, identified by converging/diverging trends. The two illustrative cases provide compelling support to this view. The first case on functional differentiation in academic tasks throughout careers exhibited clear diverging patterns. The second case provides evidence of a clear probability regime shift between class careers preceding and following employment abroad, especially amongst female population of white collar workers.

These illustrative cases, as different as they are, both relate to life course research. The scope of application of our method, however, is not restricted to this field. We argue instead that sequence synchronisation can be useful for a variety of research areas, such as time use research or analyses of historical processes, or music studies.

This paper only dealt with visualisation techniques. This does not mean that sequence synchronisation is not of interest for other ways of analysing sequences, such as dissimilarity measurements, clustering, dissimilarity trees and so on. One interesting question relates to applying optimal matching to sequences that have been previously synchronised. Unless the Levenshtein II coding scheme is used (Lesnard 2010), the outcome is not the same as with non-synchronised sequence data. In some cases, optimal matching analyses could benefit from synchronisation, because they could lead to clusters that are better defined according to a structuring event, such as marriage, childbirth or incarceration. A second interesting question concerns analytic operations that could follow visualisation of synchronised data. Visualisation is indeed useful for identifying trends, but has limited robustness to establish results. Statistical counting techniques and testing could be adapted to the type of hypotheses synchronisation allows to develop.

Another series of questions still need to be thoroughly addressed. Is sequence alignment limited to the inclusion of one single event? Lifecourse and many other temporal processes exhibit multiple events. How can we, as sequence analysts, study the interaction between, for example, successive childbirths and professional career?

Removing historical timeline or age-based time axis also raises important questions. Indeed, getting married at age 20 does not mean the same as getting married at age 70. The same for historical periods applies: getting married in 1900 does not mean the same as getting married today. In which cases synchronisation would be to proscribe? Which pitfalls are to be avoided?

This opens up several deeper theoretical and methodological questions that would deserve clarification. What are the epistemological and ontological implications of synchronising individual sequences and detach them from historical time and/or from age-based process time? Can we answer to these questions in general terms, or do they always depend on the substantial issues addressed in the enquiry? Last but not least, how can the analyst combine the process time of synchronised sequential data and the historical time? Cohort-based analyses of synchronised sequence data perhaps offer a path to address this question.

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