Human Language Technologies (HLT) Workshop 2006

Machine Translation and Statistical Language Learning in the KSU Lab for Knowledge Discovery in Databases

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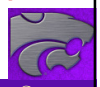
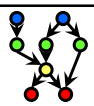
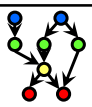
Joint work with: Waleed Al-Jandal, Tejaswi Pydimarri, Chris Meyer
Tuesday, 30 May 2006

Laboratory for Knowledge Discovery in Databases
Kansas State University
http://www.kddresearch.org/KSU/CIS/HLT-General-20060530.ppt





HLT Research at Kansas State: Scope, Goals and Technical Objectives



Outline

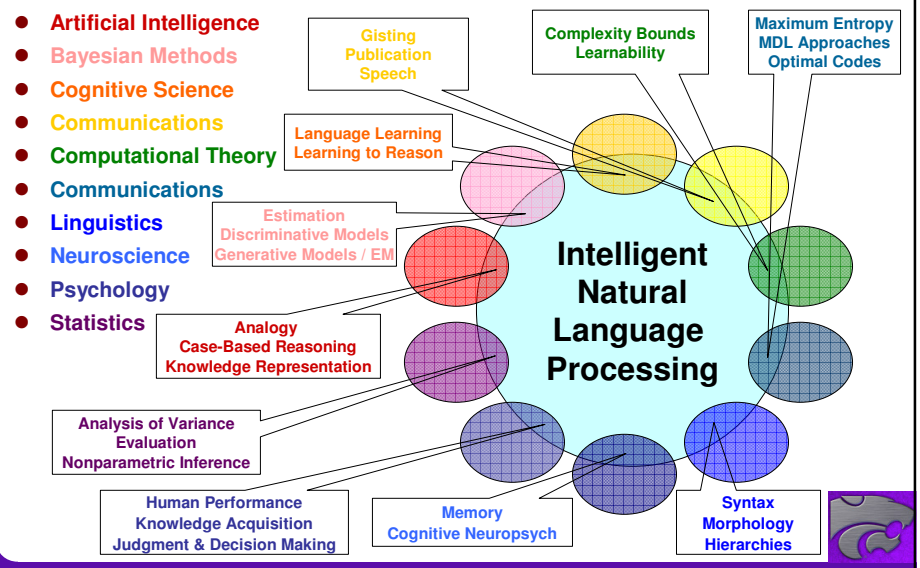
- **Background, Related Work and Rationale**
- **Technical Objectives and Significance**
- **Development Plan**
- **Preliminary Progress Report**
- **Future Directions: Opportunities for Collaboration**

Problem Statement: Machine Translation

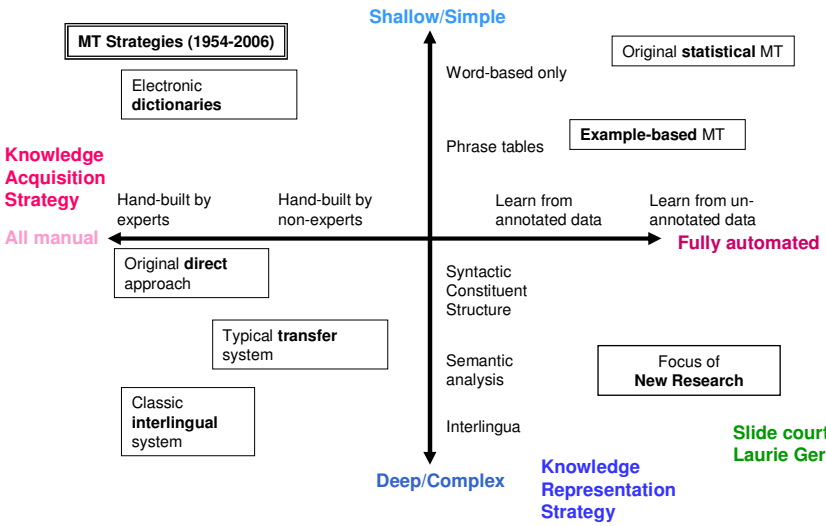
- **Basic Task Specification**
  - **Source: foreign sentence *f***
  - **Target: native sentence *e* (e.g., English)**
- **Input**
  - **Parallel training corpora (documents) or speech: (*f, e*) pairs**
  - **Usually, but not always, produced manually**
- **Expected Output: translations *e* for new sentences *f***
- **What Does This Mean?**
  - **Alignment, parsing tasks**
  - **Interactive, possibly real-time, translation tasks**

Overview: Enabling Technologies

- Artificial Intelligence
- Bayesian Methods
- Cognitive Science
- Communications
- Computational Theory
- Communications
- Linguistics
- Neuroscience
- Psychology
- Statistics



Background [1]: Translation Strategies



Slide courtesy of Laurie Gerber

Background [2]: Recent Progress in Statistical MT

Slide by C. Wayne, DARPA
from talks by Kevin Knight,
2003-2005

2002

insistent Wednesday may recurred her trips to Libya tomorrow for flying

Cairo 6-4 (AFP) - an official announced today in the Egyptian lines company for flying Tuesday is a company " insistent for flying " may resumed a consideration of a day Wednesday tomorrow her trips to Libya of Security Council decision trace international the imposed ban comment .

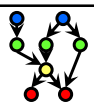
And said the official " the institution sent a speech to Ministry of Foreign Affairs of lifting on Libya air , a situation her receiving replying are so a trip will pull to Libya a morning Wednesday " .

2003

Egyptair Has Tomorrow to Resume Its Flights to Libya

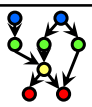
Cairo 4-6 (AFP) - said an official at the Egyptian Aviation Company today that the company egyptair may resume as of tomorrow, Wednesday its flights to Libya after the International Security Council resolution to the suspension of the embargo imposed on Libya.

" The official said that the company had sent a letter to the Ministry of Foreign Affairs, information on the lifting of the air embargo on Libya, where it had received a response, the first take off a trip to Libya on Wednesday morning ".



Related Work: Phrase-Based Learning for SMT

- 1. phrase alignments from word-aligned model
  - Used in GIZA++ toolkit [Och & Ney, 2000]
  - See IBM models [Brown, 1993]
- 2. linguistically motivated models
  - [Yamada & Knight, 2001; Imamura, 2002]
  - Require subtree matching in syntax tree (parse tree)
- 3. joint phrase model
  - [Marcu & Wong, 2002]
  - Directly learns phrase-level alignment of parallel corpus
- 4. generative phrase alignment [Koehn, Och & Marcu, 2003]
- 5. hierarchical models [Chiang, 2005; Taskar, 2005]



RATIONALE

- What Works: Phrase-Based Translation Methods
- Who it Works for & When & Where it Works
  - 5S: Streams, Structures, Spaces, Scenarios, Societies
  - Application context: the "performance element"
- How/Why it Works: Synthesis of Technologies
  - 1. Moore's Law: Advances in Processing Power
  - 2. Better Metrics: Bilingual Evaluation Understudy (BLEU)
  - 3. Bigger Corpora: Arabic, Chinese
  - 4. New Technical Advances in Computational Linguistics

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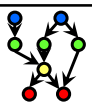
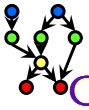


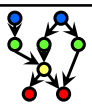
Limitations of Current State of the Art

- Applications: How Far Can Current Methods Take Us?
- Role of Knowledge
  - Correction models
  - Context-specificity
- "Use What Works": Brute-Force Technology?
  - Unsatisfying for grammarians, semantics researchers
  - Some successes with latent semantic analysis in NLP
- Info Retrieval (IR) vs. Extraction (IE), Understanding
- Utility Measures: Are Metrics Meaningful?



Novel Contributions [1]: Context-Specific Machine Learning

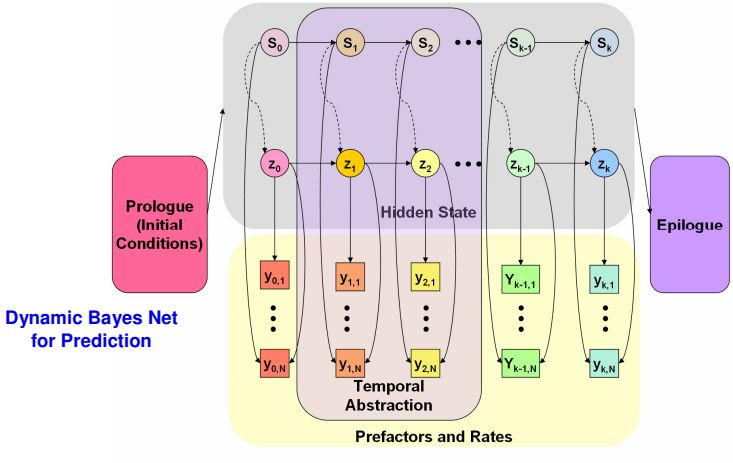
- Using Context
  - Word-sense disambiguation (Roth, 1998)
    - ⇨ Homonyms
    - ⇨ Part-of-speech tagging
  - Context-Specific Independence
    - ⇨ Knowledge maps *aka* probabilistic similarity networks (Heckerman, 1991)
    - ⇨ Graphical models (Boutillier *et al.*, 1996)
    - ⇨ Entity clustering (Barash & Friedman, 2002)
- Detection of Hidden Changes in Context
- Contextual Correction



Novel Contributions [2]: Relational Knowledge Representation

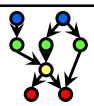
- First-order relational models
  - Description logics
  - Graphical models
- Representation: Bridging Learning and Reasoning
- Semantics
  - Traditional wisdom: tradeoff
  - New idea (cf. Koller, 2001)
    - ⇨ Greater expressiveness
    - ⇨ Lower complexity

Novel Contributions [3]: Learning in Graphical Models



Continuing Work:
Speeding up Approximate Inference using Edge Deletion - J. Thornton (2005)
Bayesian Network tools in Java (BNJ) v4 - W. Hsu, J. M. Barber, J. Thornton (2006)

Technical Plan: Development Objectives, Progress, and Collaboration Opportunities



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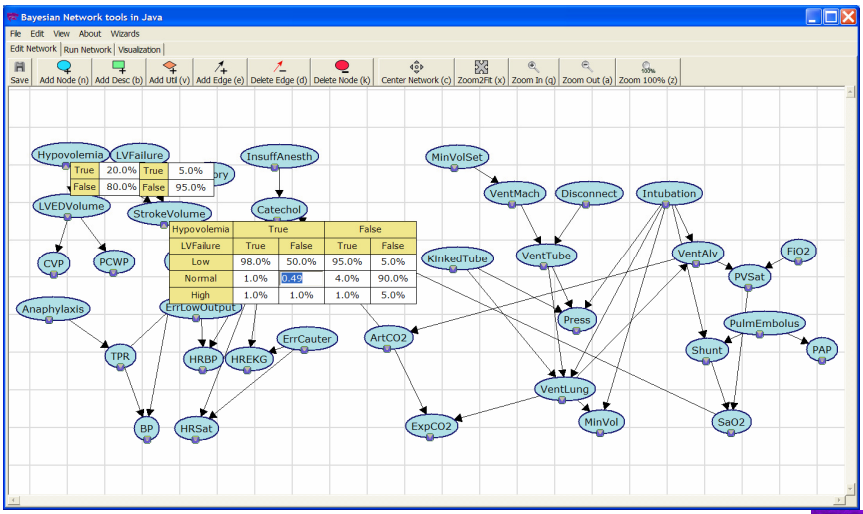
Development Plan: Approximate Timeline

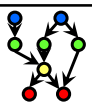
- 2005
  - Spring: Statistical Machine Translation (SMT) Group founded
  - Fall: SMT seminar – 12 papers on state of the field
  - Resource: SMT bibliography
- 2006
  - Spring: getting set up with corpora, GIZA, BLEU
  - Summer: NIST evaluation; BNJ v4 releae
  - Fall: SMT seminar – lessons learned; Targeted Excellence on HLT
  - Winter: how-to workshop on MT techniques; BNJ v5 development
- 2007 and Beyond
  - Spring: regional workshops on Learning, Memory, Cognition
  - Fall: tools integration

Bayesian Network tools in Java (BNJ) v4



© 2005 KSU Bayesian Network tools in Java (BNJ) Development Team

ALARM Network



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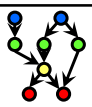
Preliminary Progress Report: 2001-2006

- 2001: Start of KSU Bioinformatics program
- 2002: EPSCoR First Award, bioinformatics, BNJ v2
- 2003: Summer KSU REU in Bioinformatics, BNJ v2, SRL-2003
- 2004: NSF ITR & FIBR; BNJ v3; ICSNW workshop, PODS-2004
- 2005: Start of Statistical Machine Translation (SMT) Group
- 2006: Learning, Memory, and Cognition Working Group
  - Development of end-to-end SMT system inspired by GIZA
  - Registration for 2006 NIST Evaluation
  - BNJ v4 & 5
  - HLT Targeted Excellence proposal
- 2007 & Beyond: interfaces – new BNJ/GEM, WEKA, ECJ

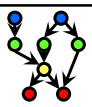


Work in Progress

- End-to-end Statistical Machine Translation System
  - Flexible, modular tools for
    - Alignment
    - Parsing
    - Phrase-based learning
    - Transformation-based learning (cf. Brill)
  - New modules substituted into infrastructure as completed
- Comparisons with New Corpora
  - Media studies: political journalism, large-volume data mining
  - Language studies: historical linguistics, etc.
- New Metric Development

Methodology

- Overall Scientific Approach
  - Using context-specific learning
  - Classification-based error detection
    - Committee machines: bagging & boosting
    - Mixture models: hierarchical mixture of experts (HME), etc.
    - Cascade filters
  - Integrative semisupervised learning
    - Clustering
    - Human categorization and ontology development
- Applications-Oriented: Real Translation Tasks
- User-Centric: Real Task-Specific Metrics



Next Steps

- Establishing an Interdisciplinary Research Initiative
  - K-State / KU / UNL collaboration
  - Resources: Linguistic Data Consortium
  - NIST evaluations
- Involving End Users of Machine Translation
  - Document users
  - Machine learning, data mining, info extraction researchers
- Novel Applications
  - Social networks and collaborative recommendation
  - Gisting and beyond

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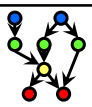
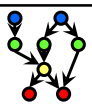


Opportunities for Collaboration [1]: Computational Sciences

- Information Extraction and Intelligent IR
  - Learning models for IE: ontologies
  - Latent semantic analysis
- Machine Learning
  - Natural language learning
  - Time series learning and understanding
  - Relational and first-order models
- Automated Reasoning
  - Probabilistic
  - Case-based and analogical
- Data Mining and Warehousing
- Grid Computing

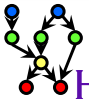
Opportunities for Collaboration [2]: Application and User-Centric Disciplines

- Anthropology
- Human Factors
- International Studies
  - Policy Studies
  - Business: Trade, Finance
  - Cultural Studies
- Journalism
- Library Science
- Modern Languages
- Political Science



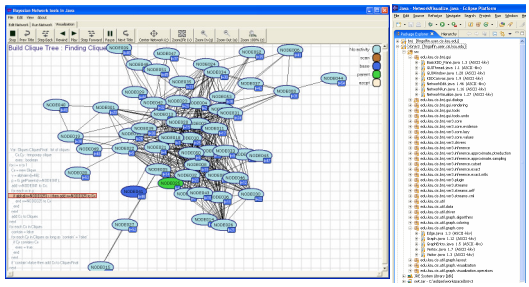
Opportunities for Collaboration [3]: Linguistics and Psychology

- Cognitive Science
  - Intelligent systems and cognitive modeling
  - Cognitive neuropsychology: lesion studies, fMRI, *etc.*
- Educational Psych: Human Language Acquisition
- Ergonomics and Human Factors
- Linguistics: Computational Models of Language Production
- Judgment and Decision Making
  - Computational linguistic models of dialogue, negotiation
  - Utility-theoretic models of translation evaluation
- Psycholinguistics
  - Computational models
  - Translation as experimental test bed

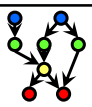


Educational Outreach: Human-Computer Interface Issues

- Desiderata
  - Usability (Q&A)
  - Ergonomics
  - Accessibility
  - View control
- Elements
  - Unified data model
  - Visualization widgets
  - Figures of merit, evaluation mechanism (cf. *BNJ*)
- Outreach: HCII Overlap & Tech Transfer



CPCS-54 Network © 2004 KSU BNJ Development Team



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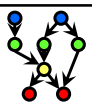

Acknowledgements

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  - Violetta Cavalli-Svorza (USA, Carnegie Mellon University)
  - Susan Gauch (USA, University of Kansas)
  - Abdelhadi Soudi (Morocco)
  - Kirsten Hildrum (IBM T. J. Watson Labs)
  - More collaborations sought in HLT and HCII!

Questions and Discussion