



Question Answering

NLP Seminar, Fall 2009, TAU

A presentation by Ariel Stolerman
Instructor: Prof. Nachum Dershowitz

Overview

- ▶ What is Question Answering?
- ▶ Approaching QA
 - ▶ Answer extraction
- ▶ A brief history
- ▶ Main Domains
 - ▶ NL database systems
 - ▶ Dialog systems
 - ▶ Reading comprehension systems
 - ▶ Open domain QA
- ▶ TREC
- ▶ **Question answering based on semantic graphs**



What is Question Answering?

- ▶ **Main aim:**

- present the user with a short answer to a question rather than a list of possibly relevant documents.

- ▶ Difficult finding answers on the WWW → QA Tech becomes more relevant

But what is a good answer?

Approaching Question Answering

- ▶ **Domains:**
 - ▶ Closed domain QA:
dealing with questions under a specific domain
 - ▶ Open domain QA:
dealing with questions about basically everything
- ▶ **General approach:**
 - ▶ Analyze and classify the question
 - ▶ Using information retrieval techniques, construct a subset of available relevant documents
 - ▶ Analyze the retrieved documents, search for wanted entities
 - ▶ If found, return the entity as a response, i.e. extract answer



Where do answers come from???

▶ Question reformulation pattern

Q: What is a dog?

▶ Word matching

A: A dog is *an animal*...

▶ Question Classification

▶ Semantic parsing:

Relational qtargets - R-CAPITAL-PLACE - What is California's capital?

▶ Type matching (role labeling)

Abstract qtargets - A-DEFINITION, A-WHY-FAMOUS-PERSON - Who was Jane Goodall?

▶ Relation matching

▶ **Logical inference**

▶ Ranking pairs inference (hypernyms, synsets)

Was WalMart sued for sexual discrimination?

▶ WSD

▶ World knowledge

▶ Coreference resolution

▶ ...

▶ Definitions

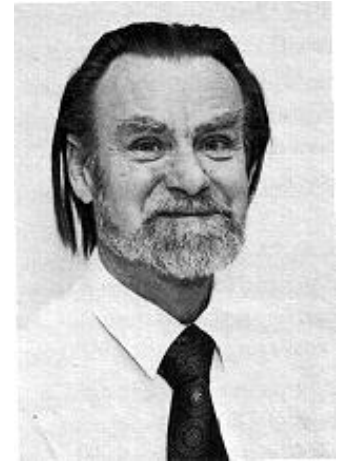
T: *WalMart defended itself in court today against claims that its female employees were kept out of jobs in management because they are women*

▶ Clarifications from the user

H: *WalMart was sued for sexual discrimination*

A brief history of QA

- ▶ Not a new field of research – Simmons, 1965
“have a conversation with a book”
- ▶ Can be found in many areas of NLP research:
 - ▶ Natural language database systems
 - ▶ Dialog systems
 - ▶ Reading comprehension systems
 - ▶ QA in open domains



Natural Language Database Systems

- ▶ Analyzing questions to produce a database query

“list all players who scored more than 600 points in all games in 2009”

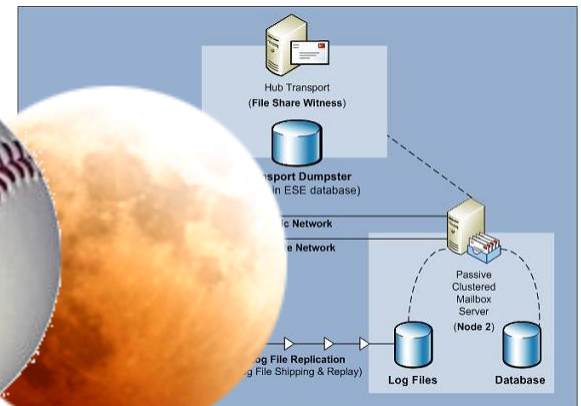


```
select player_name
from players
where (total_score > 600) and (year=2009)
```

- ▶ From the first QA systems to be created

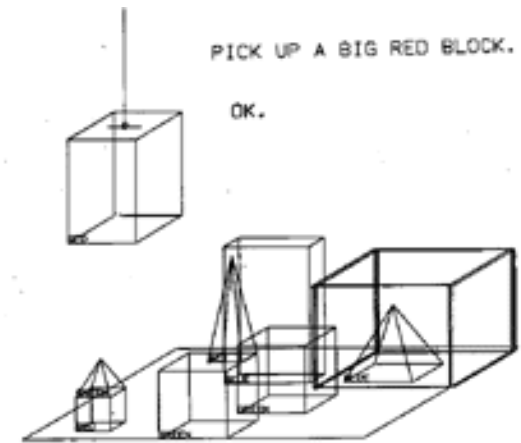
- ▶ Examples:

- ▶ BASEBALL
- ▶ LUNAR



Dialog Systems

- ▶ Conversation with a computer
 - ▶ Answering questions
- ▶ Examples:
 - ▶ SHRDLU
 - ▶ [ELIZA](#)
 - ▶ chatterbots



```
Person: PICK UP A BIG RED BLOCK.  
Computer: OK. (does it)  
Person: GRASP THE PYRAMID.  
Computer: I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.  
Person: FIND A BLOCK WHICH IS TALLER THAN THE ONE YOU  
ARE HOLDING AND PUT IT INTO THE BOX.  
Computer: BY "IT", I ASSUME YOU MEAN THE BLOCK WHICH  
IS TALLER THAN THE ONE I AM HOLDING.  
Computer: OK. (does it)  
Person: WHAT DOES THE BOX CONTAIN?  
Computer: THE BLUE PYRAMID AND THE BLUE BLOCK.
```


Reading Comprehension Systems

- ▶ Used to test reading level of school children
- ▶ Using reading comprehension systems to test language understanding of computer systems
- ▶ Examples:
 - ▶ QUALM
 - ▶ Quarc
 - ▶ Deep Read



How Maple Syrup is Made

Maple syrup comes from sugar maple trees. At one time, maple syrup was used to make sugar. This is why the tree is called a "sugar" maple tree. Sugar maple trees make sap. Farmers collect the sap. The best time to collect sap is in February and March. The nights must be cold and the days warm. The farmer drills a few small holes in each tree. He puts a spout in each hole. Then he hangs a bucket on the end of each spout. The bucket has a cover to keep rain and snow out. The sap drips into the bucket. About 10 gallons of sap come from each hole.

- Who collects maple sap? (Farmers)
- What does the farmer hang from a spout? (A bucket)
- When is sap collected? (February and March)
- Where does the maple sap come from? (Sugar maple trees)
- Why is the bucket covered? (to keep rain and snow out)

Open Domain QA

- ▶ No specific domain restrictions
- ▶ Use of large text collections
- ▶ The WWW is the most popular text collection source for open domain systems
- ▶ Pros and Cons:
 - ▶ No limitation = lots of information / false information
 - ▶ Dated information / Outdated information



TREC – Text Retrieval Conferences

- ▶ Encouraging IR research areas since 1992
- ▶ Numerous tracks exploring numerous research fields:
 - ▶ Genomic track
 - ▶ Legal track
 - ▶ ...
 - ▶ Question Answering
- ▶ Increasing difficulty from year to year

Text REtrieval Conference (TREC)

...to encourage research in information retrieval from large text collections.



TREC QA track: <http://trec.nist.gov/data/qamain.html>

Question Answering based on Semantic Graphs

Lorand Dali, Delia Rusu, Blaž Fortuna, Dunja
Mladenić & Marko Grobelnik

Department of Knowledge Technologies,
Jožef Stefan Institute, Slovenia

Presented at the WWW conference, Madrid, April 2009

Motivation

FEATURE - Chinese medicine threatens Sumatran tiger.

Two of Indonesia's three species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say.

According to traditional Chinese medical belief, mental problems, laziness, malaria, epilepsy, toothache and lack of sexual appetite can be treated with tiger parts, leading to rampant poaching.

"Poaching is changing all the time...this trend for tiger products is new. There are people wanting tiger products who didn't want them before," Ron Lilley, coordinator for species conservation at WWF, said.

Lilley said tigers in Indonesia, now reduced to about 500 animals on the island of Sumatra, are particularly vulnerable. Poaching is a severe threat, with huge markets for tiger bones in China.

"This is...perhaps a billion-dollar industry, mostly illegal and run by people not interested in sustainability," he said.

According to South Korean immigration statistics, the country imported 3,994 kilograms (8787 pounds) of tiger bones from Indonesia between 1970 and 1993, making Indonesia their largest source.

That's a lot of tigers, Lilley said, since the bones of one tiger weigh less than 10 kilograms (22 pounds).

Speaking this week after the announcement of a joint venture with photo equipment manufacturer Kodak, which has pledged 50 million rupiah (\$21,000) to saving the Sumatran tiger, Lilley said.

"Our estimate is that 14 tigers are killed every year...maybe more. A population of less than 100 tigers has a very low possibility of surviving for the next 50 years because there can be no genetic diversity," he said.

Extinction of the tiger is a real fear in Indonesia, which has seen the Bali tiger die out in the 1940s and the Java tiger disappear in the late 1980s.

Despite concerns over poaching, the biggest threat to the Sumatran tiger is the destruction of its habitat, Lilley said.

"Tiger populations have crashed without exception in all areas of the world," Lilley said. In Indonesia, this was "in the balance because conservation areas are being eaten into."

The WWF estimates the world tiger population at about 7,200. There are around 3,750 Bengal tigers left in India and just under 2,000 tigers in Southeast Asia, excluding Indonesia.

Subijanto, a spokesman for the Forestry Ministry, said Indonesia was committed to protecting the tigers, which live within Sumatra's four designated conservation areas.

The Kerinci conservation project, an area of around three million hectares (7.4 million acres) in west Sumatra, was being supported by funds from the World Bank, Subijanto said.

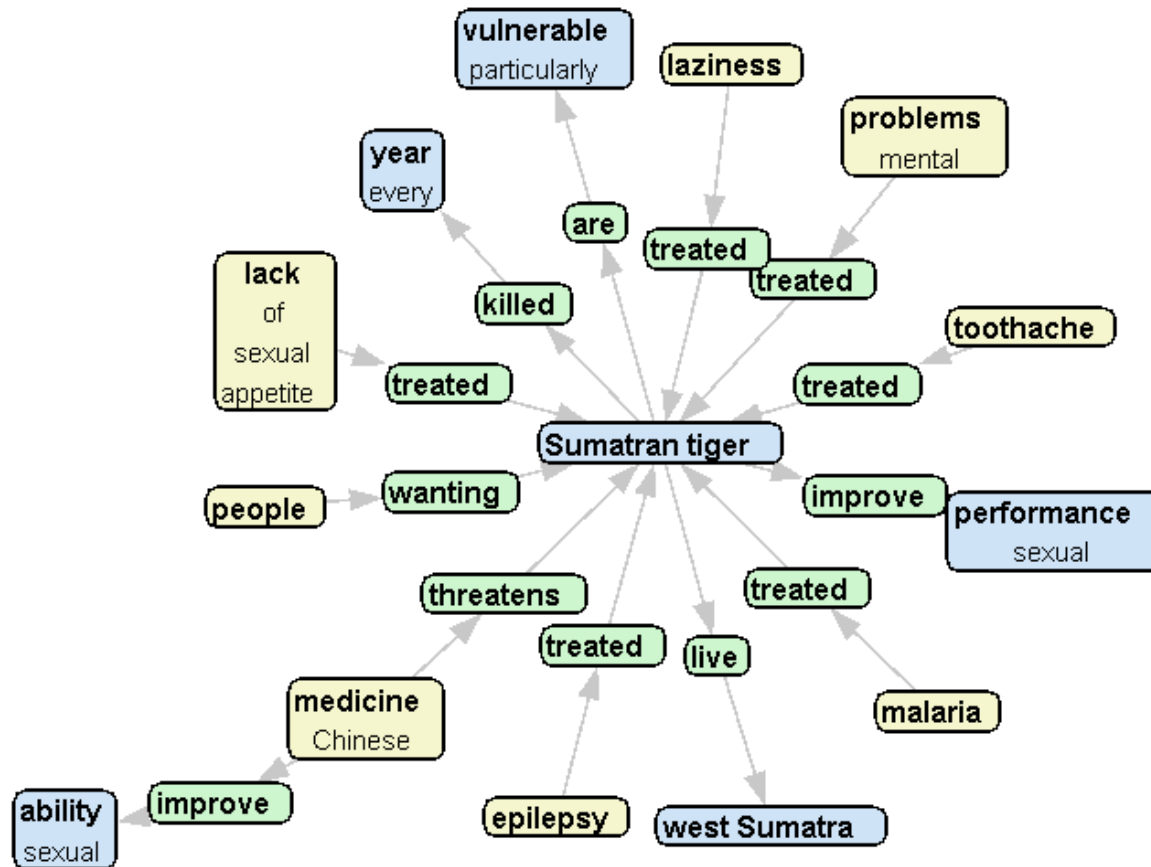
While the Sumatran tiger is a fully protected species under the 1990 Conservation Act, Lilley said the amount of money to be made by developing land in a burgeoning Asian economy is huge.

"There is not as much money generated in leaving a conservation area as it is...as there is in building big roads, airstrips, big hotels, swimming pools...," he said.

Motivation

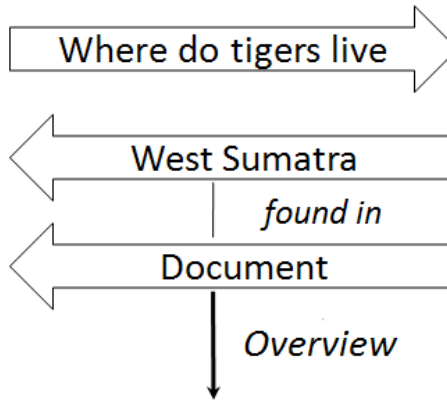
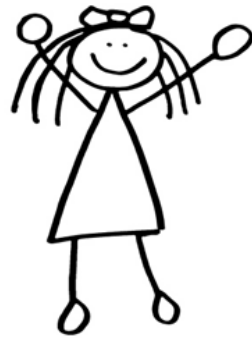
FEATUR

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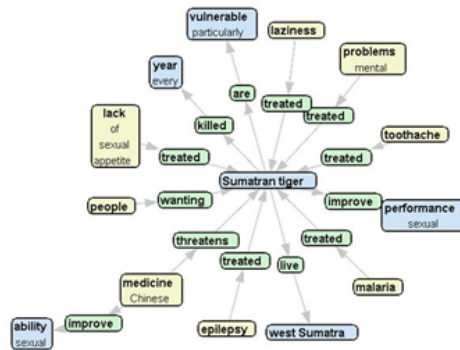
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System Overview



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Semantic graph



Facts

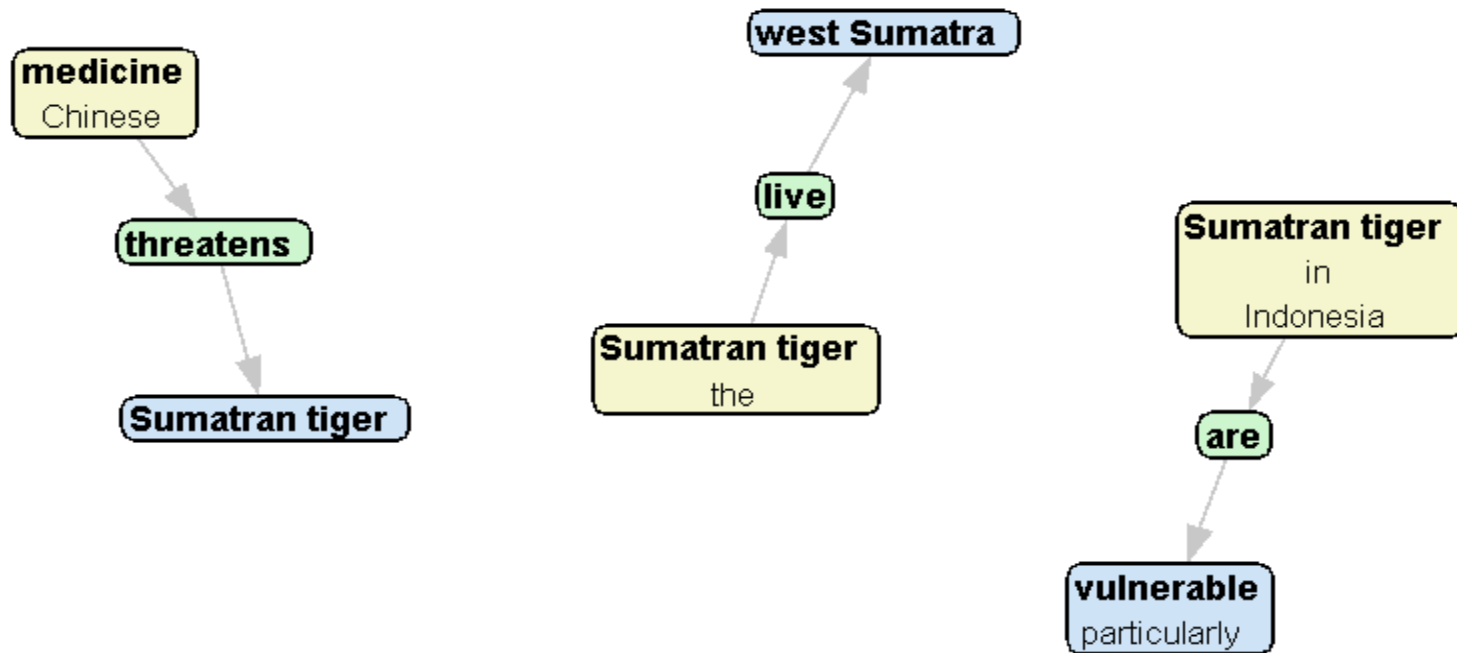
tigers live west Sumatra
 tiger is vulnerable
 medicine threatens tiger
 toothache treated tiger
 people want tiger

Summary

There are people wanting tiger products who didn't want them before, " Ron Lilley, coordinator for species conservation at the WWF in Jakarta, told Reuters. Subijanto, a spokesman for the Forestry Ministry, said Indonesia was committed to protecting the tigers, which live within Sumatra's four designated conservation areas.

Triplets

- ▶ Facts stated in the text
- ▶ The core of the sentence (subject, verb, object)



Question Answering

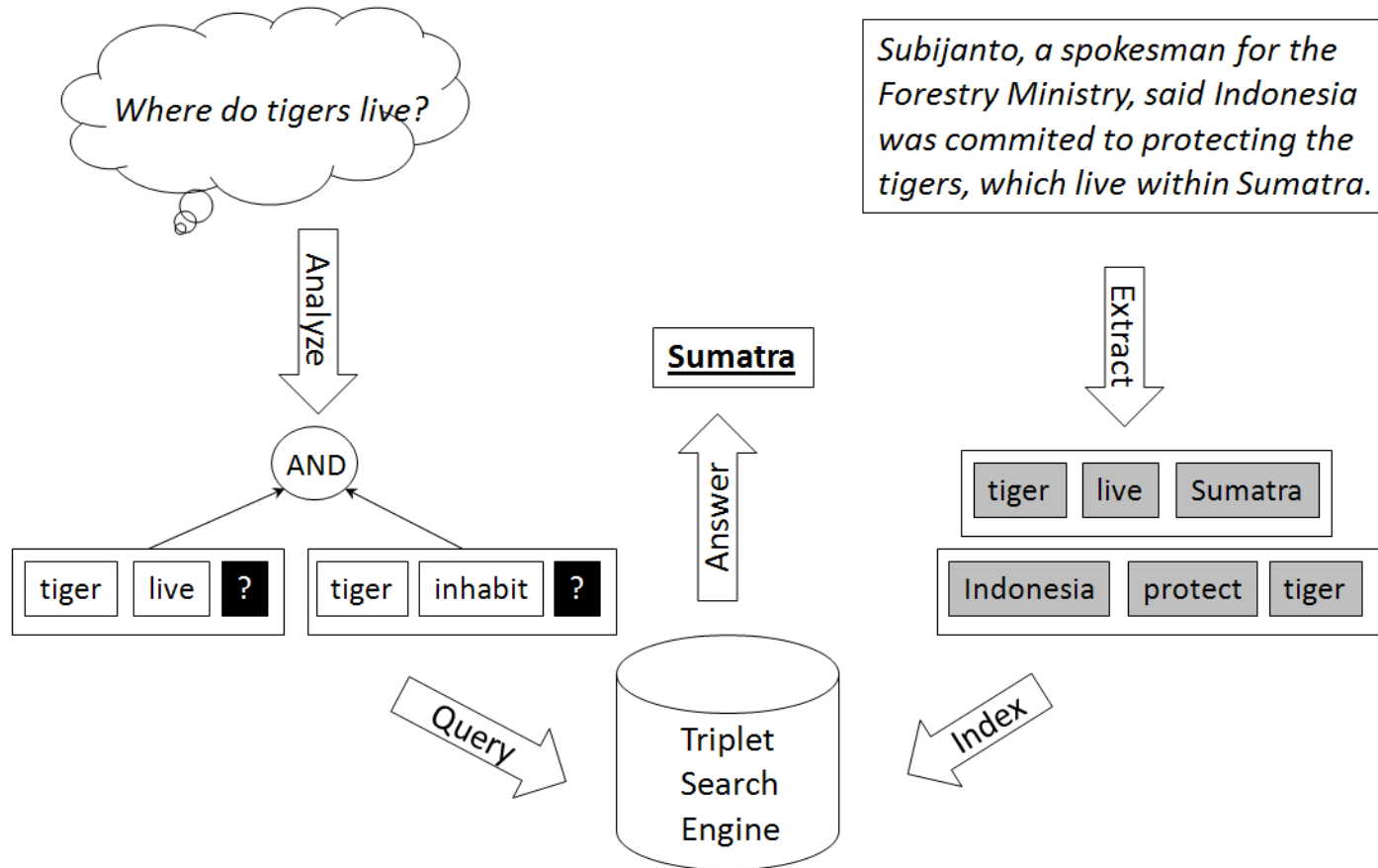
Offline:

- ▶ Extract facts (triplets) from text
- ▶ Index triplets to enable structured search on them

Online:

- ▶ Analyze questions to obtain the queries for the triplet search
- ▶ Retrieve the answer and the document containing it
- ▶ Browse the document overview

Question Answering



Question Types

Type

- ▶ Yes/No questions
- ▶ list questions
- ▶ quantity questions
- ▶ location questions
- ▶ time questions
- ▶ reason questions

Example

- ▶ *Do animals eat fruit?*
- ▶ *What do animals eat?*
- ▶ *How much fruit do animals eat?*
- ▶ *Where do animals eat?*
- ▶ *When do animals eat?*
- ▶ *Why do animals eat fruit?*

Parsing → treebank → query expansion (WordNet)

where do tigers live

Ask

We found that

tigers	live	the following
Siberian tigers	surviving	world
tigers	live	Sumatra

Chinese medicine threatens Sumatran tiger. Subijanto, a spokesman for the Forestry Ministry, said Indonesia was committed to protecting the **tigers**, which **live** within **Sumatra**'s four designated conservation areas.

 *Related documents*

world **CHINA: FEATURE - Tigers must earn their meat in China.** With only about 300 **Siberian tigers surviving** in the **world**, and only 20 in the wild in China, that help must come soon, said Liu.

Sumatra **INDONESIA: FEATURE -**

 *Related documents***INDONESIA: FEATURE - Chinese medicine threatens Sumatran tiger.**

FEATURE - Chinese medicine threatens Sumatran tiger.

Two of Indonesia's three species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say.

According to traditional Chinese medical belief, mental problems, laziness, malaria, epilepsy, toothache and lack of sexual appetite can be treated with tiger parts, leading to rampant poaching of the animal in Asia, the World Wide Fund for Nature (WWF) said.

"Poaching is changing all the time...this trend for tiger products is new. There are people wanting tiger products who didn't want them before," Ron Lilley, coordinator for species conservation at the WWF in Jakarta, told Reuters.

Lilley said tigers in Indonesia, now reduced to about 500 animals on the island of Sumatra, are particularly vulnerable. Poaching is a severe threat, with huge markets for tiger bones in China, South Korea and Taiwan.

"This is...perhaps a billion-dollar industry, mostly illegal and run by people not interested in sustainability," he said.

According to South Korean immigration statistics, the country imported 3,994 kilograms (8787 pounds) of tiger bones from Indonesia between 1970 and 1993, making Indonesia their largest supplier.

That's a lot of tigers, Lilley said, since the bones of one tiger weigh less than 10 kilograms (22 pounds).

Document Overview

Analyze the document containing the answer:

- ▶ Highlight facts described by **subject – verb – object** triplets (identified in the Penn Treebank parse tree)
- ▶ Obtain the document semantic graph
- ▶ View the automatic document summary

Semantic Graph

FEATURE - Chinese medicine threatens Sumatran tiger.

Two of Indonesia's rare species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say.

According to traditional Chinese medical belief, tigers' manes, whiskers, teeth and claws can be traded with tiger parts, leading to rampant poaching throughout the island. But tigers are rapidly vanishing in Java. There are about 500 Sumatran tigers left on the island of Sumatra, but the population is falling. Poaching is a severe threat, with tiger manes for tiger bones in the illegal traditional Chinese medicine industry, mostly illegal and can be people not interested in sustainability. The wild tiger population in Indonesia between 1975 and 1990, mainly Indonesia, that they had to spend 10 years to spend 10 million dollars (320,000) to saving the Sumatran tiger. The tiger population in Indonesia is estimated to be around 1,000 in 1990. The tiger population in Indonesia is estimated to be around 1,000 in 1990. The tiger population in Indonesia is estimated to be around 1,000 in 1990.

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Document Plain text format

Semantic Graph

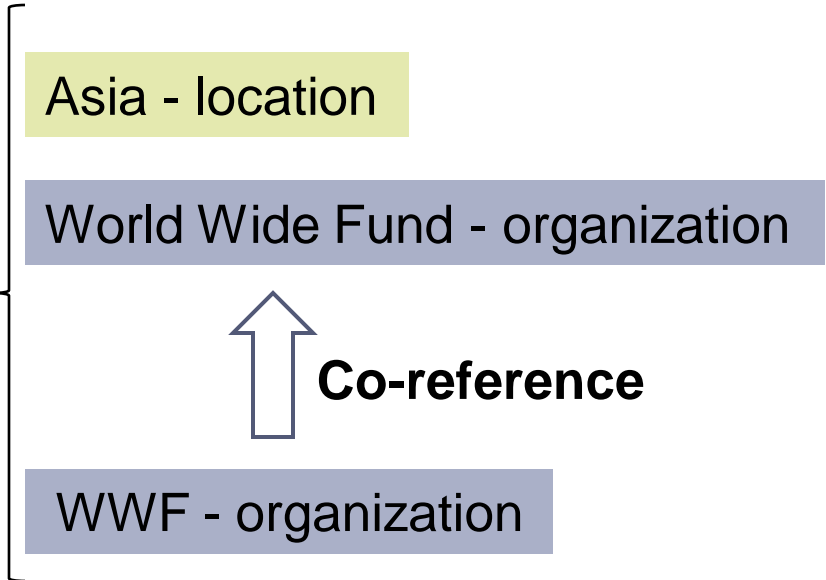
FEATURE - Chinese medicine threatens Sumatran tiger.

Document
Plain text format

Two of Indonesia's rare species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say. According to traditional Chinese medical belief, mental problems, laziness, malaria, epilepsy, toothache and lack of sexual appetite can be treated with tiger parts, leading to rampant poaching throughout the tiger's range, they say. There are around 600 Sumatran tigers left in the world, according to the World Wide Fund for Nature. In 2004, the species was declared to be critically endangered. It is one of the most endangered big cats in the world. Poaching is a severe threat, with tiger manes for tiger bones in This is a... (text is mostly illegible due to small font size).

According to traditional Chinese medical belief, mental problems, laziness, malaria, epilepsy, toothache and lack of sexual appetite can be treated with tiger parts, leading to rampant poaching of the animal in **Asia**, the **World Wide Fund (WWF)** said.

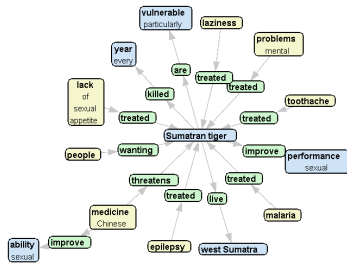
Named entity extraction
Co-reference resolution



Document Summary

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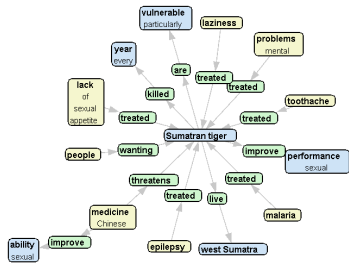
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Two of Indonesia's rare species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say. According to traditional Chinese medical belief, mental problems, laziness, malaise, vertigo, toothache and loss of sexual appetite can be treated with tiger parts, leading to rampant poaching throughout the tiger's range. The best tiger poachers to view these are ancient Sumatran tiger poachers who still hunt their victims, says Lily, coordinator for Sumatran tigers. Lily said tigers in Indonesia, now reduced to about 500 animals on the island of Sumatra, are particularly vulnerable. Poaching is a common threat, with tiger markets for tiger bones in China, perhaps a billion-dollar industry, steadily rising and set to triple this month in Kuala Lumpur, he said. According to South Korean conservationists, the tigers required 2,000 kilograms (4,400 pounds) of tiger bones from Indonesia between 1975 and 1993, making Indonesia the third largest tiger market, Lily said, since the bones of one tiger weigh less than 10 kilograms (22 pounds). Leaving this when after the announcement of a joint venture with pharmaceutical manufacturer Korea, which has targeted 10 million kg (22 million lbs) of Sumatran tiger. The estimates that tigers are killed every year. Indonesia's population of about 100 tigers has a very low probability of surviving to the next 50 years because there are no reserves of the tiger in a state in Indonesia, which has seen the Sumatran tiger disappear in the late 1980s. Despite concerns over poaching, the tiger trade to the Sumatran tiger in the direction of its habitat, Lily said. "Tiger conservation has been established worldwide at all levels of the world," Lily said. In Indonesia, the need "to be better because conservation areas are being eaten up." The IUCN estimates the world tiger population at about 2,000. There are about 2,700 Sumatran tigers left in the wild and just under 2,000 tigers in South-east Asia, including Indonesia. Indonesia, a conservation area for the Sumatran tiger, said Indonesia was committed to protecting the tiger, which has within Sumatra's four designated conservation areas. The world conservation project, an effort to protect the Sumatran tiger, if a reserve area in Sumatra, was being reported to build from the tiger's habitat, Lily said. Inside the Sumatran tiger is a fully protected species under the 1980 Convention Act, Lily said the amount of money to be made by developing land is a burgeoning market economy. "There is not as much money generated in having a conservation area as it is. So there is building big roads, airports, big hotels, swimming pools," he said.



Feature Extractor



Document Summary

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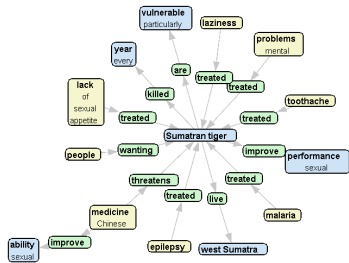
Two of Indonesia's rare species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say. According to traditional Chinese medical belief, mental problems, laziness, malnutrition, toothache and loss of sexual appetite can be treated with tiger parts, leading to rampant poaching throughout the tiger's range. The trade for tiger products is now worth an average of \$100,000 a year, according to a report by the World Wildlife Fund (WWF). The WWF estimates the world tiger population at about 2,000. There are around 2,700 Sumatran tigers left in the wild and just under 2,000 tigers in South-east Asia, including Indonesia. Indonesia is a large tiger habitat. Last Indonesia was committed to protecting the tiger, which has within Sumatra's four designated conservation areas. The WWF conservation project, an effort to protect the tiger's habitat, is a major project in Sumatra, with funding expected to be built from the tiger's habitat. Indonesia said. Indonesia's Sumatran tiger is a fully protected species under the 1980 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The WWF said. "There is not as much money generated in having a conservation area as there is in building big roads, airports, big hotels, swimming pools," he said.



Feature Extractor



Linear SVM



- Features:
- linguistic
 - document
 - graph

Document Summary

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According to South Korean newspaper statistics, the trade required 500 kilograms (1,100 pounds) of tiger bones from Indonesia between 1975 and 1990, making Indonesia the world's largest supplier of tiger bones. Since the bones of one tiger weigh less than 10 kilograms (22 pounds), leaving little room after the announcement of a joint venture with South Korean manufacturer Korea, which has exported 10 million kg (22 million lbs) to Japan for the tiger bone wine.

The extinction of the tiger is a global concern. Indonesia's population of tigers has a low level of genetic diversity, which means that the tiger population there can be vulnerable to disease. The tiger is a rare big cat in Indonesia, which has been the tiger's habitat for about 10,000 years. The tiger population in Indonesia is estimated to be around 1,000.

People concerned over poaching the tiger have been the Sumatran tiger in the protection of its habitat, Liley said.

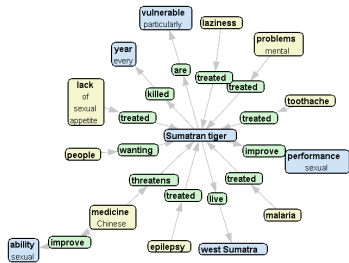
"Tiger conservation has been established around all areas of the world," Liley said. "In Indonesia, the tiger is the focus because conservation areas are being established." The IUCN estimates the world tiger population at about 2,000. There are around 2,700 Sumatran tigers left in the wild and under 2,000 tigers in South-east Asia, including Indonesia.

Indonesia, a conservation area for the Sumatran tiger, said Indonesia was committed to protecting the tiger, which live within Sumatra's four designated conservation areas. The Sumatran tiger project, an area of around three million hectares (7.4 million acres) in west Sumatra, was being supported by funds from the World Bank, Subijanto said.

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Ranking

Feature Extractor

Linear SVM

Linear Model

The Kerinci conservation project, an area of around three million hectares (7.4 million acres) in west Sumatra, was being supported by funds from the World Bank, Subijanto said. **[10.0912]** Subijanto, a spokesman for the Forestry Ministry, said Indonesia was committed to protecting the tigers, which live within Sumatra's four designated conservation areas. **[9.4155]**

Document Summary

FEATURE - Chinese medicine threatens Sumatran tiger.

Two of Indonesia's three species of tigers have become extinct and the third is severely threatened because of the belief that tiger parts can improve sexual performance, experts say. According to traditional Chinese medical belief, mental problems, laziness, malaria, epilepsy, toothache and lack of sexual appetite can be treated with tiger parts, leading to rampant poaching. "Poaching is changing all the time...this trend for tiger products is new. There are people wanting tiger products who didn't want them before," Ron Lilley, coordinator for species conservation in Indonesia, said. Lilley said tigers in Indonesia, now reduced to about 500 animals on the island of Sumatra, are particularly vulnerable. Poaching is a severe threat, with huge markets for tiger bones in China. "This is...perhaps a billion-dollar industry, mostly illegal and run by people not interested in sustainability," he said. According to South Korean immigration statistics, the country imported 3,994 kilograms (8787 pounds) of tiger bones from Indonesia between 1970 and 1993, making Indonesia their largest source. That's a lot of tigers, Lilley said, since the bones of one tiger weigh less than 10 kilograms (22 pounds). Speaking this week after the announcement of a joint venture with photo equipment manufacturer Kodak, which has pledged 50 million rupiah (\$21,000) to saving the Sumatran tiger, Lilley said. "Our estimate is that 14 tigers are killed every year...maybe more. A population of less than 100 tigers has a very low possibility of surviving for the next 50 years because there can be no reproduction. Extinction of the tiger is a real fear in Indonesia, which has seen the Bali tiger die out in the 1940s and the Java tiger disappear in the late 1980s. Despite concerns over poaching, the biggest threat to the Sumatran tiger is the destruction of its habitat, Lilley said. "Tiger populations have crashed without exception in all areas of the world," Lilley said. In Indonesia, this was "in the balance because conservation areas are being eaten into." The WWF estimates the world tiger population at about 7,200. There are around 3,750 Bengal tigers left in India and just under 2,000 tigers in Southeast Asia, excluding Indonesia. Subijanto, a spokesman for the Forestry Ministry, said Indonesia was committed to protecting the tigers, which live within Sumatra's four designated conservation areas. The Kerinci conservation project, an area of around three million hectares (7.4 million acres) in west Sumatra, was being supported by funds from the World Bank, Subijanto said. While the Sumatran tiger is a fully protected species under the 1990 Conservation Act, Lilley said the amount of money to be made by developing land in a burgeoning Asian economy is huge. "There is not as much money generated in leaving a conservation area as it is...as there is in building big roads, airstrips, big hotels, swimming pools...," he said.

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Conclusions

- ▶ Enhanced question answering system
- ▶ Question answering, where the answer is supported by documents
- ▶ Document browsing
 - ▶ Facts
 - ▶ Document semantic graph
 - ▶ Automatic document summary

References

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http://trec.nist.gov/data/qa/t2007_qadata.html
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- ▶ The AnswerArt system homepage:
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Thanks for listening!

Questions?

Don't ask me, ask Jeeves...