

The slide has a decorative background with colorful circles (green, pink, yellow, blue) and dashed lines. The title "Course Objectives" is at the top in large red bold font. Below it is a bulleted list of objectives:

- First course in database systems
- Cover the fundamental concepts
- Learn to use Database Management System (**DBMS**) and **SQL**.
- Study the internals of DBMS (that's our job)
- Learning state-of-the-art open source DBMS
- Learn to develop DB-assisted applications
- **Advanced topics 1:** Big Data, NoSQL, NewSQL, Distributed SQL, IoT Streaming Data, DB for AI
- **Advanced topics 2:** Cloud DB, mobile DB, XML DB, multimedia DB, parallel/distributed DB ...

At the bottom left is the course identifier "CSIE30600/CSIEB0290 Database Systems". At the bottom right is a purple circle labeled "Course Information 2".

Course Information

- Course Title: Database Systems
- Course Number: CSIE30600/CSIEB0290
- Meeting Time: Thu 09:10~12:00
- Classroom: Science/Engineering Building II A329
- Instructor's Office: Sci/Eng Building II C308
- **Office Hours: Thu 17:00 - 18:00**
- Phone Number: (03) 8693020
- **Email Address:** showyang@gms.ndhu.edu.tw

Grading Policy

- Assignments 25%
- Midterm 25%
- Final Exam 25%
- Term project 25%

- (may change if necessary)

Web Pages

- Course page: e學苑 - e-Learning@NDHU
- Instructor's homepage:
<http://web.csie.ndhu.edu.tw/showyang>

Assignments

- There will be several written and programming assignments.
- All assignments **MUST** be submitted on e-Learning platform. (not by email !!)
- There will be a **deadline** and a **grace period**.
- Submit **BY the deadline** !!
- Grace period is for **unexpected events** (server/net down, net congestion, earthquakes, typhoons, ...)
- No late submission for **ANY** reason !!!

Individual Term Project

- An on-line database application (details will be announced in class)
- Use an open source DBMS as backend
- Browser or smart phone as user interface
- Can use any technique to connect the DBs.
- We will discuss Python/PHP +
SQLite/MySQL/PostgreSQL/MongoDB.
- Demonstration/report due date: **June 12, 2025.**

Online Class (just in case)

Teams link:

<https://teams.microsoft.com/l/meetup-join/19%3az6QLI1m3Hd8BHpPW0mDJpJjiSKLszoUIMPJZdrivc1%40thread.tacv2/1658531135758?context=%7b%22Tid%22%3a%22edba3211-8174-4411-b089-357c588fa127%22%2c%22Oid%22%3a%22e83708da-2e73-4b78-a037-e2bbca1f4d94%22%7d>

Join by ID:

- Meeting ID: 440 956 272 439
- Passcode: RkiWc9

Textbooks

- Ⓐ Carlos Coronel and Steven Morris. ***Database Systems: Design, Implementation & Management, 14th Edition***. Cengage Learning, Inc., 2023. (DSDIM14) (<https://www.cengageasia.com/title/default/detail?isbn=9780357673034>)
- Ⓐ Avi Silberschatz, Henry F. Korth and S. Sudarshan. ***Database System Concepts, 7th Edition***. McGraw-Hill, 2019/2020. (DBSC7) (<https://www.db-book.com/>)
- Ⓐ Ramez Elmasri and Shamkant B. Navathe. ***Fundamentals of Database Systems, 7th Edition***. Pearson, 2016. (FDBS7) (<https://www.pearson.com/us/higher-education/program/Elmasri-Fundamentals-of-Database-Systems-7th-Edition/PGM189052.html>)
- Ⓐ Recommended but not required.

References



- Ⓐ C. J. Date. ***Database Design and Relational Theory: Normal Forms and All That Jazz, 2nd Edition***. Apress, 2019.
- Ⓐ Carlos Coronel and Steven Morris. ***Database Systems: Design, Implementation, & Management, 13th Edition***. Cengage Learning, 2018.
- Ⓐ Wilfried Lemahieu, Bart Baesens and Seppe vanden Broucke. ***Principles of Database Management: The Practical Guide to Storing, Managing and Analyzing Big and Small Data***. Cambridge University Press, 2018.
- Ⓐ Thomas Connolly and Carolyn Begg. ***Database Systems- A Practical Approach to Design, Implementation, and Management, 6th Edition***. Pearson, 2015.
- Ⓐ Garcia-Molina, J. D. Ullman, and J. Widom. ***Database Systems: The Complete Book, 2nd Edition***, Prentice Hall, 2008. (<http://infolab.stanford.edu/~ullman/dscb.html>)
- Ⓐ Jeffrey D. Ullman and Jennifer Widom. ***A First Course in Database Systems, 3rd Edition***, Prentice Hall, 2007. (<http://infolab.stanford.edu/~ullman/fcdb.html>)

SQL References



- Allen G. Taylor and Richard Blum. ***SQL All-in-One For Dummies, 4th Edition***. For Dummies, 2024.
- Alan Beaulieu. ***Learning SQL: Generate, Manipulate, and Retrieve Data, 3rd Edition***. O'Reilly Media, 2020.
- Anthony Molinaro and Robert de Graaf. ***SQL Cookbook: Query Solutions and Techniques for All SQL Users, 2nd Edition***. O'Reilly Media, 2020.
- Upom Malik, Matt Goldwasser, Benjamin Johnston. ***SQL for Data Analytics: Harness the power of SQL to extract insights from data, 3rd Edition***. Packt Publishing, 2022.
- GoalKicker.com. ***SQL Notes for Professionals***. (good desktop ref) (<https://books.goalkicker.com/SQLBook/>)

SQL References (cont.)

- Bobby Iliev. ***Introduction to SQL***. MIT License, 2020.
- Mike McGrath. ***SQL in Easy Steps, 4th Edition***. In Easy Steps Ltd. 2020.
- Kevin Kline, Daniel Kline and Brand Hunt. ***SQL in a Nutshell: A Desktop Quick Reference, 4th Edition***. O'Reilly Media, Inc. 2020.
- Ben Forta. ***SQL in 10 Minutes a Day, Sams Teach Yourself, 5th Edition***. Sams Publishing, 2019.
- James R. Groff, Paul N. Weinberg, Paul Weinberg, James Groff. ***SQL: The Complete Reference, 3rd Edition***. McGraw-Hill, 2009.
- Alex Kriegel and Boris M. Trukhnov. ***SQL Bible, 2nd Edition***. Wiley, 2008.

Python Programming

- Ⓐ Eric Matthes. *Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 3rd Edition*. No Starch Press, 2023.
- Ⓐ Steve Holden, Anna Ravenscroft and Alex Martelli. *Python in a Nutshell: A Desktop Quick Reference, 4th Edition*. O'Reilly Media, 2023.
- Ⓐ Johannes Ernesti and Peter Kaiser. *Python 3: The Comprehensive Guide to Hands-On Python Programming*. Rheinwerk Computing, 2022.
- Ⓐ Brett Slatkin. *Effective Python: 135 Specific Ways to Write Better Python, 3rd Edition*. Addison-Wesley Professional, 2024.
- Ⓐ Luciano Ramalho. *Fluent Python: Clear, Concise, and Effective Programming, 2nd Edition*. O'Reilly Media, 2022.
- Ⓐ Wes McKinney. *Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, 3rd edition*. O'Reilly Media, 2022.
- Ⓐ A Byte of Python(free online book)(<https://python.swaroopch.com/>)

Python & Data Science

- Ⓐ Wes McKinney. *Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, 3rd Edition*. O'Reilly Media, Inc., 2022.
- Ⓐ Luca Massaron and John Paul Mueller. *Python for Data Science For Dummies, 3rd Edition*. John Wiley & Sons, Inc., 2024.
- Ⓐ Jake VanderPlas. *Python Data Science Handbook: Essential Tools for Working with Data*, O'Reilly Media, Inc., 2023.
- Ⓐ Yuli Vasiliev. *Python for Data Science: A Hands-On Introduction*. No Starch Press, 2022.

PHP and MySQL References

- Robin Nixon. **Learning PHP, MySQL & JavaScript, 7th Edition.** O'Reilly Media, Inc., 2024.
- Jon Duckett. **PHP & MySQL: Server-side Web Development.** Wiley, 2022.
- W. J. Gilmore. **Beginning PHP and MySQL: From Novice to Professional, 5th Edition,** Apress, 2018.
- Andrew Comeau and Stephen Burge. **MySQL Explained: Your Step By Step Guide, 2nd Edition,** CreateSpace Independent Publishing Platform, 2017.
- Luke Welling and Laura Thomson. **PHP and MySQL Web Development, 5th Edition,** Addison-Wesley Professional, 2016.
- Paul DuBois. **MySQL, 5th Edition (Developer's Library).** Addison-Wesley Professional, 2013.

On-line References

- Wikibooks, **Structured Query Language.** (https://en.wikibooks.org/wiki/Structured_Query_Language) (SQL:2011)
- Wikibooks, **MySQL.** (<https://en.wikibooks.org/wiki/MySQL>)
- Wikibooks, **PostgreSQL** (<https://en.wikibooks.org/wiki/PostgreSQL>)



On-line SQL Resources

- **Online SQL interpreter (for the DB Concepts book)**
(<https://www.db-book.com/university-lab-dir/sqljs.html>)
- **SQLite online**
(<https://sqliteonline.com/>)
- **The Try-SQL Editor (W3Schools)**
(https://www.w3schools.com/sql/trysql.asp?filename=trysql_asc)
- **Online SQL Compiler (Tutorialspoint)**
(https://www.tutorialspoint.com/execute_sql_online.php)

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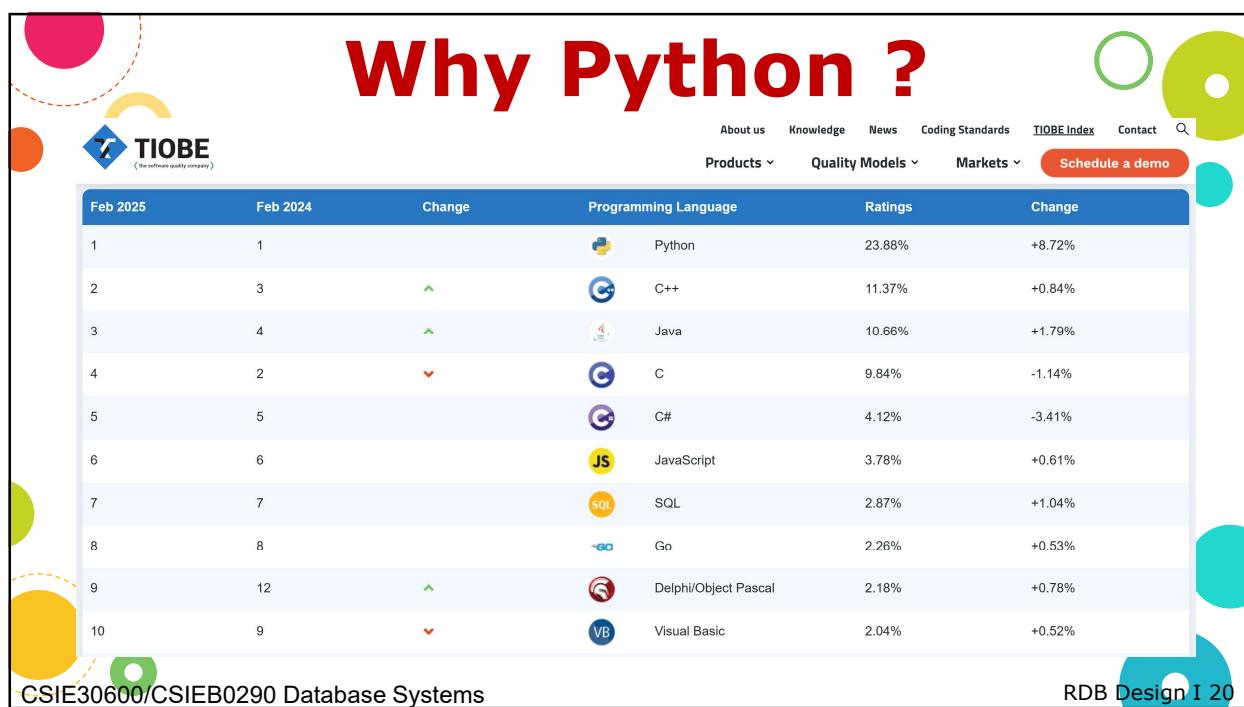
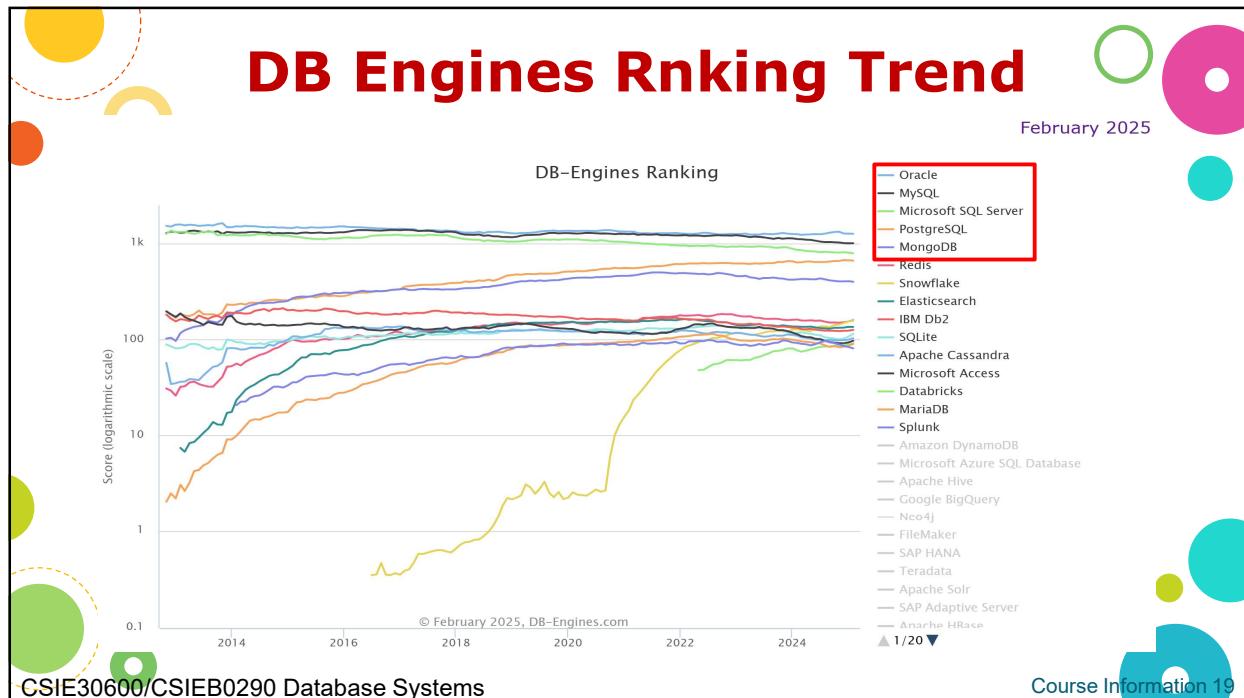
Why MySQL, PostgreSQL, MongoDB?

424 systems in ranking, February 2025

Rank	DBMS			Database Model	Score		
	Feb 2025	Jan 2025	Feb 2024			Feb 2025	Jan 2025
1.	1.	1.	Oracle	Relational, Multi-model	1254.82	-3.93	+13.38
2.	2.	2.	MySQL +	Relational, Multi-model	999.99	+1.84	-106.67
3.	3.	3.	Microsoft SQL Server	Relational, Multi-model	786.87	-11.69	-66.70
4.	4.	4.	PostgreSQL +	Relational, Multi-model	659.62	-3.79	+30.21
5.	5.	5.	MongoDB +	Document, Multi-model	396.63	-5.87	-23.73
6.	↑ 7.	6.	Redis +	Key-value, Multi-model	157.91	+4.55	-2.80
7.	↓ 6.	↑ 9.	Snowflake +	Relational	155.58	+1.68	+28.13
8.	8.	↓ 7.	Elasticsearch	Multi-model	134.63	-0.29	-1.11
9.	9.	↓ 8.	IBM Db2	Relational, Multi-model	125.44	+2.46	-6.79
10.	10.	10.	SQLite	Relational	113.82	+7.13	-3.47
11.	11.	↑ 12.	Apache Cassandra +	Wide column, Multi-model	102.58	+3.39	-6.69
12.	12.	↓ 11.	Microsoft Access	Relational	96.54	+3.84	-16.63
13.	13.	↑ 17.	Databricks +	Multi-model	90.03	+2.19	+13.13
14.	14.	↓ 13.	MariaDB +	Relational, Multi-model	89.50	+3.92	-7.73
15.	15.	↓ 14.	Splunk	Search engine	80.56	-2.53	-11.09
16.	↑ 17.	↓ 15.	Amazon DynamoDB +	Multi-model	75.58	+2.58	-7.31
17.	↓ 16.	↓ 16.	Microsoft Azure SQL Database	Relational, Multi-model	72.76	-1.02	-6.80
18.	18.	18.	Apache Hive	Relational	62.49	+5.61	-3.32
19.	19.	19.	Google BigQuery +	Relational	54.89	+1.85	-8.74
20.	20.	↑ 22.	Neo4j +	Graph	45.34	+1.65	-1.27

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Why Python ?

PYPL Index

Worldwide, Feb 2025 :

Rank	Change	Language	Share	1-year trend
1		Python	29.85 %	+1.6 %
2		Java	15.15 %	-0.7 %
3		JavaScript	7.92 %	-0.8 %
4		C/C++	7.19 %	+0.5 %
5		C#	6.13 %	-0.5 %
6		R	4.55 %	-0.1 %
7		PHP	3.72 %	-0.8 %
8	↑↑	Rust	3.07 %	+0.6 %
9	↑↑	Objective-C	2.86 %	+0.5 %
10	↓↓	TypeScript	2.74 %	-0.1 %

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Why Python ?

ZDNet Programming Language Popularity Index

Rank	Language	Popularity
1	Python	30.9%
2	Java	25.1%
3	JavaScript	15.2%
4	C#	7.2%
5	PHP	6.2%
6	C	5.9%
7	R	3.7%
8	Objective-C	2.4%
9	Swift	2.3%
10	TypeScript	1.1%

ZDNet Index (2024)

Most Popular Programming Languages of 2025 !

Rank	Language	Share (%)
1	Python	30.9%
2	Java	25.1%
3	JavaScript	15.2%
4	C#	7.2%
5	PHP	6.2%
6	C	5.9%
7	R	3.7%
8	Objective-C	2.4%
9	Swift	2.3%
10	TypeScript	1.1%

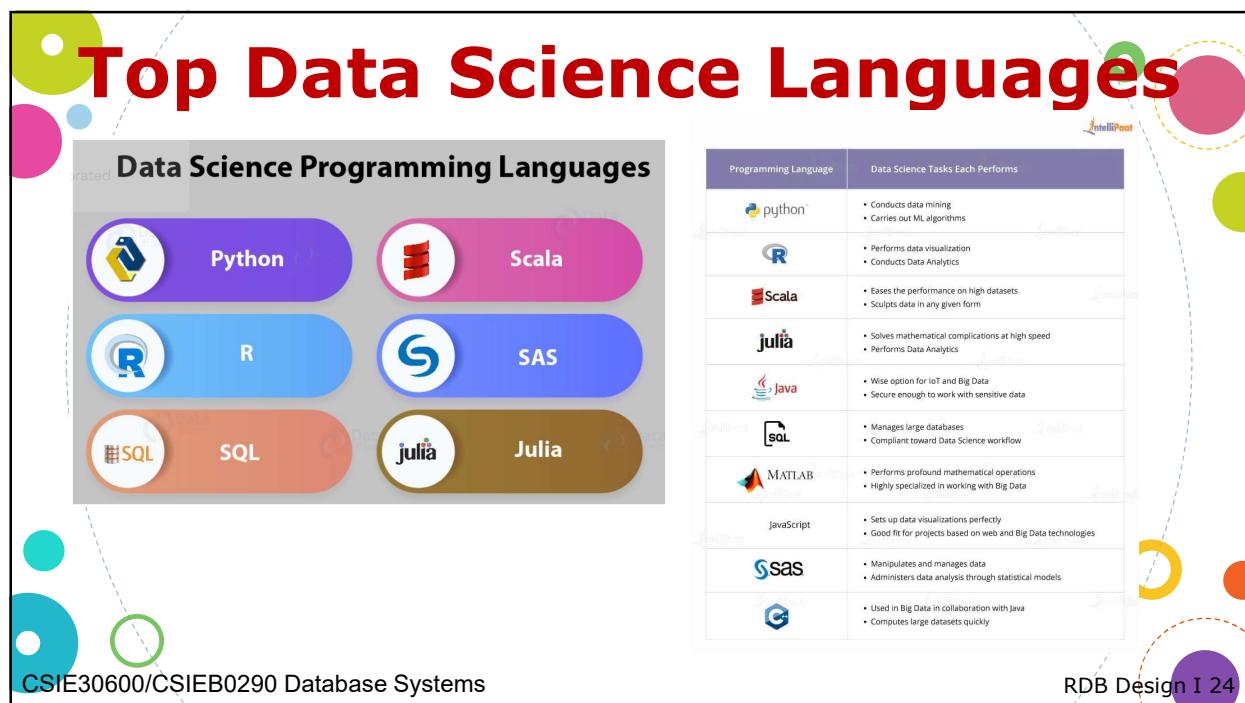
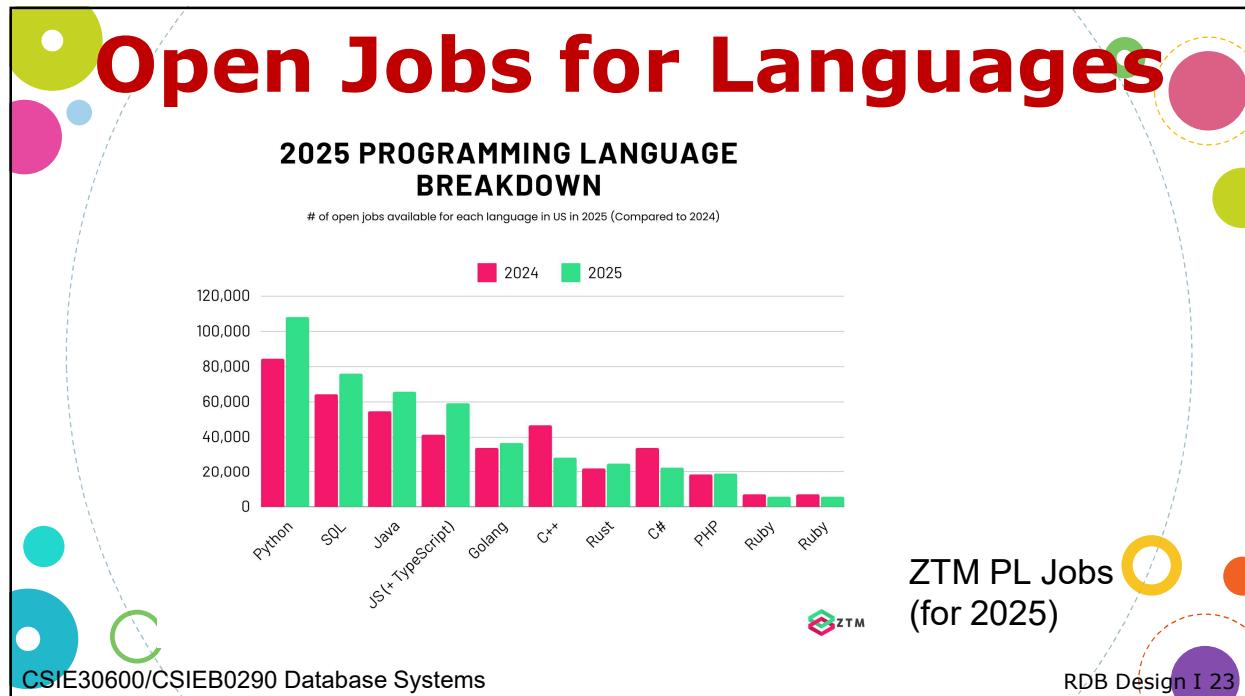
@coderjetsetjoy

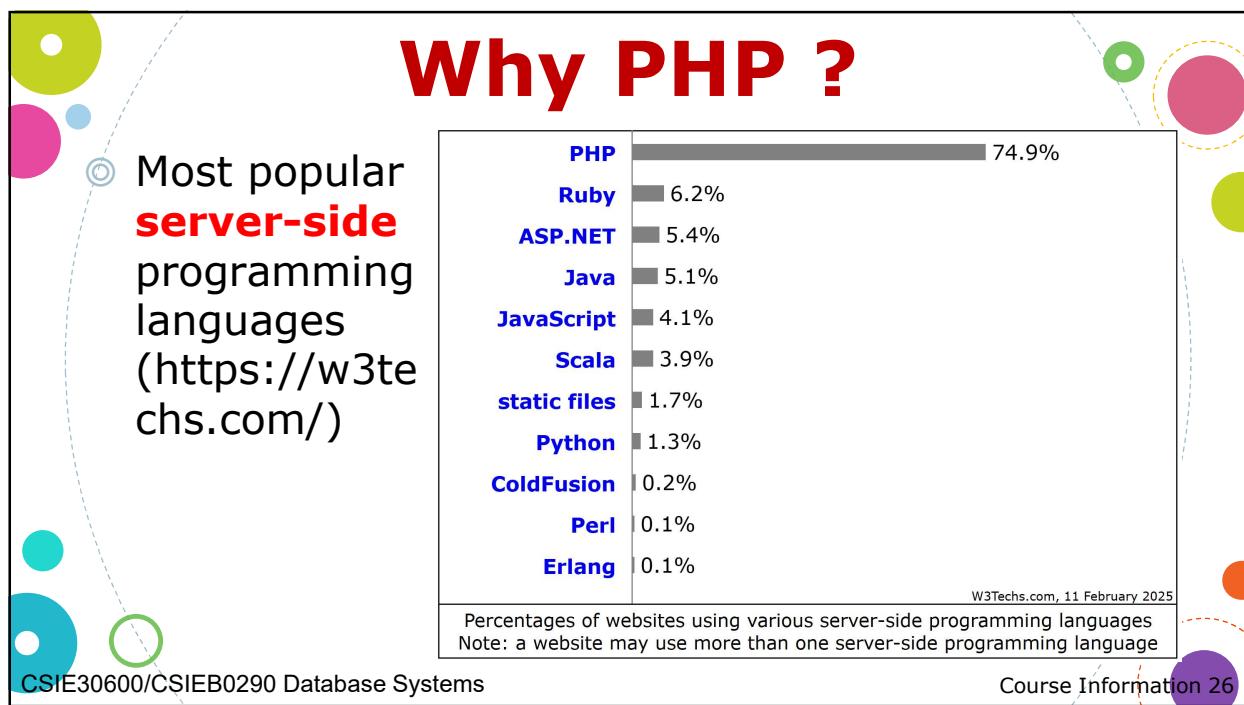
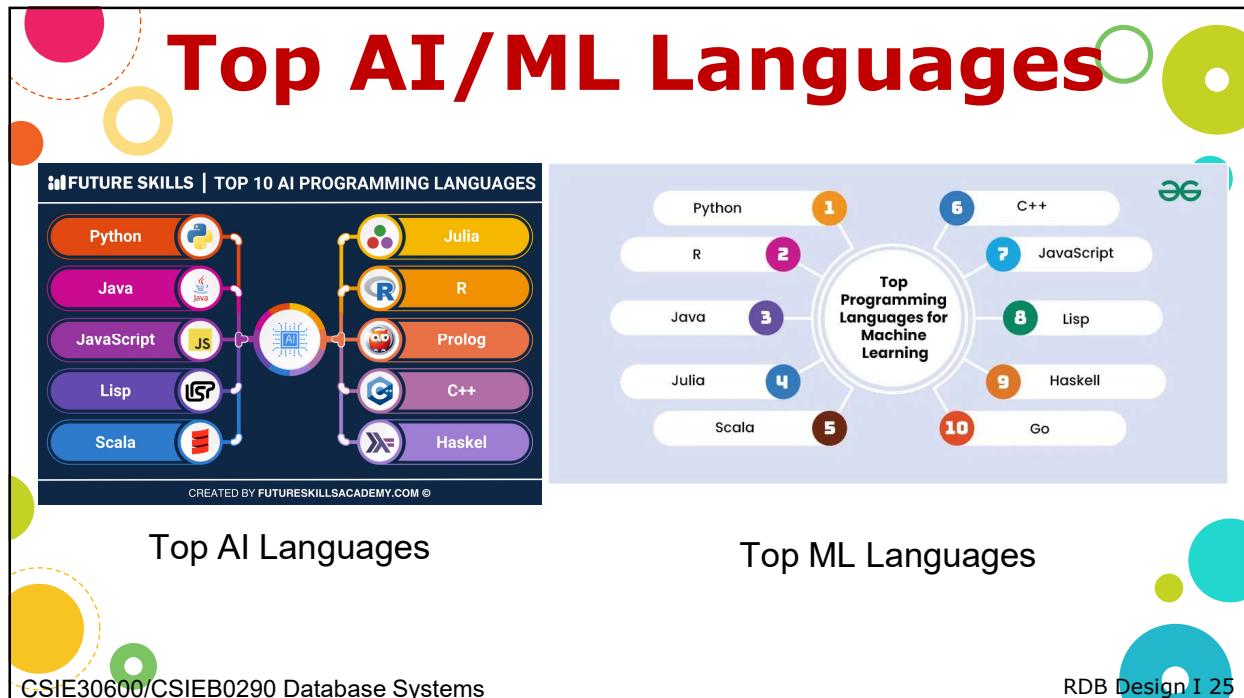
Which Language Are You Currently Learning ?

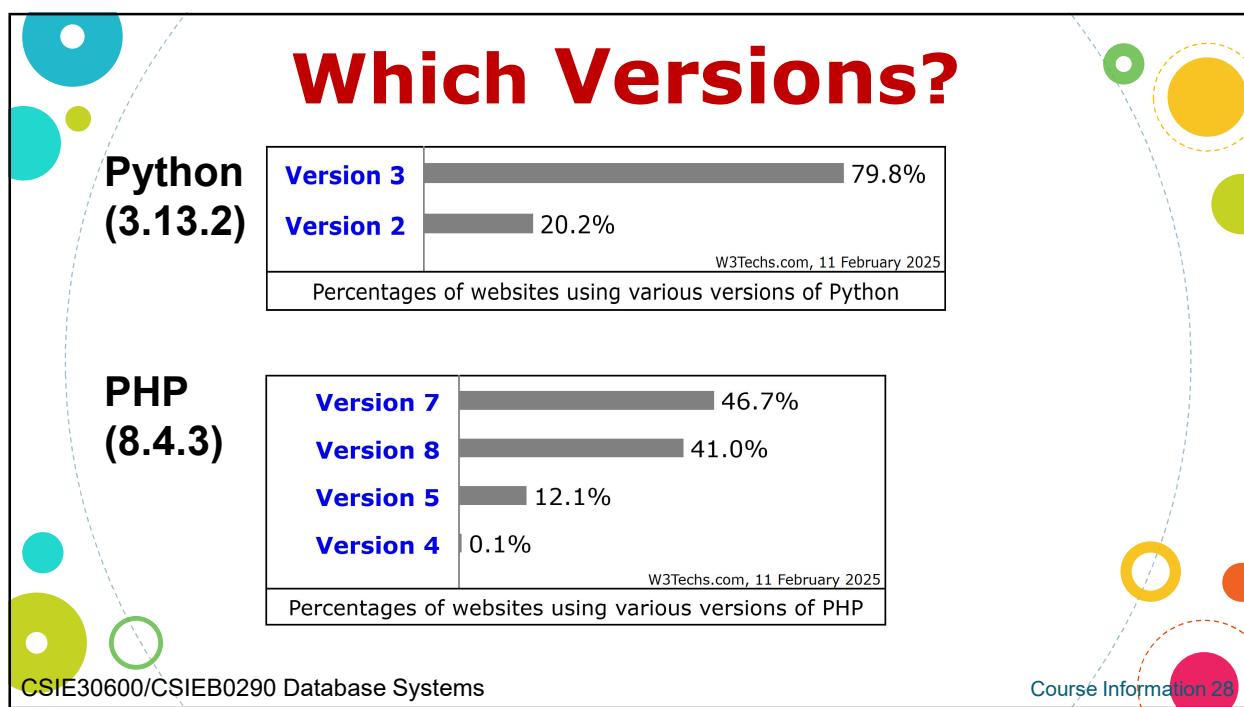
@coderjetsetjoy (2025)

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What about JavaScript ?

(<https://w3techs.com/>)

Most popular client-side programming languages

© W3Techs.com	usage	change since 1 January 2025
1. JavaScript	98.9%	
2. Flash	1.0%	
3. Java	0.1%	

percentages of sites

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PHP vs JavaScript (1)

PHP VS JAVASCRIPT: KEY DIFFERENCES

Features	PHP	Javascript
Server-side language	Yes	Not without additional frameworks
Client-side language	No	Yes
OOP	Yes	Yes
Supports database	Yes	→ No
Open source	Yes	Yes
Performance	Comparatively slow	Fast
Works within browser	No	Yes
Garbage collection	Yes	Yes
Interchangeable objects and arrays	No	Yes
Accepts lower and uppercase variables	Yes	No

>[hackr.io](#)

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PHP vs JavaScript (2)

PHP	JavaScript
<ul style="list-style-type: none"> • Server-side scripting language • Used for back-end development • More secure (as it is not visible in browser) • Helps to build high-level interactive web pages • Quite slow performance • More features available • Combined with HTML • MariaDB, MySQL, and PostgreSQL; • WordPress, Drupal, Joomla • Best for e-commerce and other websites using CMS 	<ul style="list-style-type: none"> • Client-side scripting language • Mainly used for front-end development • Has tools for enhancing security but needs more effort to do so • Helps to build user-friendly creative web pages • Fast performance • Less load on a server and less server traffic • Combined with HTML, XML, Ajax • AngularJS and ReactJS: • MongoDB, CouchDB, and NoSQL • Best for dynamic SPAs

DB for JavaScript

- As a client-side language, built-in DB support is not a primary concern.
- Can still use **embed DBs** with small footprint.
- **Oracle** provides JavaScript support in the MySQL to write **JavaScript stored programs**.
- Many NoSQL DBs provide APIs for JavaScript access. (MongoDB, CouchDB, Redis, ...)

JavaScript for Server-side?

Fastest growing client-side programming languages since 1 January 2025

	sites
1. JavaScript	5.1
2. Java	0.1
3. WebAssembly	0.1

daily increase of number of sites per million

Mostly used with environment/frameworks such as Node.js, Express.js, ... (out of the scope of this course)

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Python vs PHP

theknowledgeacademy

Aspect	PHP	Python
Syntax and readability	Similar to C and Perl, PHP can be verbose	Clean, elegant syntax, emphasis on readability
Web Development	Strong focus, popular frameworks available	Versatile, frameworks for web and more
Community and support	PHP has a vast and active community, and abundant resources	Python has a vibrant community, and an extensive library ecosystem
Performance and scalability	PHP is optimised for Web Development, fast execution	Python has efficient libraries, used in data analysis and ML
Learning curve	PHP has a relatively gentle learning curve	Python has a gentle learning curve, beginner-friendly
Job market and demand	PHP is in strong demand, especially in Web Development	Python is in high demand and used in a wide range of applications
Use cases	Web Development, CMS, e-commerce	Web Development, data analysis, ML, AI, automation

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Is PHP dying ?

Google Trend

Python PHP JavaScript

Still used by 74.9% of the websites (W3tech)

- Python and JavaScript/frameworks are rising.
- Will be **invincible** if you learn all **THREE !!**

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Why Study Databases?

- Databases used to be *specialized applications*, now they are a *central component* in modern systems.
 - Knowledge of DB concepts is essential
- Databases are **everywhere**, even when you don't see them explicitly
 - Banking + credit cards: all transactions
 - Airlines: reservations, schedules
 - Universities: registration, grades
 - Telecommunications/networks
 - (more on next slide)

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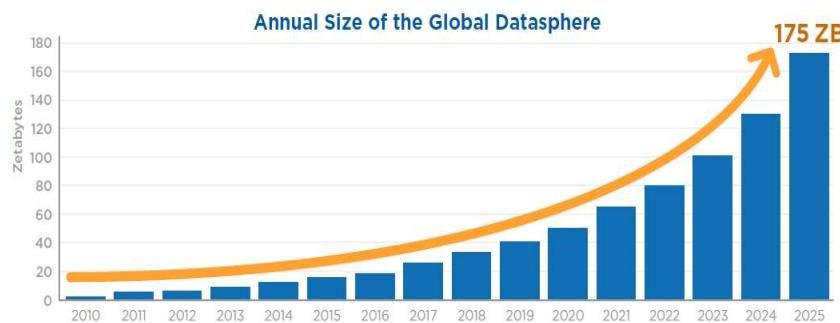
Why Study Databases?

- Sales: customers, products, purchases
- Manufacturing: production, inventory, orders, supply chain
- Human resources: employee records, salaries, tax deductions
- Web sites: generated from databases; front-ends to databases
- Scientific research, e.g., studying the environment
- Your own data!
- Global data volume grows faster than ever! (next slide)
- Sky-high demand for Big data and NoSQL/NewSQL DB!
- Streaming data from IoT devices
- AI/ML models need huge amount of data to build
- **Data needs to be managed**

Global DataSphere

- **DataSphere**: the sum of ALL data around the world!
- Global DataSphere will grow from 33ZB in 2018 to **175 ZB** by 2025 (IDC)

Figure 1 - Annual Size of the Global Datasphere



Why Study Databases?

Because data is **valuable**:

- E.g., bank account records, tax records, student records, personal information ...
- It must be **protected** - no matter what happens whether we have machine crashes, disk crashes, hurricanes/floods;
- It also needs to be protected from **people**

Why Study Databases?

Because data is often **structured**:

- Bank account records all follow the same structure
- We can exploit this regular structure
 - To retrieve data in effective ways (that is, we can use a query language)
 - To store data efficiently
- Dealing with **unstructured data** still needs **database** technologies.
- Big data needs database + **new techniques**

Why Study Databases?

- Because the **database field has made significant contributions** to basic computer science:
 - Concepts and techniques have been applied to different problems and different areas
 - Because **DBMS software is highly successful** as a commercial technology (Oracle, SQL Server, ...)
 - Because **DB research is highly active and VERY interesting!**
- Lots of opportunities to have practical impact

AI/ML Need Data

- Artificial Intelligence (AI) and Machine Learning (ML) will affect nearly all aspects of our lives.
- AI/ML need huge amount of data work !!
- Example:** The raw training set of ChatGPT4 was **45TB** of compressed plaintext (**570GB** after filtering). Number of parameters is **1.7 trillion**.
- Data is King !!!** But you have to know **how** to use it, with **what tools**.

Syllabus




CSIE30600/CSIEB0290 Database Systems

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- Introduction
- Databases and database users
- Database system concepts and architecture
- Relational model and constraints
- Relational algebra (and calculus**)
- Basic & intermediate SQL (how to use a DB)
- Database design with ER/EER models
- ER/EER to relational mapping
- Open source RDBMS(MySQL, PostgreSQL, ...)
- DB applications development (with Python, PHP, ...)

Syllabus (cont.)



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- Relational database design I – Functional dependencies and normalization
- Relational database design II – Further normalization and design algorithms
- Big data processing**
 - Basic concepts, big data storage, MapReduce
 - NoSQL/NewSQL/Distributed SQL, graph databases
- Big data analytics**
 - Data warehousing
 - Online/realtime analytical processing
 - Data mining

Syllabus (cont.)

- Complex data types**
- Storage systems and structure**
- Indexing methods**
- Query processing & optimization
 - Query processing
 - Query optimization
- Transaction management
 - Transactions
 - Concurrency control
 - Recovery**



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Syllabus (cont.)

- Object and object-relational databases**
- Semi-structured data and XML**
- Web databases

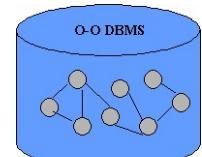


Figure 1: O-O Database Structure

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Syllabus (cont.)**

- Parallel and distributed databases
- Cloud computing and data trends
- NoSQL and NewSQL databases
- Blockchain databases

Course Information 47

Syllabus (Advanced Topics)**

- Database security
- Active databases
- Temporal and real-time databases
- Spatial databases
- Multimedia databases
- Deductive databases
- Information retrieval and Web search
- Mobile and pervasive data management
- Streaming data management/analytics
- DBs for AI/ML

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Accept the DB Challenges

- A very interesting and challenging course
- Be prepared for some theoretical discussion on principles and algorithms.
- Yes! We have homework and assignments.
- Don't be late for the class. You will NOT be able to keep up with the pace.
- Ask questions if you miss the point.
- Design your own examples.
- Join us on the DB challenges !!!



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