Economic Actors, Legal Actions and ACT-R

Kenning Marchant

LYCURGUS
Mississauga, Ontario, Canada

LYCURGUS

- *multidisciplinary computational models*
- *law, economics and psychology*

Two 'wished for' extensions of ACT-R in the context of law and economics

- *Goal selection : based on the functional logic of emotions / feelings*
- *Legal rules as cognitive production rules*

Standard Critiques of Self-Interest Based Economics

- *Carrying on the tradition started by Adam Smith, economists supply their own psychology (e.g. Becker) :*
- *Human cognition is equivalent to an internally consistent (complete, transitive) mathematical preference ordering over all possible outcomes*
- *Frank et al. : those trained in economics are more selfish than others*
- *Rabin, e.g. : in many situations people prefer 'fairness' to 'utility maximization'*
- *If economics were being conceived now ...*
  - *ACT-R, or something like it*

Goal selection and ACT-R

- *"However we, like most of cognitive psychology, have not bothered to peer beyond the goals we get subjects to adopt in our experiments." (Atomic Components of Thought, p. 40)*

- *"The setting of the initial value G for a task goal is a topic about which ACT-R has little to say. When an experimenter tells a subject something is worth a dollar versus a penny, how does this convert to an internal value of G ...? How valuable is solving a puzzle, versus passing a course, versus saving one's life? ACT-R takes the agnostic economist's position of simply assuming these maps [sic] onto some internal values without deeply inquiring why." (Atomic Components of Thought, p. 63)*

A Functional Logic of Feelings & Emotions

Attended Goal Structure Appraisal	*Motivational Appraisal*
G1. goal state achieved or maintained (no (further) action required)	*contentment or happiness*
G2. opportunity to achieve a goal state (action required to achieve it)	*interest or excitement*
G3. dissipation of opportunity (further action a waste of time)	*disappointment*

A Functional Logic of Feelings & Emotions (cont'd)

Attended Goal Structure Appraisal	*Motivational Appraisal*
L1. threat to goal state (action required to thwart)	*fear/apprehension*
L2. loss/impairment of a goal state (action required to restore it)	*anger or sadness*
L3. dissipation of threat (further action not required)	*relief*

EMOTION/EVOLUTION-DIRECTED GOALS - EXAMPLES OF CONSUMER PRODUCTS AS SUB-GOALS

1. PHYSICAL WELL-BEING

PIZZA

PAIN KILLERS

IN SOME COUNTRIES : GUN OWNERSHIP

2. SEXUAL ACCESS, PREFERABLY EXCLUSIVE

COSMETICS

BIKINIS

DIAMOND RINGS

3. STATUS (MEMBERSHIP OR RANK)

PEER GROUP CLOTHING

UNIVERSITY DEGREE

MERCEDES BENZ OR PORSCHE

EMOTION/EVOLUTION-DIRECTED GOALS - EXAMPLES OF CONSUMER PRODUCTS AS SUB-GOALS (cont'd)

4. CONTROL OF MATERIAL RESOURCES

STOCK MARKET INVESTMENTS

LOTTERY TICKETS

5. 1 - 4 FOR GENETIC RELATIVES, ESPECIALLY OFFSPRING

Emotions / feelings and ACT-R : some speculative implications

- *generation / selection / conflict resolution among goal categories*
- *emotions/feelings and attention*
- *emotional salience and memory/recall - activation*
- *role of emotions in evaluating alternative courses of action before action taken*
- *phenomena where, in contrast to ACT-R, people do not necessarily learn from the environment / patterns of failure or success, e.g buying lottery tickets*

Legal rules as cognitive production rules

- *Example : property*
- *Something which 'belongs' to us*
- *Hohfeld : No, your **rights can only be produced by other people's behavior** - or its absence*
- *Property : others suppress all their behaviors so that the owner can deploy his / hers*
- *This includes 'no-right' to interfere in owner's use of property*
- *A property relation expressed as a logical production:*

IF -{B(I-i)sct} THEN +/-{bisct}

How is the -{B(I-i)sct} cognitively produced?

- *Property constraints at most partly physical, always institutional*
- *Cognitive learning required : declarative, procedural; environmental cues re institutional/legal constraints*
- *Motivation :*

  IF [non-compliance] THEN [sanction]

  & IF [compliance] THEN [no sanction]
- *The logical - & psychological - theory of legal rules :*

IF (IF [non-compliance] THEN [sanction]

& IF [compliance] THEN [no sanction])

THEN [compliance]

Other legal/institutional arrangements

- *Corresponding logical, learning and motivational specifications for other basic legal relations such as*
  - *exchange/contract (mutual conditional promises of performance)*
  - *authority (selection of another's behavior by communication)*
  - *conventions triangulated by informal sanctions (e.g. deference)*
  - *composites : teams; organizations*

Concluding thought

One of the futures of ACT-R could be in supplying a unified theory of cognition to other social science disciplines.

References

- Anderson, John R. & Christian Lebiere (1998), *The Atomic Components of Thought*. Mahwah, NJ : Lawrence Erlbaum.
- Barkow, Jerome H., Leda Cosmides & John Tooby (1992), *The Adapted Mind*. Oxford : Oxford University Press.
- Becker, Gary (1996), *Accounting for Tastes*. Cambridge, MA : Harvard University Press.
- Frank, Robert H., T. D. Gilovich & D. T. Regan (1993), "Does Studying Economics Inhibit Cooperation?", *Journal of Economic Perspectives*, Spring 1993.
- Frijda, Nico H. (1986), *The Emotions*. Cambridge : Cambridge University Press.
- Lazarus, Richard S. (1991), *Emotions and Adaptation*. Oxford : Oxford University Press.
- Marchant, Kenning (1999), "Cognitive Specification of Economic Actors : A Computational Alternative to 'Rationality'", in International Association for Research in Economic Psychology, XXIV Annual Colloquium, *Inquiries into the Nature and Causes of Behavior*, Vol. 2.
- Ortony, Andrew, Gerald L. Clore & Allan Collins (1988), *The Cognitive Structure of Emotions*. Cambridge : Cambridge University Press.
- Rabin, Matthew (1998), "Psychology and Economics", *Journal of Economic Literature*, XXXVI (Spring 1998), 11.
- Smith, Adam, (1976 [1774], *The Theory of Moral Sentiments*. Oxford : Oxford University Press.
- Smith, Adam, (1937 [1776], *The Wealth of Nations*, New York : Modern Library.

Subject to revision
Please refer to author prior to quotation or citation

Economic Actors, Legal Actions and ACT-R : A Discrete Mathematical Alternative to Rational Choice

Kenning Marchant
LYCURGUS
lycurg@ibm.net

This presentation outlines development of law and economics models in which computational programs such as ACT-R might generate more psychologically realistic specifications of human decision-making and problem solving than the 'rational choice' assumptions used in standard economics.

A particular focus is the need to supplement ACT-R with specification of how goal states are generated, such as by feelings and emotions.

The main psychological assumption of neoclassical economics, 'rationality', has been widely criticized as unrealistic and even unreasonable. It equates the human mind with a transitive preference ordering over available outcomes, typically goods and services, also assuming full information (e.g. Kreps 1990). However, it generates utility and welfare functions which a calculus-based analysis demands. A call to abandon the rationality assumption is a call to abandon the central mathematical apparatus of neoclassical economics.

A different mathematical approach to the specification of economic phenomena implies the possibility of different modeling of human cognition. This paper outlines an alternative based on discrete mathematics (e.g. Bourbaki 1968).

The technique involves the construction of intuitively plausible structured sets representing human behavior and the physical environment; and index and coding sets. Their organization is expressed through (1) classes of instrumental (or 'technical') economies, (2) production of behaviors consistent with the principles of ACT-R (Anderson & Lebiere 1998); (3) development of a logic of goal-state selection based on appraisal frameworks (e.g. Frank 1988; Lazarus 1991; Barkow, Cosmides & Tooby 1992; Picard 1998); and (4) logic-based institutional (legal) arrangements as constraints on behavior (Hohfeld 1964; Lindahl 1977; Santos & Carmo 1993; Allen 1998; Williamson 1996) - which together can define a complete economic system.

The logical core of the appraisal process is that (1) top level biological or social structures which humans seek to achieve or maintain arise from evolutionary and ontological development; and (2) other states can be affectively appraised in combinations of gain/loss, opportunity/threat, opportunity/threat dissipation or positive or negative interpersonal comparisons.

The model has the properties of a formal language in mathematics, with instrumental economies playing the role of 'syntax', and institutional arrangements the role of 'semantics'. The products of an economy expressed in such a 'language' sum to a Leontief-type input-output matrix (Leontief 1986).

Some extensions and applications of the model under development are :

(1) 'Markets' of all kinds can be specified as constrained sets of concurrent, coincident or sequential cognitive processes. These segregate into partitions (sets of equivalence relations with distinct properties) by means of which the law of requisite variety (Ashby 1961), a generalization of 'supply' and 'demand', may apply to determine revenue, income or market shares.

(2) 'Bounded rationality' (cf. Simon 1982) analytically distinguishes classes of cognitive 'error' or limitation in such sectors as : information acquisition; logical processing; goal-tree specification; goal state generation; behavior selection; behavior production. System performance can be approached diagnostically in terms of collective (i.e. distribution of) learning, syntactical (technical), grammatical (institutional) and behavior production competencies and other distributed cognitive processing characteristics.

(3) Organizations or other institutional control structures as 'expressions in the language of the system', and their viability, can be evaluated in terms of the (a) loss of, or (b) construction, expansion, contraction or maintenance of, discrete structural (e.g. topological) characteristics. Structures in the external environment can be specified as logical 'threats' or 'opportunities' in relation to these structural characteristics.

References [Preliminary]

Allen, Layman E. (1998), "Some Examples of Using the Legal Relations Language in the Legal Domain : Applied Deontic Logic", 73 *Notre Dame Law Review* 535.

Anderson, John R. (1990), *The Adaptive Character of Thought*., Hillsdale, NJ, Lawrence Erlbaum.

Anderson, John R. (1993), *Rules of the Mind*.. Hillsdale, NJ, Lawrence Erlbaum.

Anderson, John R. & Christian Lebiere (1998), *The Atomic Components of Thought*. Mahwah, NJ, Lawrence Erlbaum.

Ashby, William Ross (1960), *Design for a Brain*, London : Chapman & Hall.

Ashby, William Ross (1961), *An introduction to cybernetics*, London : Chapman & Hall.

Ashcraft, Mark H. (1994), *Human Memory and Cognition*, New York, NY : HarperCollins.

Barkow, J., Cosmides, L. & Tooby, J. (1992). *The Adapted Mind*. New York : Oxford University Press.

Beer, Stafford, (1985), *Diagnosing the System for Organizations*, Chichester : John Wiley.

Bourbaki, Nicolas, (1968), *Théorie des ensembles* (English : *Theory of sets*), Paris: Hermann.

Casti, John L. (1992), *Reality Rules : Picturing the World in Mathematics, Vols. I & II*, New York: John Wiley.

Clark, Andy (1997), *Being There : Putting Brain, Body and World Together Again*, Cambridge, MA: MIT Press.

Commons, John R. (1939), *Legal Foundations of Capitalism*, Madison, WI: University of Wisconsin Press [1968]

Davis, M. D., R. Sigal and E. J. Weyuker (1994), *Computability, complexity and languages*, Boston, Academic Press.

Donald, Merlin (1991), *Origins of the Modern Mind : Three Stages in the Evolution of Culture and Cognition*, Cambridge, MA: Harvard University Press.

Frank, Robert H. (1988), *Passions within Reason : The Strategic Role of the Emotions.* New York : W. W. Norton.

Frijda, Nico H. (1986), *The Emotions.* Cambridge : Cambridge University Press.

Gazzaniga, Michael S. (ed.) (1995), *The Cognitive Neurosciences*, Cambridge, MA : MIT Press.

Hohfeld, W. N. (1964), *Fundamental Legal Conceptions, as Applied in Judicial Reasoning*, New Haven, Yale University Press.

Johnson-Laird, Philip N. (1983), *Mental Models*, Cambridge, MA : Harvard University Press

Kreps, David M. (1990), *A Course in Microeconomic Theory*, Princeton : Princeton University Press.

Lazarus, Richard S. (1991), *Emotion and Adaptation*, New York : Oxford University Press.

LeDoux, Joseph (1996), *The Emotional Brain*, New York : Touchstone.

Lindahl, Lars (1977), *Position and Change: A Study in Law and Logic*, Dordrecht, Holland : D. Reidel.

Leontief, Wassily W. (1986), *Input-Output Economics*, New York: Oxford University Press.

Marchant, Kenning (1999), "Cognitive Specification of Economic Actors : A Computational Alternative to 'Rationality'", in International Association for Research in Economic Psychology, XXIV Annual Colloquium, *Inquiries into the Nature and Causes of Behavior*, Vol. 2.

Ortony, Andrew, Gerald L. Clore & Allan Collins (1988), *The Cognitive Structure of Emotions.* Cambridge : Cambridge University Press.

Picard, Rosalind (1998), *Affective Computing*. Cambridge, MA : MIT Press.

Santos, F. & J. Carmo (1993), "A Deontic Logic Representation of Contractual Obligations" in John-Jules C. Meyer and Roel J. Wieringa (Eds.), *Deontic Logic in Computer Science*. New York : Wiley.

Simon, H. A. (1969), *The Sciences of the Artificial*, Cambridge MA : MIT Press.

Simon, H. A. (1982), *Models of Bounded Rationality*, Cambridge MA : MIT Press.

Simon, H. A. et al. (1992), *Economics, Bounded Rationality and the Cognitive Revolution*, Brookfield, VT: E. Elgar.

Williamson, Oliver E. (1996), *The Mechanisms of Governance*, New York : Oxford University Press

June 1999