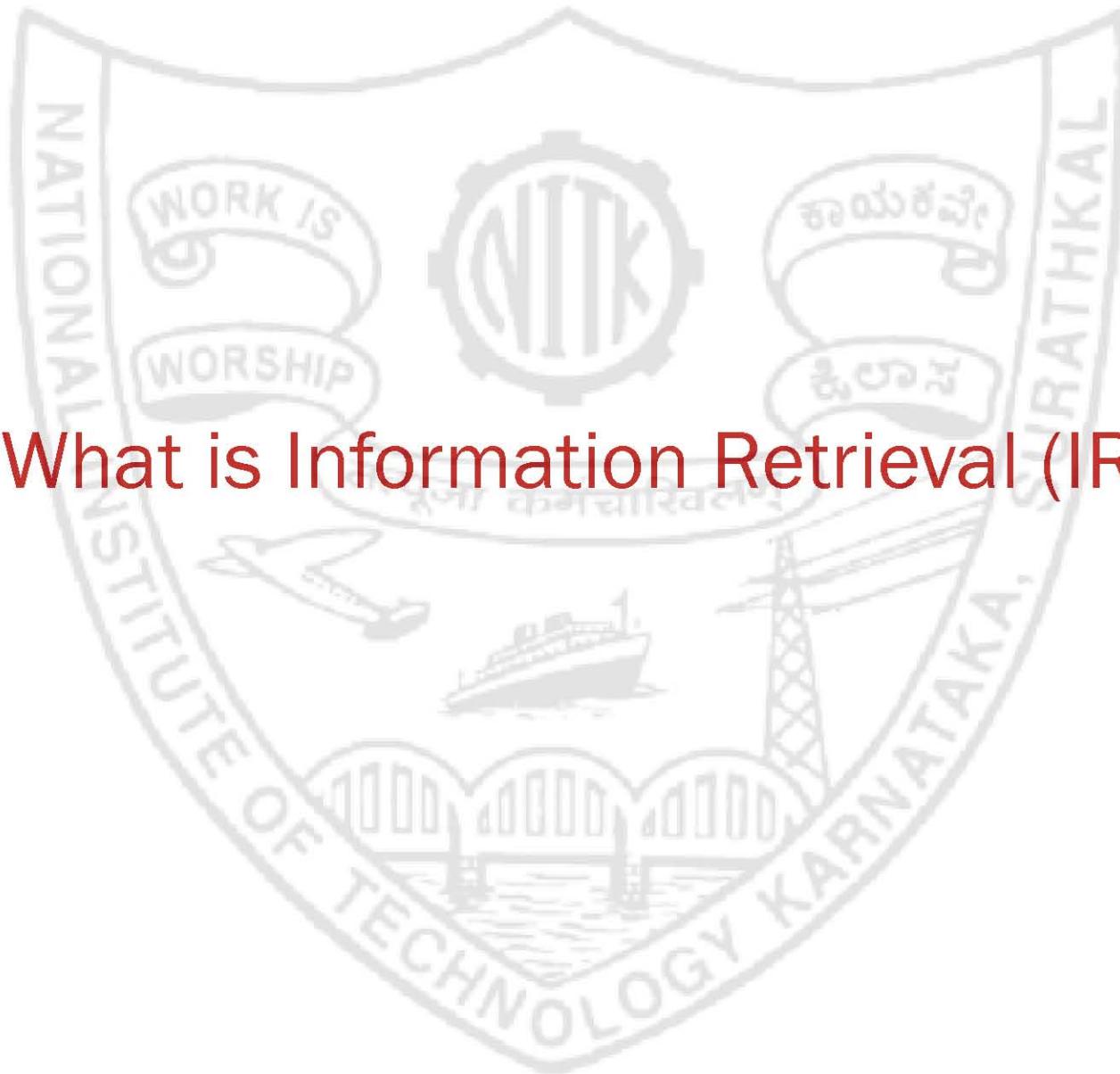




Information Retrieval

Introduction, Basics and Concepts

What is Information Retrieval (IR)?



What is Information Retrieval (IR)?

- ▶ IR Textbook definition (Manning et al):
- ▶ Finding material (usually documents) of an unstructured nature (usually text) that satisfies an information need from within large collections (usually stored on computers)
- * hence, different from how database access works!

What is Information Retrieval (IR)?

- ▶ You have a *collection of documents*
 - ▶ Books, web pages, journal articles, photographs, video clips, tweets, products, ...
- ▶ You have an *information need* (typically expressed in natural language)
 - ▶ “nitk”
 - ▶ “species of roses that will grow in India”
 - ▶ “how warm is it going to be today?”
- ▶ You want those documents that best satisfy that need.

Data v/s. Information

- ▶ **Data:** a set of facts.



Ref: Ackoff, "From Data to Wisdom", 1989

Data v/s. Information

- ▶ **Data:** a set of facts.
- ▶ **Information:** data that are processed to useful; provides answers to "**who**", "**what**", "**where**", and "**when**" questions

Ref: Ackoff, "From Data to Wisdom", 1989

Data v/s. Information

- ▶ **Data:** a set of facts.
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- ▶ **Knowledge:** application of data and information; answers "**how**" questions.

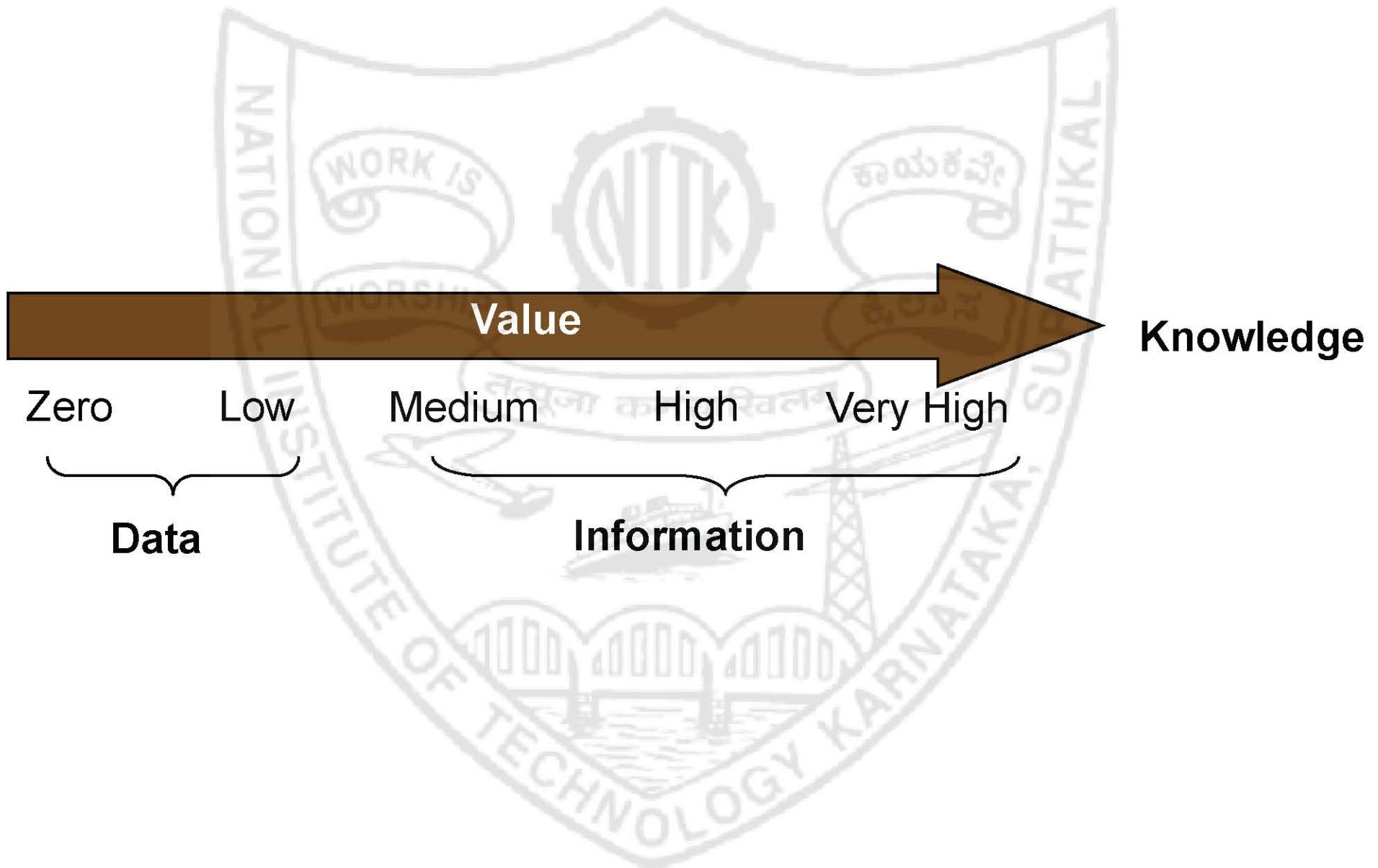
Ref: Ackoff, "From Data to Wisdom", 1989

Data v/s. Information

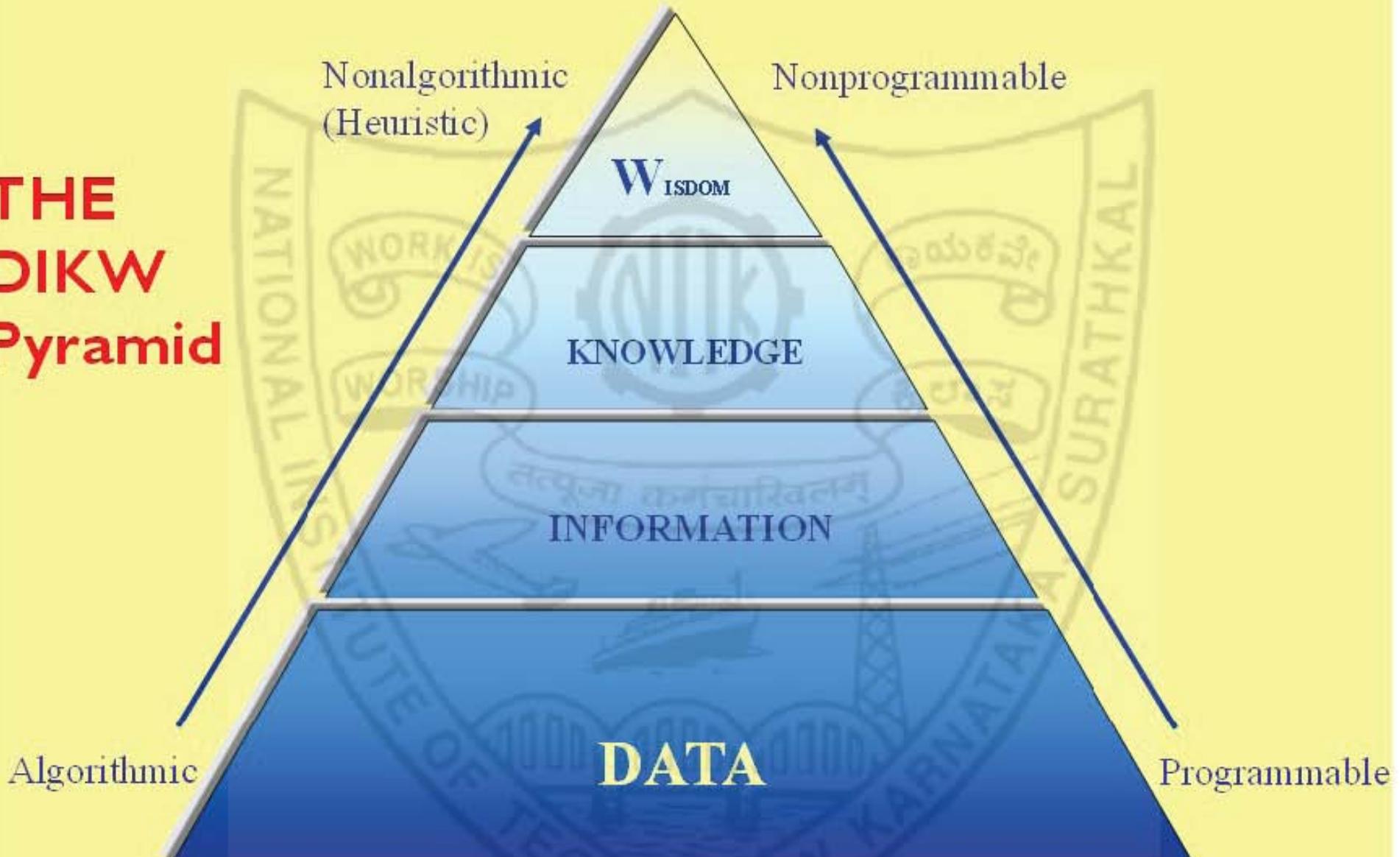
- ▶ **Data:** a set of facts.
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- ▶ **Knowledge:** application of data and information; answers "**how**" questions.
- ▶ **Understanding:** an appreciation of "**why**"
- ▶ **Wisdom:** evaluated understanding.

Ref: Ackoff, "From Data to Wisdom", 1989

Relationship between D, I and K



THE DIKW Pyramid



From Data Processing to Knowledge-based Systems

Applications of IR and IR systems ...



Searching in your databases, library catalogs...

Central Library, NITK, Surathkal

Powered by LIBSYS

Simple Advanced Additional Browse ISBN No Accession No HOME | HELP | EXIT

Results : 34 Record(s) found for "Any Field('information' and 'retriev...' for All publishing years Books etc database. Mode : view Back

Title	Author	Call No
ORGANIZING INFORMATION PRINCIPLES OF DATA BASE AND RETRIEVAL SYSTEMS	SOERGEL,D	025.04 S6817
INTRODUCTION TO MODERN INFORMATION RETRIEVAL -- 1983	SALTON,G	025.04 S17
THE ANALYTICO SYNTHETIC FOUNDATION	FUGMAN,R	025.48 F95

Books etc BOOK BANK STANDARDS THESIS CONF. PROC. CD-ROMS VIDEO TAPES XEROX SERIAL PUBL Articles Data New Additions Journal Browse My Account Check-outs Reservation History Recommendation External Database

Query Designer

Tables (70)

- AWBuildVersion
- DatabaseLog
- ErrorLog
- Department
- Employee
- EmployeeID
- NationalIDNumber
- ContactID
- LoginID
- ManagerID
- Title
- BirthDate
- MaritalStatus
- Gender
- HireDate
- SalariedFlag
- VacationHours
- SickLeaveHours
- CurrentFlag
- rowguid

Column	Alias	Table	Output	Sort
EmployeeID		Employee	<input type="checkbox"/>	NoSort
FirstName		Contact	<input checked="" type="checkbox"/>	NoSort
LastName		Contact	<input checked="" type="checkbox"/>	NoSort
AddressID		EmployeeAddr...	<input type="checkbox"/>	NoSort
AddressLine1		Address	<input checked="" type="checkbox"/>	NoSort

Search functionalities in email inbox...

Looken 10 - +text:business +text:meeting +text:delainey

File Edit View History Favorites Index Options ?

business meeting delainey

Everything (521) Mails (5902) Contacts (864) Tasks (14) Attachments (2555) Files (24)

From Date Subject

Right click on the search result to open the extensive context menu

From To Subject

David W Delainey David W Delainey Discussion Online Archiv

John J Lavorato David W Delainey Sent Online Archiv

John Belden David W Delainey All docum Online Archiv

John J Lavorato David W Delainey Sent Online Archiv

John Leff David W Delainey Discussion Online Archiv

John Leff David W Delainey 'sent mail Online Archiv

John Leff David W Delainey 'sent mail Online Archiv

John Leff David W Delainey Sent Online Archiv

John Leff David W Delainey 'sent mail Online Archiv

John J Lavorato David W Delainey Discussion Online Archiv

John J Lavorato David W Delainey 'sent mail Online Archiv

Mark Frevert; Joh... David W Delainey Discussion Online Archiv

David Oxley; Wes... David W Delainey Discussion Online Archiv

James Colwell; Sall... David W Delainey Discussion Online Archiv

Topic Conversation

Conversation with ...

Mails to ...

Mails from ...

Timespan Between

Extract Email addresses

Repeat search including only...

Repeat search hiding...

Summarize

Move to Folder

Copy items to Folder...

Delete item

Categorize

Reply

Forward emails directly from the results list

Forward To All

Forward Mail

Customize Columns...

Re: Spring Business Meeting

Path: Online Archive - christian.schmidt@axonic.net\ENRON\

From: David W Delainey

To: John J Lavorato

John, what do you want to do with this? We had discussed but I wanted to follow up.

Regards
Delainey

Forwarded by David W Delainey

on 01/29/2014
02:03 PM

Eric Thode@ENRON
01/22/2014 01:42 PM

To: David W Delainey/HOU/ECT@ECT

cc: Dorie Hitchcock/HOU/ECT@ECT

Subject: Re: Spring Business Meeting

57367 items

Most popular IR application...

Web Search

The screenshot displays a web browser window with four tabs open, each showing search results for "species of roses that will grow well in India".

- Tab 1 (Google):** Shows results for "best kids books 2016".
- Tab 2 (Yahoo):** Shows results for "species of roses that will grow well in India".
- Tab 3 (Bing):** Shows results for "species of roses that will grow well in India".
- Tab 4 (Google):** Shows results for "species of roses that will grow well in India".

The main content area shows search results from various sources:

- Bing Results:**
 - Types of Roses - Hedge** hedgerose.com/types-of-roses
Well, now ya know! FLORIBUND, characterized by prolific sprays of
 - 5 Ways to Grow Roses i** www.wikihow.com/Grow-Roses
2 MIN 140K VIEWS
19-11-2016 · Video embedded · ... as a result, require more room
 - Roses: Planting, Growing** www.almanac.com/plant/roses
Do you have to have male and female roses? roses a
- Yahoo Results:**
 - Lily's Garden - Shop Local - Local delivery Ann Arbor/Ypsilanti** www.lilysgarden.com/▼
Family owned and operated
 - Luxury & Affordable Roses - 1000 Roses - rosebox.ca** www.rosebox.ca/▼
Visit Rose Box For A Custom Quote For Your Next Wholesale Order Of Luxury Roses.
 - Costa Brava Immobilien - costabrava-immo.com** www.costabrava-immo.com/▼
Villen, Wohnungen und Grundstücke an der Costa Brava .
 - Rose Flower - Varieties and Types of Roses - TheFlowerExpert** www.theflowerexpert.com/content/mostpopularflowers/rose▼
Information on **Rose** flowers including meaning, **types**, colors, facts, biology, ... simple, 5-petaled flowers followed by very colorful hips that last well into the winter, ... Most **Rose varieties are grown** by budding on an understock (lower portion of ...)
 - Perfect weather for rose plantation - Times of India** [Times of India](#)

Other popular IR applications...

Site-specific Search

The image shows a web browser window with two tabs open. The left tab is a Flickr search results page for "roses", displaying various rose photos. The right tab is a Pinterest explore page for "roses", titled "Roses" and featuring categories like David Austin, David Austin Roses, Pink Roses, Flowers, Shrubs, and Gardening. Below the tabs, there are several thumbnail images of roses.

Search: roses | Flickr

1000+ ideas about Roses ...

flickr Explore

Photos People

Any license Safe

Everyone's photos

Roses

David Austin David Austin Roses Pink Roses Flowers Shrubs Gardening

The Basics of Growing Roses

Keep plants moist before and after planting. Prepare the soil well with

Dr. Sowmya Kamath S, Dept of IT, NITR Surathkal

Other popular IR applications...

Product Search

Amazon.in: roses

www.amazon.in/s/ref=nb_sb_noss_2/255-2472110-895

Search

1000+ ideas about Ro...

amazon.in Try Prime

All roses

END OF SEASON SA

Hello, Sign in Try Prime

Shop by Category Your Amazon.in

1-16 of 7,48,257 results for "roses"

Show results for

Home & Kitchen >

- Artificial Flowers
- Home & Décor
- Ornaments

Outdoor Living >

- Flower Seeds
- Roses
- Fertilizer & Soil
- Flowers

Movies & TV Shows >

- Movies

Books >

- Romance
- Food, Drink & Entertaining
- Reference

<https://www.pinterest.com/explore/roses/>

Roses Delivery | Send Bou...

1-800-FLOWERS.COM, INC. (US) https://www.180

Search

1000+ ideas about Ro...

1800 flowers 1800 baskets.com fruit bouquets.com Cheryl's Fannie May THE POPCORN FACTORY STOCK YARDS WOLFERMAN'S

Sign In

Enter Keyword or Product Number

SEARCH

1800Flowers All Brands

International Delivery

January Birthday Bash SHOP NOW

Home » Roses

ROSE HEADQUARTERS

Shop All Roses

Roses & Other Blooms

Wow Roses

Rose Plants

CHAT NOW

Dr. Sowmya Kamath S, Dept of IT, N

Other popular IR applications...

Vertical Search

The image displays two side-by-side vertical search interfaces.

Pipl (Left): This interface features a large blue "pipl" logo at the top. Below it is a search bar with the placeholder "Name, Email, Username or Phone". To the right of the search bar is a "Location" field. A large, semi-transparent watermark of a graduation cap with the words "NATIONAL INSTITUTE OF TECHNOLOGY" and "WORK IS WORSHIP" is overlaid on the page. The main headline reads "Search Over 3,236,8". Below this, a sub-headline states "With the world's largest people search engine, Pipl can find anyone, anywhere, anytime". A "Google Scholar" logo is prominently displayed in the center. At the bottom, there is a "Recommended articles" section listing several academic papers, and a footer with the tagline "Stand on the shoulders of giants" and a link to "Go to Google Scholar".

tveyes (Right): This interface features a large "tveyes" logo at the top with the tagline "THE SEARCH ENGINE FOR BROADCAST™". The main headline is "ON TV? FIND IT ON TVEYES.". Below this, a sub-headline reads "Global search engine for television and radio." A "START FREE TRIAL" button is located in a dark box. To the right, a screenshot of the tveyes software interface shows a newsroom dashboard with video thumbnails and search results. The interface includes sections for "Program", "Satellite", "Power Search", "Search", "Lister", "Training", and "Help". The overall theme is broadcast media search.

There is also group-specific related search...

The screenshot shows the Google News interface for the 'Health' category. The top navigation bar includes the Google News logo, a search bar, and links for 'Follow' and 'Share'. Below the navigation, there are tabs for 'Latest', 'Medicine', 'Healthcare', 'Mental health', 'Nutrition', and 'Fitness'. A large watermark of the 'NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL' logo is overlaid on the page.

Wockhardt To Supply Millions Of Doses Of COVID-19 Vaccines To UK

NDTV · 5 hours ago

- Covid-19 vaccine development sparks political controversy in India | Coronavirus update

DW News · 7 hours ago

[View Full coverage](#)

Wockhardt enters deal with UK govt to fill finish Oxford coronavirus vaccine

Moneycontrol · 5 hours ago

- Wockhardt To Supply COVID-19 Vaccines To UK

NDTV Profit · 4 hours ago

Cross-lingual information retrieval (CLIR)...

2lingual

roses

Search pages written in: English ▾ and Hindi ▾

English results for roses

Roses

(Ad) www.info.com/ ▾

Get **Roses** Info. Metasearch & Social Results Now. What does the web say? Related topics. Try Info.com. Enhanced results. See social too. Find the best info. Dig deeper. Beyond Search. Topic bubbles. Info.com social search.

→ Visit Website

Luxury Premium Flowers - Worldwide Delivery

(Ad) www.fleurdeluxe.com/ ▾

Real **Roses** That Last A Year | Bespoke Flower Arrangements In A Box | Gold **Roses**. Payment Options Available. Sign Up Online. Steps: Pick Your Box And Colour, We Ship It When You Want It, Feel The Love For A Whole Year.

→ Visit Website

Roses Discount Stores

[https://www.rosesdiscountstores.com/](http://www.rosesdiscountstores.com/)



Roses Discount Store offers great, quality items at low prices, every day! **Roses** - The smart way to shop.

benny blanco & Juice WRLD - **Roses** feat. Brendon Urie -

https://www.youtube.com/watch?v=S_1MXIIHWMQ



Dec 5, 2018 ... "Roses" out now: <http://smarturl.it/RosesBB>
Animation by Vince Mckelvie Follow benny blanco:
<http://www.instagram.com/itsbennyblanco...>

Four **Roses** Bourbon

2lingual Google Search

powered by **Google**™

Hindi results for गुलाब - [Translated roses from English to Hindi] - Turn off automatic query translation

गुलाब - विकिपीडिया

<https://hi.wikipedia.org/wiki/गुलाब>



गुलाब एक बहुवर्षीय, झाड़ीदार, कंटीला, पुष्टीय पौधा है जिसमें बहुत सुंदर सुगंधित फूल लगते हैं। इसकी १०० से अधिक जातियाँ हैं जिनमें से अधिकांश एशियाई मूल की हैं। जबकि कुछ जातियों के मूल प्रदेश यूरोप, उत्तरी अमेरिका तथा उत्तरी पश्चिमी ...

गुलाब को ज्यादा फूल देने के लिए तैयार करने का नया ...

<https://www.youtube.com/watch?v=nupKcyrFQ-E>



1 अक्टूबर 2017 ... Today awesome garden talk about how to care rose plant before winter how to care rose plant in October month how to boost rose flowering in winter... this tec...

गुलाब जामन

<https://www.pakwangali.in/sweet...in.../839731.html>



मीठा खाना हो और गुलाब जामुन के लिए मन न ललचाए, ऐसा नहीं हो सकता...तो चलिए बनाना सीखते हैं भारतीय मिठाइयों में अपनी खास जगह रखने वाले गुलाब जामुन -

गुलाब पर ज्यादा फूल कैसे लाएं, Gulab per Jada Flowers ...

https://www.youtube.com/watch?v=oFdcsbhN_Jc



18 अक्टूबर 2017 ... गुलाब पर ज्यादा फूल कैसे लाएं, Gulab per Jada Flowers kaise lai. The One Page. Loading... Unsubscribe from The One Page? Cancel Unsubscribe. Working... SubscribeSubscribedUnsubscribe 154K. Loading... Loading... Working ... Add to ...

Recommender Systems

Frequently Bought Together



Total price: \$83.09

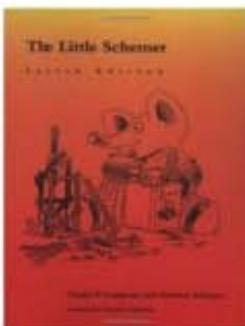
Add both to Cart

Add both to List

- This item: Structure and Interpretation of Computer Programs - 2nd Edition (MIT Electrical Engineering and Computer Science) by Harold Abelson Paperback \$50.50
- The Pragmatic Programmer: From Journeyman to Master by Andrew Hunt Paperback \$32.59

Customers Who Bought This Item Also Bought

Page 1 of 13



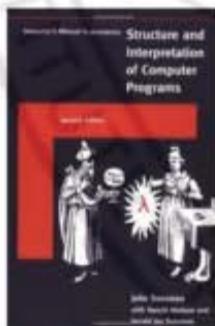
The Little Schemer - 4th Edition

› Daniel P. Friedman

★★★★★ 64

Paperback

\$36.00



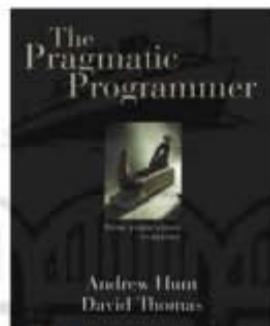
Instructor's Manual t/a
Structure and Interpretation
of Computer Programs...

› Gerald Jay Sussman

★★★★★ 5

Paperback

\$28.70



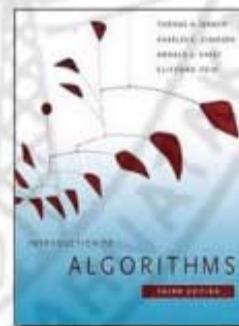
The Pragmatic
Programmer: From
Journeyman to Master

› Andrew Hunt

★★★★★ 328

Paperback

\$32.59



Introduction to Algorithms,
3rd Edition (MIT Press)

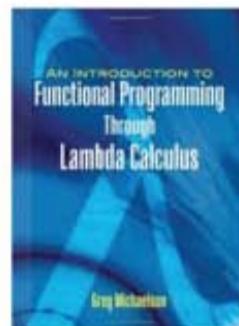
› Thomas H. Cormen

★★★★★ 313

#1 Best Seller in Computer
Algorithms

Hardcover

\$66.32



An Introduction to
Functional Programming
Through Lambda...

› Greg Michaelson

★★★★★ 23

Paperback

\$20.70

Mining the Web for knowledge...

surathkal beach lighthous... X +

https://www.google.co.in/#q=surathkal+beach+lighthouse

1000+ ideas about Ro...

surathkal beach lighthouse

All Flights Images Maps News More Settings Tools Sign in

About 23,500 results (0.40 seconds)

Images for surathkal beach lighthouse



→ More images for surathkal beach lighthouse Report images



IITK Beach gate See photos See outside

the surathkal lighthouse - Picture of Surathkal Beach, Mangalore ...
<https://www.tripadvisor.in/LocationPhotoDirectLink-g297630-d3265823-i55519414-...>

Surathkal Beach, Mangalore Picture: the surathkal lighthouse - Check out TripAdvisor members' 1399 candid photos and videos.

Light house of surathkal beach. - Picture of NITK ... - TripAdvisor
<https://www.tripadvisor.in/LocationPhotoDirectLink-g297630-d3444283-i86299125-...>

NITK Lighthouse Mangalore Picture: Light house of surathkal beach - Check out TripAdvisor

NITK Beach

Website Directions

4.4 ★★★★☆ 13 Google reviews

Tourist Attraction - Srinivasa Nagar, Surathkal

Address: Srinivasa Nagar, Surathkal, Mangalore, Karnataka 575025

Answering your everyday questions..

Gate 51a Terminal 2

Category

Ticket type: World Perk Rewards Premier Access

[View email](#)

Car rental

Economy 2 door sedan

Hertz rental car reservation

Name Mr. John Smith Booking Number E12345678

Thu, 18 Apr, 2013 Fri, 26 Apr, 2013
11:40 21:50

Hertz San Diego
987 Harbor Dr, San Diego, CA 92101

[Get directions](#)

[Manage reservation](#)

[View email](#)

Next Appointment

Agency Meeting
11:30 AM

Ninth Ave, New York, NY 10011

[Email guests](#)

Flights

Delta Air Lines

weather

San Francisco



63°

SCATTERED CLOUDS
5mph
10%

TUE

68°
48°

WED

67°
44°

THU

65°
48°

FRI

57°
46°

Hotels

The Connaught Hotel

Carlos Place, Mayfair, London W1K 2AL, United Kingdom

Check in from 12:00pm today



[Call](#)

[Hotel information](#)

[View email](#)

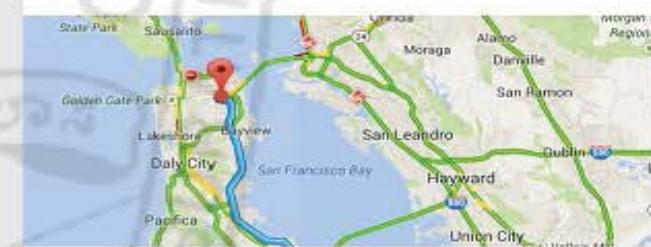
Packages



Traffic & Transit

57 mins to work

Normal traffic on US - 101



[Navigate / 57 mins via US - 101](#)

Restaurant Reservations

Broder

2508 SE Clinton St, Portland, OR 97202

[Reservation in 1 hour](#)

Travel time walking 45 minutes



[Get directions](#)

And answering complex questions !

WolframAlpha computational intelligence.

Home loan 100,000 at 3.7 percent apr for 30 years \$10,000 balloon payment

Extended Keyboard Upload Examples Random

Assuming fixed rate mortgage | Use adjustable rate mortgage instead
Also include: points | interest-only period | tax rate

Input information:

fixed rate mortgage	
annual percentage rate	3.7%
loan period	30 years
balloon payment	\$10 000.00 (US dollars)
loan amount	₹100 000 (Indian rupees)

Monthly payments:

monthly payment	- ₹682
effective interest rate	3.763%

Mortgage totals:

amortized principal paid	- ₹652 008
balloon	₹752 008
total interest paid	₹406 348
total payments	₹506 348

Units >



principal
interest
balloon

And answering complex questions !

 **WolframAlpha** computational knowledge engine

x² + 5x + 6 = 0

Input: $x^2 + 5x + 6 = 0$

Alternate forms:

$(x + 2)(x + 3) = 0$

$\left(x + \frac{5}{2}\right)^2 - \frac{1}{4} = 0$

Solutions:

$x = -3$

$x = -2$

Web Apps Examples Random Open code ↗

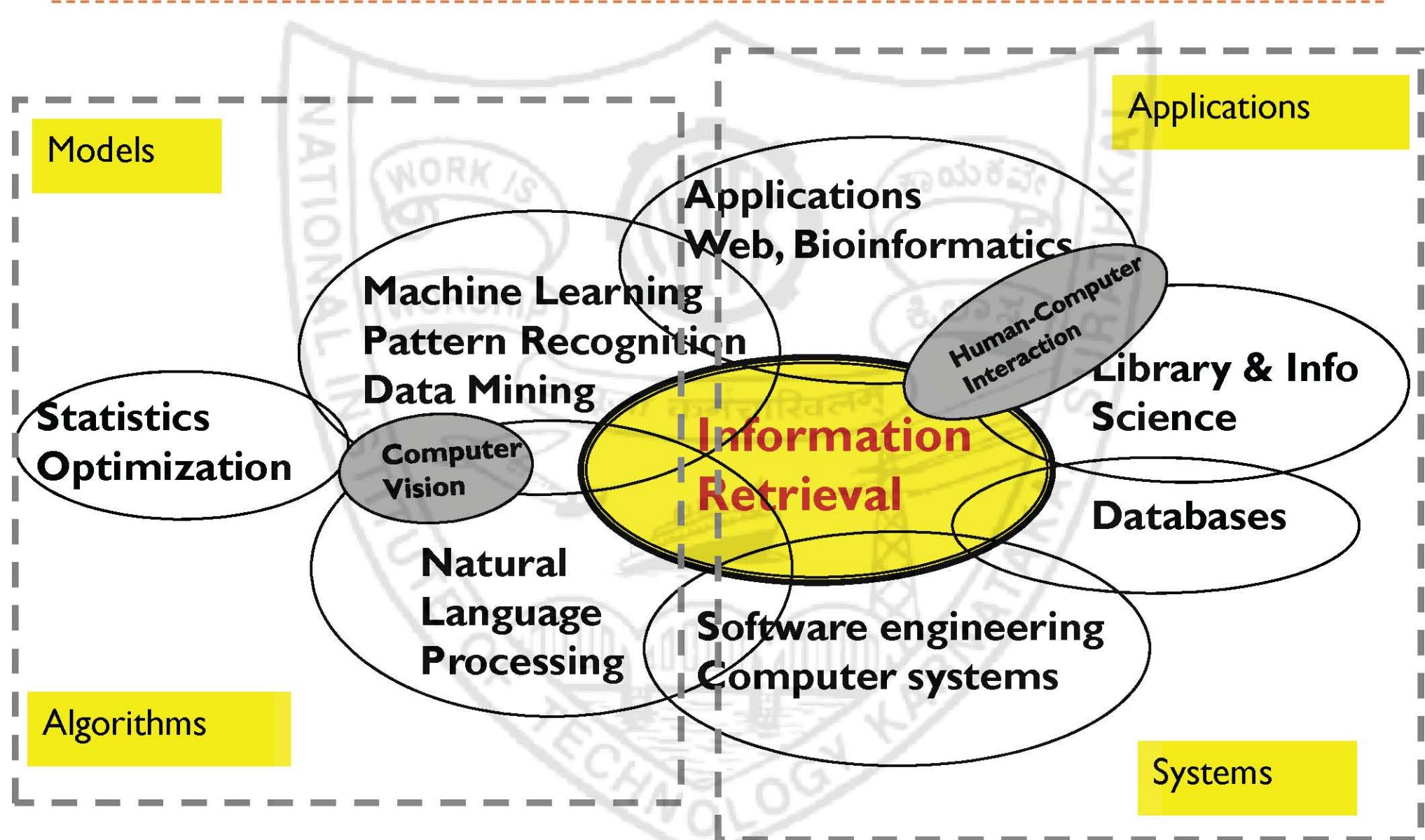
Step-by-step solution Try it! ↗

INFORMATION RETRIEVAL ..

A phrase that encompasses a very broad spectrum of applications, problems and research areas like -

- Text Mining, Semantics, NLP, Machine Learning, NLU, Artificial Intelligence.....!!!

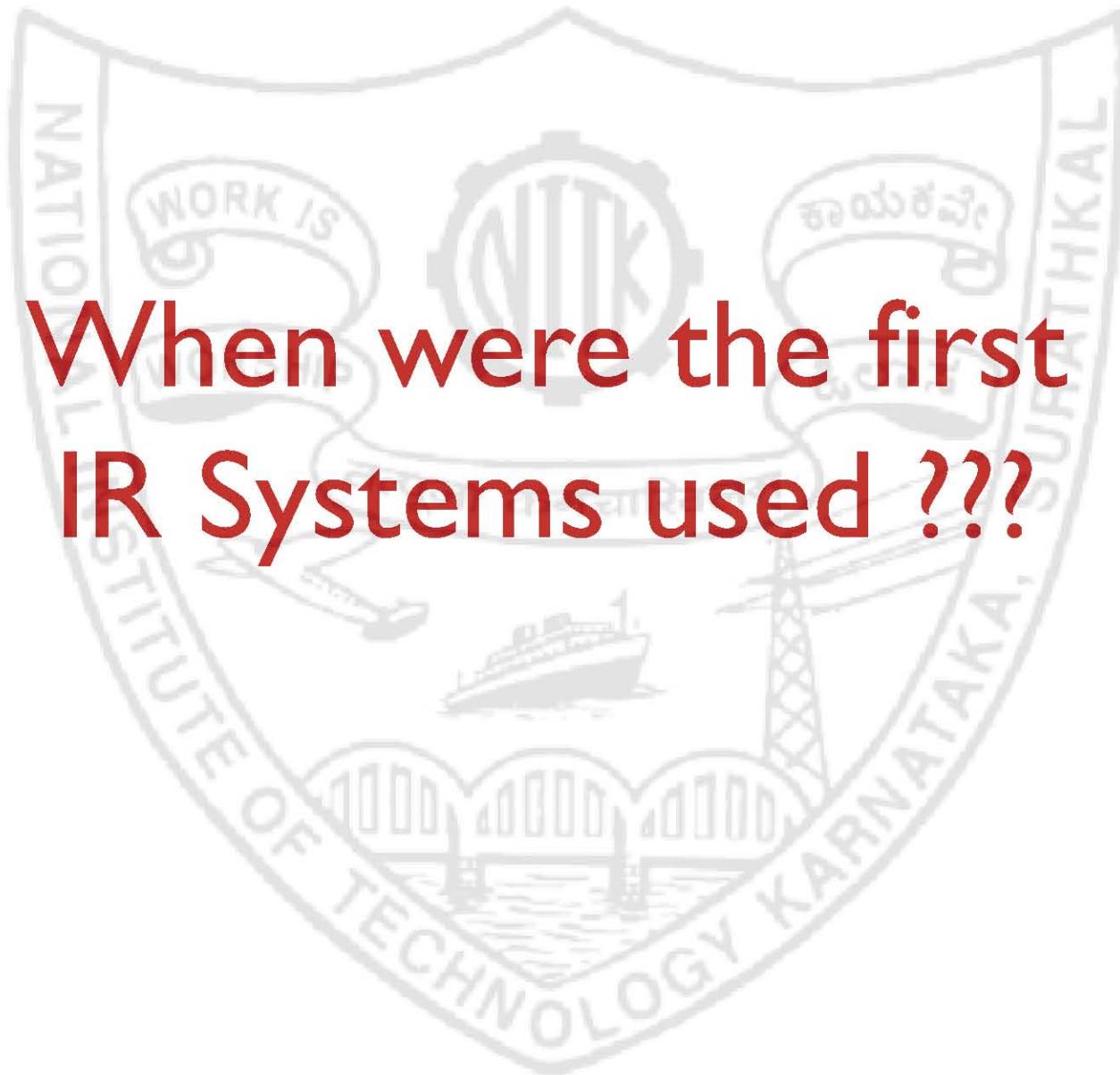
IR and Related Areas...



Information Retrieval Systems

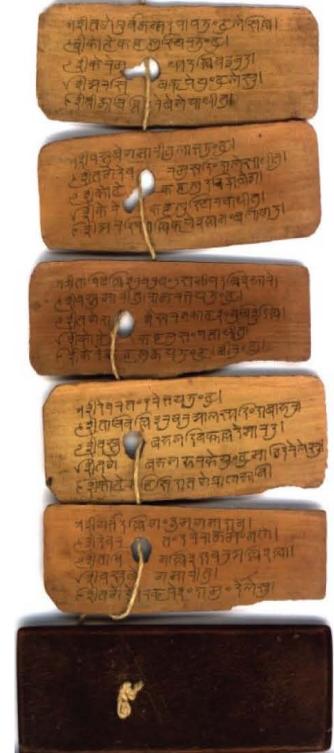
A Brief History

**When were the first
IR Systems used ???**



Information Retrieval Systems - History

- ▶ 5000 year history –
 - ▶ For clay tablets, papyrus, hieroglyphics, and books.



Information Retrieval Systems - History

- ▶ 5000 year history –
 - ▶ Actively used concepts -
 - ▶ Labelling
 - ▶ Categorization
 - ▶ Ordering
 - ▶ Indexes
 - ▶ Now the core techniques of modern IR systems!!

Information Retrieval Systems - History

- ▶ Catalogue cards (Pre-computer area)



Information Retrieval Systems - History

▶ Catalogue cards (Pre-computer area)

▶ Pros -

- ▶ Simple enough to be easily understandable
- ▶ Extensive enough to allow detailed classification.

▶ Cons —

- ▶ Experts must catalogue each item individually
 - ▶ *Problem:* A lot of manual work!
 - ▶ *Full text search:* Every word is a keyword!



Information Retrieval Systems - History

- ▶ **Concordances** (Pre-computer area)
- ▶ Can contain –
 - ▶ Commentary
 - ▶ Definitions
 - ▶ monolingual/multilingual topical cross-indexing
 - ▶ ...

Index

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- See also Native Americans*

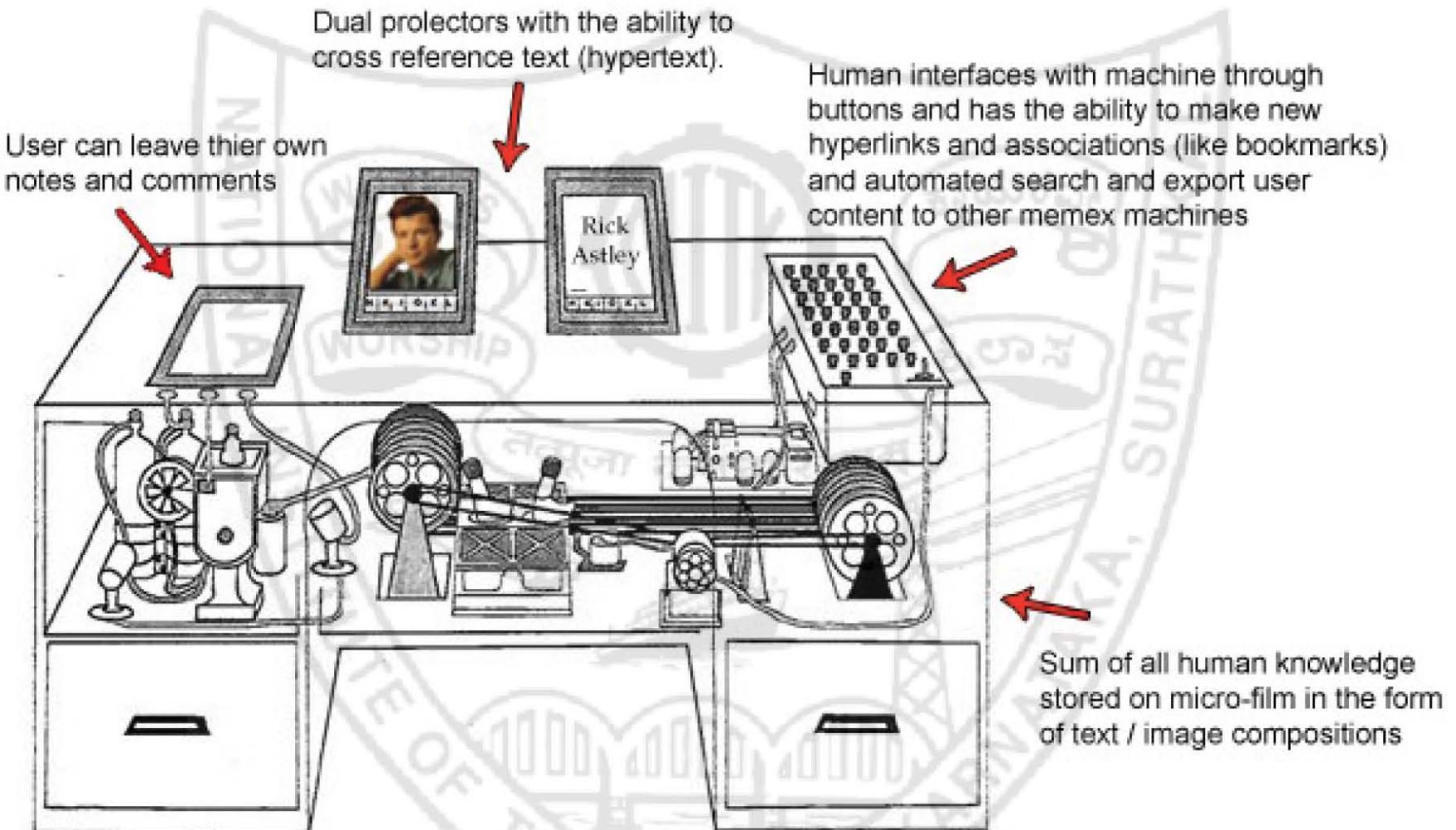
Information Retrieval Systems - History

- ▶ **The Memex (1945)** (Early-computer era)
 - ▶ Vision of a “hypertext” based PDA, proposed by Vannevar Bush.

Ref: Vannevar Bush, “As We May Think”, The Atlantic Monthly (1945)

- ▶ Proposed the novel idea of - “Selection by association”
 - ▶ *“A device in which an individual stores their books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility.”*

Information Retrieval Systems - History

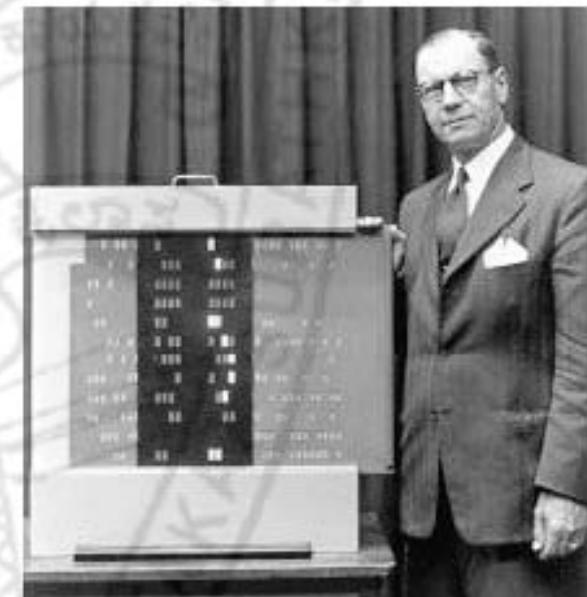


THE MEMEX

Information Retrieval Systems - History

▶ 1950 – 1960s

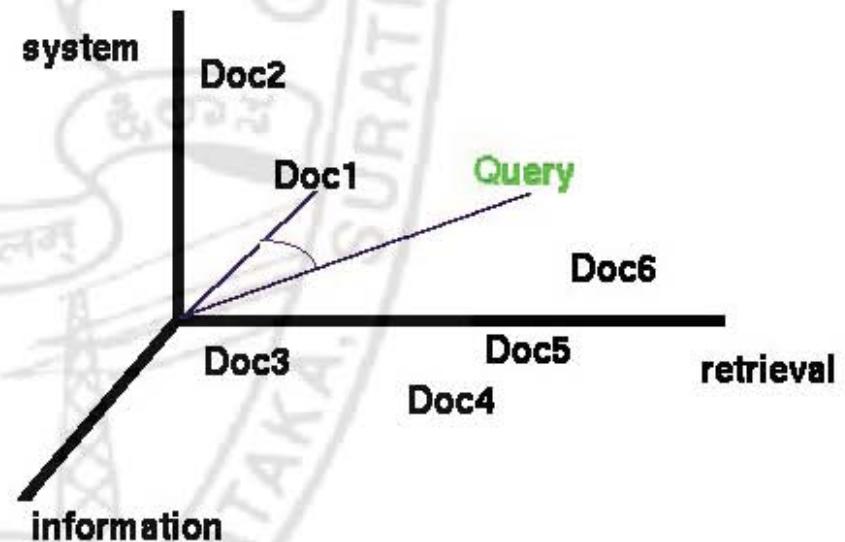
- ▶ 1957: Hans-Peter Luhn (IBM) used words as indexing units for documents
- ▶ Measure similarity between documents by word overlap.



Information Retrieval Systems - History

▶ 1960 – 1970s

- ▶ Gerard Salton and his students (Harvard, Cornell) create the SMART system.
- ▶ Concept of -
 - ▶ Boolean and Vector space models
 - ▶ Relevance feedback



Information Retrieval Systems - History

▶ 1980's:

- ▶ Large document database systems, many run by companies
- ▶ E.g. Lexis-Nexis, Dialog, MEDLINE & MeSH



LexisNexis™



Information Retrieval Systems - History

▶ 1990's:

- ▶ Searching FTPable documents on the Internet
 - ▶ Archie, WAIS
- ▶ Searching the World Wide Web
 - ▶ Lycos, Yahoo, Altavista
- ▶ Recommender Systems
 - ▶ Ringo, Amazon, NetPerceptions
- ▶ Automated Text Categorization & Clustering

Recent IR History

► 2000's onwards....

- ▶ Link analysis for Web Search :
 - ▶ Google, Bing, Yahoo, Yandex, Baidu...
- ▶ Automated Information Extraction (IE)
 - ▶ JASPER, DARPA Engine, Whizbang, Burning Glass..
- ▶ Multimedia IR
 - ▶ Image, Video, Audio and music (TinEye, YouTube....)
- ▶ Cross-Language IR and IE
 - ▶ DARPA TIDES, 2Lingual
- ▶ Document Summarization Engines
 - ▶ Google KnowledgeGraph, Bing Semantic, SenseBot.
- ▶ Learning to Rank, Personalized Recommender Systems
 - ▶ NLP, Analytics, Machine Learning
- ▶ Question Answering, Conversational Agents ...
 - ▶ IBM Watson, Wolfram Alpha, Evi, Siri ...

More reading...

- ▶ Jones, K. S., & Willett, P. (Eds.). (1997). *Readings in information retrieval*. Morgan Kaufmann.
- ▶ Bookstein, A. (1983). Information retrieval: A sequential learning process. *Journal of the American Society for information Science*, 34(5), 331-342.
- ▶ Roberts, N. (1984). The pre-history of the information retrieval thesaurus. *Journal of documentation*.