Interactive Question Answering

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June 8, 2006
What is Interactive Question-Answering?

- What is the problem we are trying to solve?
- Who is asking the questions?
  - Information professionals → intelligence analysts
  - What are the information needs?
  - One view of the information needs of the intelligence analyst
- Question-Answering?
  - What kinds of questions?
  - What is different about question-answering?
  - Why “question-answering”?
- Interactive?
  - What are the dimensions of “interactivity”?
  - Why “interactive”?
- Challenges for the future
What is the problem?

- Tsunami of information
  - “In the last 30 years mankind has produced more information than in the previous 5,000.” *(Information Overload Causes Stress. March/April, 1997. Reuters Magazine)*
  - Reduced time for reasoning and decision-making

- Technology contributes to the problem
  - Vast amounts of information made available
  - Even with filters, amount is huge
  - “Technostress” (coined in 1984 by Craig Brod, a clinical psychologist; “inability to cope with new computer technologies”)
Problem (2)

- Need to target quality information
  - Challenge: Not everyone’s notion of quality is the same
  - Relevant, sourced, time-anchored, specific answer, broad answer?

- Technologists’ solutions are often technically but not socially adequate
  - High rate of new information, contradictory information, huge amounts of irrelevant data, data duplication → frustration
  - Data usefulness and value

- Need technologies that
  - target information and
  - take into account the social dimensions of information
Who is the audience?

- Casual user: Pieces of information; often unconstrained topics
- Information professional
  - Subject-matter expert
  - Access to large amounts of diverse data
  - Responsible for problem domain
    - Over time
    - Short-term tasking and insights
  - Work cooperatively with others interested in the same or closely related topic (e.g., biological weapons → financial information)
  - Bring to bear
    - Expertise
    - Domain knowledge
    - World knowledge
    - Reasoning, aggregation of information and prediction
- Intelligence analysts, detectives, lawyers, historians, anthropologists, news reporters
Intelligence analysis (1)

- Analysts
  - Generally, expert in a mission or topic area
    - Ordinarily, well-educated in the subject area
    - Know what they need to find out
      - If the task is to identify drug smuggling routes out of Afghanistan, an economic analyst may want to know whether the soil in a suspected smuggling area supports cultivation of poppy
  - Constantly cognizant of pedigree and reliability (source, date, etc.) of information
  - Require answer/information justification ("how did you arrive at that answer?")
- In most cases, there is a potential problem, not yet a real one
  - Role is to detail and anticipate a problem
  - Historical information valuable for contribution to future planning and current status: past behavior may predict future actions
  - Less frequently proving a case based on history, e.g., murder; more like serial killer
Intelligence analysis (2)

- Characterization of information needs of intelligence analysis
- Risk Assessment
  - Traditionally, risk defined as probability (of a known phenomenon) x consequences (degree of harm) (in insurance or banking, for example)
  - Based on historical data
- In intelligence analysis
  - Don’t know the event
  - Factors are not limited to statistical likelihood
  - Analytic risk assessment has multiple dimensions
    - Motivation and intent
    - Knowledge and resources
    - Opportunity and vulnerabilities
  - Constant set of questions address these factors
Intelligence analysis (3)

Dimensions of Risk Assessment

- **MISSION and TASK**
- **Who?**
- **Why?**
- **What?**
- **Motivation and Intent**
- **Knowledge and Resources**
- **Opportunity and Vulnerabilities**
- **When?**
- **Where?**
- **How?**

Who?

Why?

What?
Intelligence analysis (4)

- Weapons of mass destruction
- Motivation and Intent
  - Who? Terrorist organizations, scientists, states of interest
  - Why? Psychological impact, money, fear, power
  - What? Plans, activities
- Knowledge and Resources
  - What? What are the characteristic of chemical weapons? Grade (military, industrial grade); Form (liquid, gas, powder); Effect (blister, choking, blood, nerve); Mortality (high, limited, none)
  - Who? Bioscientist with access to a lab; plastics factory employee
  - How? Access to financial resources; safe houses
- Opportunity and Vulnerabilities
  - Where? Transportation centers, nuclear plant locations, financial institutions
  - Who? Travel plans
  - When? Events of interest, past targets
  - How? IED, airplane
Este, un espacio propicio para reflexionar sobre el despertar de los pueblos en la lucha por la autodeterminación, la soberanía, la integridad territorial, la independencia, la paz y contra la guerra imperialista encabezada por el gobierno de los Estados Unidos de América…

Por eso queremos expresarles unas reflexiones sobre la lucha del pueblo colombiano por la Paz con Justicia Social.

**Fuerzas Armadas Revolucionarias de Colombia (FARC)**

**Who?**
- Organization name
- Members
- Size
- Leadership
- Roles
- Location
- Mission...

**Who?**
- Name
- Age
- Birthplace
- Location
- Education/Skills/Political Views
- Family
- Associates...

**Why?**
- Motivation
- History
- Culture...

**How?**
- State sponsorship (money, arms…)
- Drug trafficking...

**What?**
- Kidnapping
- Car bombing
- Murder...

**Where?**
- Location
- Targets
- Vulnerabilities
- Activities...

**When?**
- Travels
- Accesses…
Intelligence analysis (5)

- The analyst must
  - Collect and reason about the information discovered
  - Stay aware of new data, new ideas from colleagues working on related problems, new events
  - Integrate new information into standing hypotheses, evaluate it and assess how it fits into a growing picture
    - Being open to different hypotheses is crucial to successful analysis
- Analyst needs assistance in finding targeted, relevant information
Finding information (1)

- Search engines
  - Moving slowly into the question-answering space
  - Some have added expanded searches
  - However, generally remain key-word based and retrieve document lists

- World Wide Web
  - Current technologies (Google, et al.) provide rapid and massive access
    - Good for the “information novice”
    - Generally, looking for single facts
      - User knows there is an answer → may not know the answer but knows it’s there
        - What is the capital of Tajikstan? Countries have capitals…
        - When was Ghandi born? People have birth dates…
Finding information (2)

- Knowledge bases
  - Domain information
  - Issues
    - Effective for fixed domains, which do not change greatly
    - Generation of new axioms both time and resource intensive

- Commercial efforts
  - Frequently Asked Questions (FAQs)
  - Access to standing repositories of information (help manuals, instructions, knowledge stores, etc.)
  - Assisting with information access in educational settings
  - Domain-specific
Finding information (3)

- Most of today’s technologies do not target specific information needs
  - “Will Indonesia impose sanctions against terrorism?”
    - Google: 368,000 pages
    - None of the top 10 documents has information which answers this question

- Are there other, robust ways of finding information that
  - Integrate information from multiple documents
  - Understand and respond to the specific needs of the user
  - Suggest the presence of unrequested but related information
  - Propose alternate paths of exploration to the user?
Question-answering as a solution

- DTO’s AQUAIN (Advanced Question Answering for Intelligence) Program
- Advanced research program
  - Leader in the support of question-answering research
  - Has produced dramatic results over the past four years
    - Participants have established the benchmark for success in TREC at over 70%
  - Has moved beyond factoid questions into highly complex questions involving multiple dimensions and reasoning
  - Incorporates the human and social dimensions of information to provide a cooperative discovery environment
- Design
  - QA systems must
    - Understand the question
    - Discover the information
    - Formulate the answer
Question Understanding/Negotiation

Answer Discovery

Question Formulation

Answer Generation and Presentation

Ranked list of relevant answers with pedigree, access to original source document, time
Cross-document information integration
Direct access to relevant multilingual and multimedia data
Inferences indicated and justified
Missing data identified
Alternative/additional exploration paths suggested
Goals

- Provide a natural interface with the data
  - Reduce need to relate to the technology as an engineer
    - Questions in natural language
    - Dialogue-appropriate follow-up questions
      “What’s the GNP in Nepal? In Laos?”
  - Present answers, not lists of documents
- Tackle difficult language problems
  - Redundancy
  - Semantic similarity
  - Semantic inferencing
  - Missing and contradictory information
  - Deception
  - Time of information
  - Event characterization
  - Relevance
  - Opinions
- Move beyond single facts to answers built from multiple sources, data types and information requiring inference
Factoids

- Who is Alvaro Uribe Velez?
- What countries have participated in genocide in the past 30 years? List, from different sources.
- What plant can be used to treat burns?

**Document:** Aloe is effective at soothing scorched skin. (No shared terms in question and document)

Complex Questions

- Does Iran have missiles that could reach Israel?

**Answer:** “Yes. Here is a list of Iran’s current missiles and their ranges. Tel Aviv is 986 miles from Tehran….” (Missile types, range, calculation of distances)

Reasoning

- Was the biogeneticist, Muhammad Hamid, in Qatar on February 12, 2004?

**Reasoning:** Coreference (Hamid, he; biogeneticist, genomics); location (Qatar, Doha); temporal (February 12, 2004, falls between January 31, 2004, and February 17, 2004)

- Is Iran planning on ending its persecution of Baha’is?

**Document:** [No text stating that Iran plans to put an end to religious persecution.]

**Reasoning:** Ahmadinejad announced the jailing of Baha’i leaders in Tehran. Ahmadinejad refused to meet with international religious leaders.
AQUAINT (4)

- Substantial progress to date

Challenges remain
- Data fusion
- **Interactive QA**
- Multilingual and cross-lingual question-answering
- Advanced reasoning
- Social inferencing
Interactive question-answering

- AQUAINT program began addressing interactivity with “scenarios” or “tasks”
  - Scenario provides a context in which the questions will be asked and answered
  - Task reflects analytic assignment (but is only one part of the overall work the analyst is to perform)
    - Overall goals of the assignment
    - Expected dimensions to be addressed
    - Target audience for report
    - Time frame of submission

- Provides a context
  - Broad area of interest
  - Frame within which to work
  - Multiple, related questions can be generated
The Secretary of State has observed the growth of China as an economic power and has an on-going interest in understanding the role that China will play on the world scene.

As an expert on China’s economic activities and actions, you have been asked to research the following topic.

China has had a one-child policy in effect since 1979. It was implemented to keep its population growth manageable. A consequence of this policy has been a gender imbalance in the population, favoring males. Social scientists have expressed concern about societies in which there is a significant imbalance between the number of males and the number of females. What social and economic impact does such an imbalance have? What consequences has it had or will it have on China? What is China’s stance with respect to the one-child policy today? What are the prospects for the long-term social, mental and economic health of the country given their stance on this policy?

You have one week to prepare your report.
Dimensions of interactivity (1)

- How can the machine support such tasks?
  - By being a partner in the research
    - Break down the assignment into sub-tasks
    - Respond to questions by anchoring both questions and answers to the task
    - Suggest alternative avenues of exploration as related information is discovered
  - This partnership requires interactivity

- What does it mean for a question-answering system to be interactive?
  - More than human-computer interface and habiltability
  - How does the computer actually support and anticipate the user’s information needs?

- Multiple perspectives on interactivity related to question answering
  - Human – Machine
  - Human – Data
  - Machine – Context
  - Human – Human
Dimensions of interactivity (2)

- **Human-machine interaction**
  - Labov (1972) argued that discourse is highly structured, including question answer pairs
  - Such structure leads to expectations about behavior
    - Conversational principles
      - Grice: “…maxims…are better construed as…principles that we as listeners rely on and as speakers exploit.” (Bach 2005)
        - **Maxim of Quantity**: Information
          - Make your contribution as informative as is required for the current purposes of the exchange.
          - Do not make your contribution more informative than is required.
        - **Maxim of Quality**: Truth
          - Say what you believe to be true.
          - Do not say that for which you lack evidence.
        - **Maxim of Manner**: Clarity
          - Avoid obscurity of expression.
          - Avoid ambiguity...
        - **Maxim of Relation**: Relevance
          - Be relevant.

- **Discourse structure**
  - Sequence of questioning: coupled by topic
  - More information permits discourse to proceed
Dimensions of interactivity (3)

- Can question-answering systems follow such social principles?
  - Answer the information need specifically: Maxim of Quantity?
    - Not lists of documents
    - Avoid duplication and redundancy
  - Assure question understanding through clarification: Maxim of Manner?
    - “I’m sorry. I don’t understand your question. Could you restate it.”
    - “What is the largest country in Southeast Asia?”
    - “By largest, do you mean in land area, population, GNP or other?”
  - Make the answer relevant: Maxim of Relation?
    - Methods to define the range of relevant information
      - Negotiate the information space
      - Take the user beyond a single answer into additional data to explore
  - Provide evidence for the answer: Maxim of Quality?
    - Source
    - Justification
    - Reasoning
  - Support the discourse by topic expansion: Discourse progression
Dimensions of interactivity (4)

- Human-data dimension
  - In order to ask productive questions, important to understand the data
    - What’s in the data?
    - What data might be relevant?
    - Answers to single questions do not provide a notion of the breadth of the data coverage
  - Even after being told that the data are restricted to biographical data, users will ask questions that the system is unlikely to be able to answer
    - Film Notting Hill: “Do you have John Grisham’s new book?” “No, this is a travel bookstore.” “Do you have Winnie the Pooh? …”
  - If it’s not in the data, the system cannot bring it back
How might a system do this?

- Rank-ordered results with indicator of degree of relevance
- Graphic representation of the answer space: how many items hit the bull’s eye, how many are on the periphery…?
- Propose related or alternative paths of inquiry: what additional questions could you ask, how fruitful will another path be, how much information is there on the topic…?
Dimensions of interactivity (6)

- **Machine-context dimension**
  - Making sure that information is relevant is crucial
  - Analyst brings many resources to the interaction
    - Expertise
    - Preferences: relevance, quality, presentation
    - Question history
    - World-knowledge
    - Task or assignment
    - Model of interactions; discourse repository
  - These sources serve as a framework for the system:
    - Decompose tasks into series of questions
    - Access the correct data sources
    - Increase ranking of relevant answers
    - Perform appropriate inferences
    - Present answers in preferred form
Dimensions of interactivity (7)

- Human-human dimension
  - Collaboration
    - Traditional: Overt
      - Question formulation
      - Avenues of exploration
      - Hypothesis development
    - Tacit
      - Stored exploration paths by others
      - Question repository developed from the data
      - Sharing without effort
      - Stimulation of new ideas without interaction

"Sometimes you get a brainstorm, sometimes you only get the clouds."
Challenges for the future (1)

- Finding answers
  - Inference
    - Knowledge inference to improve information discovery
    - Social inferencing to support the users’ needs and expectations
  - Time, opinions, events, co-reference, perspective variation
  - Information as evidence

- Data diversity
  - Genres: blogs, email, newswire
  - Media: video transcripts, audio
  - Types: structured, unstructured
  - Sources: multilingual
Challenges for the future (2)

- Interactivity: Role of technology in supporting users’ information needs?
  - Partner in exploration
  - Social partner
  - Shared thought space
  - Tacit collaboration
  - Mission responsiveness: ask the right questions – unprompted
Thank you!