

CS245: Databases

Introduction

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2022

- Wishing you all a very happy new year
- With a positive hope that you all will be here on campus in this year
- That you will be leading regular academic activities with no constraints

Theory

- About CS245
- Text books
- Pre-requisites
- Evaluation model
- Grading policy
- Re-evaluation policy

Databases lab

- About CS246
- Pre-requisites
- Lab organization
- Lab material
- Lab teaching assistants (TAs)
- Evaluation model
- Grading policy

Syllabus

Using DBMS as a black box

- ER model
- Relational model and algebras
- SQL
- Normalization

Syllabus

Internals of relational DBMS

- File organizations
- Indexing (tree, hash, and bitmap)
- Implementation of relational operators

Syllabus

Transaction management

- ACID properties
- Concurrency control
- Crash recovery

Syllabus

Non-relational DBMS

- When time permits
- Consistency and availability trade-offs
- NoSQL databases (key-value, document, and graph)

Text Books

- R. Ramakrishnan and J. Gehrke **Database Management Systems**, McGraw Hill, 2014
- H. Garcia-Molina, J. Ullman, J. Widom, **Database System: The Complete Book**, 2nd Edition, Pearson, 2013

Course Pre-requisites

Have credited [CS203](#) Algorithms and Data Structures

Two instructors

- Dr. V. Vijaya Saradhi (saradhi@iitg.ac.in)
 - CS245: Will take the first 21 lectures; starting from 05 Jan 2022
 - CS245: Cover SQL, relational algebra and normalization
 - CS245: Will conduct two exams
 - CS246: Will conduct seven lab sessions; starting from 10 Jan 2022

Two instructors

- Dr. Amit Awekar (awekar@iitg.ac.in)
 - CS245: Will take subsequent 21 lectures; starting from 08 Mar 2022
 - CS245: Covers ER modeling, file organizations, indexing (tree, hash and bitmap), ACID properties, concurrency control, crash recovery
 - CS245: Will conduct two exams
 - CS246: Starting from 07 Mar 2022

CS245: Evaluation model

S. No.	Description	Weightage (%)	Exam Date
1	First exam	25	27-Jan-2022
2	Second exam	25	02-Mar-2022
3	Third exam	25	To be announced
4	Fourth exam	25	To be announced

- Relative grading is followed
- Check your answers and compare with the published answers
- Approach the TA in case of ambiguity
- Resolve it **within a week** publishing of marks

Syllabus

- **Using a relational DBMS** Writing SQL queries, accessing a DBMS from external applications, writing systems programs
- Each lab carries equal weightage

Material/Text Books

- Same as that of CS245

Organization

- Every lab will have an assignment
- Assignments will be shared via MS Assignments
- Upload solutions within the given time frame
- You will be given necessary information to perform the assignment
- Individual efforts is what is expected out of the given assignments

Evaluation and Grading

- The solution will be evaluated by the TAs
- Marks will be awarded as per your implemented solution
- Re-evaluation request must be made before the next lab assignment
- Relative grading is followed

Introduction

- Integral part of our day-to-day life
- Sometimes we have not paid close attention while interacting with the database systems
- Examples

Example - 01

List of courses

List of Courses Offered in the Winter Semester (Jan-May), 2022

S. No.	CourseNo.	Course Title	L	T	P	C	Type of Course	Offered to	Exam Slot	Exam Date and Time	Name(s) of Course Instructor(s)
1	BT202N	Molecular Biotechnology	3	0	0	6	Minor	B.Tech 4th semester	G	10-05-2022(9:00 to 12:00)	Dr. Jagannathan B. G.
2	BT206	Microbiology	3	0	0	6	Compulsory	B.Tech 4th semester	D	07-05-2022(9:00 to 12:00)	Dr. Kumar Manish, Dr. Patra Sanjukta
3	BT207	Genetic Engineering	3	0	0	6	Compulsory	B.Tech 4th semester	C	06-05-2022(9:00 to 12:00)	Dr. Patra Sanjukta, Dr. Kumar Sachin
4	BT208	Transport Phenomenon in Bioprocesses	3	1	0	8	Compulsory	B.Tech 4th semester	A	04-05-2022(9:00 to 12:00)	Dr. Selvaraju
5	BT209	Bioreaction Engineering	3	0	0	6	Compulsory	B.Tech 4th semester	B	05-05-2022(9:00 to 12:00)	Dr. Mati S. K.
6	BT211	Basic Biotechnology Lab	0	0	6	6	Compulsory	B.Tech 4th semester			Dr. Trivedi V.
7	BT305	Computational Biology	2	0	2	6	Compulsory	B.Tech 6th semester	A1	04-05-2022(14:00 to 17:00)	Dr. Ramakrishnan V.
8	BT306	Bioseparation Engineering	3	0	2	8	Compulsory	B.Tech 6th semester	B1	05-05-2022(14:00 to 17:00)	Dr. Ramesh A., Dr. Goswami Pranab
9	BT307	Biological Data Analysis	2	0	2	6	Compulsory	B.Tech 6th semester	C1	06-05-2022(14:00 to 17:00)	Dr. Bora Biplab
10	BT308	Bioengineering	3	0	0	6	Compulsory	B.Tech 6th semester	D1	07-05-2022(14:00 to 17:00)	Dr. Goswami Pranab, Dr. Mandal B.B.
11	BT402	BTech Project-II	0	0	6	6	Compulsory	B.Tech 8th semester			Dr. Arun Goyal, Dr. Rajkumar P Thummar
12	BT403	Human Biology and Diseases	3	0	0	6	Dept. Elective	B.Tech 8th semester	C	06-05-2022(9:00 to 12:00)	Dr. Limaye A. M., Dr. Kumar Manish
13	BT411	Metagenomics	3	0	0	6	Dept. Elective	B.Tech 8th semester	A	04-05-2022(9:00 to 12:00)	Dr. Tamuli Ranjan
14	BT412	Enzymology	3	0	0	6	Dept. Elective	B.Tech 8th semester	D	07-05-2022(9:00 to 12:00)	Dr. Goyal Arun
15	BT416	Bioenvironmental Engineering	3	0	0	6	Dept. Elective	B.Tech 8th semester	E	08-05-2022(9:00 to 12:00)	Dr. Das Debasish
16	BT420	Drug Design and Discovery	3	0	0	6	Dept. Elective	B.Tech 8th semester	B	05-05-2022(9:00 to 12:00)	Dr. Kanauja S. P., Dr. Kumar Sachin
17	BT502	Quantitative Biology	3	0	2	8	Compulsory	M.Tech. 2nd semester	A	04-05-2022(9:00 to 12:00)	Dr. Kanauja S. P., Dr. Limaye A.M.
18	BT504	Biomolecular and Cellular Process Engineering	3	0	0	6	Compulsory	M.Tech. 2nd semester	B	05-05-2022(9:00 to 12:00)	Dr. Swaprakasan S.
19	BT520	Applied Biology and Bioengineering Lab	0	0	6	6	Compulsory	M.Tech. 2nd semester			Dr. Bora Biplab
20	BT601	Analytical Biotechnology	3	0	0	6	Dept. Elective	B.Tech 6th semester, M.Tech. 2nd semester, PhD	F	09-05-2022(9:00 to 12:00)	Dr. Ghosh S.S.
21	BT605	Gene Therapy	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	G1	10-05-2022(14:00 to 17:00)	Dr. Nagotu Shriniva
22	BT608	Microbial Biotechnology	3	0	0	6	Dept. Elective	B.Tech 6th semester, M.Tech. 2nd semester, PhD	G	10-05-2022(9:00 to 12:00)	Dr. Kaur Gurvinder
23	BT609	Bioprocess Engineering	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	D	07-05-2022(9:00 to 12:00)	Dr. Dasu V. V.
24	BT619	Essentials of Genetics (OPEN ELECTIVE)	3	0	0	6	Open Elective	B.Tech 6th semester, M.Tech. 2nd semester, PhD	F1	09-05-2022(14:00 to 17:00)	Dr. Chaturvedi Rakhi
25	BT621	Advances in Plant Genetic Engineering and Functional Genomics	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	C	06-05-2022(9:00 to 12:00)	Dr. Sahoo L.
26	BT622	Biofuels	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	A1	04-05-2022(14:00 to 17:00)	Dr. Pakshrajani K.
27	BT630	Physical Cell Biology (OPEN ELECTIVE)	3	0	0	6	Open Elective	B.Tech. 8th semester, M.Tech., 2nd semester, PhD	G	10-05-2022(9:00 to 12:00)	Dr. Anand B.
28	BT634	Animal Models in Biomedical Research	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	A1	04-05-2022(14:00 to 17:00)	Dr. Kumumakkara A.B.
29	BT639	NMR Spectroscopy: Principles and Applications	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	C	06-05-2022(9:00 to 12:00)	Dr. Chaudhary Nitin
30	BT640	Neural Imaging and Signal Systems	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	F	09-05-2022(9:00 to 12:00)	Dr. Gupta Navin
31	BT643	Biointerface Engineering	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	G1	10-05-2022(14:00 to 17:00)	Dr. Pandey Lalit
32	BT699	M. Tech Project II (MTP II)	0	0	0	24	Compulsory	M.Tech. 4th semester			Dr. Priyadarshi Sapari, Dr. Sanjukta Patra
33	BT651	Quantum Chemistry of Atoms and Molecules	3	0	0	6	Dept. Elective	M.Tech. 2nd semester, PhD	D	07-05-2022(9:00 to 12:00)	Dr. Swaminathan R.
34	CE201	Surveying	3	0	0	6	Compulsory	B.Tech. 2nd year students of Civil Dept.	A	04-05-2022(9:00 to 12:00)	Dr. Ajay Dashora
35	CE205	Structural Analysis I	1	0	1	6	Compulsory	B.Tech 4th Sem.	B	05-05-2022(9:00 to 12:00)	Dr. Anjan Dutta

Example - 02

List of open electives

List of Open electives for Winter Semester(Jan - May 2021) of Academic year 2020-2021

Sl.no	Course Code	Course Name	Class Slot
1	CE559	Watershed Management & Remote Sensing Application	F
2	ME671	Biomaterials: Design and Applications	F
3	ME674	Soft Computing in Engineering	F
4	CS577	C-Based VLSI Design: Synthesis, Optimization and Verification	F
5	DD606	Product Detailing	F
6	BT633	Human Biology and Diseases	F
7	BT622	Biofuels	F
8	BT640	Neural Imaging And Signal Systems	F
9	CL618	Natural Gas Engineering	F
10	CL625	Fundamentals of Micro-nano Fluidics and Micro-Fabrication	F
11	CL639	Biofluid Mechanics	F
12	CL643	Computer Aided Applied Optimization	F
13	EE626	Pattern Recognition and Machine Learning	F
14	PH446	Fundamentals of Astrophysics	F
15	PH465	Optoelectronics	F

Example - 03

HSS elective allotment

Indian Institute of Technology Guwahati

Academic Affairs

HSS Elective Allocation for January May 2021 Semester

Sl. No	Roll No	Name	Course No	Course Name
1	170101001	Aayush Patni	HS 424	Economics of Uncertainty and Information
2	170101002	Abhishek Jaiswal	HS 415	History of Contemporary India
3	170101003	Aditya Vardhan Gara	HS 415	History of Contemporary India
4	170101004	Ajinkya Shivashankar	HS 420	Writing Systems of the World
5	170101005	Aman Mishra	HS 401	Management of Organizational Behaviour
6	170101006	Aman Raj	HS 429	Indian Business History
7	170101007	Aniket Rajput	HS 401	Management of Organizational Behaviour
8	170101008	Annanya Pratap Singh Chauhan	HS 429	Indian Business History
9	170101009	Anubhav Tyagi	HS 424	Economics of Uncertainty and Information
10	170101011	Aranya Aryaman	HS 415	History of Contemporary India
11	170101012	Arpit Gupta	HS 429	Indian Business History
12	170101013	Aryan Agrawal	HS 429	Indian Business History
13	170101014	AVIRAL GUPTA	HS 424	Economics of Uncertainty and Information
14	170101015	Avneet Singh Channa	HS 415	History of Contemporary India
15	170101016	B Shri Raam Reddy	HS 424	Economics of Uncertainty and Information
16	170101017	Rohith Chodavarapu	HS 424	Economics of Uncertainty and Information
17	170101018	Bhavani ratti	HS 421	Sociological Perspectives on Modernity

Example - 04

List of Foreign Students

Citizenship of India (OCI)
Self - Financed Candidates
Information for incoming exchange students
Information Regarding Internship Before Arriving at IITG
After Arriving at IITG

Guwahati. He/she will also bear travel cost from his/her home country to India(Guwahati)

Student should attach either a bank statement showing that they have enough finances in their own bank account or a letter from their parents or sponsors certifying that they will support all the expenses incurred by the student as mentioned above in (1)

DOAER will forward the list of selected students to DOAA, (with the departmental approval/selection report) along with (1) and (2) received from the student for processing and obtaining the Director's approval. [More...](#)

List of current international students

Category

2019
2018
2017
2016
2015

SL. NO.	NAME	COUNTRY	PROGRAM	DEPT.
1	Dr. Md. Arifur Rahman Khan	Bangladesh	Post Doc	BSBE
2	Marina Orrite Serrano	Spain	B.Tech. (Exchange)	EEE
3	Dr. Sayed Mehdi Dehdashti	Iran	Post Doc	BSBE
4	Yusuke Ono	Japan	B.Tech. (Internship)	Mechanical Engineering
5	Takahiro Hiramatsu	Japan	B.Tech. (Internship)	Mechanical Engineering
6	Ms. Adejoke Naomi Kolawali	Nigeria	Research Intern	BSBE
7	Mr. Albion W. L. Gonzalez	Spain	B.Tech. (Exchange)	Mechanical Engineering
8	Mr. Florian Drouet	France	M.Tech.	Civil Engineering
9	Mrs. Kawkab Kanjo	Syria	M.Tech.	Biosciences and Bioengineering
10	Mr. Ali Jraisheh	Syria	M.Tech.	Mechanical Engineering
11	Mr. Nafiseh Manteghi	Iran	M.Tech.	Biosciences and Bioengineering

Example - 05a

List of Hostels (static)

The screenshot shows a university website with a navigation bar at the top. The navigation bar includes links for Home, Rules, Scholarship, SAC, Boards, SA Courses, Hostels, Forms, Quick Links, and Team. A login button is also present. On the left side of the page, there is a promotional banner for an online anonymous counselling portal. The banner features three blue buttons with text: "Are you feeling Low?", "Are you confronted with situations that you are not sure how to deal with?", and "Or you find it difficult to discuss in a face to face situation?". Below the banner, there is a call to action: "Visit our Online Anonymous Counselling Portal". The right side of the page displays a vertical list of hostels: Borak, Brahmaputra, Dibang, Dihing, Dhansiri, Karmeng, Kapili, Lohit, Manas, Married Scholars', Slang, Subenai, and Umiam. At the bottom of the page, there are sections for Students' Achievements, All Achievements, Recent Announcements, and Past Announcements. There are also two news cards at the bottom: one about IIT-Guwahati students building a car and another about Tobacco Free Guidelines.

STUDENTS' AFFAIRS

Home Rules Scholarship SAC Boards SA Courses Hostels Forms Quick Links Team

Are you feeling Low?

Are you confronted with situations that you are not sure how to deal with?

Or you find it difficult to discuss in a face to face situation?

Visit our
Online Anonymous Counselling Portal

Borak
Brahmaputra
Dibang
Dihing
Dhansiri
Karmeng
Kapili
Lohit
Manas
Married Scholars'
Slang
Subenai
Umiam

Students' Achievements All Achievements Recent Announcements Past Announcements

ITI-Guwahati students build car that can go 0-60 km/hour in 6 seconds

To promote a weekend culture of racing in a safe environment, a team of IIT- Guwahati

18 NOV 2020 Tobacco Free Guidelines Circular - 15/2020

Read More >

Example - 05b

List of Items (dynamic)

The screenshot shows a web browser window with multiple tabs open. The active tab displays the Amazon homepage. A sidebar menu is visible on the left side of the page, listing various shopping categories and features. The main content area features a large promotional banner for 'Amazon Fashion' with a 'SUPER SALE' offer from 1st to 3rd January, advertising up to 70% off. Below the banner, there are sections for 'Home essentials | Amazon Brands & more', 'EOSS | Style for Mens | Up to 70% off', and a sign-in button. Further down, there are sections for 'Laptops from Top Brands' and other promotional offers.

- SQL - Wikipedia
- Email - V Vijaya Saradhi
- Online Shopping site in ...

Hello, Sign in

- Fire TV Stick
- Kindle E-Readers & eBooks
- Audible Audiobooks
- Amazon Prime Video
- Amazon Prime Music

Shop By Department

- Mobiles, Computers
- TV, Appliances, Electronics
- Men's Fashion
- Women's Fashion
- See All ▾

Programs & Features

- Gift Cards & Mobile Recharges

Amazon Fashion

SUPER SALE

UP TO 70% OFF

Home essentials | Amazon Brands & more

EOSS | Style for Mens | Up to 70% off

Sign in for your best experience

Sign In securely

Laptops FROM TOP BRANDS

Vijaya saradhi

CS245: Databases

Observations

In the presented examples

- Examples 1 to 4 are in tabular form
- Each table has **fixed** number of columns
- Each table has **varying** number of rows
- Columns within a table hold values
- Example 5a/5b on the other hand not merely resembles data. However, they are stored in the table format

Application Specific

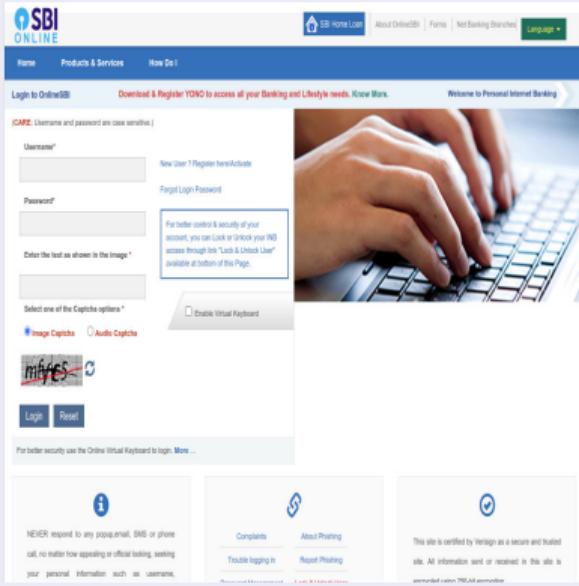
- Structured
- Un-structured

What Differentiates These?

- How elements are stored?
- How queries are formulated?
- How elements are retrieved?
- How elements are updated?
- How multiple user engagement is handled?
- How volume of the queries is handled?
- How data integrity is achieved?

Structured - Example 01

Banks



Queries

read What is my savings bank balance?

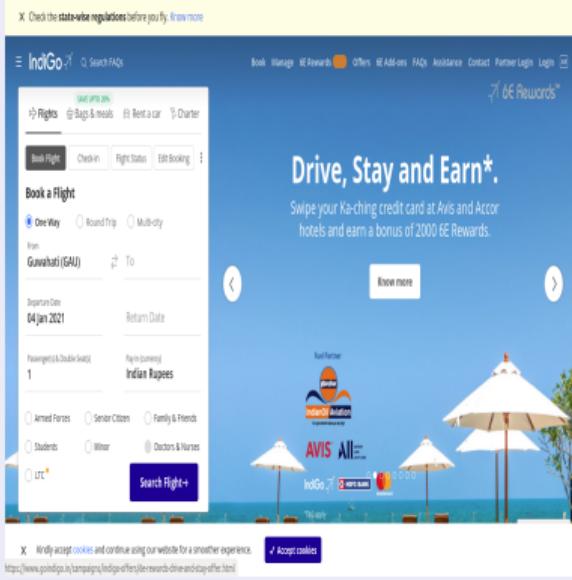
write Deposite 10000 rupees

write Withdraw 5000 rupees

read Provide me the last months bank statement

Structured - Example 02

Airlines



Queries

read List flights between Guwahati & Vizag on 15-Jan-2021

write Book a ticket of 5 passengers on flight 6E-512

write Pay money

read & write Modify the date of travel from 15-Jan-2021 to 16-Jan-2021 on the same flight with same set of passengers

Structured - Example 03

Railways



Queries

read List trains between Guwahati & Vizag on 15-Jan-2021

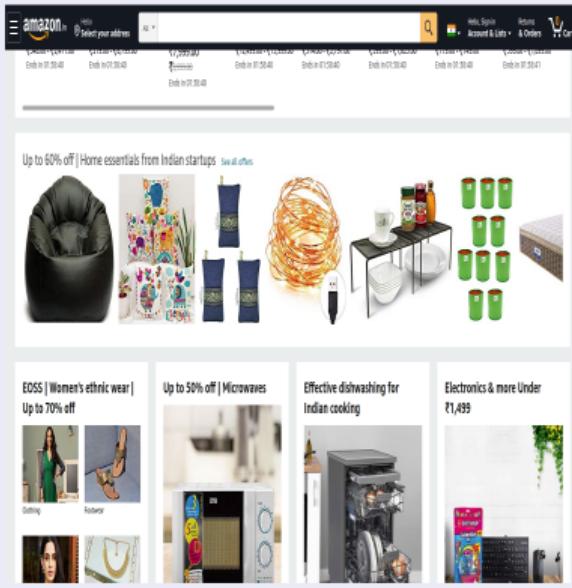
write Book a ticket of 5 passengers on train 12345 & 12842

write Pay money

read & write Modify the date of travel from 15-Jan-2021 to 16-Jan-2021 on the same train with same set of passengers

Structured - Example 04

E-commerce



Queries

read List books on database management systems

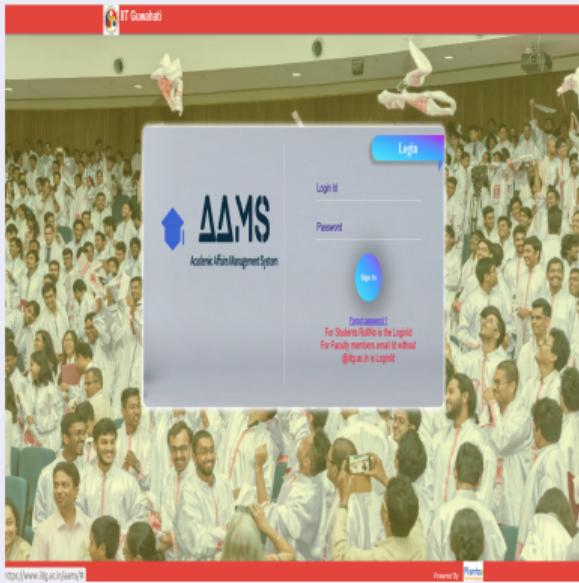
write Buy the book by Raghu Ramakrishnan

write Pay money

ready & write Modify the shipping address

Structured - Example 05

University



Queries

- read Show my transcript
- read Show the list of courses this semester
- write Add the elective CS544
- read & write Drop the added elective
- read & write Register

Structured - Example 06

Competitive Exams

The screenshot shows the homepage of the Joint Seat Allocation Authority (JSSAA) for the Academic Year 2020-21. The top navigation bar includes links for Home, JSSAA Office Memorandum, Business Rules, Message from Chairman Clerk, Certificate Formats, and Contact Us. A banner at the top states "Joint Seat Allocation Authority 2020 IITs, NITs, IEST, IITs and Other-GFTIs for the Academic Year 2020-21". The main content area is divided into several sections:

- Important Information:** Includes links for Refund for NIT System, Important Instructions to Candidates, Information Regarding Admission in NIT+ System after CSAB Special Rounds, Public Notice: Change of Willingness (October 18, 2020), Instructions to Candidates, State of Eligibility Document, Print Lacked Choices, Counselling Schedule (Updated on Nov 06, 2020), Seal Width, View Participating Institute Profile, and Important Instructions to Candidate for Admission as per CSAB.
- Qualifying Examination:** Lists IITs (Admitted 2020), IITs (May 2020 B.E./B.Tech.), IITs (May 2020 B.E./B.Tech.), IITs (May 2020 B.E./B.Tech.), and IITs (May 2020 B.E./B.Tech.).
- Admitting Institutes:** Lists IITs, IITs (EST), IITs (Tuglaqabad), and Other-GFTIs.
- News & Events:** Information Regarding Admit Related to NIT+ System. It mentions the second phase of CSAB 2020 is still in progress, the release of the initial and CSAB related to NIT+ System will be informed from 20th December, 2020. Candidates can refer to JSSAA Admit rule and CSAB Information brochure candidate to assess their eligibility for admits. The admit will be released in the account for which the details had already been provided by the candidate during the registration process. (CSAB 2020).
- Opening and Closing Ranks:** Lists OPR-CR in 2020 and OPR-CR in 2016/2017/2018/2019.

Queries

- read Show my list of choices
read Select IIT Roorkee, 4 years B Tech in CSE
read & write Delete IIT Ropar, 4 years B Tech in Chemical Engineering
write Add NIT Warangal, 4 years B Tech in ECE
write Confirm my choices
write Float my choices
write Pay the fee

Structured - Example 07

Passport

The screenshot shows the homepage of the Passport Seva website. At the top, there is a banner with the text: "Andras (POPKs) have been resumed. Please refer to the list of operational POPKs and POPKs in the Latest News Section. Applicants may reschedule their appointment." Below the banner, there is a video thumbnail showing a web conference held on 24th Jun 2020 for the event of Passport Seva Diwas 2020.

On the left side, there is a sidebar with the following buttons:

- New User Registration
- Existing User Login
- Check Appointment Availability
- Track Application Status

Below the sidebar, there is a section for "National Call Centre" with the phone number 1800-258-1800 and dropdown menus for "Passport Office" and "Country".

On the right side, there is a "Before You Apply" section with several links:

Information Center	Forms and Affidavits	Document Advisor	Feedback and Grievance
Getting Started	Tatkal Appointment Opening Time		
FAQs	Appointment Availability Status		
Passport Act and Rules	Fee Calculator		
Quick Guides	Know your Police Station		
Instructions Booklet	Locate Passport Seva Kendra		
All India Network of Passport Services	Locate Common Service Centers		
Public Advisory	Caution for Public		

At the bottom of the page, there are two sections: "Steps to Apply" and "Value Added Services".

Queries

- read Show the available free slots
- write Book the slot on
12-Jan-2021
- write Submit relevant documents
- write Pay the fee

Structured - Example 08

Land Registration



Queries

read Show my land records

write Book the available slot with the Registrar

write Pay stamp duty

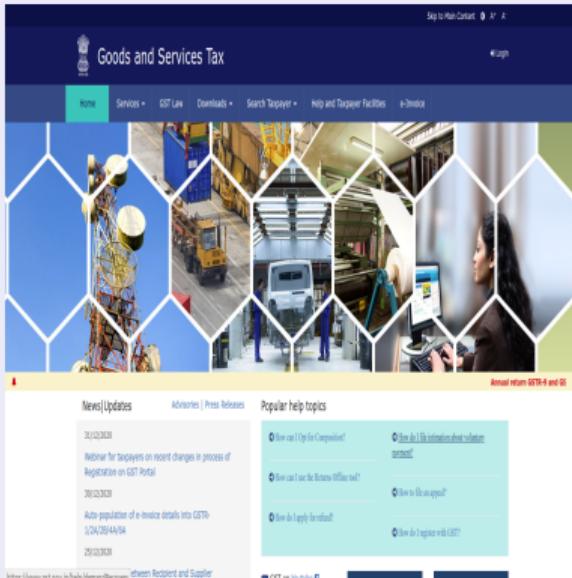
write Register biometric data

write Submit relevant documents

write Register my land

Structured - Example 09

GST



Queries

read Show how much tax to be paid this month

read & write Pay the tax amount

write Claim tax concessions

read Show the tax paid history for last three months

Structured - Example 10

Income Tax

The screenshot shows the official website for e-Filing Anywhere Anytime of the Income Tax Department, Government of India. The main header features the Indian flag and the text "e-Filing Anywhere Anytime". Below the header, there are links for "About Us", "Feedback", "Accessibility Options", "Contact Us", "e-Newspaper", and "Help". A search bar is also present.

The main content area includes a large purple banner with the text "NO MORE FEE. GET YOUR PAN INSTANTLY" and a "APPLY NOW" button. To the right of the banner, there are sections for "New To e-Filing?", "Registered User?", and "Forgot Password?". Below these are "Download" links for IT Return Preparation Software, Other Forms Preparation Software, DSC Management Software, e-Filing FAQs on DTVBY Forms, FAQs on Return Filing, and ITR Notified Forms AY 2020-21.

On the left side, there is a sidebar with "Quick Links" for filing ITRs, instant PAN through Aadhaar, Tax Calculators, e-Pay Tax & Challans, e-Verify Return, View Form 26AS(Tax Credit), Outstanding Demand, ITR Status, Know Your TAN | AO, Verify Your PAN Details, Tax Calendar, Check Refund Dispatch Status, and Verification of applicability w.r.t YTMN. There is also an "Authenticator" section for Notificatory Order issued by ITD and Reminders | Campaigns.

At the bottom, a blue box contains the text: "This year ITR filing is user friendly. Everything crystal clear. Effort of the team is appreciated. 08-09-2020". Below this, there is a table showing statistics:

Individual Registered Users	: 895,516
Registered and Aadhaar Linked	: 120,434
Not-Registered but Aadhaar Linked	: 16,32,93,35
e-Verified ITRs (20-21)	: 10,954,17

Queries

- read Get the form number ITR-1
- read & write Fill this years tax returns information
- write Save the entered data
- write Pay the remaining tax amount
- write File the tax returns

What is the underlying structure?

Queries

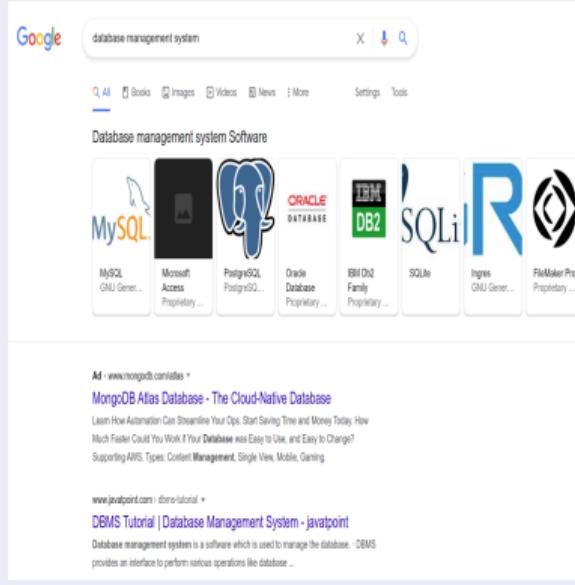
- Data is stored in a tabular format
- Stored data is from the system defined data types
- Operations are centered around tables
- Tables are manipulated; rows of tables are manipulated
- Multi-user, volume, scale, integrity etc.

Un-structured

- Text
- Documents
- Images
- Audio
- Videos
- Source code
- Software binaries
- Graphs
- Maps
- Biometric databases
- :

Unstructured - Example 01

Text

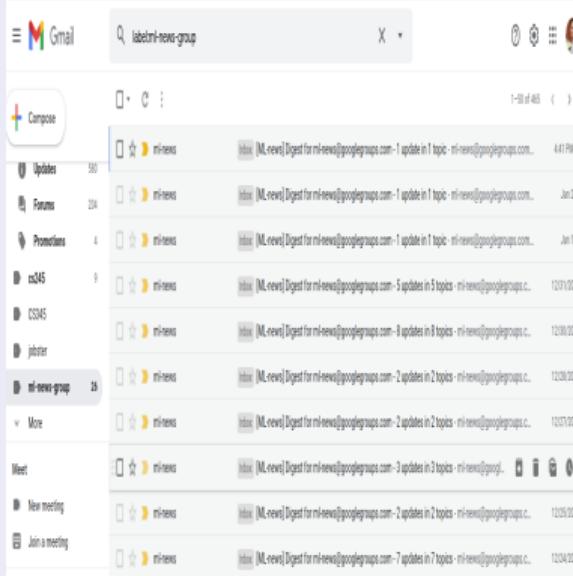


Queries

- Query expressed in natural language
- Retrieved data is text, pdf, ppt, etc
- Data: Only querying allowed
- Understanding user intent is important

Unstructured - Example 02

Text



Queries

- Retrieve emails from specified cs245 course
- Retrieve emails containing text “database management”
- Compose email to course instructor
- Delete emails

Unstructured - Example 03

Documents

The screenshot shows a journal website for "Neural Networks". The top navigation bar includes links for "Articles & Issues", "About", "Publish", "Submit your article", and "Guide for authors". The header also displays "10 issues" and "5,535 Impact Factor". Below the header, the page title is "Volume 135". A sidebar on the left lists categories such as "Select all", "Download PDFs", "Export citations", "Show all article preview", "Contents", "Neuroscience", "Learning Systems", "Mathematical and Computational Analysis", and "Engineering and Applications". The main content area displays a list of articles:

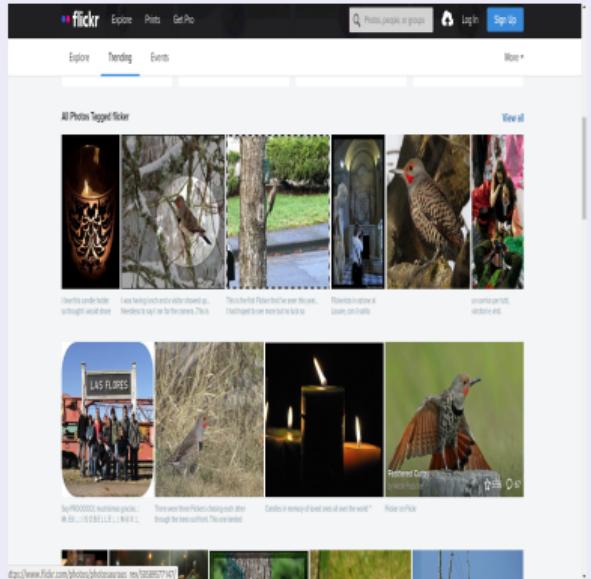
- Neuroscience**
 - Neuroscience** • Full article
A comprehensive study of class incremental learning algorithms for visual tasks
Eduardo Meléndez, Adelio Pimpão, Ismael Faustino
Pages 10-14
[Download PDF](#) [Article preview](#)
 - Neuroscience**
 - Insights on the role of external globus pallidus in controlling absence seizures**
Xiaoyan Wang, Xianzhi Yang, Zhenyu Zhu, Beiping Yu, Yafei He, ... , Daqing Guo
Pages 15-20
[Download PDF](#) [Article preview](#)
 - Neuroscience**
 - Sparse deep dictionary learning identifies differences of time-varying functional connectivity in brain regions-developmental study**
Chen Qiao, Lan Yang, Wenzhong Cai, Zeng-Ren Xu, Ya-Ping Wang
Pages 21-26
[Download PDF](#) [Article preview](#)
 - Neuroscience**
 - Exploration of image statistics with sparse coding in the case of stereo vision**
Gert A. J. J. Sijbers, Ward M. Pottgieter, Georges A. Vervaeke
Pages 27-32
[Download PDF](#) [Article preview](#)

Queries

- List all the articles published in March 2018
- List all the articles containing “SQL”
- Show the article titled “A Relational Model of Data For Large Shared Data Banks”
- List all the articles published by the author E. F. Codd

Unstructured - Example 04

Images

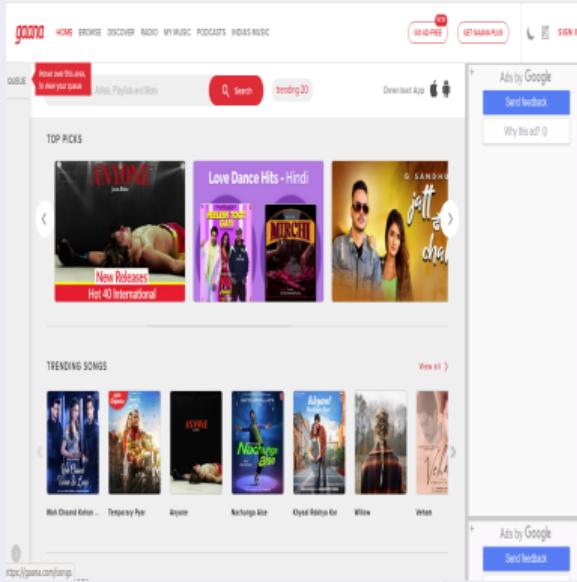


Queries

- Show the images with IIT Guwahati
- Show the images containing serpentine lake
- Show the images in the year 2020
- Show the images from the author

Unstructured - Example 05

Audio

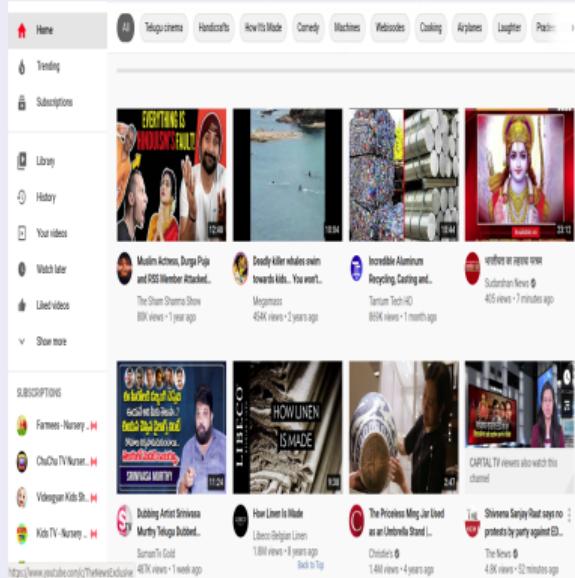


Queries

- List all songs by Shri. S. P. Balasubrahmaniam
- List all songs by Smt. Lata Mangeshkar
- List all the songs in the movie Gadar
- Play the song “Main Nikla”

Unstructured - Example 06

Video



Queries

- Search videos by a natural language query (IIT Guwahati)
- Show the videos by a particular author
- Play a selected video
- Show the live show TV debate

Unstructured - Example 07

Source Code

The screenshot shows a GitHub repository page for the project `vim/vim`. The main navigation bar includes links for Why GitHub?, Team, Enterprise, Explore, Marketplace, Pricing, Search, Sign In, and Sign Up. Below the search bar, there are filters for Issues, Pull requests, Actions, Projects, Wiki, Security, and Insights. The repository name `vim/vim` is displayed in large blue text. A red horizontal bar highlights the `Code` tab. The repository has 11,000 stars and 1,000 forks. The commit history is listed with the most recent at the top:

- brannond patch #2,296: sort test fails when locale is Canadian English (36 minutes ago) 12,111 commits
- github Update runtime files (yesterday)
- REINHOLD patch #2,249: updated references to the file Carbon.BIN (5 months ago)
- si patch #2,224: Build with Ruby and clang may fail (8 days ago)
- nk8 patch #2,172: MS-Windows installer doesn't work (3 months ago)
- pjwmpa patch #7,435 (5 years ago)
- surfne patch #2,220: fuzzy matching doesn't give access to the icon (22 hours ago)
- arc patch #2,226: sort test fails when locale is Canadian English (38 minutes ago)
- tsuk patch #1,249: awaiting the distribution doesn't work as documented (13 months ago)
- anayel patch #2,215: C or cmax times out, correctly doesn't always run (18 days ago)
- cevralyev patch #2,215: Github actions CI isn't used for all available platforms (17 days ago)
- glitchbot patch #1,210: test fix: use --heavy by git diff (15 months ago)
- stefan patch #3,197: Help: complete warnings (8 months ago)

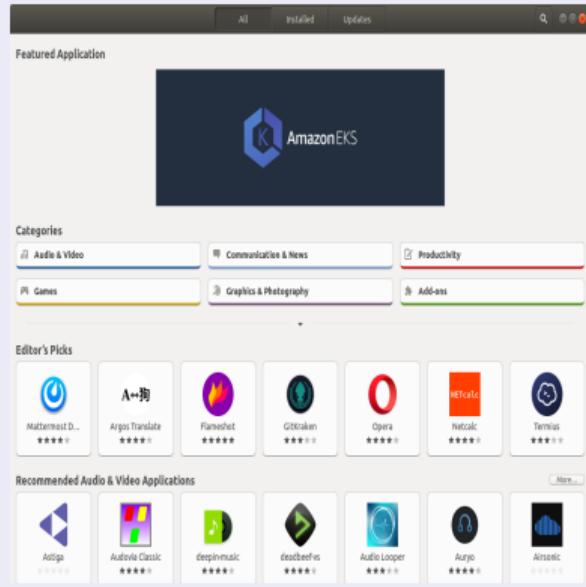
On the right side of the commit list, there are sections for `About`, `Releases`, `Sponsor this project`, and `Packages`. The `About` section includes the official Vim repository link (www.vim.org) and a `README` link. The `Releases` section shows 11,000 tags. The `Sponsor this project` section has a link to <https://www.vim.org/sponsor/index.php>. The `Packages` section is currently empty.

Queries

- List the changes made to `edit.c` on Wednesday, 30-Dec-2020
- Un-do changes made on Wednesday, 30-Jan-Dec-2020
- List who all modified the file `insert.c` between 01-Jan-2021 and 05-Jan-2021
- Insert a new file `menu.c`

Unstructured - Example 08

Binaries

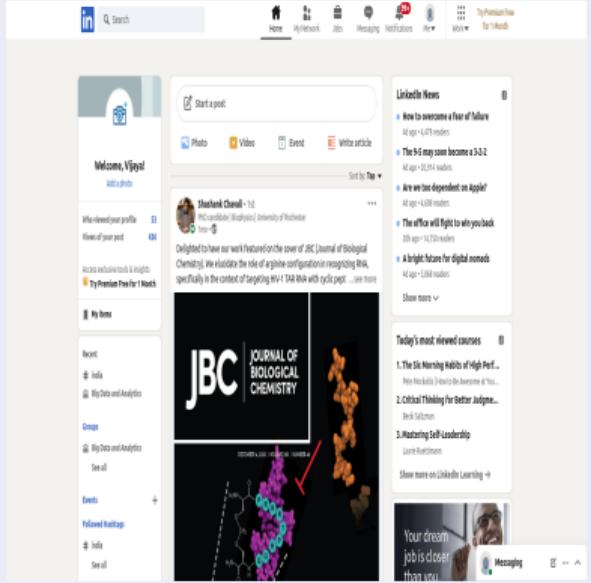


Queries

- Update vim
- Install firefox new version
- Delete all the previous installed versions of firefox
- Update all libraries

Unstructured - Example 09

Graphs

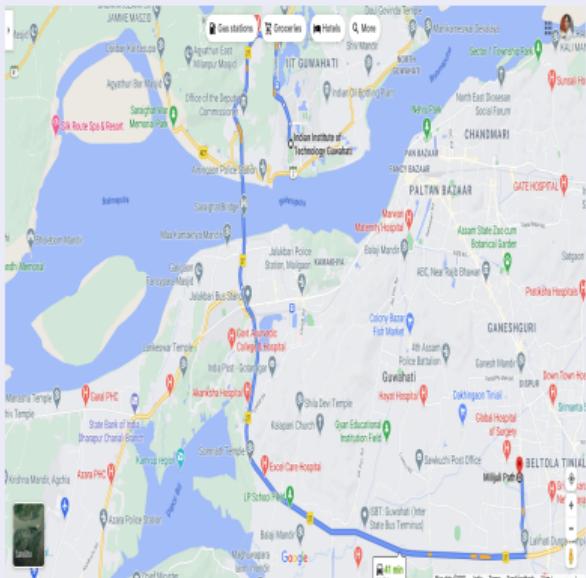


Queries

- List all my school friends
- List all my colleagues at previous company
- Make a new connection with the HR of that company
- Post a job requirement which reach to all my known contacts and their contacts only.

Unstructured - Example 10

Maps



Queries

- Show the map at my location at specified resolution
- Show all the ATMs only
- Show all the hotels near by my area
- Show the route between place A to place B.
- Show all the alternate routes between A and B

Unstructured - Example 11

Biometric databases



Queries

- Verify the person with the given finger print!
- Verify the person with given AADHAR number
- Verify the person with face

What it contains?

- A DBMS is a **collection of programs** that enables users to **create and maintain** a database
- DBMS is a **general-purpose software system**
- It facilitates the process of
 - Defining
 - Constructing
 - Manipulating and
 - Sharing database among various users and applications

Elements

Defining a database involves specifying

- the **data types**
- **data structures**
- **constraints** on the data to be stored in the database
- Database descriptive information is also stored by the DBMS
- The description is in the form of database catalog which is the **meta-data**

Constructing, Manipulating and Sharing

Elements

- Constructing the database is the process of storing the data on some **storage medium** that is controlled by the DBMS
- **Manipulating** a database includes functions such as
 - Querying the database to retrieve specific data
 - Updating the database to reflect changes in the mini-world
 - Generating reports from data
- **Sharing** a database allows multiple **users** and **programs** to access the database simultaneously

An Example

University Database

- Storing information about students, courses, & grades
- Database structure and a few samples of data for such a database

An Example

Student

name	student_number	class	major
Smith	17	1	CS
Brown	8	2	CS

Course

name	number	credit_hours	department
Intro to CS	CS1310	4	CS
Data structures	CS3320	4	CS
Discrete Maths	MA2410	3	MATH
Databases	CS3380	3	CS

An Example

Section

sid	number	semester	year	instructor
85	MA2410	Fall	2007	King
92	CS1310	Fall	2007	Anderson
102	CS3320	Spring	2008	Knuth
112	MA2410	Fall	2008	Chang
119	CS1310	Fall	2008	Anderson
135	CS3380	Fall	2008	stoneson

An Example

Grade_Report

stdent_number	sid	grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

Prerequisite

course_number	prerequisite
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

University Database

- The database is organized in five files
- Each of which stores **data records of same type**
- STUDENT file stores records of all the students
- COURSE file stores records of all the courses
- ...

Define

- To *define* this database, structure of records of each file must be specified
- Specify different *types of data elements* to be stored for each record
- STUDENT record includes: Name, Student_number, Class and Major
- A similar description should be done for all the files
- Descriptions specify domain example: grade must be from the set {‘A’, ‘B’, ‘C’, ‘D’, ‘F’, ‘I’}

Construct

- To *construct* this database, we store data to represent each student, course, section, grade report, and prerequisite
- Each of these must be in different **files**
- Records in various files may be **related**
- Example: Record **Smit** in Student file is **related to** two records in Grade_Report file
- Similarly, each record in **Prerequisite** file relates to two course records
 - One representing course
 - Other representing prerequisite
- Such relations are prevalent in **relational databases**

Manipulate - Querying

- Involve querying and updating
- Example: Retrieve the transcript of ‘Smith’
- List names of students who took database course in fall 2008 and their grades in that section
- List the pre-requisites of database course

Manipulate - Updating

- Change the class of ‘Smith’ to sophomore
- Create a new section for database course for this semester
- Enter a grade of ‘A’ for ‘Smith’ in the database section of last semester