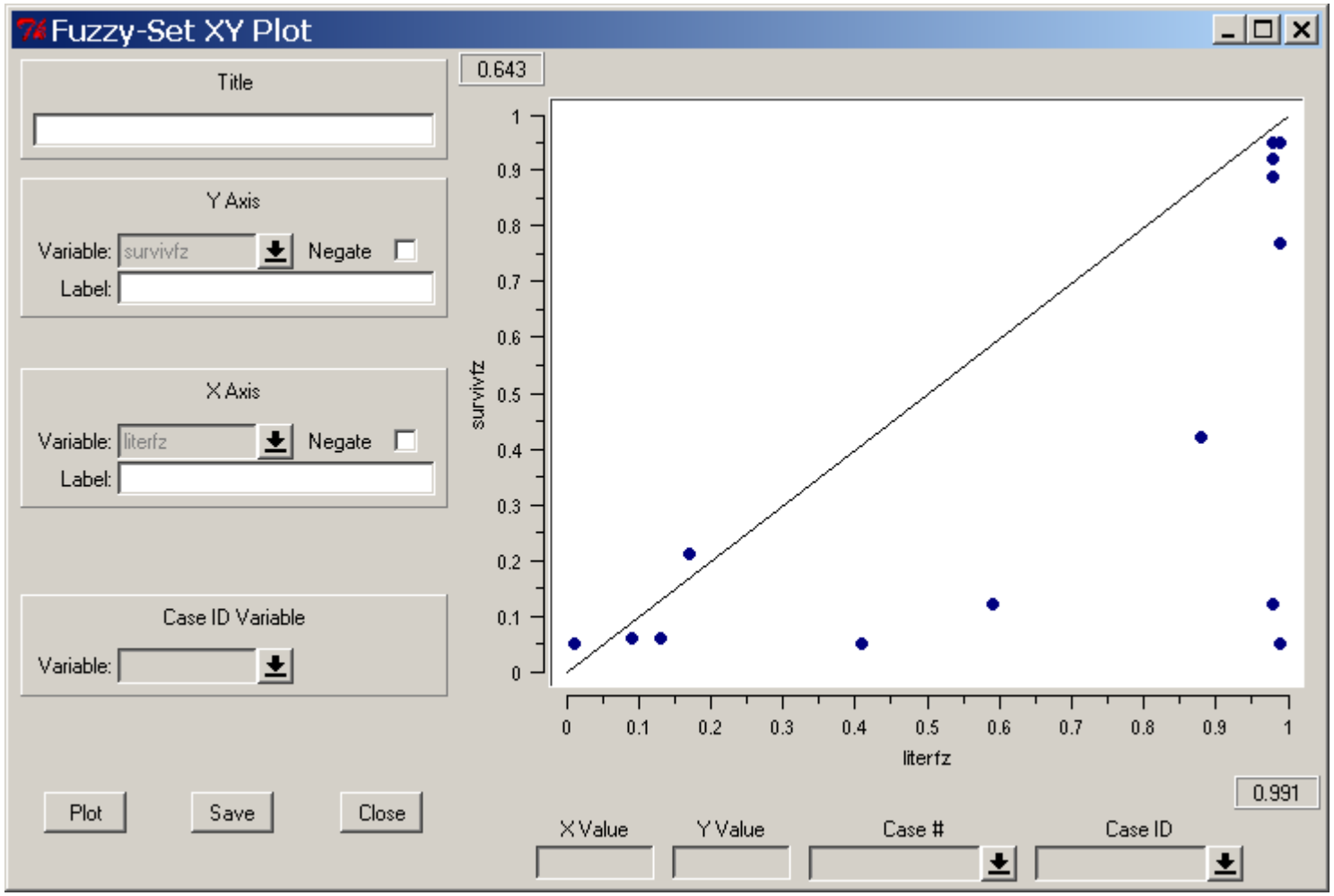
What Happens to Necessary Conditions in Truth Table Analyses?

Truth table analysis is focused on sufficient combinations of conditions. It is reasonable to inquire about the fate of necessary conditions in these analyses.

It is important to recognize what a necessary condition looks like. In a fuzzy scatterplot, most of the points will be below the main diagonal of the plot, and the number in the box below the bottom right corner will show the degree on consistency with the superset relation.

The following plot shows the relation between degree of membership in the set of literate countries (X) and degree of membership in the set of countries whose democracies survived during the interwar period. (These data are from the book *Configurational Comparative Methods*.) The degree of consistency with necessity is 0.991. The number on the box above the upper right corner shows the relevance (coverage) of the necessary condition (0.643).



Necessary conditions are sometimes suggested in truth table spreadsheets. Consider the following spreadsheet:

Edit Truth Table

File Edit Sort

indusfz	stablfz	develfz	urbanfz	literfz	number	survivfz	raw consist.
1	1	1	1	1	4	1	0.904206
0	1	1	0	1	2	1	0.804270
1	1	1	0	1	2	0	0.708772
0	1	0	0	1	1	0	0.528571
0	0	0	0	1	2	0	0.520900
1	0	1	1	1	1	0	0.445256
1	0	1	0	1	1	0	0.378205
0	1	0	0	0	2	0	0.278027
0	0	0	0	0	3	0	0.215976

Specify Analysis Cancel Standard Analyses

Notice that a subset of the rows coded 1 on literate (literfz) are coded 1 on the outcome (survivfz). This is also true for stability (stablfz) and developed (develfz), which suggests it might be good idea to check their consistency with the superset relation (develfz = 0.831; stablfz = 0.920).

These patterns in the truth table indicate that these three conditions will likely appear in the complex and intermediate solutions.

Here's the parsimonious solution:

```
--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.804270

                        raw       unique
                      coverage    coverage   consistency
                     ----------  ----------  ----------
~indusfz*develfz     0.284038    0.193662    0.814815
stablfz*urbanfz      0.519953    0.429577    0.873767

solution coverage: 0.713615
solution consistency: 0.850350
```

Notice that there is no sign of literate (literfz) and neither developed (develfz) nor stable (stablfz) appears in both recipes. The goal of the parsimonious is just that—to achieve sufficiency as parsimoniously as possible. But according to the truth table, all rows coded 1 on the outcome have three conditions in common: literfz, stablfz, and develfz.

Here's the intermediate solution:

```
--- INTERMEDIATE SOLUTION ---
frequency cutoff: 1.000000
consistency cutoff: 0.804270
Assumptions:
literfz (present)
urbanfz (present)
develfz (present)
stablfz (present)
indusfz (present)
```

	raw coverage	unique coverage	consistency
literfz*develfz*stablfz*~indusfz	0.281690	0.191315	0.813559
literfz*urbanfz*develfz*stablfz	0.468310	0.377934	0.900677

```
solution coverage: 0.659624
solution consistency: 0.865948
```

Notice that both recipes now include the three conditions shared by the truth table rows coded 1 on the outcome. Still, I would not automatically call all three necessary conditions. (The consistency of develfz with the superset relation is borderline, 0.831.)

In general, you should conduct a necessity test for any condition that is common across all the recipes reported for the intermediate solution. Remember that the finding that a condition is common across all the recipes in the intermediate solution does NOT imply necessity.

Jointly Necessary Conditions

It is important to remember that most of the time we are able (in social science) to identify conditions that are “usually” necessary or “almost always” necessary. The usual consistency with the superset relation is around 0.80 → 0.95 when we claim we have found an interesting pattern suggestive of necessity. This fact (inconsistency) complicates the assessment of **jointly** necessary conditions.

For example, if the consistency of X ≥ Y is 1.0 and the consistency of Z ≥ Y is 1.0, then we can state with confidence that the consistency of XZ ≥ Y is 1.0 (i.e., the consistency of min(X,Z) as a superset of Y is 1.0).Try to draw a Venn diagram that contradicts this conclusion, or try to come up with three fuzzy scores that contradict this principle.

If there is any inconsistency, however, the data set includes cases where X < Y. If the consistency of X ≥ Y is 0.90, there will be a nontrivial number of cases where X < Y. If the consistency of Z ≥ Y is also 0.90, then the consistency of XZ ≥ Y will be less than 0.90, to the extent that the cases where X < Y are not the same as the cases where Z < Y (i.e., the inconsistent cases do not overlap).

The important point is that when you intersect “usually” necessary conditions, their intersection may NOT meet the “usually” necessary threshold.

Let's return to our truth table spreadsheet for illustration:

Edit Truth Table

File Edit Sort

indusfz	stablfz	develfz	urbanfz	literfz	number	survivfz	raw consist.
1	1	1	1	1	4	1	0.904206
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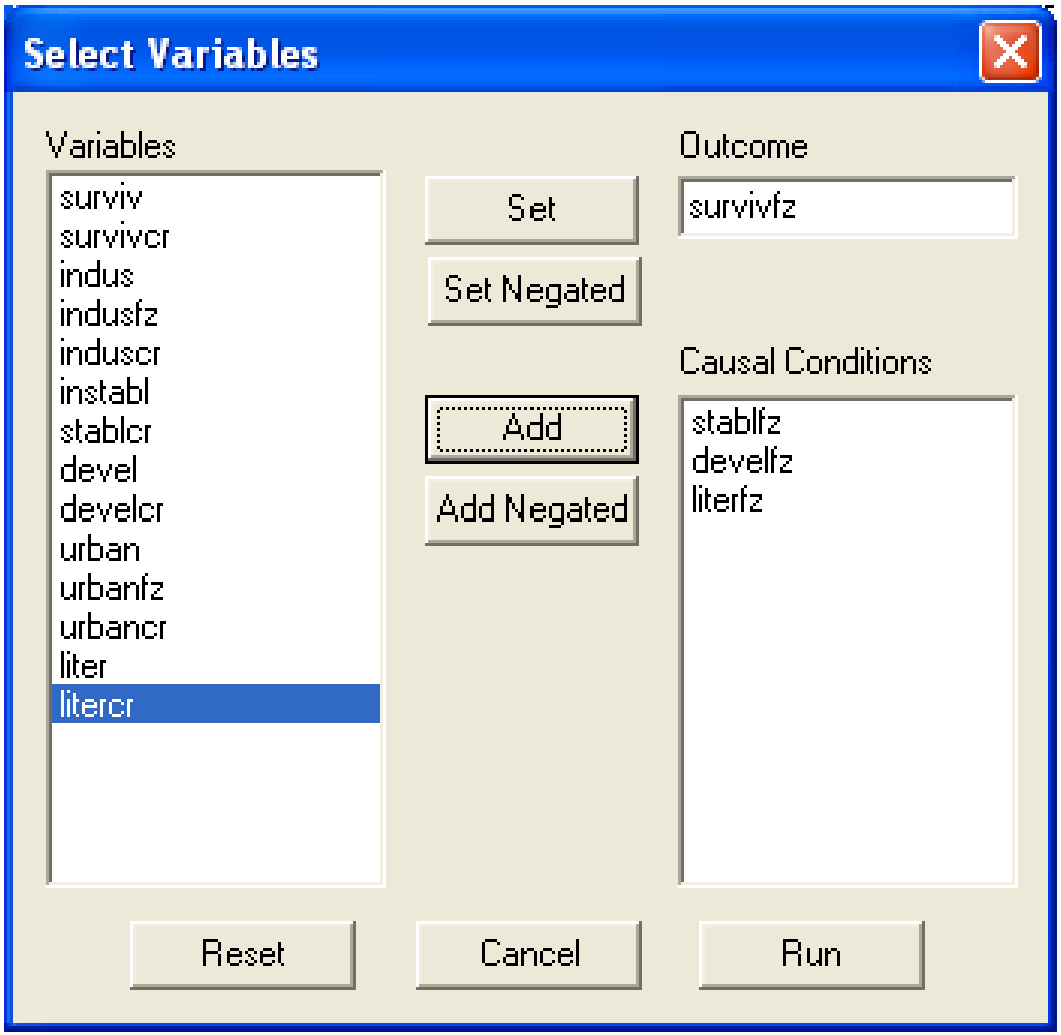
1	1	1	0	1	2	0	0.708772
0	1	0	0	1	1	0	0.528571
0	0	0	0	1	2	0	0.520900
1	0	1	1	1	1	0	0.445256
1	0	1	0	1	1	0	0.378205
0	1	0	0	0	2	0	0.278027
0	0	0	0	0	3	0	0.215976

Specify Analysis | Cancel | Standard Analyses

As I mentioned before, this spreadsheet indicates that there are three candidates for necessary conditions analysis: stablfz, develfz, and literfz. In fact their superset relations with the outcome are 0.920, 0.831, and 0.991, respectively.

What is their joint necessity? The subset/superset procedure in fsQCA can be used to assess joint necessity, even though it was not designed to do so.

Here's the dialogue box:



And here's the table of results:

```
Outcome: survivfz
                                                raw
                              consistency  coverage     combined
                              ----------  ----------  ----------
stablfz*develfz*literfz       0.868812    0.823944    0.911791
stablfz*develfz               0.868812    0.823944    0.796522
stablfz*literfz               0.792683    0.915493    0.780823
develfz*literfz               0.775466    0.830986    0.739506
stablfz                       0.706943    0.920188    0.545771
develfz                       0.774617    0.830986    0.586946
literfz                       0.642803    0.990610    0.441149
```

First, remember to ignore the "combined" column—it's experimental.

Second, remember that the "consistency" column in this output refers to consistency of X as a subset of Y (survivfz). This is not the consistency calculation we want because we are interested in the consistency of X as a superset of Y—to what degree is Y contained within X. If Y is contained within X, then the intersection of X with Y will account for a substantial proportion of Y. This is in fact what the "raw coverage" column in this output shows. So the consistency scores we want are actually reported in the "raw coverage" column of the subset/superset analysis output.

The results show acceptable joint consistency. The intersection of all three conditions (first row) has a consistency score of 0.824 as a superset of the outcome. Notice that if we had used 0.90 as the cutoff for "usually," we can achieve a superset consistency score of 0.915 with stablfz*literfz.

A Note on Terminology

This series of slides uses the terms “necessary” and “necessity” liberally. It is important to understand that this language is generally not needed and that it is possible to use language that is more neutral (and therefore more palatable to most social science audiences).

For example, we can ask: What causally relevant conditions are shared by the cases that display the outcome? Literacy may or may not make sense as a necessary condition for democratic survival. However, it is perfectly reasonable to note that the democracies that survived all shared high levels of literacy. Again, the emphasis is on conditions shared by cases of the outcome.

Note that this is the reverse of the logic of the sufficiency analysis. In a truth table analysis, we ask: do cases with specific causal conditions share the same fate (i.e., share the same outcome)?

So the difference between a superset/necessity analysis and a subset/sufficiency analysis is the focus: shared antecedent conditions (superset analysis—the degree to which X is a superset of Y) versus shared outcome (subset analysis—the degree to which X is a subset of Y).