Pattern matching

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ABSTRACT AND KEYWORDS	
Abstract	Pattern matching is comparing two patterns in order to determine whether they match (i.e., that they are the same) or do not match (i.e., that they differ). Pattern matching is the core procedure of theory-testing with cases. Testing consists of matching an "observed pattern" (a pattern of measured values) with an "expected pattern" (a hypothesis), and deciding whether these patterns match (resulting in a confirmation of the hypothesis) or do not match (resulting in a disconfirmation). Essential to pattern matching (as opposed to pattern recognition, which is a procedure by which theory is built) is that the expected pattern is precisely specified before the matching takes place.
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Abstract

Pattern matching is comparing two patterns in order to determine whether they match (i.e., that they are the same) or do not match (i.e., that they differ). Pattern matching is the core procedure of theory-testing with cases. Testing consists of matching an “observed pattern” (a pattern of measured values) with an “expected pattern” (a hypothesis), and deciding whether these patterns match (resulting in a confirmation of the hypothesis) or do not match (resulting in a disconfirmation). Essential to pattern matching (as opposed to pattern recognition, which is a procedure by which theory is built) is that the expected pattern is precisely specified before the matching takes place.

Conceptual Overview and Discussion

The Concept of Pattern Matching

A pattern is any arrangement of objects or entities. The term “arrangement” indicates that a pattern is non-random. Theories “predict” some pattern of values of variables. Such predictions are usually called hypotheses. The term “expected pattern” will be used here for specifications of the hypothesis that allow for a rigorous comparison with an “observed pattern” of values of variables in a test.

Donald T. Campbell coined the term “pattern identification” as a characteristic of qualitative analysis which he defines as holistic (i.e., analyzing the pattern) rather than atomistic (i.e., analyzing its constituents). He argued that the single case study design could provide for a strong test of a theory if an entire set of expectations deduced from that theory (which together would constitute an “expected pattern”) could be shown to be true in that case. Campbell also called this a “configurational approach”. He insisted that qualitative analysis in this design tends to disconfirm rather than confirm prior belief due to the requirement that, in the test, each separate element of a pattern or configuration that is observed is exactly as expected. As noted by Thomas D. Cook and Donald T. Campbell, the strength of this “non-equivalent, dependent variables design” is precisely that the variables that constitute the pattern or configuration are non-equivalent, i.e., not substitutable.

Yin’s Approach to Pattern Matching

Robert Yin discusses pattern matching as the most desirable analytic strategy in case study research. He discusses two main types of pattern matching in theory-testing, (a) the pattern in a non-equivalent *dependent* variables design (in which the initially predicted value must be found for each element of a pattern of dependent variables) and (b) the pattern in a non-equivalent *independent* variables design. An example of the latter is a pattern derived from a typological or configurational theory in management. Yin states that pattern matching in the *dependent* variables design should be rigorous, i.e., such that the hypothesis is disconfirmed even if only one variable of the pattern does not behave as predicted. For the *independent* variables design, however, he recommends a different approach. Yin states that one should formulate different expected patterns of independent variables, each based on a different and mutually exclusive (“rival”) theory and that the concern of the case study would be to determine which of the rival patterns has the largest overlap with the observed one. An additional complication in this approach is that Yin presents some examples in which the rival pattern does not represent a real (theoretical) explanation but rather a version of a null hypothesis.

Applications

Independent Variable Designs

Campbell’s and Yin’s approach to pattern matching is implicitly limited to the testing of propositions about characteristics of single cases (which can be tested in single cases) and not about differences between cases (see the entry on Theory-testing with cases). Expected and observed patterns, therefore, consist of values of variables that all pertain to the single case. The simplest type of an independent variable pattern consists of the expected value of only one independent variable (rather than of a number of variables), given the value of a dependent variable. There are only two propositions on which such single point expected patterns can be based, (a) necessary condition propositions, and (b) sufficient condition propositions.

Necessary condition propositions state that an outcome Y is only possible if condition X is present. To test such a proposition, a case must be selected in which outcome Y is present. The expected pattern is: X is present. (Note that the proposition does not entail any prediction about conditions of the absence of Y.) It is observed whether X is present in the selected case. The observed pattern is either that X is present or that X is absent. Pattern matching in this case consists of checking what the value of X is in the observed pattern.

Sufficient condition propositions state that an outcome Y is always present when condition X is present. To test such a proposition, a case must be selected in which outcome Y is absent. (Note that the proposition does not entail any prediction about conditions of the presence of Y.) The expected pattern is: X is absent. Pattern matching in this case consists of checking what the value of X is in the observed pattern.

Configurational theories usually specify a number of conditions that together, i.e. in a configuration, must be present for an outcome to exist. If a configuration consists of, say, four elements, these can be seen as four separate necessary conditions. Four single point independent variable patterns could be specified and tested as described above for the necessary condition proposition, but it is also possible to specify a single four-point pattern (e.g., [A+/B+/C+/D+]) which is expected to be observed in a case in which the outcome is present. The observed and the expected pattern do not match if any of the four variables is absent and, in such a case, the hypothesis is disconfirmed.

Process theories are a type of configurational theory in which not only the presence of a number of conditions is specified but also their temporal order. The expected pattern in a case in which Y is present is, for instance, [A+ → B+ → C+ → D+]. The observed pattern must reflect the temporal order in which conditions A, B, C, and D occurred (if at all) and a match is confirmed only A, B, C, and D have the same temporal place in expected and the observed pattern.

Dependent Variable Designs

Similar to independent variable designs, the simplest type of a pattern in a dependent variable design consists of the expected value of only one dependent variable, given the value of an independent variable. Here also, such single point expected patterns can only be based on a necessary condition proposition or a sufficient condition proposition. To test a ***necessary condition proposition*** in a dependent variable design, a case must be selected in which condition X is absent. The expected pattern is: Y is absent. Pattern matching in this case consists of checking whether outcome Y is absent in the observed pattern. To test a ***sufficient condition proposition*** in a dependent variable design, a case must be must be selected in which condition X is present. Pattern matching in this case consists of checking whether outcome Y is present in the observed pattern.

As mentioned above, Campbell used the term ***configuration*** for a pattern of dependent variables. Pattern matching with a configuration of dependent variables in a case in which the condition X is present consists of checking whether the expected values of each of the dependent variables have the expected value. If a ***temporal*** order is expected in the configuration of dependent variables, pattern matching additionally consists of checking whether the observed outcomes have occurred in the expected order.

However, dependent variable single case study designs are relatively rare in practice because most theorists and researchers, even those who adhere to necessary condition hypotheses (i.e., who believe in constraints on outcomes that can be theorized and tested) do not believe that sufficient conditions are credible in the social sciences. Most researchers frame the outcomes that follow certain conditions as (more) likely rather than as inevitable. The dependent variable designs discussed so far cannot be used for testing probabilistic propositions. However, pattern matching can also be used as a testing procedure in a sample case study design (see the entry on Theory-testing with cases).

Critical Summary

Every hypothesis derived from a proposition can be formulated as an “expected pattern”, which specifies the values of one or more variables (either independent or dependent) which should be observed in a case (or a sample) if the hypothesis is true. Pattern matching, therefore, is the core procedure in every theory-testing study.

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