JDiBrief - Analysis

Conjunctive Analysis of Case Configurations:

Author: Timothy C. Hart, Griffith University

PURPOSE: Crime analysts and researchers of crime patterns know intuitively, and empirically, that 'context matters'. That is, crime patterns are caused by a multitude of factors, and these are not easily disentangled from one another. Conjunctive Analysis of Case Configurations (CACC) is a data analysis technique that specifically looks at the composite profile of a particular unit of analysis (that is, a person or a place). The technique is used to understand the complex causal relationships that emerge when combinations of variables are present or absent when examining a particular outcome such as crime. CACC can be used to explore patterns in data or in support of more formal tests of research hypotheses.

METHOD: One data file is needed for the analysis, where rows of data represent each unit of analysis (i.e., persons or places) and columns represent predictor variables (characteristics that might be associated with the outcome) as well as some outcome measure (e.g., recorded crime). The following steps summarise the data preparation process:

Step 1 – creation of a truth table. A truth table is made up of the variables contained in an existing data file, and includes both the outcome variable (e.g., recorded crime) and predictor variables (i.e., characteristics that might be associated with the outcome). Each row in a truth table reflects a unique combination of possible predictor variables that could be observed in the existing data.

Step 2 – populating the truth table. Each characteristic in the data file needs to be aggregated into one of the rows that defines the truth table. First the data need to be sorted by the predictor variables sequentially. In other words, the data would be sorted by X_1, then X_2, then X_3 and so on. Next, the data need to be analysed to determine how many times a specific profile is observed in the data. If the outcome variable is also dichotomous (e,g, presence or absence of crime), another column can be added to calculate proportionately how often variable is observed for each case profile..

Step 3 – preparing the case profiles for data analysis. To do this, decision rules for defining dominant case configurations first need to be established. Dominant case configurations are typically defined as when five or more of the same profiles are present in relatively small data sets (i.e., when the sample size of the original data <1,000 before the profiles are created). However, when large data sets are analysed the threshold for defining a dominant profile is typically 10 or more observations. After these decision rules are applied, the resulting truth table contains one row for each of the dominant case configurations that are empirically observed in the original data. When this step is complete, a researcher can begin analysing patterns of case configurations.

APPLICATION: CACC can be used to explore patterns in data or in support of more formal tests of research hypotheses. To date, CACC has been applied to study patterns in carjacking outcomes; the situational contexts for self-defensive gun use; intimate partner violence; crime and the distribution of alcohol outlets; bus stops in relation to robberies; police discretion; strategies for preventing maritime pirate attacks; and the violent victimisation of university students.

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Conjunctive Analysis of Case Configurations:
PURPOSE & THEORY (2 of 5)

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PURPOSE: Crime analysts and researchers of crime patterns know intuitively, and empirically, that 'context matters'. That is, crime patterns are caused by a multitude of factors, and these are not easily disentangled from one another. For instance, research often looks to determine correlates of offending behavior at the individual (offender) level, or at the place level to make sense of crime patterns.

Traditional data analysis techniques such as regression or correlation analysis are concerned with single predictors (variables) of crime, or the effects of associations between pairs of variables. What these quantitative approaches cannot do is consider the complex causal relationships of combinations of variables.

Conjunctive Analysis of Case Configurations (CACC) is a data analysis technique that overcomes these limitations, and specifically looks at the composite profile of a particular unit of analysis (that is, a person or a place). The technique is used to understand the complex causal relationships that emerge when combinations of variables are present or absent when examining a particular outcome such as crime. It builds on other qualitative approaches (such as qualitative comparative analysis (QCA) methods) and generates analytical results on the profile of characteristics associated with crime and offenders.

CACC can be used to explore patterns in data or in support of more formal tests of research hypotheses. It was first introduced as a method in Criminology by Miethe and colleagues in 2008. Since then a growing number of studies have employed CACC to identify dominant case configurations in data, and to explore the diversity within case configurations, and other patterns that are not easily identified and/or quantified with more traditional analytic techniques. In academic research, CACC has been used to better understand patterns in carjacking outcomes; intimate partner violence; crime and the distribution of alcohol outlets; police discretion; strategies for preventing maritime pirate attacks; and the violent victimization of university students.

Whilst there is no obvious theoretical orientation to the CACC technique, the purpose of it is clear; to find patterns in data which have multiple characteristics associated with crime (or other constructs of criminal behavior). Because of this, it could plausibly be employed to test a number of theoretical propositions and has much wider application in the crime prevention practitioner world. As the technique can generate place-based composite profiles, it is also a plausible way of CACC lends itself to defining control areas when conducting evaluation analyses. Future research will benefit from the continued application of CACC as it provides a richer understanding of how 'context matters'.

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Conjunctive Analysis of Case Configurations:
METHOD (3 of 5)

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The general idea behind CACC is to aggregate individual characteristics (i.e. observations) into groups of unique case configurations. This can be accomplished by following three basic steps and using a data file where rows of data represent each unit of analysis (i.e., persons or places) and columns represent predictor variables (characteristics that might be associated with the outcome) as well as some outcome measure(e.g., recorded crime).

Step 1 – creation of a truth table. The first step in CACC is to construct a truth table (also known as a data matrix). A truth table is made up of the variables contained in an existing data file, and includes both the outcome variable (e.g. recorded crime) and predictor variables (i.e. characteristics that might be associated with the outcome). Each row in a truth table reflects a unique combination of possible predictor variables that could be observed in the existing data. For example, suppose each of the predictor variables in Table 1 (i.e., X_1, X_2, and X_3) is a dichotomous measure, where '0' represents the absence of a characteristic and '1' represents its presence. From this a truth table with eight case profiles (i.e., $2^3=8$) would be generated, with each row reflecting one of the possible composite profiles.

Step 2 – populating the truth table. The second step in CACC requires aggregating each characteristic in an existing data file into one of the rows that defines the truth table. First the data need to be sorted by the predictor variables sequentially. In other words, the data would be sorted by X_1, then X_2, then X_3 and so on. Next, the data need to be analysed to determine how many times a specific profile is observed in the data (the 'N cases' column in Table 1). See the online appendix for syntax on how to do this in SPSS. If the outcome variable is also a dichotomous variable (e.g., presence or absence of crime), another column can be added to calculate proportionately how often variable is observed for each case profile.

Profile #	X_1	X_2	X_3	N cases	Y
1	0	0	0	nc1	y1/nc1
2	0	0	1	nc2	y2/nc2
3	0	1	0	nc3	y3/nc3
4	0	1	1	nc4	y4/nc4
5	1	0	0	nc5	y5/nc5
6	1	0	1	nc6	y6/nc6
7	1	1	0	nc7	y7/nc7
8	1	1	1	nc8	y8/nc8

Table 1 - *Hypothetical CACC Truth Table with 8 Case Profiles, adapted from Miethe et. al. (2008)*

Step 3 – preparing the case profiles for data analysis. To do this, decision rules for defining dominant case configurations first need to be established. Dominant case configurations are typically defined as when five or more of the same profiles (N cases) are present in relatively small data sets (i.e., when the sample size of the original data <1,000 before the profiles are created). However, when large data sets are analysed the threshold for defining a dominant profile is typically 10 or more observations. After these decision rules are applied, the resulting truth table contains one row for each of the dominant case configurations that are empirically observed in the original data. With this step complete, a researcher can begin analysing patterns of case configurations.

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Conjunctive Analysis of Case Configurations:
CASE STUDY (4 of 5)

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APPLICATION: CACC can be used to for describing, exploring, or testing hypothesis related to observed patterns of case configurations. Here, two examples are provided which demonstrate how the technique is applied in exploratory analysis and research.

Using data from the U.S. National Crime Victimization Survey (NCVS), researchers produced a CACC truth table so that they could describe the situational contexts for self-defensive gun use. In this study, the normative boundaries were defined as case configurations that fell within ±1 standard deviation (SD) of the average values for all situations combined. By rank ordering situational contexts of self-defensive gun use according to their overall frequency, and their relative distribution of helping and hurting consequences, these researchers were able to identify 1) the particular situational factors that were important for understanding when gun use by victims is most common; and 2) under which circumstances it was used most effectively.

ID	Type of Crime	Offender Armed w/Gun	Private Home	At Night	Offender On Drugs or Alcohol (known)	Mean	N
1	Rape/SA	Yes	Yes	No	Yes	0.17	6
2	Robbery	Yes	Yes	No	No	0.09	11
3	Assault	Yes	No	No	Yes	0.09	55
4	Robbery	Yes	Yes	No	Yes	0.08	13
5	Assault	Yes	No	Yes	Yes	0.07	104
6	Assault	Yes	Yes	No	Yes	0.06	62

Table 2 . *Example of a CACC truth table, adapted from Hart and Miethe (2009), showing the situational factors and the likelihood that self-protective action involving a firearm is taken.*

CACC can also be used to support more formal tests of research hypotheses. For example, it has recently been used to test whether public bus stops are likely to be part of the nearby environment of street robbery incidents. To do this, the researchers created a CACC truth table associated with robbery incident locations, which was defined by the presence or absence of seven activity nodes (types of land use). This CACC truth table also included a column representing the likelihood that a public bus stop was also part of the robbery environment. Differences in the overall rank order of the dominant situational profiles, based on the likelihood variable, were statistically tested. Other statistics were used to identify differences between specific pairs of profiles. Using CACC in this manner allowed the researchers to test the hypothesis that the presence or absence of public bus stops in the proximate environment of robbery incidents was due to chance.

From a police operations or crime prevention perspective, these results have actionable implications. For crime prevention efforts that emphasise crime generators and attractors, for example, the results suggest that particular profiles of risky places can be empirically identified. In the case of bus stops, conjunctive analysis clearly identifies 'dangerous places' and thus provides the basis for further investigation of their particular risk-enhancing properties.

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Conjunctive Analysis of Case Configurations:
RESOURCES (5 of 5)

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GENERAL RESOURCES

- Research brief on 'Establishing Situational Context in Risk Terrains' (employing CACC) – available at http://rutgerscps.weebly.com/uploads/2/7/3/7/27370595/conjunctiveanalysis_insightsbrief.pdf

A SELECTION OF ACADEMIC PAPERS AND BOOK CHAPTERS

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