

Term Information

Effective Term Summer 2025

General Information

Course Bulletin Listing/Subject Area Linguistics
Fiscal Unit/Academic Org Linguistics - D0566
College/Academic Group Arts and Sciences
Level/Career Undergraduate
Course Number/Catalog 3804
Course Title AI Models of Language
Transcript Abbreviation AI Language Models
Course Description This non-programming course introduces students to AI language models like ChatGPT, explains how they work and what kinds of things they can do, and contrasts them with models of human language and mind.
Semester Credit Hours/Units Fixed: 3

Offering Information

Length Of Course 14 Week, 12 Week, 8 Week, 7 Week, 6 Week, 4 Week
Flexibly Scheduled Course Never
Does any section of this course have a distance education component? No
Grading Basis Letter Grade
Repeatable No
Course Components Lecture
Grade Roster Component Lecture
Credit Available by Exam No
Admission Condition Course No
Off Campus Never
Campus of Offering Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites
Exclusions
Electronically Enforced No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code 16.0102
Subsidy Level Baccalaureate Course
Intended Rank Freshman, Sophomore, Junior, Senior

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Students will understand the basic mechanisms by which AI language models work
- Students will be able to explain what AI language models can and cannot do
- Students will understand how humans approach language differently from AI models

Content Topic List

- AI models
 - ChatGPT
 - Human language processing
 - Human mind
 - Memory
 - Probability
 - Attention
- Yes

Sought Concurrence

Attachments

- LING 3804 syllabus.pdf: Original syllabus
(Syllabus. Owner: McCullough, Elizabeth Ann)
- LING 3804 syllabus revised.pdf: Revised syllabus
(Syllabus. Owner: McCullough, Elizabeth Ann)
- LING 3804 sample lecture notes.pdf: Sample lecture notes
(Other Supporting Documentation. Owner: McCullough, Elizabeth Ann)
- LING 3804 concurrence Philosophy.pdf: Concurrence (PHILOS)
(Concurrence. Owner: McCullough, Elizabeth Ann)
- LING 3804 concurrence CSE.pdf: Concurrence (CSE)
(Concurrence. Owner: McCullough, Elizabeth Ann)
- LING 3804 concurrence Psychology no response.pdf: Concurrence (PSYCH)
(Concurrence. Owner: McCullough, Elizabeth Ann)
- LING 3804 response letter.docx: Notes about resubmission
(Cover Letter. Owner: McCullough, Elizabeth Ann)

Comments

- Please see Subcommittee feedback email sent 10/25/24. *(by Neff, Jennifer on 10/25/2024 02:01 PM)*

COURSE REQUEST
3804 - Status: PENDING

Last Updated: Neff, Jennifer
02/19/2025

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	McCullough, Elizabeth Ann	09/30/2024 11:21 AM	Submitted for Approval
Approved	McCullough, Elizabeth Ann	09/30/2024 11:21 AM	Unit Approval
Approved	Vankeerbergen, Bernadette Chantal	10/07/2024 01:21 PM	College Approval
Revision Requested	Neff, Jennifer	10/25/2024 02:01 PM	ASCCAO Approval
Submitted	McCullough, Elizabeth Ann	02/13/2025 11:48 AM	Submitted for Approval
Approved	McCullough, Elizabeth Ann	02/13/2025 11:48 AM	Unit Approval
Approved	Vankeerbergen, Bernadette Chantal	02/19/2025 10:34 AM	College Approval
Pending Approval	Jenkins, Mary Ellen Bigler Hanlin, Deborah Kay Hilty, Michael Neff, Jennifer Vankeerbergen, Bernadette Chantal Steele, Rachel Lea	02/19/2025 10:34 AM	ASCCAO Approval

Detailed notes about LING 3804 resubmission
February 2025

In addition to the responses to the individual points, presented in-line below, this resubmission has removed the GE designation, as it was felt the course would not have time to cover reflective thinking about how formal theories are formed and tested, as seems to be the intent of the newer GE theme.

The Subcommittee declined to vote on the request at this time as they ask that the following be addressed in a revision:

- The Subcommittee asks that the department concretize the syllabus as they are currently unable to assess what is expected of students each week. The syllabus should make clear to students how time will be spent in each session of the course so that they understand how they can be successful week by week. Specifically, the Subcommittee requests that the department expand the following aspects of the syllabus with greater detail: the course description and expected learning outcomes, assignment descriptions, and weekly schedule. The Subcommittee requests that each class meeting on the weekly schedule include topic(s) to be covered along with relevant assignments and materials to provide the Subcommittee with a sense of how much work is required of students. The Subcommittee also recommends that the department include due dates of any supplemental assignments in the weekly schedule as well. For reference, a course that provides an appropriate level of detail regarding these aspects of its syllabus is [Linguistics 4052, available as a sample syllabus on the Arts and Sciences Curriculum and Assessment Services website](#). [Syllabus pp. 3-5]

A daily schedule showing lecture topics, assignments and due dates has been added to the syllabus.

- As the department continues to develop the weekly content of the course, the Subcommittee encourages them to consider which units across the university may have an interest in the course, where there is potential overlap so that the department can reach out to those units for concurrence.

Concurrence was requested from CSE, Philosophy, and Psychology. CSE and Philosophy explicitly offered concurrence. Psychology did not respond to the request, which was sent on November 21.

Note that the CSE statement of concurrence makes reference to waiving a linguistics course requirement. This statement refers to the requirements of a certificate program currently in development, not a pre-requisite requirement for this course. There are no pre-requisite requirements for this course.

- The Subcommittee notes that there are no required texts for this course as the department did not find any textbooks at an appropriate level. The Subcommittee certainly trusts the judgement of the department, but they do believe that there are other resources available (such as peer-reviewed articles and well-researched journalism) that could be utilized to complement the course content and orient students to current discussions of this technology in the field. The Subcommittee encourages the department to include resources of this kind on the syllabus. [Syllabus p. 3]

Peer-reviewed articles in this area (computational linguistics) are generally written for graduate- or higher-level researchers with extensive programming experience, whereas this course is designed for undergraduates with no programming experience. We feel the jargon and frequent use of novel notation would make these resources unsuitable for this level of course.

Some less technical example readings on impacts of AI language models have been added for later lectures, but these would not substitute for a technical explanation of the transformer architecture using standardized terms and mathematical notation.

A sample lecture notes pdf has been included to demonstrate the intended nature of the lecture notes.

- The Subcommittee notes that the syllabus references an OSU standard grading scheme and recommends that the department remove this, as the university does not have a standard grading scale. Additionally, the grading scale seem to be missing the mark of E as well as the percentage range 0-59, so the Subcommittee recommends adjusting the scale to include this information. [Syllabus p. 4]

This has been corrected.

- The Subcommittee asks that the department ensure that the reference to the **Office of Institutional Equity** in the religious accommodations statement is a hyperlink to the office's email. Additionally, the Subcommittee asks that the link below be added to the bottom of the religious accommodations statement, as it is a part of the required text. Please feel free to copy and paste these two links into the statement directly from the Subcommittee's feedback. Otherwise, the full statement with the links can be found in an easy to copy/paste format on the [Arts and Sciences Curriculum and Assessment Services website](#). [Syllabus p. 6]
 - **(Policy: [Religious Holidays, Holy Days and Observances](#))**

This has been added.

Syllabus template document

1 Course number and title

LING 3804: AI Models of Language

2 Format of instruction and number of contact hours per week

Lecture, 3 credits

3 Prerequisites

None – the math required for this course will be taught within this course.

4 Description of course

This non-programming course introduces students to AI language models like ChatGPT, explains how they work and what kinds of things they can do, and contrasts them with models of human language and mind.

The course has the following expected learning outcomes:

1. understand the basic mechanisms by which AI language models work;
2. be able to explain what AI language models can and cannot do.

5 Required texts

Due to the novelty of A.I. large language models, there do not seem to be any textbooks at an appropriate level. The course will be therefore be taught primarily from lecture notes, which will be made available on the course web site.

6 Length and format of all papers, homework, laboratory assignments, and examinations

Successful course participation involves:

- Regular attendance and active participation (10% of grade).
- Completing six problem set assignments (handed out about a week and a half before they are due), handed in through Carmen (10% each, 60% total). Late assignments are only accepted if extensions are requested and granted, and are penalized 20% on a per-question basis, so try to submit as many questions as possible on time.
- Two non-cumulative midterm exams, administered during the course meeting time (15% each, 30% total).

The problem sets each contain about 5-6 problems with numerical answers or sometimes drawings of graphs or networks. Most questions on problem sets are similar in format to practice questions asked during lecture for completion credit. Exam questions are also similar in format to problem set questions or practice questions in lecture.

7 Grading information, indicating the percentages assigned to various requirements

See Section 6.

Grading scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	E
93%+	90%+	87%+	83%+	80%+	77%+	73%+	70%+	67%+	60%+	<60%

8 Weekly topical outline of course meetings, topics, readings, film screenings, and homework

Weekly calendar (students will have access to the lecture notes as links on the calendar):

Week	Mon 11:59pm	Tue	Wed 11:59pm	Thu
1		Lecture Notes 1: Biological Neurons – ions, ligands and neurotransmitters		Lecture Notes 1: Biological Neurons – a formal model of a neuron (McCullough Pitts), Problem Set 1 handout (on cued association formation and cueing).
2		Lecture Notes 2: Concepts as Activation Patterns – long-term potentiation, models of memory formation as cued associations between concepts,		Lecture Notes 2: Concepts as Activation Patterns – matrices of synaptic weights, properties of cued associations in distributed associative memory.
3		Lecture Notes 3: Probability and Bayes Law, Review Problem Set 1	Problem Set 1 due	Lecture Notes 4: Generative Probability Models, Problem Set 2 handout (on probability).
4		Lecture Notes 5: Biological Models of Uncertainty – a vector superposition model of uncertainty,		Lecture Notes 5: Biological Models of Uncertainty – propagation and resolution of uncertainty

5	Problem Set 2 due	Lecture Notes 6: Models of Learning – single neuron model of generalization (McCullough Pitts), Review Problem Set 2		Lecture Notes 6: Models of Learning – single neuron model of generalization (McCullough Pitts) Problem Set 3 handout (on introduction, propagation and resolution of ambiguity through matrix multiplication).
6		Lecture Notes 7: Models of Complex Learning – backpropagation, human limits on backpropagation		Lecture Notes 7: Models of Complex Learning – formal limits (vanishing and exploding gradients)
7	Problem Set 3 due	Lecture Notes 8: State Machines and Probabilistic Sequence Models, Review Problem Set 3		Lecture Notes 9: Recurrent Neural Networks
8		Midterm 1 review session		Midterm 1
9		Lecture Notes 10: Attention Models – biology of attention, a formal model of attention Problem Set 4 handout (on single neuron learning).		Lecture Notes 10: Attention Models – models with multiple attention heads, transformer models,
10		Lecture Notes 11: Sequence Memory – biological sequence memory, biological limits on sequence memory	Problem Set 4 due	Lecture Notes 11: Sequence Memory – positional encoding in transformer models Review Problem Set 4 Problem Set 5 handout (on attention models).
11	Reading: Wei et al. (2023)	Lecture Notes 12: What AI Language Models Do Well		Lecture Notes 12: What AI Language Models Do Well
12	Problem Set 5 due	Lecture Notes 13: What AI Language Models Do Poorly – logic and reasoning, Review Problem Set 5 Problem Set 6 handout (on logical inference, decision theory or reinforcement learning).	Reading: McCoy et al. (2019)	Lecture Notes 13: What AI Language Models Do Poorly,
13	Reading: Bender et al. (2021)	Lecture Notes 14: What AI Language Models Do Poorly,		Lecture Notes 14: What AI Language Models Do Poorly,
14	Problem Set 6 due	Lecture Notes 15: What AI Language Models Do Poorly, Review Problem Set 6	Reading: Inan et al. (2023)	Lecture Notes 15: What AI Language Models Do Poorly,

15		Midterm 2 review session		Midterm 2
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References

- Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the dangers of stochastic parrots: Can language models be too big? In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* New York: Association for Computer Machinery – ACM.
- Inan, H., Upasani, K., Chi, J., Rungta, R., Iyer, K., Mao, Y., Tontchev, M., Hu, Q., Fuller, B., Testuggine, D., & Khabasa, M. (2023). Llama guard: Llm-based input-output safeguard for human-ai conversations.
- McCoy, T., Pavlick, E., & Linzen, T. (2019). Right for the wrong reasons: Diagnosing syntactic heuristics in natural language inference. In A. Korhonen, D. Traum, & L. Màrquez (Eds.), *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics* (pp. 3428–3448). Florence, Italy: Association for Computational Linguistics.
- Wei, J., Wang, X., Schuurmans, D., Bosma, M., Ichter, B., Xia, F., Chi, E., Le, Q., & Zhou, D. (2023). Chain-of-thought prompting elicits reasoning in large language models.

9 Statement on academic misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct <http://studentlife.osu.edu/csc/>.

10 Statement about disability services

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration,

make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

11 Statement about religious accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

12 Statement about mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614- 292-5766. CCS is located on the 4th floor of the Younkin Success Center and the 10th floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

LING3804: Lecture Notes 2

A Model of Associative Memory

The next few lectures will define a reference model to try to explain language:

1. We will model associative memory as relations between states of cortical activation.
2. We will model ideas as collections of cued associations in associative memory.
3. We will model language as a process of encoding, transmitting, and decoding ideas.

This first lecture is on associative memory.

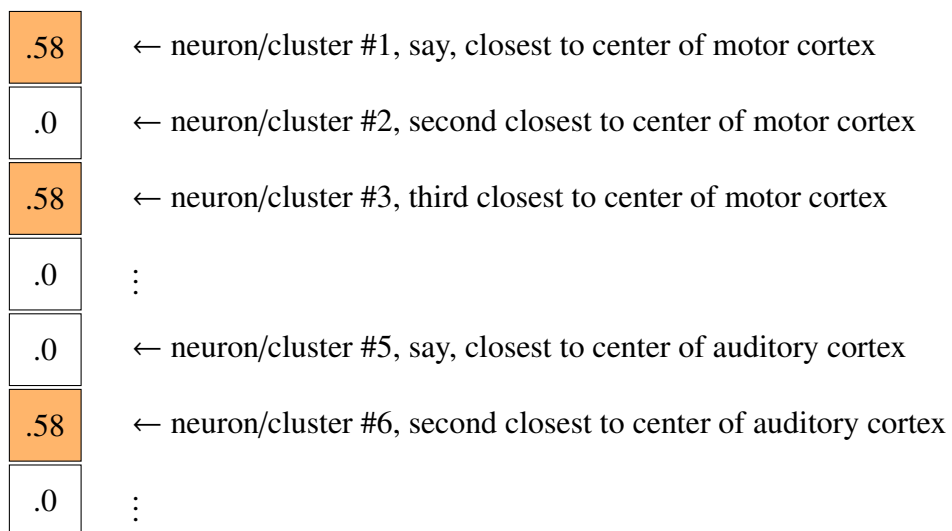
Contents

2.1	Mental states as patterns of neural activation	1
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2.1 Mental states as patterns of neural activation

Mental states (e.g. from looking at pictures) are associated with active firing of characteristic patterns of neurons [Mitchell et al., 2008].

Activation of neurons in the cortex can be modeled with **vectors** of firing rates for neurons or clusters:



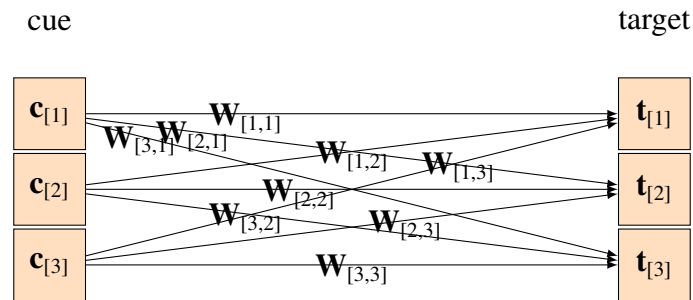
(The values are typically 'normalized' so that the point is always one unit away from the origin.)

This kind of model is called ‘distributed’ because the activation is distributed around the cortex. Individual elements of vectors (or characteristic subsets of elements) are called **features**. An n -length vector may also be read as the **coordinates** of a point in an n -dimensional space.

2.2 Cued associations as connectivity weights between neurons/clusters

Mental states can be used as **cues** to other associated **target** mental states.

These associations happen by **long-term potentiation** (sensitization) of synapses between pre-synaptic and post-synaptic neurons that are active in the cue and target states, respectively.



Synaptic weights can be shown in **matrices**, with a row for each target and a column for each cue:

$W_{[1,1]}$	$W_{[1,2]}$	$W_{[1,3]}$
$W_{[2,1]}$	$W_{[2,2]}$	$W_{[2,3]}$
$W_{[3,1]}$	$W_{[3,2]}$	$W_{[3,3]}$

Potentiation can then be modeled using matrices of connections for each pair of neurons/clusters in cue and target patterns (specifically it’s an outer product of cue and target vectors, with the cue on the right) [Marr, 1971, Anderson et al., 1977, Murdock, 1982, Smolensky, 1990,

McClelland et al., 1995, Howard & Kahana, 2002]:

synaptic weights (cue:columns; target:rows)							target	cue							
.0	.29	.29	.0	.29	.0	.29	.58	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.29	.29	.0	.29	.0	.29	.58	.0	.50	.50	.0	.50	.0	.50	.0
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.29	.29	.0	.29	.0	.29	.58	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

This is just a matrix product: the value at row i , column j of the result is the sum of the product of each element in row i of the first factor $\mathbf{M} \in \mathbb{R}^{I \times K}$ (the target) with the corresponding element in column j of the second $\mathbf{N} \in \mathbb{R}^{K \times J}$ (the cue):

$$(\mathbf{M}\mathbf{N})_{[i,j]} = \sum_{k=1}^K \mathbf{M}_{[i,k]} \cdot \mathbf{N}_{[k,j]}$$

The target may then be obtained by applying the association weights to the cue (matrix product):

target	synaptic weights (cue:columns; target:rows)							cue
.58	.0	.29	.29	.0	.29	.0	.29	.0
.0	.0	.0	.0	.0	.0	.0	.0	.50
.58	.0	.29	.29	.0	.29	.0	.29	.50
.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.0	.0	.0	.50
.58	.0	.29	.29	.0	.29	.0	.29	.0
.0	.0	.0	.0	.0	.0	.0	.0	.50

To compute the activation of each post-synaptic neuron (row) in the target vector, the activation of each of the pre-synaptic neurons in the cue is multiplied by the synaptic weight in the memory

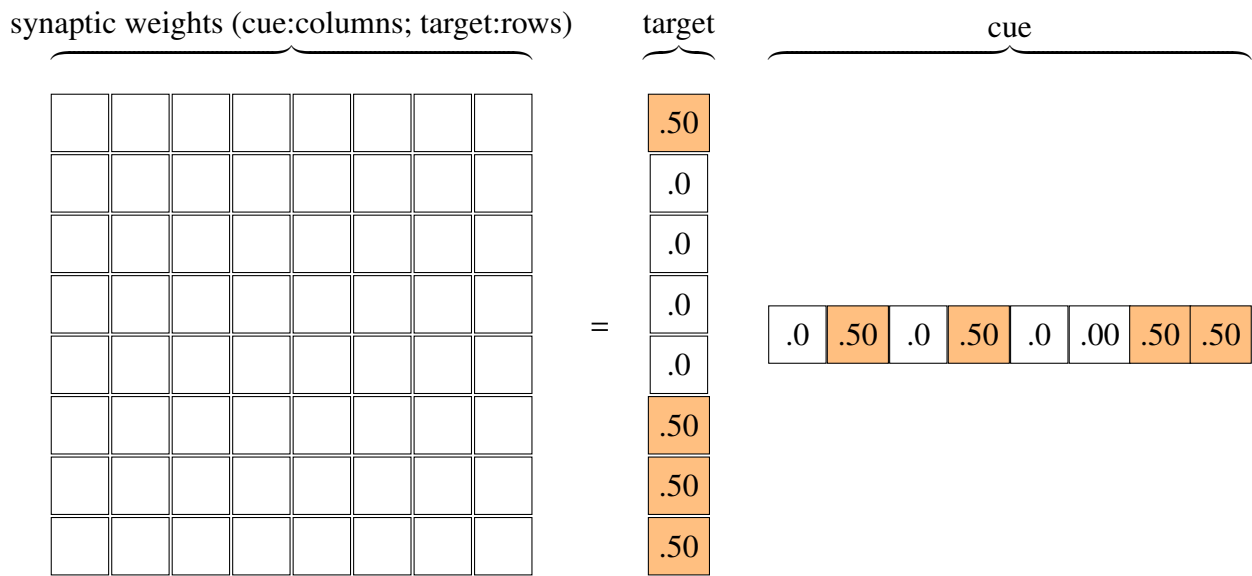
matrix for that pre-synaptic neuron (column) synapsing with that post-synaptic neuron (row). The contributions of each pre-synaptic neuron are weighted by the corresponding synaptic weight and added together. So, to compute the top element of the target, the four .50's of the 2nd, 3rd, 5th and 7th elements of the cue are multiplied by .29, .29, .29 and .29, respectively (the 2nd, 3rd, 5th and 7th elements of the top row) and added together to give .58, and the other elements in the top row of the matrix are multiplied by zeros in the cue so they don't change anything when they are added in. The same thing happens for each lower row of the matrix, to define each lower element of the target, until you have the result in the figure.

Cued association seems to be directional (North Korea → China, but China ↯ North Korea).

(This will show up later in our discussion of priming.)

Practice: forming associations

Suppose you have cue and target mental states characterized by the below patterns of cortical activation. What synaptic weights result from long-term potentiation of the cue state immediately followed by the target state:



Practice: cueing

Now suppose you cue the below associative memory matrix of synaptic weights with the below

vector of cortical activations. What will be the result?

target	synaptic weights (cue:columns; target:rows)								cue
	.0	.0	.0	.0	.0	.0	.0	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.50
	.0	.25	.25	.0	.25	.0	.25	.0	.50
	.0	.25	.25	.0	.25	.0	.25	.0	.0
	.0	.0	.0	.0	.0	.0	.0	.0	.50
	.0	.25	.25	.0	.25	.0	.25	.0	.0
	.0	.25	.25	.0	.25	.0	.25	.0	.50
	.0	.0	.0	.0	.0	.0	.0	.0	.0

2.3 Robustness to incomplete cues ('holographic memory')

Associations from incomplete cues yield complete (but weaker) targets:

target	synaptic weights								cue
.29	.0	.29	.29	.0	.29	.0	.29	.0	
.0	.0	.0	.0	.0	.0	.0	.0	.0	← missing!
.29	.0	.29	.29	.0	.29	.0	.29	.0	← missing!
.0	.0	.0	.0	.0	.0	.0	.0	.0	
.0	.0	.0	.0	.0	.0	.0	.0	.50	
.29	.0	.29	.29	.0	.29	.0	.29	.0	
.0	.0	.0	.0	.0	.0	.0	.0	.50	

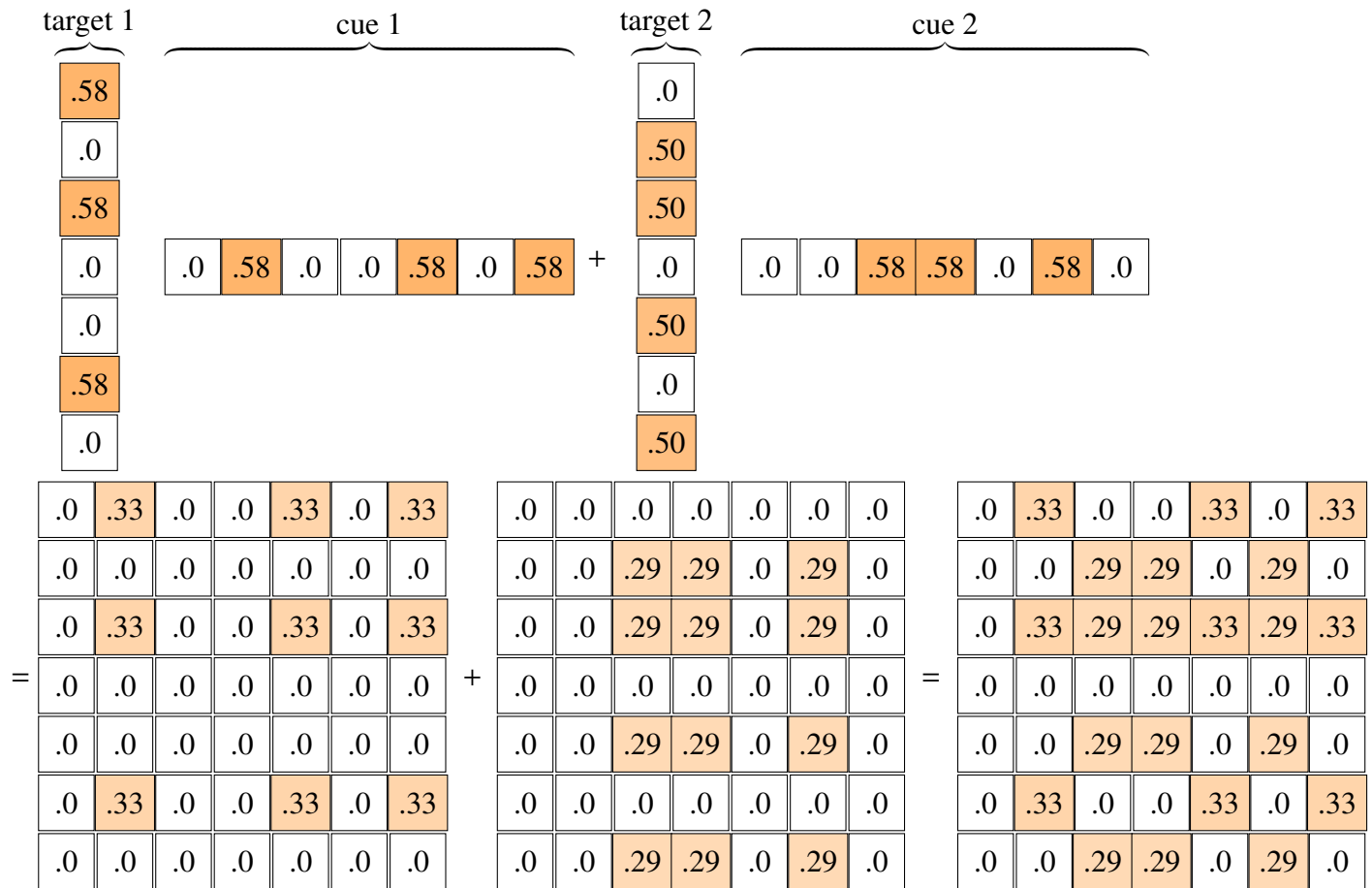
To compute the activation of each post-synaptic neuron (row) in the target vector, the activation of each of the pre-synaptic neurons in the cue is multiplied by the synaptic weight in the memory matrix for that pre-synaptic neuron (column) synapsing with that post-synaptic neuron (row). The contributions of each pre-synaptic neuron are weighted by the corresponding synaptic weight and added together. So, to compute the top element of the target, the two .50's of the 5th and 7th elements of the cue are multiplied by .29 and .29 (the 5th and 7th elements of the top row) and added together to give .29, and the other elements in the top row of the matrix are multiplied by zeros in the cue so they don't change anything when they are added in. The same thing happens for

each lower row of the matrix, to define each lower element of the target, until you have the result in the figure.

This provides a natural model of brain plasticity following trauma.

2.4 Associations can be combined

Multiple associations can be combined (stored together) in the same set of synapses:



the resulting associations can still be cued:

	target 1		synaptic weights		cue 1					
	.58		.0	.33	.0	.0	.0	.33		.0
	.0		.0	.0	.29	.29	.0	.29	.0	.58
	.58		.0	.33	.29	.29	.33	.29	.33	.0
	.0	=	.0	.0	.0	.0	.0	.0	.0	.0
	.0		.0	.0	.29	.29	.0	.29	.0	.58
	.58		.0	.33	.0	.0	.33	.0	.33	.0
	.0		.0	.0	.29	.29	.0	.29	.0	.58

However, when the stored cues overlap (e.g. the 3rd element in the cues below):

	target 1		cue 1		target 2		cue 2
	.0				.0		
	.58				.0		
	.0				.58		
	.0		.58	.0	.0	.58	.0
	.58		.0	.58	.0	.50	.50
	.0		.0	.58	.0	.0	.50
	.58		.0	.58	.58	.0	.50
	.0		.0	.58	.0	.50	.0
	.58		.0	.58	.0	.50	.50
	.58	+			.0		
	.0				.58		
	.58				.0		
	.58				.58		
	.58				.0		
	.58				.0		
	.58				.0		
	.58				.0		
	.58				.0		
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	.58				.0		

the resulting associations ‘interfere’ with each other when cued, yielding a combined target:

combined target	synaptic weights	cue 1
{	{	{
.0	.0	.58
.58	.33	.0
.16	.0	.58
.16	.29	.0
.58	.29	.0
.16	.0	.58
.58	.33	.0
.16	.0	.58
.58	.29	.0
.16	.29	.0
.58	.0	.58
.16	.33	.0
.58	.0	.58
.16	.29	.0
.58	.29	.0
.16	.0	.58
.58	.33	.0

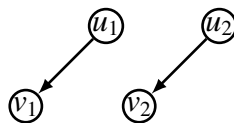
This has been proposed as a process by which forgetting happens [Howard & Kahana, 2002].

2.5 Graphical representations of mental states and cued associations

Recall mental states are coordinates of points in mental space, linked by cued associations:

target v_1	cue u_1	target v_2	cue u_2	=
{	{	{	{	{
.71	.0	.0	.0	.0
.0	.58	.58	.71	.41
.71	.0	.58	.71	.41
.0	.58	.0	.0	.82
.0	.58	.58	.0	.41
.0	.0	.0	.0	.0
.0	.0	.58	.41	.41

Cued associations in an associative memory can be represented graphically:



(arbitrarily squashing the n coordinates/dimensions into a two-dimensional figure).

2.6 Multiple associations (multiplexing and tensors)

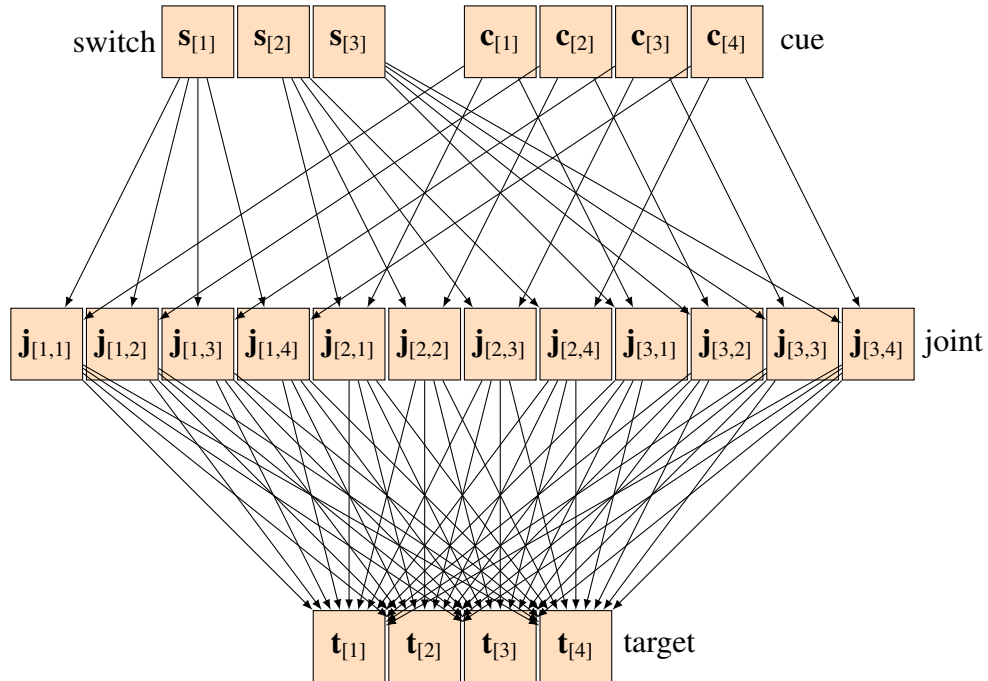
Mental states can cue multiple targets without interference using ‘switching’ elements n .

(Let’s just assume these are the first few elements of each vector.)

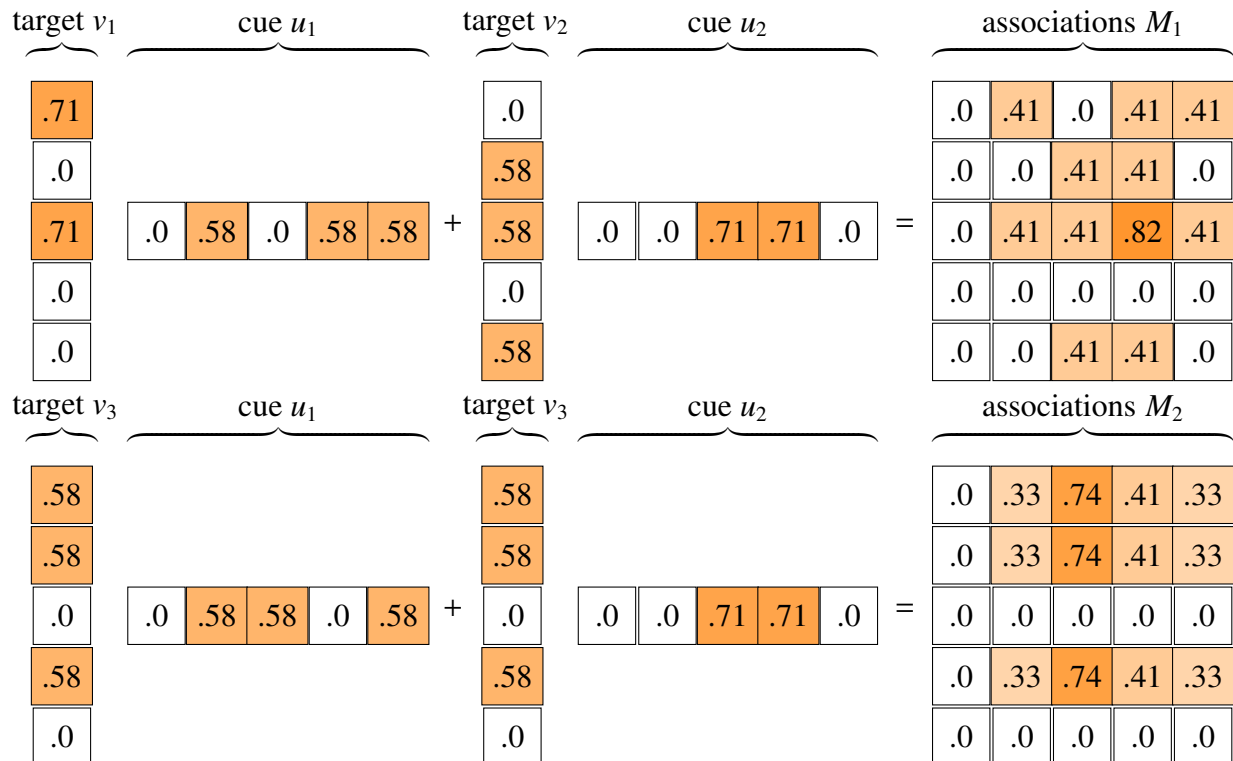
Then define a ‘joint’ element for each non-switching element: fire if both it and switch n fire.

Associations M_n may then be cued on these joint features instead of regular elements.

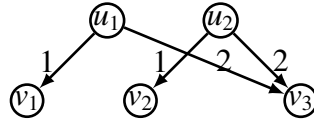
For example, if $n = 3$:



Associations from joint features are modeled using numbered layered matrices (tensors):



Numbered association layers can be represented graphically using edge labels:



Similar ‘(de-)multiplexing’ and has been proposed as a model of the hippocampus [Marr, 1971].

References

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- [Murdock, 1982] Murdock, B. B. (1982). A theory for the storage and retrieval of item and associative information. *Psychological Review*, 89, 609–626.
- [Smolensky, 1990] Smolensky, P. (1990). Tensor product variable binding and the representation of symbolic structures in connectionist systems. *Artificial intelligence*, 46(1-2), 159–216.

Thursday, November 21, 2024 at 10:40:34 Eastern Standard Time

Subject: Re: Concurrence request from Linguistics (LING 3804)
Date: Thursday, November 21, 2024 at 10:39:25 AM Eastern Standard Time
From: D'Arms, Justin
To: McCullough, Liz

Hi Liz,

Philosophy supports this proposal.

Justin

Justin D'Arms
Professor and Interim Chair
Department of Philosophy
The Ohio State University
350 University Hall, 230 North Oval
Columbus OH 43210
614.292.7914

From: McCullough, Liz <mccullough.136@osu.edu>
Date: Thursday, November 21, 2024 at 10:17 AM
To: D'Arms, Justin <darms.1@osu.edu>
Subject: Concurrence request from Linguistics (LING 3804)

Hi Justin,

Linguistics is seeking concurrence from Philosophy for a new undergraduate course, LING 3804, with the title "AI Models of Language." I've attached the syllabus and course request here, as well as the concurrence form. You can complete the form, or simply reply to this email with your recommendation. Of course, let us know if you need any clarification or additional information about the course.

We look forward to your response!

Best,
Liz

Liz McCullough, Ph.D.
Undergraduate Program Coordinator
Department of Linguistics
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Pronouns: she/her/hers / Honorific: Dr.

Thursday, February 13, 2025 at 09:56:53 Eastern Standard Time

Subject: Re: Concurrence request from Linguistics (LING 3804)
Date: Wednesday, February 12, 2025 at 1:49:34 PM Eastern Standard Time
From: Williamson, Donald
To: Schuler, William
CC: McCullough, Liz
Attachments: image001.png, image002.png, image003.png

Hi William,

CSE faculty discussed your concurrence request recently and we are fine with providing concurrence for this course, without conditions. We learned that students that have completed CSE 3521 or CSE5052 can waive the linguistics course requirement and enroll in this course, which will benefit CSE students.

Best,

Donald S. Williamson
Associate Professor
Director, [The ASPIRE Group](#)
Affiliated faculty, Translational Data Analytics Institute
[Computer Science and Engineering](#)
493 Dreese Labs, [2015 Neil Ave, Columbus, OH 43210](#)
williamson.413@osu.edu



THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

From: Schuler, William <schuler.77@osu.edu>
Date: Tuesday, January 21, 2025 at 5:04 PM
To: Williamson, Donald <williamson.413@osu.edu>
Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi Donald,

Yes, I agree with these suggestions. I'll proceed with the course request then.

Thanks!

wm

From: Williamson, Donald <williamson.413@osu.edu>
Date: Saturday, January 18, 2025 at 9:30 AM
To: Schuler, William <schuler.77@osu.edu>
Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi William,

Sorry for the delay. I looked at the materials on the website, mainly the slides and schedule. And they seem to be acceptable to CSE students. Depending on the status of the student, however, the material on context grammars (lecture notes 6) may need a little background to explain what that entails. The material on backpropagation (lecture notes 8), may also need to introduce the idea of supervised learning, and possibly linear regression, to better understand the ideas of parameter fitting. There is also some python code in these notes, which I assume will be removed later once you have a chance to update everything.

Best,

Donald S. Williamson

Associate Professor

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Affiliated faculty, Translational Data Analytics Institute

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williamson.413@osu.edu



THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

From: Schuler, William <schuler.77@osu.edu>

Date: Monday, January 13, 2025 at 3:02 PM

To: Williamson, Donald <williamson.413@osu.edu>

Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi Donald,

Did you have a chance to take a look at those proposed course lecture notes yet?

If so, what do you think of this as a basic framework?

wm

From: Schuler, William <schuler.77@osu.edu>

Date: Friday, December 20, 2024 at 6:08 PM

To: Williamson, Donald <williamson.413@osu.edu>

Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi Donald,

While the others work out the questions about the revenue, I'll share with you a mockup of the course web site with some of the lecture notes filled in:

<https://www.asc.ohio-state.edu/schuler.77/courses/3804/index.html>

The earlier ones are more completely worked out, and the later ones are just cut and

paste sketches, but it might give you some idea of what the course would look like.

Does this look broadly acceptable to CSE?

wm

From: Williamson, Donald <williamson.413@osu.edu>
Date: Thursday, December 19, 2024 at 9:18 AM
To: Schuler, William <schuler.77@osu.edu>, McCullough, Liz <mccullough.136@osu.edu>, Arora, Anish <anish@cse.ohio-state.edu>, Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Ramnath, Rajiv <ramnath.6@osu.edu>
Subject: Re: Concurrence request from Linguistics (LING 3804)

In terms of collaboration, I am fine with handling that duty for now, since I currently teach CSE's neural network course which has overlapping topics with the proposed LING 3804 course (e.g., Attention, Recurrent neural networks, backpropagation,...), although we may look to get others involved at some point, ones from CSE whose research/teaching are more closely related with AI language models. I can also help assess the broad acceptability of the material for CSE students.

I'm not sure about the revenue aspect of cross listing, so I'll allow [@Arora, Anish](#), [@Fosler-Lussier, Eric](#) and [@Ramnath, Rajiv](#) (who I added to this conversation), to chime in.

Best,

Donald S. Williamson
Associate Professor
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493 Drees Labs, 2015 Neil Ave, Columbus, OH 43210
williamson.413@osu.edu



THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

From: Schuler, William <schuler.77@osu.edu>
Date: Tuesday, December 17, 2024 at 5:03 PM
To: Williamson, Donald <williamson.413@osu.edu>, McCullough, Liz <mccullough.136@osu.edu>
Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Arora, Anish <anish@cse.ohio-state.edu>
Subject: Re: Concurrence request from Linguistics (LING 3804)

Ok, that makes sense about the programming variant of the course. I would have no problem sharing course materials or (as chair) giving concurrence for a programming version of this course, which to my mind would have to be a fairly different course.

I have a question about cross-listing for the original non-programming course: is my understanding correct that, between colleges, cross-listing is handled with revenue flowing from whichever college is not providing the instructor to whichever college is providing the instructor (which is different from within-college cross-listing)? Is that more or less correct? If so, do you anticipate having us teach the course, or splitting the teaching somehow?

Also, with whom would I collaborate on the development? I was anticipating re-purposing a lot of existing latex diagrams for the lecture notes on associative memory and ambiguity resolution in human sentence processing (e.g. as it relates to word probabilities in LLMs), and I'd like to make sure all that stuff would be broadly acceptable to CSE sooner rather than later.

Thank you,

William

From: Williamson, Donald <williamson.413@osu.edu>

Date: Wednesday, December 11, 2024 at 7:45 AM

To: Schuler, William <schuler.77@osu.edu>, McCullough, Liz <mccullough.136@osu.edu>

Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Arora, Anish <anish@cse.ohio-state.edu>

Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi William,

Thanks for providing this additional context. I actually think the focus on mathematical models of human memory and its contrast to AI models may serve a portion of our CSE majors/minors, especially the non-programming aspects of it. Hence, I still feel a collaboration would be beneficial. From your third point, I would like to clarify that CSE would like to cross list this version of the course, without a programming component. The intent of condition 3, was that CSE may like to offer a separate course (in the future) related to this, but one that includes programming. Hence, we do not suggest combining programming and non-programming content here.

Best,

Donald S. Williamson

Associate Professor

Director, [The ASPIRE Group](#)

Affiliated faculty, Translational Data Analytics Institute

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493 Drees Labs, 2015 Neil Ave, Columbus, OH 43210

williamson.413@osu.edu



THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

From: Schuler, William <schuler.77@osu.edu>

Date: Tuesday, December 10, 2024 at 1:36 PM

To: McCullough, Liz <mccullough.136@osu.edu>, Williamson, Donald <williamson.413@osu.edu>

Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Arora, Anish <anish@cse.ohio-state.edu>

Subject: Re: Concurrence request from Linguistics (LING 3804)

Hi all!

Thank you for your conditional concurrence. I think we can work with that, but I have some questions about the below conditions 2 and 3:

I don't think the course syllabus mentioned this, but the idea for this course originated as part of a set of three non-programming but AI-related certificates initiated by our college and divisional deans, with the goal of serving an industry desire for (non-programmer) managers to have an awareness about what an AI LLM is and how it differs from a human content provider. The expectation is then that this course would serve as a required course for these certificates. As such, a large portion of this course would be spent on mathematical models of human memory (specifically, distributed associative memory) and its use in human sentence processing, to serve as a contrast to transformer-based models, using related mathematical representations (attention matrices).

Given that goal from our end, would CSE still want to collaborate on the development of this course (condition 2 below)?

If not, are there other conditions CSE would like to attach about the name and/or content of the course to distinguish it from CSE offerings?

If CSE would still like to collaborate on development, are there any thoughts about how a ***programming*** version of this course would be cross-listed (condition 3 below, if that's the intent)? I'm not sure I see how programming and non-programming content could effectively be taught with the same lectures.

Thanks for your help!

William Schuler
Professor and Chair
Department of Linguistics
The Ohio State University

From: McCullough, Liz <mccullough.136@osu.edu>
Date: Tuesday, December 10, 2024 at 12:35 PM
To: Williamson, Donald <williamson.413@osu.edu>, Schuler, William <schuler.77@osu.edu>
Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Arora, Anish <anish@cse.ohio-state.edu>
Subject: Re: Concurrence request from Linguistics (LING 3804)

Thanks, Donald (and all)! We appreciate your efforts on this request. I'm looping in William Schuler here, as the faculty member involved in developing this course.

Best,
Liz

Liz McCullough, Ph.D.
Undergraduate Program Coordinator
Department of Linguistics
106 Oxley Hall
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mccullough.136@osu.edu

Pronouns: she/her/hers / Honorific: Dr.

From: Williamson, Donald <williamson.413@osu.edu>
Date: Monday, December 9, 2024 at 6:00 PM
To: McCullough, Liz <mccullough.136@osu.edu>
Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Arora, Anish <anish@cse.ohio-state.edu>
Subject: Re: Concurrence request from Linguistics

(LING 3804)

Dear Liz,

CSE discussed this course, and we agreed to provide a conditional approval of this proposal, based on the following conditions:

CSE can cross-list this course, where it will not be open to CSE students with credit in core CSE AI/ML courses (e.g., CSE 3521, 5523)

CSE and Linguistics will collaborate on the development of this course

CSE can offer a modified version of this course, that includes programming and other advanced topics

Ultimately, we see this as a timely and relevant course that would benefit students from both departments. We also believe our experience teaching this material would be useful. Let me know if you have any questions or if you'd like to discuss more.

Best,

Donald S. Williamson

Associate Professor

Director, [The ASPIRE Group](#)

Affiliated faculty, Translational Data Analytics Institute

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THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

From: Arora, Anish <anish@cse.ohio-state.edu>

Date: Thursday, November 21, 2024 at 10:22 AM

To: McCullough, Liz <mccullough.136@osu.edu>, Williamson, Donald <williamson.413@osu.edu>

Cc: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Morris, Jeremy <morris.343@osu.edu>, Blanas, Spyros <blanas.2@osu.edu>

Subject: RE: Concurrence request from Linguistics (LING 3804)

Hi Liz,

This is to acknowledge your message. By this message, I share the ask with our curriculum committee chair (Prof. Williamson)

for considering this matter and developing the committee's recommendation to me in this matter (as well with other folks who need to be in the loop for awareness). We've had a host of similar request, so I'll ask Donald to feedback to us about their ETA.

With best wishes,
Anish

Anish Arora
Distinguished Professor of Engineering and Chair
Computer Science and Engineering
Faculty Director, 5G-OH Connectivity Center
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Ingrid Rivera
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THE OHIO STATE UNIVERSITY

From: McCullough, Liz <mccullough.136@osu.edu>
Sent: Thursday, November 21, 2024 10:14 AM
To: Arora, Anish <anish@cse.ohio-state.edu>
Subject: Concurrence request from Linguistics (LING 3804)

Hi Anish,

Linguistics is seeking concurrence from CSE for a new undergraduate course, LING 3804, with the title "AI Models of Language." I've attached the syllabus and course request here, as well as the concurrence form. You can complete the form, or simply reply to this email with your recommendation. Of course, let us know if you need any clarification or additional information about the course.

We look forward to your response!

Best,
Liz

Liz McCullough, Ph.D.
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Pronouns: she/her/hers / Honorific: Dr.

Thursday, February 13, 2025 at 09:57:54 Eastern Standard Time

Subject: Concurrence request from Linguistics (LING 3804)
Date: Thursday, November 21, 2024 at 10:19:27 AM Eastern Standard Time
From: McCullough, Liz
To: Wegener, Duane
Attachments: LING 3804 syllabus revised.pdf, LING 3804 concurrence form.pdf, LING 3804 course request.pdf

Hi Duane,

Linguistics is seeking concurrence from Psychology for a new undergraduate course, LING 3804, with the title "AI Models of Language." I've attached the syllabus and course request here, as well as the concurrence form. You can complete the form, or simply reply to this email with your recommendation. Of course, let us know if you need any clarification or additional information about the course.

We look forward to your response!

Best,
Liz

Liz McCullough, Ph.D.
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