Cognitive Science Major Assessment Report, 2018-2019

I. Student Learning outcomes/goals: [List all learning outcomes for the major]

1. **Foundational Assumptions** State, explain, and debate, from diverse perspectives, the *computational / representational assumption* that characterizes cognitive science and provides cohesion for the field. Discuss the nature of and motivation for the *interdisciplinary assumption* that characterizes cognitive science and provides great breadth for the field.
2. **Symbol Systems** Define the symbol system concept, perform simple symbolic computation in LISP and Prolog, and describe classic knowledge representations which are grounded in the physical symbol system hypothesis, including semantic nets, state spaces, frames, scripts, and production systems.
3. **Neural Networking** Identify and define basic neuroanatomical components, describe fundamentals concepts associated with neuroscience, and engage in neural network modeling to the extent that conversational fluency with connectionism is achieved for purposes of application and debate.
4. **Darwinian Processes and Phenomena** Articulate evolutionary theory both in classical terms and from an abstract algorithmic perspective, describe the standard computational instantiations of this theory (genetic programming and genetic algorithms), and explain how evolutionary ideas and extensions are providing new insights into the nature of the mind. Discuss fields of knowledge that are grounded in evolutionary theory, like evolutionary psychology and memetics.
5. **Language and Culture** Define and discuss the basic elements of language, including phonology, morphology, syntax, semantics, and pragmatics. Describe the role of image schema and conceptual metaphor in making meaning. Discuss big ideas in language and culture such as Saussure's dichotomies, his work on structuralism and Levi-strauss' application of it to cultural understandings, the work of Propp and Greimas on narratology, Jacobson's functions of communication, Grice's maxims, the Whorf hypothesis, and Merlin Donald's theories on the origin of the modern mind.
6. **Psychological Investigations** Delineate elements of psychological experimentation and discuss issues pertaining to statistical reasoning and research methods. Investigate the merits of various cognitive models of psychological processes pertaining to perception (the Gestalt Guys, Gibson), attention (Broadbent, Kahneman), memory (Miller, Anderson), and learning (Piaget, Vygotsky, Bruner, Papert).
7. **Consciousness and Controversies** Characterize the big issues, such as qualia and intentionality, and discuss/debate controversies associated with the field, such as the Chinese Room and the Imagery Debate.
8. **Embodiment, Emergence, and Distributed Cognition** Provide synopses of emerging fields which are increasingly central to cognitive science, such as situated cognition, complex dynamical systems, and distributed cognition.
9. **Formal Systems and Theories of Computation** Describe and discuss formalisms such as Post production systems, Turning machines, Church's Lambda Calculus, propositional and predicate calculus, generative grammars, typographical number theory, Lindenmayer systems.
10. **Algorithms and Automata** Discuss well-known algorithmic approaches to cognitive processing such as Marr's tri-level model of visual processing and and Doug Hofstadter's parallel terraced scan approach to perception. Describe the essentials of Markov processes for modeling an assortment of cognitive phenomena. Describe automata such as finite state machines and recursive transition networks.

II. Assessment activities completed in academic year 2018/2019

a. **Report student learning outcomes/goals assessed in academic year 2018/2019**:

The following numbers are the cognitive science program assessment values that we obtained for each of the 10 cognitive science program learning outcomes in our current round of assessment. (The process for arriving at the numbers, as well as the nominal meaning of the numbers, is described in the Cognitive Science Program Learning Outcomes Assessment Plan.) Nine students were enrolled in the Cognitive Science Capstone Seminar, the learning outcomes assessment venue, this past fall semester.

LO #1	LO #2	LO #3	LO #4	LO #5	LO #6	LO #7	LO #8	LO #9	LO #10
1.89	1.72	1.50	1.56	1.44	1.78	1.67	1.39	1.22	1.33

Two faculty members from the Cognitive Science Program Advisory Board, David Vampola and Craig Graci, served as evaluators this year. According to the assessment plan, these numbers are interpreted in the following manner with respect to *approaching* / *meeting* / *exceeding* expectations for the learning outcomes:

- Foundational Assumptions $\longrightarrow$ exceeds
- Symbol Systems $\longrightarrow$ exceeds
- Neural Networking $\longrightarrow$ exceeds
- Darwinian Processes and Phenomena $\longrightarrow$ exceeds
- Language and Culture $\longrightarrow$ meets
- Psychological Investigations $\longrightarrow$ exceeds
- Consciousness and Controversies $\longrightarrow$ exceeds
- Embodiment, Emergence, and Distributed Cognition $\longrightarrow$ meets
- Formal Systems and Theories of Computation $\longrightarrow$ meets
- Algorithms and Automata $\longrightarrow$ meets

This year we will continue with the approach that we adopted two years ago (see the 2016/2017 learning outcomes assessment report) for interpreting the numbers. At that time, we determined to answer the question "What do these numbers tell us?" by doing three things: (1) reflecting upon the scores from the broadest of perspectives, (2) partitioning the learning outcomes into three subsets according to learning outcome scores and reflecting on the results with respect to the partition, and (3) saying something about the learning outcomes designated during the previous round of assessment for special attention in the current round.

(1) Students were found to be exceeding expectations with respect to six of the ten learning outcomes, and they were found to be meeting expectations with respect to the other four learning outcomes. These results are more satisfying than those of the previous year. For those of us who worked quite closely with the vast majority of the students in both of the cohorts, they are not in the least bit surprising. The students enrolled in the 2018 capstone course seemed to us to be much stronger, on the whole, than those enrolled in the 2017 capstone course. Overall, it would appear that the students are productively learning a range of things that are rooted in the values of our cognitive science program.

(2) The partition of learning outcomes this year, determined by the process of identifying the three highest score outcomes, the three lowest score outcomes, and the remaining (middle score) outcomes, consists of the following three subsets:

- *High score set* - Learning outcomes 1, 2 and 6: Foundational Assumptions, Symbol Systems, Psychological Investigations.
- *Low score set* - Learning outcomes 8, 9 and 10: Embodiment, Emergence, Distributed Cognition, Formals Systems and Theories of Computation, Algorithms and Automata.
- *Middle score set* - Learning outcomes 3, 4, 5 and 7: Neural Networking, Darwinian Processes and Phenomena, Language and Culture, Consciousness and Controversies.

The high score set is different this year than in the previous two years, when this set remained constant. Based on what may be the most salient commonality, this set of learning outcomes (LOs 1, 2 and 6) might be named the "Seminal Cognitive Science" set, since the foundational assumptions, symbolic AI, and cognitive psychology have so dramatically influenced the field. The "lowest scores" set (LOs 8, 9 and 10), which we dubbed the "Theoretical Frameworks" set last year, has remained constant for a

number of years.

In our previous learning outcomes assessment report, we suggested a number of questions with respect to these dynamic partitions that we felt might be worthy of contemplation over time. Perhaps this year would be a good time to give them due consideration.

For now, we will simply make two observations. First, the migration of LO 2 (Symbol Systems) into the highest scores set may well be due to the fact that the BS/BA ratio for graduating seniors is higher this year than it has been in recent years, and BS degree students are the ones who take the symbolic AI sequence. Second, with respect to the lowest scores set, it is worth remembering that the number of students taking the Cog356 (Formal Systems and Generative Processes) course as seniors tends to be quite high. In fact, two-thirds (38/57) of the Cog356 students over the past four years were seniors. The Capstone Exam, given to students in the fall semester of their senior year, would simply not pick up on any learning about formal systems for the students who take Cog356 during their final semester.

(3) In our previous report, we determined to focus particularly in this report on the learning outcomes relating to neural networks (LO 3), Darwinian processes and phenomena (LO 4), language and culture (LO 5), and psychological investigations (LO 6). Here, in tabular form, are the requisite results and interpretations for our assessment of these learning outcomes:

Measure	Goal	Results and Interpretations
Cognitive Science Capstone Exam	3	**Result**: The score "exceeding expectations". **Interpretation**: The students have a fairly sound knowledge of what neural networks are, how they are trained, how they execute, and what the are particularly good at doing.
Cognitive Science Capstone Exam	4	**Result**: The score was "exceeding expectations". **Interpretation**: The students have a fairly sound knowledge of evolutionary processes from an algorithmic perspective, and some acquaintance with applications to cognitive science.
Cognitive Science Capstone Exam	5	**Result**: The score was "meeting expectations". **Interpretation**: The students have a somewhat fractured knowledge of linguistics, beyond the basic elements of language. Certainly, they should read some Lakoff and Johnson.
Cognitive Science Capstone Exam	6	**Result**: The score was "exceeding expectations". **Interpretation**: The students have a fairly sound knowledge of some of the ideas and methods in psychology that are featured in cognitive science theory and practice.

b. **Report all changes implemented or proposed based on assessment data gathered**:

(1) We will discuss the possibility of adding a complex clause to the prerequisite for the capstone course (Cog468) with the intention of increasing the proportion of students who take Cog356 before their final semester. This could well have an effect on the chronically low numbers for learning outcomes 9 and 10.

(2) We will search for an artful way to incorporate a brief introduction to *systems thinking* into our curriculum. The impetus for doing this stems from the polysemous nature of the phrase *complex systems*. In cognitive science the phrase generally has connotations of emergent behavior resulting from the interaction of relatively simple objects of a particular type. However, the phrase is also associated with the *fifth discipline* ideas championed by Peter Senge, according to which the behavior of a system is understood in terms of structural relationships, feedback loops, and other elements which may not be readily apparent. Since students, when asked about complex systems, sometimes say things which suggest confusion in their minds about the distinction between the two types of complex systems, it may be that a brief introduction to the latter will help to clarify the deep distinction between the two types of complex systems. Additionally, systems thinking is increasingly thought to be a valuable skill for a

viable, resilient workforce, so it might not be a bad idea to think about infusing it somehow into our curriculum, along side long-recognized-as-valuable critical thinking skills.

c. **Required resources to implement the above changes**:

No additional resources are required.

d. **Recommended changes to the assessment process**:

(1) In the past, we have intuitively determined which learning outcomes to focus on each year, rather than engaging in a systematic process of visitation. We think that it might be a good idea to establish a systematic process. In fact, we will commence this year to consider the learning outcomes by cycling through the following three sets: A = {1,2,3,4}, B = {1,5,6,7} and C = {1,8,9,10}. LO 1, foundational assumptions, will be considered seriously each year. In the "A years" we will focus on three essential ways to frame cognition, symbol systems (LO 2), neural networks (LO 3) and Darwinian processes (LO 4). In the "B years" we will focus on three essential contributing domains to the field of cognitive science, psychology (LO 5), language/culture (LO 6) and philosophy (LO 7). In the "C years" we will focus on alternative/abstract/algorithmic ideas within the field, namely, embodiment, emergence, distributed cognition (LO 8), formals systems (LO 9), and algorithms and automata (LO 10).

(2) We will, in the future, compare learning outcome assessment numbers of BS degree students with those of BA degree students, with an eye towards discovering differences and contemplating their meanings with respect to curricular reform.

III. Assessment activities planned for upcoming academic year 2018/2019

Measure	Goals / Line of Inquiry
Cognitive Science Capstone Exam	Focus particularly on the learning outcome set A, which consists of learning outcomes 1, 2, 3 and 4
CogSci Board Conversation	Dedicate at least one board meeting to discussion of learning outcomes assessment, including the questions raised in our previous report