A&S New Course Proposal: CS 1671

A. Course:

Department: Department of Computer Science

Number: **CS 1671**

Title: Human Language Technologies

Credits: 3 credits

B. Instructors:

Rebecca Hwa (hwa@cs.pitt.edu), Assistant Professor

Diane Litman (litman@cs.pitt.edu), Professor

Janyce Wiebe (wiebe@cs.pitt.edu), Associate Professor

C. Departmental Approval:

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Chair's Signature   Date

Note to Chairs: Your signature indicates that you and the appropriate faculty or committee in your department believe that there is a demonstrated need for this course in your departments curriculum, and you have adequate resources, including TA support when appropriate, to offer this course on a regular basis.

D. Rationale for New Course:

Language is the primary medium through which humans make intellectual exchanges. The field of Natural Language Processing (NLP) studies computational approaches of analyzing human languages. It is concerned both with the scientific questions of how communication can be modeled as a mathematical process and whether the model may shed light on how people communicate with each other; and the engineering questions of how technologies that are aware of human languages can facilitate communications between people.

The introduction of this elective upper-level undergraduate course to the Computer Science curriculum is motivated by several reasons. *First, the course topic is of immense relevance to today's information-driven economy*. Computers are necessary tools to harness huge amounts of information, a great deal of which are communications in natural languages. For example, a well-designed search engine enables us to pin-point the desired information by efficiently processing through billions and billions of web-pages. We believe that it is imperative that students are prepared to wield technologies that will tame the ever-increasing information sources. *Second, the course builds upon foundational computer science concepts*. The proposed course affords students the opportunity to apply the abstract theory and algorithms they have learned in the earlier courses (CS 1501: Algorithm Implementation and CS 1502 Formal Methods in Computer Science) to concrete problems with real-world applications. This course is also complementary to existing advanced courses in the curriculum such as Artificial Intelligence (CS 1571, CS 1573). Whereas the existing courses touch on a wide range of topics relevant to AI at large, the proposed course offers more in depth. *Third, the course encourages interdisciplinary learning*. The greatest challenge to NLP is grappling with the ambiguity, irregularity, and complexity of human languages. To address these challenges would require the ability to put together ideas from not only computer science, but an understanding of topics from statistics, linguistics, philosophy, and cognitive science is also important.

We believe that the proposed course is a necessary addition to the undergraduate CS curriculum. The incorporation of this course into the curriculum will better prepare our students for both graduate-level studies and for demanding information technology positions in industry.

The proposed course is an elective, upper-level undergraduate course. It is primarily intended for Juniors and Seniors who have already passed the course on the foundational computer science courses. There will be two seventy-five minutes lectures per week.

A1. General Content:

This course provides an introduction to the field of Natural Language Processing (NLP) - the creation of computer programs that can understand, generate, and learn languages used by human. Natural language understanding will be used as a vehicle to introduce three major subfields of NLP: syntax, semantics, and pragmatics. The course will introduce both knowledge-based and statistical methods for NLP, and will illustrate the use of such methods in a variety of application areas.

A2. Purposes:

This course will expose students to real-world applications such as Speech Recognition, Information Retrieval, Dialogue Agents, Question Answering Systems, and Machine Translations by means of computational techniques such as search algorithms, dynamic programming, Hidden Markov Models, Probabilistic Context Free Grammars, and related machine learning algorithms.

A3. Methods:

Lectures, homework and term project (which will provide hands-on experience with actual systems), midterm and final exams.

B. Course Prerequisites:

CS 1501: Algorithm Implementation (with passing grade of C or better)

CS 1502: Formal Methods in Computer Science (with passing grade of C or better)

C. Recitations:

no recitation sections

D. Expected Size of Course:

52 students per section

E. Terms in which this course will be regularly offered:

Once every two years.

CS 1671: Human Language Technologies (Fall 2008)

A. Course objective: There are three main objectives for this course. First, this course aims to familiarize students with the basic concepts of processing human languages using computers. Second, this course provides students with opportunities to gain experience in conducting large-scaled empirical experimentations. Third, this course exposes students to advanced applications in human language technologies and afford them hands-on experience in working with these systems.

B. Organization: We will cover the following topics:

- Introduction (1 week)

    - Natural Language vs. Programming Language

    - Overview of linguistics

    - Review of probabilities

    - Review of formal language theory

- Speech recognition (2 weeks)

    - Acoustic Model

    - Language Model

    - Hidden Markov Model

- Syntactic Parsing (3 weeks)

    - Context Free Grammars

    - Parsing algorithms

    - Grammar Induction

- Semantics: Representing Meaning (3 weeks)

- – Knowledge representation

- – Semantic Analysis

- – Lexical Semantics

- Discourse (3 weeks)

  - – Reference resolution

  - – Text coherence

  - – Discourse structure

- Dialogue and Conversational Agents (1 week)

- Machine Translations (1 week)

- Information Retrieval (1 week)

C. Course Requirements: There will be a required textbook (Jurfasky and Martin), and possibly articles published in conferences/journals, or individual Chapters from other textbooks. Homework assignments will be comprised of both pencil and paper problem sets as well as larger programming projects (approximately one per topic area) There will be two exams: a midterm exam (during the 7th week of classes) and the final exam during finals week.

Materials will be posted on the class web page, which will be similar to the class web pages for CS 1571: `http://www.cs.pitt.edu/ hwa/cs1571/`

D1. Grading Policy (Weights):

Class Participation	10%
Midterm Exam	20%
Final Exam	30%
Assignments	40%

D2. Grading Policy (Late Policy): With the exception of special circumstances of medical or family emergencies, late assignments will not be accepted.

D3. Grading Policy (Other): Unless explicitly noted otherwise, the work in this course is to be done independently. Discussions with other students on the assignments should be limited to understanding the statement of the problems.

E. If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Office of Disability Resources and Services, 216 William Pitt Union (412) 624-7890 as early as possible in the term.

F. Academic Integrity Policy: Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, noted below, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the quiz, exam, paper or assignment will be imposed.

The integrity of the academic process requires fair and impartial evaluation on the part of faculty and honest academic conduct on the part of students. To this end, students are expected to conduct themselves at a high level of responsibility in the fulfillment of the course of their study. It is the corresponding responsibility of faculty to make clear to students those standards by which students will be evaluated, and the resources permissible for use by students during the course of their study and evaluation. The educational process is

perceived as a joint faculty-student enterprise which will perforce involve professional judgment by faculty and may involve without penalty - reasoned exception by students to the data or views offered by faculty.

Senate Committee on Tenure and Academic Freedom, February 1974

CS 1671: Assignment on Machine Translation Evaluations

Objective: Gain an understanding of the challenges in automatic evaluations of machine translation outputs.

Background: Below are 30 short machine-translated sentences. As a point of reference, each machine translated sentence is followed by three translations that were written by human translators. In this assignment, you will devise several evaluation methods that will automatically assess the quality of the machine translation, as compared with the human ones.

Part I: Before writing automatic evaluators, we'll first create a set of "gold standards" (i.e., how people might perceive the translation qualities of these machine-produced sentences). Read each sentence produced by the machine and compare it against the three human translations. Assign the sentence both an adequacy score (How closely do you think the *meaning* of the translation sentence matches the human translations) and a fluency score (How closely do you think sentence sound like Standard American English?); both scores should be on a scale from 1-5.

A guideline for adequacy judgment:

5: It has the same meaning as the human translations.

4: It has added something extra, or it has missed some small aspects that the human translations mentioned.

3: It mentions the same topic as the human translations, but misrepresented the relationships between them.

2: It uses some of the same words as the human translators, but no meaning is emerging.

1: It makes absolutely no sense.

A guideline for fluency judgment:

5: It is fluent at the level of a native English speaker.

4: It reads a little unnatural, but it is understandable.

3: It is written in broken English such that although the phrases are understandable, the sentence as a whole is hard to understand.

2: English-like phrases can be picked out, but the sentence makes no sense.

1: It looks like a string of words in random permutations.

Part II Write two automatic evaluation programs. One should computes the Minimum Edit Distance (MED) between the machine translation and the human references. The other one should compute the BLEU scores for these sentences (cf. http://www.ldc.upenn.edu/acl/P/P02/P02-1040.pdf).

Part III Compute the correlations between each automatic evaluation program's scores and your scores for these sentences. Which evaluation program agreed better with you? Examine those sentences in which the metrics strongly disagreed with you. Why did the automatic evaluation programs score these sentences the way they did? What aspects of the machine translations are these automatic evaluation programs not capturing? How would you modify these programs so that they might be better correlated with you?

Machine Translation Data File

E11-XIN20030110.0005-1

slovakia president leaves shanghai direction hong

slovakian president leaves shanghai for hong kong by air

slovak president leaves shanghai for hong kong

slovak president leaves shanghai for hong kong

E11-XIN20030128.0160-1

chinese cultural festival in ankara opens

chinese culture festival opens in ankara

the chinese culture festival inaugurated in ankara

chinese culture festival opens in ankara

E14-XIN20030108.0124-1

us defense department cancelled two test

us defense department calls off 2 missile intercept tests

u . s . department of defense cancelled two missile intercept tests

us defense department cancels two missile intercept tests

E14-XIN20030128.0160-1

chinese cultural festival opened in ankara

chinese culture festival opens in ankara

the chinese culture festival inaugurated in ankara

chinese culture festival opens in ankara

E15-AFC20030107.0003-1

bush to rejuvenation economic plan advocated

bush defends his economic stimulus package

bush defends his economic stimulus plan

bush defends his economic promotion plan

E15-XIN20030128.0160-1

chinese cultural festival in ankara inaugurated

chinese culture festival opens in ankara

the chinese culture festival inaugurated in ankara

chinese culture festival opens in ankara

E09-XIN20030110.0005-1

slovakian president flies hong kong to shanghai

slovakian president leaves shanghai for hong kong by air

slovak president leaves shanghai for hong kong

slovak president leaves shanghai for hong kong

E11-AFC20030102.0038-1

australia reopened its embassy in manila embassy

australia reopens embassy in manila

australia reopened manila embassy

australia reopens embassy in manila

E11-AFC20030110.0014-1

guard development research center praised environmental revolution

worldwatch institute praises environmental revolution

worldwatch institute applauds the environmental revolution

worldwatch institute hails environmental revolution

E11-XIN20030108.0124-1

the defense ministry lifted twice interceptor missile

us defense department calls off 2 missile intercept tests

u . s . department of defense cancelled two missile intercept tests

us defense department cancels two missile intercept tests

E11-XIN20030110.0170-1

the united states resumed received iraqi refugees

us resumes admission of iraqi refugees

u . s . resumes admission of iraqi refugees

us resumes to accept iraqi refugees

E14-XIN20030110.0005-1

slovak president left shanghai flying hong kong

slovakian president leaves shanghai for hong kong by air

slovak president leaves shanghai for hong kong

slovak president leaves shanghai for hong kong

E15-XIN20030121.0010-6

well under worker is transport equipment .

at the time , workers underground were moving equipment .

at time of the accident , the workers were in the pits moving equipment .

then workers underground were transporting equipments .

E12-AFC20030215.0016-10

the situation just the opposite . -RRB-

the situation is exactly the opposite . "

the situation is quite the contrary . "

it is on the contrary . "

E09-XIN20030121.0010-6

at that time mine shaft worker loader .

at the time , workers underground were moving equipment .

at time of the accident , the workers were in the pits moving equipment .

then workers underground were transporting equipments .

E11-AFC20030208.0077-1

krcevina silk life long hanging accidental return field

content with life , hingis has no desire to return to tennis

martina hingis happy with life and has no intention to return to the tennis court

hingis not willing to return to tennis court with leisurely life

E11-AFC20030218.0003-1

germany telecommunications industry mobilcom founder schmid declared insolvent

schmid , founder of german telephone operator mobilcom , declares bankruptcy

german telecommunications industry : schmid , founder of mobilcom , declares bankruptcy

founder of german telecom mobilcom schmid announces bankruptcy

E11-XIN20030111.0054-9

she voiced clear rich , full light .

her voice is clear , mellow and sweetly resonant .

her voice is sweet , loud and clear .

her voice is clear and mellow .

E12-AFC20030102.0038-1

the australian the re-opening office in manila embassy

australia reopens embassy in manila

australia reopened manila embassy

australia reopens embassy in manila

E12-XIN20030211.0146-4

now in iraq official inspectors about 110 .

at present , there are about 110 official arms inspectors in iraq .

at present , there are about 110 official inspection personnel in iraq .

there are now about 110 formal inspectors in iraq .

E14-AFC20030228.0014-6

analysis use only twice before their production .

only the data of their first two deliveries are used for analysis .

only the first two deliveries were used in the analysis .

analysis were only based on their previous two-birth information .

E14-XIN20030121.0010-1

lishu jixi coal mine gas explosion occurred at

gas explosion in lishu coal mine in jixi

a gas explosion took place at jixi 's lishu mine

gas explosion occurs in lishu coal mine in jixi

E14-XIN20030211.0146-4

the iraqi official inspectors about 110 people .

at present , there are about 110 official arms inspectors in iraq .

at present , there are about 110 official inspection personnel in iraq .

there are now about 110 formal inspectors in iraq .

E15-XIN20030122.0195-1

iraq war might international oil market supply enough

war in iraq may lead to sufficient supply on the world oil market

a war on iraq may cause abundant supply in international oil market

iraqi war may lead to sufficient oil supply in international oil market

E12-AFC20030228.0014-12

we believe this is a new found .

we believe this is a new finding .

we believe this is a new observation .

we think that this is a new discovery .

E09-AFC20030121.0005-1

mainland china handset user will grow will slow down

growth of mobile phone users in mainland china to slow down

mainland china : slower growth in number of mobile phone users

growth of mobile phone users ' numbers in chinese mainland to slow down

E09-XIN20030215.0094-1

japanese bell invest the development network videophone in shenyang

japan 's bell to invest in developing internet videophones in shenyang

japan bell invests in shenyang to develop ip visual phone

japan 's bell invests to develop network visual phone in shenyang

E11-XIN20030104.0061-1

belgium asked anchored dead soon samples contained fuel oil

belgium demands prompt pumping of fuel oil from anchored oil tanker

belgium demands broken-down oil tanker to have fuel oil pumped out urgently

belgium urges anchored oil tanker to pump up fuel on board

E14-XIN20030204.0083-4

warheads was carrying the goods , well preserved .

the warhead was tagged and kept in good condition .

the warhead was tagged and was kept in good condition .

the warhead was labeled and well preserved .

E15-AFC20030208.0047-1

yao ming sentiment nba the as to too fast

yao ming feels nba stardom comes too fast

yao ming sighed with emotion that the nba idol status comes too soon

yao ming feels too fast in becoming nba idol