Robert Axelrod and D. Scott Bennett, "Choosing Sides: A Landscape Theory of Aggregation," in Robert Axelrod, The Complexity of Cooperation (Princeton UP, 1997). pp. 72-94.

The question of which nations will aggregate into alliances in a given international system is highly complex; even a small system provides a huge number of possible combinations of alliances. This fact has stymied previous attempts to coherently predict just which nations will form alliances with one another, but Axelrod and Bennett reconsider the question. To begin, they set forth criteria by which to judge a useful theory of aggregation, which should:

- coherently explain why particular alliances form, as well as why others do not form,
- elucidate the not only the result, but also the process of aggregation,
- be fundamental and parsimonious, and
- be operationalizable and testable.

The solution they propose to the question of aggregation is landscape theory, a special variety of spatial modelling often used in natural and physical sciences. In the particular formulation here presented, landscape theory represents the world as *n* nations. Each nation *i* has an intrinsic size (s_i; a function of demography, geopolitics, etc.) and propensity of cooperation with each of the other countries (p_{ij}; a large, positive number if the two nations work well and often together, but large and negative if the countries have many areas of fundamental conflict). The world is then partitioned into comprehensive, mutually exclusive blocs, so that each nation is a member of exactly one bloc. Within this configuration *X*, each country has a distance $d_{ij}(X)$ from each other country – for example, if there are only two blocs, countries in the same bloc have distance 0 from one another, while countries in different blocs have distance 1[*]. Given this, each country *i* has $F_i(X)$, a quantification of frustration with the status quo *X*, which is calculated by summing over all countries *j* the product of the size, propensity for cooperation with *i*, and (figurative) distance from *i*. Mathematically, this is

$$F_i(X) = \sum_{j \neq i} s_j p_{ij} d_{ij}(X)$$

from which one can calculate the systemic frustration or energy[†] $E(X)$, which is just the sum – weighted by a country's size – of each country *i*'s frustration, i.e.

$$E(X) = \sum_{i=1}^{n} s_i F_i(X) = \sum_{i,j} s_i s_j p_{ij} d_{ij}(X)$$

The energy of the system can then be graphed in *n*-dimensions, showing the total energy of the system for every possible aggregation of nations into alliances.

This graph is the eponymous landscape; if conceptually remapped into three-dimensional space, it would appear as a surface chock full o' valleys, ridges, and scenic vistas. The system tries to achieve the lowest point in this landscape. When the configuration of the system corresponds to the bottom of one of the valleys, the system is in equilibrium: no nation could reduce its own frustration (and thus, as can be proven, the energy of the system of a whole) by changing its alliance. If it were in any other position[‡], however, the system would graphically slide downhill towards the bottom of some valley, where it would come to rest. Note that with multiple valleys, the system may not achieve the global optimum – if the system does not start in the "basin of attraction" of the lowest valley, the system will not stabilize in that

[*] The authors do not explain how one calculates distance in multipolar alliances.

[†] So called by analogy to the quantity of potential energy in physics.

[‡] I ignore the presence of unstable equilibria, which would be graphically at the tops of ridges or peaks; in such positions, the system metaphorically balances on the border between to basins of attraction, and even the slightest shift would cause the system to fall into some valley.

valley. This is analogous to game theory: the stable position at the bottom of each valley is a Nash equilibrium, and depending on starting conditions one can end in Pareto-suboptimal Nash equilibria.

This suboptimality stems in part from two assumptions built in to the model. First, it is assumed that each nation is myopic: it only observes its present state, and whether its short-term frustration is reduced by switching alliances. The second, and even stronger, assumption is that nations act independently; there is no formation of subcoalitions that can jointly coordinate their choice of alliance. The authors attempt to justify the latter assumption by invoking negotiation costs under uncertainty.

To test this theory, Axelrod and Bennett examine the predictions of landscape theory as to alliances in the years leading up to World War II. Using the Correlates of War data and a measure of p_{ij} based on historical and ethnic conflict, government types, border disagreement, and the like, they produce a landscape with two valleys. One of these – that with the larger basin of attraction, no less – corresponds in a statistically strongly significant way to the Axis and Allies of WWII; the other has the USSR, Yugoslavia, and Greece against the rest of Europe. (As the authors characterize things, there was a German camp and a Soviet camp,[§] and the major difference between the valleys was in which direction the group of democracies allied.) This compares favourably with both cluster analysis and the rational-choice approach postulated by Altfeld and Bueno de Mesquita, which produced (by the Axelrod-Bennett reckoning) much less accurate predictions. The authors also believe that their model works well in explaining post-Cold War alignments in Europe.

The general idea of landscape theory can also predict aggregation in a variety of other business and political realms, including parliamentary coalitions and democratic social cleavages. While imperfectly developed – axioms must be more clearly delineated, and a more theoretically-based calculation of energy than the mere multiplication of independent variables is needed – Axelrod and Bennett believe it shows great promise as a tool for analysis of international relations.

[§] Or, more precisely, an anti-Soviet camp and an anti-German camp; Europe wasn't quite the seething cauldron of loving neighbourliness it is (excepting, of course, France and Belgium) these days.