Building on this tradition of research, the talk will cover two further developments:

(3) *Metaphor*. Most of conceptual structure is metaphorical, in that abstract concepts are in general structured in terms of other concepts that are experienced more directly. These include most of our social, interpersonal, and emotional concepts.

The metaphorical structuring of concepts is in general not unique. Abstract concepts are defined by clusters of partly overlapping metaphors. In such cases, the concepts do not have a consistent ontology. Instead, each metaphor brings its own ontology with it. Even the Western concept of a rational argument is defined by three partly overlapping metaphors whose ontologies are not consistent with one another.

Conceptual structure is not universal.

Conceptual metaphors characterize social, interpersonal and personal realities, and therefore serve as a basis for planning and action.

(4) *Mental Imagery*. Each culture consists in part of a large set of mental images which are shared by the members of that culture to a remarkable degree. Such conventional mental images are necessary for the comprehension of much of natural language.

Such mental images are not unstructured (as in *Kosslyn's* cathode-ray-tube model) nor are they propositionally structured (as claimed by *Pylyshyn* and others). Instead they are structured by abstract image schemes. Such image schemes play a central role in the semantics of natural language.

Philosophical significance: These results clash with classical 'objectivist' views of reality and of cognition. These views are: (1) The world is made up of objects; at any given time, each object has a fixed set of properties and there is a fixed set of relationships among the objects. Classical model theory and most computer data bases reflect such a view of reality. (2) Cognitive categories are set-theoretical, thought is propositional, and logic is a model for 'correct' human reason. The results of cognitive semantics suggest that this picture is grossly inadequate.

Social significance: Suppose we are correct that abstract concepts are characterized by very different metaphors in diverse cultures. Then social and economics planning, as well as foreign policy, ought to take relevant conceptual differences into account. At present, they have barely begun to be studied.

Measuring the Political Consequences of Electoral Laws. Bernard Grofman, *School of Social Science, University of California, Irvine, CA 92717, U.S.A.*

In BAKER vs. CARR (369 U.S. 186 (1962)) the U.S. Supreme Court affirmed that judicial redress could be sought to compel a state to reapportion its legislature in accord with new census data. In a number of subsequent cases, the Court addressed

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itself to the issue of voter representation and the constituional acceptability of various apportionment and voting schemes. Most of those cases involved an explication of the meaning of the 14th Amendment 'equal protection' clause as it applied to Congressional, state, and local apportionment issues. The notion of 'equal protection' suggests various criteria which we might wish any electoral scheme to satisfy. At minimum, of course, we would wish to guarantee each citizen the right to exercise his vote. However, once we move beyond this basic right, the question of what equal protection' requires (or rather, disallows) becomes a very difficult one.

One answer is that each individual who votes should have his vote count 'equally' with that cast by every other individual; i.e., given 'one person', one vote', we wish 'one vote, one value'. The difficulty comes in operationalizing such criteria.

The principal focus of most reapportionment cases in the 60's through the mid 70's was in specifying standards for population equality of districts and mathematical formulae to assess compliance with these standards. While the Court majority in its historic decision in REYNOLDS asserted that the goal of the Court was the achievement of 'fair and effective representation', in fact, however, most of Court's energies in the apportionment area until the mid 70's were devoted to the elucidation of the standards of population equality across districts which would govern in each type of governmental jurisdiction. However, by defining equality of citizen representation in terms of equally populated districts, the Supreme Court was able to avoid in most of the early reapportionment cases ever really coming to grips with the deeper issues of the philosophy of representation. In many of the key apportionment cases (e.g., WESBERRY VS. SANDERS 376 U.S. at 18; REYNOLDS VS. SIMS 377 U.S. at 559–560), the Court's terminology, if not its reasoning, is sloppy in claiming equal representation for equal numbers of people as its goal, and then equating 'equal population' with 'equal representation'. Only a little reflection is required to see the very severe limitations of defining equality of citizen representation solely in terms of equally populated districts. As *Dixon* (1979 : 227) quite strongly (and we believe quite accurately) put it:

> (T)here is no such thing as 'equal representation' in a district system of electing legislators. There may be 'equal population' districts, which is an objectively verifiable concept. But with a district basis there can never by 'equal representation' because all districting discriminates ·by discounting utterly the votes of the minority voters.

In our talk we shall focus on issues arising out of these Supreme Court redistricting and representation cases.

(1) We shall elucidate competing criteria by which to judge the fairness of alternative redistricting schemes for single-member-district legislatures.

(2) We shall review statistical models on the nature of seats/votes relationships for singlemember districts.

(3) We shall review the controversy over the use of atlarge and multimember-district election systems and discuss the impact of such systems on minority representation.

(4) We shall look at the attempt by 'reformers' to take 'politics' out of the redistricting process.

(5) If time permits, we shall look at proposed alternatives and modifications to single-member-district plurality elections, including weighted voting, approval voting, the alternative vote, and various forms of proportional representation.

Spanning and Arbitrage in Securities Markets with Options: A State Preference Aproach. Donald J. Brown. *Cowles Foundation for Research in Economics. Yala University, New Haven, CT 06520, U.S.A., and* Stephen Ross. *School of Organization and Management, Yale University, New Haven, CT 06520, U.S.A.*

We present a model of financial markets where the space of statecontingent claims is viewed as a topological vector lattice. The nonlinear operations of meet and join in a vector lattice allow us to formally express elementary options, i.e., calls and puts, as nonlinear functions of the underlying security and riskless asset.

Within this framework, we address the following two questions: First, in what sense can a finite number of marketed securities, e.g., two, span the space of state-contingent claims, when the number of states exceeds the number of marketed securites? Second, given a set of marketed securities and their prices, when can these prices be uniquely extended, by arbitrage, to the space of all state-contingent claims?

Using the Stone–Weierstrass theorem, Stone's integral representation theorem for Daniell functionals, and Prohorov's theorem on the existence of the projective limit of a projective system of Radon measures, we give complete answers to these questions for markets with an infinite state space, where there are a finite or continuum of trading dates.

Extinction and the Coevolution of Competing Species. Jonathan Roughgarden. *Department of Biological Sciences, Stanford University, Stanford, CA 94305, U.S.A.*

All the islands of the Eastern Caribbean contain native species of lizards from the genus *Anolis.*

There are 16 islands each of which has one native species. On 15 of these the species have evolved a characteristic body size, called the 'solitary size'. But on the island of Marie Galante there is a species of lizards whose body size is much larger than the solitary size.

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