Computational Approaches to Strategy 1:0 Supplement: A Personal Research Program in Strategy 1.0

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Abstract

This document outlines what I believe to be the main dimensions of analysis that I will utilize in my research going forward. I argue that we can think about strategic behavior in terms of how strategy as a complex knowledge structure reflects ideas about rational action and rationalization processes. The document outlines problems with social scientific conceptions of strategy and rationality, and argues for an approach rooted in a focus on how strategic knowledge may be found in both human minds and institutions as well as within technical artifacts and theories of rationality and intelligence associated with them.

0.1 Release Notes

0.1.1 Introduction

As always, the disclaimer: ***please cite this in your own work if it is useful for you***.

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I have included both the "final" document and the unfinished draft that it was cannibalized from. Eventually the two will merge, but this is good enough for my purposes right now.

0.1.2 Intellectual Glue Code

This document is a supplement to my longer document on computational approaches to strategy.

I wrote my 26-page *Computational Approaches to Strategy* document as a research guide for myself; I lacked a kind of SAGE/Routledge/Springer/Blackwell research guide to connecting the theory, questions, and methods so I had to write one for myself.[1] However, that guide was not specifically devoted to research topics, it was a general theoretical and methodological statement as to how the research could be done. The sections of it concerned with possible research questions (the middle section) were the least satisfying for me even if the whole document got the job done. So I have built on some recent blogs I have written to create a stronger edifice for the research. How is this different from the *Computational Approaches to Strategy 1.0* document?

My desire is to eventually write a "stapled" dissertation containing a series of linked papers. This document's intention is to be a brief (one day!) summary of how the various research projects I will begun or have already started since I wrote my research guide fit together, an intellectual equivalent to the "glue code" (Perl, Bash and cmd.exe scripts, etc) that hold many technical systems together. Having defined what I view to be the proper theoretical and methodological relation between strategic theory and computational approaches, I now want to work very much on the questions and theory (rather than the linkage between them and the methods).

[1] Elkus, Adam (2015). Computational Approaches to Strategy. 3 November 2015. https://medium.com/strategies-of-the-artificial/computational-approaches-to-strategy-a-stable-outline-b713f1826c43

0.1.3 A Guide To This Document

Some preliminaries before the fun begins.

This document is broadly inspired by my readings in the history and sociology of science and technology, the cognitive, behavioral, social and computational sciences. However, several influences in particular stand out. First, the shadow cast by David McFarland and Keith Stanovich's writings on rationality and intelligent behavior.[2] Second, I owe Berkely I-School PhD student Sebastian Benthall an enormous debt for introducing me to the knowledge representation and knowledge management literature through his writings on technology.[3] I have written this as an condensation of a unpublished document I have written on my own personal research idea (see appendix). Midway through writing it, I realized that it was missing some core theoretical points and needed to be stated more abstractly. I elected not to finish writing the longer document (the bibliography is incomplete aside from in-text citations, not everything that came into my mind has been put down, and much of the material could be expressed more consisely). Though I will eventually merge these two documents, I have attached the "better" version in Part I and the unfinished and disorganized version in Part II.

Part I is the rough but "finished" map of my personal research program. Part II is the rough and unfinished raw material that it was taken from. I have included both here as a warning to myself not to throw away older drafts and versions if they can be helpful in polishing their "better" successors. This is a *supplement* to the main document, but it also bears a 1.0 in its title because it too will be revised in light of future knowledge and understanding from experiments and literature that I have yet to read. The citations and grammar and sentence structure are as clunky and sloppy as usual. However, I often feel it is better to get an idea out as soon as possible, and this is the most systematic view of how the computational perspective I advanced in the earlier document will inform my own work that I have yet put to paper. As with the larger document, it can be revised and cleaned up later. And, mirroring my feelings about the larger document, I see this as sufficient for now but bothersome in the loose and touchy-feely way it uses language to describe the objects of inquiry (that's the behaviorist in me, I guess!) and lacking desired coherence. Having now written a document on computational methodologies for strategic theory and a document on their application to my own personal research program, I feel very optimistic about future research. I regret that it took so long and involved so many false starts, but that roundabout process is also what gives this and its parent document their depth and breadth in terms of interdisciplinary literature and questions. Onwards!

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[2]McFarland, David. *Guilty robots, happy dogs: the question of alien minds*, Oxford University Press 2008 and Toplak, Maggie E., K. E. Stanovich, and R. F. West. "Intelligence and rationality." *Cambridge handbook of intelligence*, (2011): 784-826.

[3]In particular, Benthall's blog here http://digifesto.com/2015/01/09/know-how-is-not-interpretable-so-algorithms-are-not-interpretable/ was fascinating to me.

Chapter 1

Part I: A Rough Map of My Research Program

1.1 Summary

This outlines what I believe to be the main dimensions of analysis that I will utilize in my research going forward. I argue that we can think about strategic behavior in terms of how strategy as a complex knowledge structure reflects ideas about rational action and rationalization processes. The document outlines problems with social scientific conceptions of strategy and rationality, and argues for an approach rooted in a focus on how strategic knowledge may be found in both human minds and institutions as well as within technical artifacts and theories of rationality and intelligence associated with them.

In section *Rational Action, Rationalization, Strategy*, I look at why traditional social science conceptions of strategy and rational behavior fall short. I argue that they are unable to incorporate the observed fact that strategy is viewed as a complex knowledge structure as well as an instrumental activity. This not only raises issues of self-reference, but also misses a key element of explaining observed strategic behavior. In the section *Knowledge and Strategy.* I advance a contention that strategy should be viewed as a complex form of knowledge and from the perspective of knowledge management, knowledge representation, and other allied or related disciplines. I conclude by summarizing these contentions and how they may inform future research.

1.2 Rational Action, Rationalization, Strategy

Computational social science and social science writ large often uses ideas about rationality to think about and explain strategy.[1] Rationality, here, is usually

[1]Ayson, Robert. *Thomas Schelling and the nuclear age: strategy as social science.* Routledge, 2004.

characterized in terms of substantive (decision-making without regard to cognitive/computational cost) and procedural rationality (locally optimal decision-making under constraints).[2] Yet, as I will argue, this characterization alone ignores an important problem with using it to explain strategy: the classical Weberian distinction between rationality and rationalization.

1.2.1 Explanation of Strategy

My research aims to answer the question of what does it mean to use strategy as a mode of explanation. Smith argues that current explanations of strategy treat it as a black box, neglecting the "inner world" of strategy.[3] I have, in my document *Computational Approaches to Strategy* and other writings, elaborated more on this.[4], elaborated on this inner world and its use as a mode of explanation for observed outcomes and ill-understood processes.

Explaining strategy is hard because it represents both a conceptual structure that we use to make sense of the world but also a product of our minds, societies, and evolution. Smith and Stone[5] argue that strategic theory is distinct from other modes of inquiry because it focuses on the complex origins of strategic preferences and ideas as well as the way in which those preferences and ideas help guide an actor to a desired goal. Freedman argues that strategy is a means of generating advantage over an opponent.[6] Strategy is both a term that can be used to describe the activity of bridging beliefs and preferences and concepts as well as a term that also refers to an explicit theory or understanding of how to do so.

So, for example, we can infer from observation that the Communist Chinese had a strategy of popular mobilization in the Chinese Civil War because exhausting the opponent over time was the only way to create the necessary conditions for eventually challenging them conventionally. Or we could look at Mao Zedong's writings on the subject (and those of his confederates), and conclude that they had a concept of engaging in that activity. So while strategy can in theory be described as rational beliefs or behavior, this is not necessarily a complete or useful description. Surely strategy can be explained in terms of it, but self-awareness about the activity (sometimes explicit) is a key assumption made by the research literature in strategy. Actors have beliefs about how to strategize and these beliefs have meaningful consequences. The necessity of

[2]Simon, Herbert A. "From substantive to procedural rationality." *25 Years of Economic Theory.* Springer US, 1976. 65-86.

[3]Smith, M.L.R., Quantum Strategy: The Interior World of War, *Infinity Journal*, Volume 3, Issue No. 1, Winter, 2012, pages 10-13.

[4]Elkus, Adam, Beyond Strategy as a Means to an End, *Infinity Journal,* Vol. 3, Issue No. 4, winter 2014, pages 11-15, Elkus, Adam, Coming Down from Olympus: A Call for Normative, Descriptive, and Phenomenological Distinctions in Strategic Theory, *Infinity Journal*, Volume 4, Issue 4, summer 2015, pages 27-32, Elkus, Adam, "Strategic Theory and the Logic of Computational Modeling," forthcoming 2015

[5]Smith, M.L.R. and Stone, John, Explaining Strategic Theory, *Infinity Journal*, Issue No. 4, Fall 2011, pages 27-30.

[6]Freedman, Lawrence. *Strategy: a history.* Oxford University Press, 2013.

viewing strategy as a knowledge structure stems from the problem of traditional social science approaches to modeling strategy.

1.2.2 Rationality and strategy

Because Smith and Stone argue that we should assume that actors are rational, it is tempting to view rationality as the link between strategic theory and social and behavioral science explanations. Social science explanations, especially those in the computational social sciences, focus on rationality as the way to explain strategic behavior, where rationality is an interface between the inner conditions of an observed system and its external environment. [7] Rationality is the fit between the observed system and its goals in that environment. Hence, many explanations of strategy in mathematical and computer models often cast strategy as an algorithm for decision-making, whether in the form of game-theoretic strategy or psychological explanations for decision behavior. [8] Sometimes this is combined in the form of behavioral game theory and cognitive hierarchy approaches.[9]

However, in matters of war and political violence, strategy is not solely algorithmic in nature. Several schools of thought see strategy as an instrumental design that takes the form of a bridge, a control process, a system design, a means of creating enduring advantage, and a blueprint for controlled emergence as the situation unfolds. [10] Rationality may be a subset of this or a means of explanation, but it should not be regarded as isomorphic to strategy. Strategy touches on various types of rationality[11], such as philosophical or psychological rationality (beliefs and actions are adopted for appropriate reasons), economic rationality (maximizing a quantity) and behavioral rationality (principles of maximization related to fitness). The difference is that whereas philosophical and psychology refers to a process, economic and behavioral rationality refer to an outcome. It may be said that a simpler taxonomy is epistemic and instrumental rationality. These ideas – whether or not our beliefs about the environment of competition are true (epistemic rationality) and how we will go about achieving our goals (instrumental rationality) pervade strategic thought and practice.[12]

[7] Simon, Herbert, *Sciences of the Artificial.* MIT Press, 1996.

[8] Freedman, Lawrence. "Social Science and the Cold War." *Journal of Strategic Studies* ahead-of-print (2015): 1-21.

[9] Camerer, Colin. *Behavioral game theory: Experiments in strategic interaction.* Princeton University Press, 2003.

[10] Milevski, Lukas. "Revisiting JC Wylie's Dichotomy of Strategy: The Effects of Sequential and Cumulative Patterns of Operations." *Journal of Strategic Studies* 35.2 (2012): 223-242, Gray, Colin S. The strategy bridge: theory for practice. OUP Oxford, 2010, Wohlstetter, Albert. "Theory and opposed-systems design." *Journal of Conflict Resolution* (1968): 302-331, Evans, Michael. "The sage of the pentagon: Andrew Marshall and the defence of the West." *Quadrant* 59.6 (2015): 34, Osinga, Frans PB. *Science, strategy and war: The strategic theory of John Boyd.* Routledge, 2007.

[11] McFarland, David. *Guilty robots, happy dogs: the question of alien minds.* Oxford University Press, 2008.

[12] Toplak, Maggie E., K. E. Stanovich, and R. F. West. "Intelligence and rationality."

However, it should also be noted that strategy and rationality are, to, to a paraphrase Mirowski, an engine, not a camera. [13] Rationality is a concept that has been used to characterize both strategy post-facto and is a concept utilized in strategic theory itself. It is also a means of how institutions attempt to engineer strategic outcomes.[14] And strategy is also viewed as a device or skill whose operation can be taught and utilized instrumentally in human conflict.[15]

1.2.3 Weber, Rationality, and Strategy

Traditionally, in the social sciences, rationality has been used for far more than simply the explanation of rational behavior. [16] Strategy is distinct in that it is both a way of thinking about rationality (as per Smith and Stone) and a means of rationalization. As both of these terms will be critical later on, they are explained and contextualized below.

Conventional social science's inability to account for the way in which strategy itself serves as a tool of rational behavior[17] stems from the way in which strategy is often defined through the lens of methodological individualism and hierarchal-process explanaions for behavior.[18] Because social scientific knowledge emerged from the need to both control and rationalize complex bureaucratic structures, it often lacks self-awareness about the degree to which it is also a product of that very High Modernist need.[19] Not only does this create a self-referential issue of theories and models being used to describe the very behaviors they are engineering, their implicitly algorithmic view of decision-making often misses where algorithms fall short in describing and accounting for human behavior and cognition.[20]

Cambridge handbook of intelligence, (2011): 784-826.

[13]MacKenzie, Donald. *An engine, not a camera: How financial models shape markets.* MIT Press, 2008.

[14]Erickson, Paul, et al. *How reason almost lost its mind: The strange career of Cold War rationality.* University of Chicago Press, 2013.

[15]Marcella, Gabriel, ed.*Teaching strategy: challenge and response.* Strategic Studies Institute, 2010.

[16]Whimster, Sam, and Scott Lash. *Max Weber, rationality and modernity.* Routledge, 2014.

[17]there are qualified exceptions to this, such as metagame theory. Alexander, Joyce M. "A Study of Conflict in Northern Ireland: An Application of Metagame Theory." *Conflict Management and Peace Science* 2.1 (1976): 113-134.

[18]Heyck, Hunter. *Age of System: Understanding the Development of Modern Social Science.* JHU Press, 2015.

[19]Scott, James C. *Seeing like a state: How certain schemes to improve the human condition have failed.* Yale University Press, 1998, Heyck, Hunter. *Age of System: Understanding the Development of Modern Social Science.* JHU Press, 2015, Amadae, Sonja Michelle, and Sonja Michelle Amadae. *Rationalizing capitalist democracy: The cold war origins of rational choice liberalism.* University of Chicago Press, 2003.

[20]Shanker, Stuart G. *Wittgenstein's Remarks on the Foundations of AI.* Routledge, 2002, Copeland, B. Jack. "Turings Omachines, Searle, Penrose and the brain." *Analysis* 58.2 (1998): 128-138, Ekbia, Hamid Reza. *Artificial dreams: The quest for non-biological intelligence.* Cambridge University Press, 2008, *Erickson, Paul, et al. How reason almost lost its mind: The strange career of Cold War rationality.* University of Chicago Press, 2013, Freedman, Lawrence. "Social Science and the Cold War." J*ournal of Strategic Studies* ahead-of-print

This lack of self-awareness is also a large part of why social science and computer models is viewed with suspicion among devotees of strategy and strategic theory.[21] In confusing the rationalizing processes of social life with valid explanations for behavior, social scientists lost the trust of strategic researchers and practitioners. Max Weber distinguishes between varying forms of rationality in his sociological theory. [22] Weber looks at rationality from the framework of varying degrees of instrumentality inherent in how ends and actions are associated, with value-rational and instrumental actions as opposite ends of the pole.[23] From another perspective, however, Weber views science, technology, and bureaucracies as forms of rationalization processes.[24] Rationalization concerns the way in which instrumental motivations become the dominant source of modern authority and behavior.

1.3 Knowledge and Strategy

Strategic explanations should use rationality as a device for studying strategic phenomena and behavior, but only if researchers acknowledge the self-reference in using a form of knowledge that is also an *explanation* for how strategic actors (and those who advise them) see the world as an explanation for that phenomena and behavior.[25] In exploring this, I take a knowledge management and social studies of technology approach to thinking about strategy. My research program uses ideas from knowledge management – the field concerned with the process of capturing, distributing, and effectively using knowledge.[26] – to ground the inqury, though it combines ideas from many different fields concerned with the use of computational theories and methods in the social, behavioral/cognitive, and computational sciences as well as the history, philosophy, and social study of technology. I argue that strategy should be understood as a complex knowledge

(2015): 1-21, Freedman, Lawrence. "2 The possibilities and limits of strategic narratives." *Strategic Narratives, Public Opinion and War: Winning Domestic Support for the Afghan War* (2015): 17, McMaster, H. R. "The Uncertainties of Strategy." *Survival* 57.1 (2015): 197-208.

[21]Murray, Williamson. "Clausewitz out, computer in: military culture and technological hubris." *The National Interest* (1997): 57-64, Freedman, Lawrence. "Social Science and the Cold War." *Journal of Strategic Studies* ahead-of-print (2015): 1-21, Watts, Barry D. "Ignoring reality: Problems of theory and evidence in security studies." *Security Studies* 7.2 (1997): 115-171, McMaster, H. R. "The Uncertainties of Strategy." *Survival* 57.1 (2015): 197-208, McMaster, Herbert R. "On war: lessons to be learned." *Survival* 50.1 (2008): 19-30.

[22]Kalberg, Stephen. "Max Weber's types of rationality: Cornerstones for the analysis of rationalization processes in history." *American Journal of Sociology* (1980): 1145-1179.

[23]Alexander, Ernest R. "Rationality revisited: Planning paradigms in a post-postmodernist perspective." *Journal of planning education and research* 19.3 (2000): 242-256.

[24]Hedoin, Cyril. "Weber and Veblen on the Rationalization Process." *Journal of Economic Issues* 43.1 (2009): 167-188.

[25]Paparone, Chris. *The sociology of military science: prospects for postinstitutional military design.* A&C Black, 2012, Paparone, Christopher R. "Beyond Ends-Based Rationality: A Quad-Conceptual View of Strategic Reasoning for Professional Military Education." *Teaching Strategy: Challenge and Response*: 313.

[26]Davenport, Thomas H. (1994). "Saving IT's Soul: Human Centered Information Management". *Harvard Business Review* 72 (2): 119131

structure, not necessarily (as many social scientists think), as an algorithm for decision-making.[27]

1.3.1 Knowledge and Technoscience

Strategy is a complex form of knowledge that is used instrumentally to make sense of the world and other agents and achieve desired aims.[28] We can investigate and operationalize this approach though analysis and models of strategic knowledge in individuals, groups, and institutions.[29] Functionally, we would like to understand the purposes strategy serves, which Freedman generally defines in terms of both the representation of knowledge and belief. Individuals and groups act as containers for strategic knowledge in varying ways. Hence strategy will serve as a device used by individuals and groups to achieve their desired aims. Understanding the way in which they utilize strategy as a form of scaffolding to accomplish their aims is key. For example, we can say that a shared strategic concept among elites in Prusso-German military institutions was one that actively denied the importance of politics.

When we view computational approaches to researching strategy in terms of the explanation of the cognitive, individual, and social explanation of strategic knowledge, a key problem is resolved. Newell (1994) and others have different bands of abstraction for explanations of behavior, ranging from biological to social in nature. The bands consist of the biological, cognitive, rational, and social bands of abstraction, measured in terms of the relevant time periods (which can range from milliseconds to years and decades or more). Many social science models assume the rational band or the social band, but many combinations of levels have been used. Payne (2015a, 2016) uses the cognitive, rational, and social bands to show how strategy emerges from decision-making groups. This distinction matters a great deal in terms of strategic explanations, as a game-theoretic strategy for the Prisoners Dilemma can be viewed as either a feature of the rational band (a one-off decision with enormous consequences) or a bridge between the cognitive, rational, and social bands (an iterated decision occurring over a period of time informed by rational behavior and cognitive limitations) depending on whether or not it is iterated. Hence, it is to be argued here that strategy is a complex conceptual structure. Using strategy as an explanation requires making the warrant that it is a form of knowledge contained within in-

[27] Dolman, Everett. Pure Strategy: Power and Principle in the Space and Information Age. Routledge, 2004.

[28] Paparone, Chris. "The Sociology of the Military A Multi-Paradigmatic Review." *Contemporary Sociology: A Journal of Reviews* 43.3 (2014): 304-311, Osinga, Frans PB. *Science, strategy and war: The strategic theory of John Boyd.* Routledge, 2007, Osinga, Frans. "GettingA Discourse on Winning and Losing: A Primer on Boyd's Theory of Intellectual Evolution." *Contemporary Security Policy* 34.3 (2013): 603-624, Murray, Williamson, and Allan Reed Millett, eds. *Calculations: net assessment and the coming of World War II.* Free Press, 1992, Bracken, Paul. "Net Assessment: A Practical Guide." *Parameters* 36.1 (2006): 90, Evans, Michael. "The sage of the pentagon: Andrew Marshall and the defence of the West." *Quadrant* 59.6 (2015): 34, Watts and Krepnivech. *The Last Warrior.* Basic Books, 2015.

[29] Becerra-Fernandez, Irma, Rajiv Sabherwal, and Avelino Gonzalez. *Knowledge management.* Pearson Education, 2003.

dividuals, groups, artifacts, organizations, and communities of practice. There are broadly, utilizing Newell and others' approach, several relevant bands: cognitive, rational, and social.

One approach is rooted in examining the way in which strategy has a *functional* role as a concept governing rational action in the Weberian sense of the term. We can view strategy as a knowledge structure in terms of both functional and generative approaches of explanation. Artifacts denote ways in which strategy can be contained. Strategy may be embodied within organizational routines or sequential patterns of interaction, even if it is never explicitly formalized in a document. Common patterns may be seen if strategy is also taken to be a language or system of belief. Strategy may also obviously be found in books, papers, documents, and other shared items of strategic discourse. In sum, the functional view looks at strategy in terms of epistemic and instrumental rationality, and the knowledge structures and containers of knowledge that might explain it. How might all of this be seen from the functional view? A functional approach would view strategy in terms of a system of knowledge that is contained within a location of knowledge and the purpose that it serves. A generative approach looks at how it came to be. Available computational methods for this can be taken from multi-agent systems, agent-based models and artificial life (as well as other areas of social science simulation), knowledge representation and reasoning, knowledge management, cognitive modeling, network analysis, machine learning and data mining, and other elements of computational social science.

Another approach lies in the study of how technoscience, rationality, and computation may be viewed as Weberian processes of rationalization. One way to extend the basic approach outlined is to make technical artifacts the object of analysis. Because knowledge can be encoded within technical artifacts. the way in which decision-making systems can represent human strategic knowledge is useful to study even if the circumstances surrounding that knowledge at most constitute an unrealistic or semi-realistic micro-world[30] or pertain to a limited subset of strategic behavior that is easy to study experimentally and contributes to understanding of the whole[31] Computer systems and computational ideas in the cognitive, social, and behavioral sciences can serve as useful objects of research because of the way in which computer agents (and the behavioral, cognitive, and social ideas behind how they make decisions) are literally a formal representation[32] and language[33] for how control is exercised via systems, protocols, and other forms of hierarchy and governance. [34] This still involves a

[30]Edwards, Paul N. "The army and the microworld: Computers and the politics of gender identity." *Signs* (1990): 102-127.

[31]Charness, Neil. "The impact of chess research on cognitive science." *Psychological research* 54.1 (1992): 4-9.

[32]Petzold, Charles. *Code: The hidden language of computer hardware and software.* Microsoft Press, 2000.

[33]Friedman, Daniel P., Mitchell Wand, and Christopher Thomas Haynes. *Essentials of programming languages.* MIT press, 2001.

[34]Agar, Jon. The government machine: A revolutionary history of the computer. Cambridge, MA: MIT Press, 2003, Hughes, Agatha C. *Systems, experts, and computers: The*

form of generative and functional explanation, albeit with the manipulation of the artifacts themselves as taking center stage.

Some have argued that beliefs about strategy and conflict can broadly be understood as techno-scientific knowledge structures.[35] Because technoscience in human conflict has been traditionally thought of or managed in terms of metaphors concerning control, computation, and cognition[36], it is no wonder that computers may be key to understandng strategic knowledge.[37] Hence, technoscience, rationality, control, and cognition may be understood as a language that structures, represents, and organizes thinking about strategic behavior. This is operationalized by focusing on, as per Cold War conceptions of strategy as a programming, technical artifacts can be viewed as containers of strategic knowledge and a way of seeing strategy similar to the way that the prior section explained a knowledge management approach to thinking about strategy in individuals, groups, and communities.[38]

Cioffi-Revilla has argued that object oriented programming and software design provides a language and ontology for expressing features of the observed social world. If we can view elite perception of strategic behavior as the output of a program of instruction, the representational capacities of programming languages and software engineering techniques can help illuminate how they might conceivably express strategic and decision-making knowledge. Additionally, expert systems, cognitive agents, and robots were all part of a DARPA program to create an automated control system which failed.[39] (Roland and Shirman 2002). Expert systems, agents, and robots are all specialized forms of programming rooted in the architecture of abstract, situated, or embodied system that executes the code in an environment of interest. What does programming say about the way in which a computer might encode strategic knowledge?

Ensmenger argues[40] that minimax search in chess may be viewed as an object of social-historical study as chess programs embodied powerful beliefs about rationality, intelligence, and how it could be captured by computers, something that Simon and Schaeffer[41] (1989) saw as offering important lessons for decision-making in groups and organizations Others argue that games as closed struc-

systems approach in management and engineering,World War II and after. MIT Press, 2011.

[35]Bousquet, Antoine. "Cyberneticizing the American war machine: science and computers in the Cold War." *Cold War History* 8.1 (2008): 77-102, Bousquet, Antoine. "Chaoplexic warfare or the future of military organization." *International Affairs* 84.5 (2008): 915-929.

[36]Edwards, Paul N. *The closed world: Computers and the politics of discourse in Cold War America.* MIT Press, 1997.

[37]Gray, Chris Hables. *Peace, war, and computers.* Psychology Press, 2005.

[38]Becerra-Fernandez, Irma, Rajiv Sabherwal, and Avelino Gonzalez. *Knowledge management.* Pearson Education, 2003.

[39]Roland, Alex, and Philip Shiman. *Strategic computing: DARPA and the quest for machine intelligence, 1983-1993.* MIT Press, 2002.

[40]Ensmenger, Nathan. "Is chess the drosophila of artificial intelligence? A social history of an algorithm." *Social Studies of Science* 42.1 (2012): 5-30.

[41]Simon, Herbert A., and Jonathan Schaeffer. The game of chess. No. AIP-105. CARNEGIE-MELLON UNIV PITTSBURGH PA ARTIFICIAL INTELLIGENCE AND PSYCHOLOGY PROJECT, 1990.

tures have a powerful role in the origins of social science theories, strategy, and computing.[42] What kinds of assumptions about behavior go into the design of game agents in adversarial agents, and how does it encode knowledge about the structure of the game, the beliefs players have about the game, and assumptions about rational behavior within it?

1.3.2 Conclusion

Thus, the strategic explanations that I am personally interested in take one of two broad forms, both of which cast in terms of analyzing strategic knowledge in terms of rational action and rationalization (though unequally in focus).

1. **Research about how strategic knowledge is contained within individuals and groups**. How does strategic knowledge serve a functional purpose in the areas in which it can be found and how the areas in which it can be found also generate strategic knowledge? This program of research aims to examine how computational techniques can shed light on functional and generative approaches to strategic knowledge. Work by Gordon has illustrated the way in which strategy is a complex relational conceptual structure.[43] We can view strategy as a knowledge structure in terms of both functional and generative approaches of explanation. A functional approach would view strategy in terms of a system of knowledge that is contained within a location of knowledge and the purpose that it serves. A generative approach looks at how it came to be.

2. **Computational methods for examining how computation can be viewed as a language for expressing strategic knowledge**. How ideas about cognition, computation, and rationality have been used as a language to describe components of strategy and enact them in programs and games. How do programs and games (technical artifacts) encode strategic knowledge, and what assumptions and ideas do they contribute back to how we think about reasoning and decision-making as components of strategy? This program of research examines the manner in which programs and ideas about rationality encode knowledge about strategy (or subcomponents of it) and provide a language for the implementation and evaluation of of strategy and decision-making. Cioffi-Revilla[44] has argued that object oriented programming and software design provides a language and ontology for expressing features of the observed social world. Different methods of programming, especially those viewed in terms of autonomy and decision-making (agents, expert systems, etc), can help

[42]Von Hilgers, Philipp. *War games: a history of war on paper.* MIT Press, 2012., Leonard, Robert. *Von Neumann, Morgenstern, and the creation of game theory: From chess to social science, 19001960. Cambridge University Press*, 2010.

[43]Gordon, Andrew S. *Strategy representation: An analysis of planning knowledge.* Taylor & Francis, 2004.

[44]Cioffi-Revilla, Claudio. *Introduction to Computational Social Science.* Springer, 2014

illuminate the basic metaphors and language that we use to talk about strategy and rationality.

Chapter 2

Appendix/Unfinished Research Program Map

2.1 Introduction

This document defines a map of my personal research program. Other work I have done (Elkus 2015), has focused more generally on computational approaches to strategy and intellectual justifications for them. Here, I focus specifically on the theme I identified in that document, the use of computational artifacts as research tools to open strategys cognitive, behavioral, and ideational and social black box. Others have identified this as a barrier to strategic explanation it does not tell us much about the semi or intangible and semi and unobservable elements behind strategic behavior (Smith 2012). The intent of this document is to provide a road map for generating what I hope to be a few papers explaining my approach to researching strategy that could form a stapled dissertation of related papers on the themes advanced here.

My research aims to answer the question of what does it mean to use strategy as a mode of explanation? Strategy is hard because it represents both a conceptual structure that we use to make sense of the world but also a product of our minds, societies, and evolution. Smith and Stone (2011) argue that strategic theory is distinct from other modes of inquiry because it focuses on the complex origins of strategic preferences and ideas as well as the way in which those preferences and ideas help guide an actor to a desired goal. Freedman (2013) argues that strategy is a means of generating advantage over an opponent. Strategy is both a term that can be used to describe the activity of bridging beliefs and preferences and concepts as well as a term that also refers to an explicit theory or understanding of how to do so.

So, for example, we can infer from observation that the Communist Chinese had a strategy of popular mobilization in the Chinese Civil War because exhausting the opponent over time was the only way to create the necessary conditions for eventually challenging them conventionally. Or we could look at

Mao Zedongs writings on the subject (and those of his confederates), and conclude that they had a concept of engaging in that activity. So while strategy can in theory be described as rational beliefs or behavior, this is not necessarily a complete or useful description. Surely strategy can be explained in terms of it, but self-awareness about the activity (sometimes explicit) is a key assumption made by the research literature in strategy (Freedman 2013). Actors have beliefs about how to strategize and these beliefs have meaningful consequences.

I argue broadly that knowledge representation, knowledge management, and studies of technology and society are several approaches of use to thinking about strategy. These collectively create a picture of strategy as a complex form of human knowledge about how to achieve a desired end in adversarial conditions, and evidence for it can located in the human individuals and communities that utilize it and the technological systems and concepts of rationality and decision behavior that serve as both intellectual and programmatic language for expressing and implementing the knowledge. So specifically, I am looking at the questions (1): How does strategic knowledge serve a functional purpose in the areas in which it can be found and how the areas in which it can be found also generate strategic knowledge? (2): How do programs and games (technical artifacts) encode strategic knowledge, and what assumptions and ideas do they contribute back to how we think about reasoning and decision-making as components of strategy?

This defines two approaches that I would like to demonstrate the effectiveness of in my eventual dissertation:

Computational methods for researching the functional and generative elements of strategic knowledge. This program of research aims to examine how computational techniques can shed light on functional and generative approaches to strategic knowledge. We can view strategy as a knowledge structure in terms of both functional and generative approaches of explanation. A functional approach would view strategy in terms of a system of knowledge that is contained within a location of knowledge and the purpose that it serves. A generative approach looks at how it came to be.

Computational methods for examining how computation can be viewed as a language for expressing strategic knowledge. This program of research examines the manner in which programs and ideas about rationality encode knowledge about strategy (or subcomponents of it) and provide a language for the implementation and evaluation of of strategy and decision-making. Cioffi-Revilla (2014) has argued that object oriented programming and software design provides a language and ontology for expressing features of the observed social world. Different methods of programming, especially those viewed in terms of autonomy and decision-making (agents, expert systems, etc), can help illuminate the basic metaphors and language that we use to talk about strategy and rationality.

2.2 Knowledge Representation in Strategy

Because Smith and Stone argue that we should assume that actors are rational, it is tempting to view rationality as the link between strategic theory and social science explanations. Social science explanations, especially those in the computational social sciences (Simon 1997, Cioffi-Revilla 2014), focus on rationality as the way to explain strategic behavior, where rationality is an interface between the inner conditions of an observed system and its external environment. Rationality is the fit between the observed system and its goals in that environment. Hence, many explanations of strategy in mathematical and computer models often cast strategy as an algorithm for decision-making, whether in the form of game-theoretic strategy (Ayson 2004) or psychological explanations for decision behavior (Erickson and Klein 2013). Sometimes this is combined in the form of behavioral game theory and cognitive hierarchy approaches (Camerer 2003, Latiek 2011).

However, in matters of war and political violence, strategy is not solely algorithmic in nature (Dolman 2005). Neo-Clausewitzian, Boydian, and Net Assessment schools of thought (Gray 2010, Osinga 2009, Watts and Krepnivech 2015) argue that strategy is an instrumental design for enhancing what Stanovich (2009) might characterize as epistemic rationality (match between beliefs about the world and reality) and instrumental rationality (ability to achieve ones desired aims). More broadly, strategy touches on various types of rationality (McFarland 2008), such as philosophical or psychological rationality (beliefs and actions are adopted for appropriate reasons), economic rationality (maximizing a quantity) and behavioral rationality (principles of maximization related to fitness). The difference is that whereas philosophical and psychology refers to a process, economic and behavioral rationality refer to an outcome. Ends-based rationality is the dominant perspective within strategic theory, but it is often justified through a deliberate confusion of normative and descriptive modes of analysis (Elkus 2014, 2015).

Another distinction between strategy and social science lies in the cognitive band used to represent the explanation itself. Newell (1994) and others have different bands of abstraction for explanations of behavior, ranging from biological to social in nature. The bands consist of the biological, cognitive, rational, and social bands of abstraction, measured in terms of the relevant time periods (which can range from milliseconds to years and decades or more). Many social science models assume the rational band or the social band, but many combinations of levels have been used. Payne (2015a, 2016) uses the cognitive, rational, and social bands to show how strategy emerges from decision-making groups. This distinction matters a great deal in terms of strategic explanations, as a game-theoretic strategy for the Prisoners Dilemma can be viewed as either a feature of the rational band (a one-off decision with enormous consequences) or a bridge between the cognitive, rational, and social bands (an iterated decision occurring over a period of time informed by rational behavior and cognitive limitations) depending on whether or not it is iterated.

Hence, it will be argued that social study of strategy is a knowledge representation and reasoning (Brachman and Levesque 2004) and knowledge management (Beccerra-Fernandez and Sabwheral 2015) problem. Findler (1989), Thagard (1992), and Gordon (2011) establish three contrasting views of representing strategy in computational and cognitive models. Findler casts strategy as a mechanism that observes and evaluates an environment and recommends a course of action. Thagard subsumes strategy under adversarial problem-solving, a way of making the best decision based on the expected behavior and beliefs of a notional opponent., Both Findler and Thagard see strategy as both representation and mechanism.. Gordon collects instances of strategic knowledge and argues that strategy is a shared relational structure for planning knowledge. The field of knowledge management distinguishes between different locations of knowledge, identifying individuals and groups, artifacts, organizations, and communities of practice as locations of knowledge (Beccerra-Fernandez and Sabwheral 2015). Many have looked at how groups and organizations can act as both containers of and producers of (for example, Mahnken 2011 and Watts and Krepnivech 2015) strategic knowledge. Strategic knowledge can be embodied and contained within people, artifacts, and organizational entities.

Hence, it is to be argued here that strategy is a complex conceptual structure. Using strategy as an explanation requires making the warrant that it is a form of knowledge contained within individuals, groups, artifacts, organizations, and communities of practice. There are broadly, utilizing Newells approach, several relevant bands cognitive, rational, and social. We can view strategy as a knowledge structure in terms of both functional and generative approaches of explanation. A functional approach would view strategy in terms of a system of knowledge that is contained within a location of knowledge and the purpose that it serves. A generative approach looks at how it came to be. Available computational methods for this can be taken from multi-agent systems, agent-based models and artificial life (as well as other areas of social science simulation), knowledge representation and reasoning, knowledge management, cognitive modeling, network analysis, machine learning and data mining, and other elements of computational social science. This denotes several relevant areas of study.

2.2.1 Individuals, Groups, and Artifacts

Functionally, we would like to understand the purposes strategy serves, which Freedman generally defines in terms of both the representation of knowledge and belief. Individuals and groups act as containers for strategic knowledge in varying ways. Hence strategy will serve as a device used by individuals and groups to achieve their desired aims. Understanding the way in which they utilize strategy as a form of scaffolding to accomplish their aims is key. For example, we can say that a shared strategic concept among elites in Prusso-German military institutions was one that actively denied the importance of politics. Artifacts denote ways in which strategy can be contained. Strategy may be embodied within organizational routines or sequential patterns of interaction, even if it is never explicitly formalized in a document. Common patterns may be seen if strategy is also taken to be a language or system of belief. Strategy may also obviously be found in books, papers, documents, and other shared items of strategic discourse. In sum, the functional view looks at strategy in terms of epistemic and instrumental rationality, and the knowledge structures and containers of knowledge that might explain it. How might all of this be seen from the functional view?

2.2.2 Strategic Communities

Generatively, we would like to understand how strategic beliefs and intuitive and formal theories emerge. This contributes to strategy and computational social science by demonstrating the application of computational methods to theoretical questions in strategy. Strategic concepts and understandings may also emerge endogenously from the strategic actors themselves, through either a process of cultural ebb and flow or the emergence of shared understandings and behaviors in elite organizations, institutions, and communities. Additionally, some organizations, traditional or temporary, can create new strategic knowledge through shared work on a complex problem. For example, the RAND Corporation (Abella 2009), the Net Assessment community (Watts and Krepnivech 2015), Scharnhorsts school in Prussia (Paret 2009), the Special Operations Research Office (Maxwell 2013), and the Makers of Modern Strategy community formed by Edmund Mead Earle (Ekbladh 2011/12) all represented purpose-driven social entities where multiple perspectives could be combined together to generate strategic knowledge. Strategic communities of practice are often sources of strategic knowledge. The strategy blogosphere, for example, in 2005-2015 functioned as a network of individuals, many of whom were self-taught, who examined strategic problems and theory and helped create new discursive understandings of strategic theory and problems (Greer 2015). Some communities of practice can be seen as operating inside an intellectual tradition or school of thought at a level broad enough to be called a research program or research community in the sense that philosophers and historians of science often suggest and may be simulated or evaluated via computational means (Thagard 1993, Thagard 2012). Strategic knowledge programs and communities can be thought of as structures that both enable and constrain the growth of strategic knowledge. How might all of these be seen from the generative view?

2.3 Strategic and Decision Knowledge and Technical Artifacts: A Sociotechnical Systems Approach

One way to extend this basic approach is to extend knowledge representation and reasoning/knowledge management by making technical artifacts the object of analysis. Because knowledge can be encoded within technical artifacts (Beccerra-Fernandez and Sabwheral 2015). the way in which decision-making systems can represent human strategic knowledge is useful to study even if the circumstances surrounding that knowledge at most constitute an unrealistic or semi-realistic micro-world (Edwards 1990) or pertain to a limited subset of strategic behavior that is easy to study experimentally and contributes to understanding of the whole (Ensmenger 2011). Computer systems and computational ideas in the cognitive, social, and behavioral sciences can serve as useful objects of research because of the way in which computer agents (and the behavioral, cognitive, and social ideas behind how they make decisions) are literally a formal representation (Petzold 2000) and language (Friedman and Wand) for how control is exercised via systems, protocols, and other forms of hierarchy and governance (Agar 2003, Galloway 2006).

The constituent fields of use here are cognitive engineering (Lee and Kirlik 2013), which examines the psychological context of human-system interaction, the philosophy of technology (Bijiker et al, Vermaas et al 2011), which explains technical artifacts in terms of their context of use and their embeddedness within particular sociotechnical systems, and science and technology studies (Sismondo), which examines the social sources of scientific and technological discourses. There is also an emerging field of machine ethics (Anderson and Anderson 2011) concerning the development of decision-making systems and interest broadly in the role that software and algorithms play in control over money, information, and others examine how science and technology concerning decision-making systems and simulations may be viewed as both extensions of human social and behavioral structures and constituents of those structures (see, for example, Woolgar 1985, De Landa 1992, Edwards 1997, Hayles 1999, Mirowski 2001, Boden 2006, Latour 2007, Turkle 2009, Edwards 2010, Dyson 2012, Ensmenger 2012, Mindell 2015, Markoff 2015, Nisbett 2015, Kline 2015, Domingos 2015, Bousquet 2009, Rid 2016, Payne 2016).

Edwards (1997) argues that the social history of cognitive science, computing, and the behavioral sciences in the Cold War may be understood as a system of shared beliefs and metaphors concerning the control of complex technical and bureaucratic systems. Other Cold War histories link computing, artificial intelligence, and cognitive concepts such as bounded rationality to Cold War decision-making issues (Mirowski 2001, Roland and Shirman 2002, Erickson and Klein 2013, Heyck 2015). Of key interest here are, for example, Mirwoskis note (2001) that programming has a dual meaning the instruction of a computer and the way in which a system (biological or social) can be moved to a desired state and Erickson and Kleins observation (2013) that bounded rationality as a term partially originated with Cold War limitations on computing resources. Lawson, Bousquet, and others echo and broaden this with their focus on regimes of social beliefs and practices in military technoscience and their origins in the science, engineering, and technology communities (Lawson 2011, Bousquet 2009).

Broadly speaking, information technology artifacts are of particular use to us. As Edwards (1997) and Heyck (2015) observe, the Cold War created a scientific and technical establishment oriented around the idea of hierarchal, adaptive control under limitations. Mindell (2004) argues that control, feedback, and computation have been a part of conflict practice since World War I. Bousquet and De Landa (2010, 1992) trace this back to the Enlightenment era. Finally, Wohlsetter (1968), Marshall (1972), Wylie (1967) and Boyd (1976) all have cast strategy either in programmatic terms or utilizing language such as control, complexity, and bounded rationality. This reference is not coincidental. Military technoscience, government power, computing, artificial intelligence, and behavioral and cognitive sciences have also had broadly reciprocal relationships with each other (Edwards 1997, Mirowski 2001, Agar 2003, Dyson 2012, Erickson and Klein 2013, Heyck 2015). De Landa (1992), Edwards (1997), Bousquet (2009), and Rid (2016) show how strategic understandings can be encoded within technical artifacts by humans. And Payne (2015b, 2016) examine how adversarial instrumental knowledge may be encoded within artificially intelligent agents while Rid (2016) examines how the desire to automate decision-making and the risks of automation in part led to current concerns over cybersecurity.

There are several prominent sources of material. Ensmenger (2011) argues that minimax search in chess may be viewed as an object of social-historical study as chess programs embodied powerful beliefs about rationality, intelligence, and how it could be captured by computers, something that Simon and Schaeffer (1989) saw as offering important lessons for decision-making in groups and organizations. Games have long been viewed as a way of denoting closed systems of competitive and cooperative interaction (Leonard 2014) and a source of insight about human cognition (Gobet, Retschitski, and de Voogt 2004). Games and simulations also may be viewed as objects to think with and complex representational structures (Turkle 2009, Der Derian 2009). The broad field of adversarial reasoning focuses on how strategic and tactical understandings in limited domains can be encoded within agents for the purpose of games, simulations, and decision-support (Kott and McEneaney 2006, Kott 2006, Tecuci et al 2006).

However, we can also go even deeper and examine the way in which game agents and other programs and design tools can be viewed as representational forms for strategy. As Heyck observes (2015), many ideas in the social and behavioral sciences were designed as to maximize fit with their simulation or representation on a computer. Mirwoskis observation about programming as a metaphor has already been observed. Dupuy (2009) and Shanker (1998) have argued that foundational ideas in cognitive science are explicitly computational and mechanistic in nature. In regards to adversarial behavior, Tecuci et al (2006) have encoded a Clausewitzian strategic ontology in an intelligent agent and Kennedy et al (2009) have looked at how self-simulation can help a robotic teammate understand patrol and guard duty knowledge and behavior in an human teammate. Defense technologist Scott (2015) has also argued that code may be understood as a form of maneuver. Finally, Hughes and Hughes (2011) argue that systems, expertise, and computers comprise a generalized viewpoint about how problems from military command and control to poverty can be tackled.

Hence, it is to be argued here that the manner in which programs and ideas about rationality encode knowledge about strategy (or subcomponents of it) and provide a language for the implementation and evaluation of of strategy and decision-making. It is to be argued that these can be studied by building technological artifacts and examining the ways in which they encode knowledge relative to ideas in strategy and the social sciences. This can be done through the use of programming languages and software design methods, game agents, expert systems, and robots to illuminate ideas about the linkage between computation, the cognitive, behavioral and social sciences, and the way in which computational and machine metaphors can allow for the expression of strategic knowledge. It contributes to social science by combining interpretive, institutional, and sociological ideas with ideas in cognitive engineering and the philosophy of technology and linking these qualitative and often verbal approaches to the construction and manipulation of technological artifacts. In specific, it looks at two metaphors in particular: programs/computationalism and games and simulations.

2.3.1 Strategy and Programs

Cioffi-Revilla (2014) has argued that object oriented programming and software design provides a language and ontology for expressing features of the observed social world. If, as per Mirwoski (2011), we can view elite perception of strategic behavior as the output of a program of instruction, the representational capacities of programming languages and software engineering techniques can help illuminate how they might conceivably express strategic and decision-making knowledge. Additionally, expert systems, cognitive agents, and robots were all part of a DARPA program to create an automated control system which failed (Roland and Shirman 2002). Expert systems, agents, and robots are all specialized forms of programming rooted in the architecture of abstract, situated, or embodied system that executes the code in an environment of interest. What does programming say about the way in which a computer might encode strategic knowledge?

2.3.2 Strategy and Game Agents

Ensmenger (2011) argues that minimax search in chess may be viewed as an object of social-historical study as chess programs embodied powerful beliefs about rationality, intelligence, and how it could be captured by computers, something that Simon and Schaeffer (1989) saw as offering important lessons for decision-making in groups and organizations. Leonard (2014) and von Hilgers (2014) also argues that games as closed structures have a powerful role in the origins of social science theories, strategy, and computing. What kinds of assumptions about behavior go into the design of game agents in adversarial agents, and how does it encode knowledge about the structure of the game, the beliefs players have about the game, and assumptions about rational behavior within it?