

# SQL in Programming Languages

Slides derived from those by Jeffrey D. Ullman

# SQL and Programming Languages

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- The user does not want to execute SQL statements
- She wants to interact with an application targeted to her domain
  - Limited set of choices
  - Simple execution of complex operations
  - Graphical interface:
    - Simple data input
    - Nice data output (presentation)

# Applications

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- They are written in traditional programming languages:
  - C, C++, Java, Fortran, C#, F#, Visual Basic, Cobol
- Host languages

# Approaches

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- Embedded SQL
  - Older approach (since the 70s)
- Call Level Interface (CLI)
  - Most recent
  - SQL/CLI, ODBC, JDBC

# Embedded SQL

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- In the embedded SQL approach the programmer inserts SQL statements directly in the source code of the host programming language
- A precompiler is used to translate the code so that SQL statements are translated into function/procedure calls of the specific DBMS API
- From a file containing embedded SQL to a file in the same language containing function calls

# Concrete Examples

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- In DB2 you can develop embedded SQL applications in the following host programming languages: C, C++, COBOL, FORTRAN, and REXX
- The DB2 precompiler is invoked with PREP (PRECOMPILE)
- In Postgres the preprocessor for C is called ECPG

# Call Level Interface

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- Sending commands to DBMS by means of function calls of an API
  - standard **SQL/CLI** ('95 and then part of SQL:1999)
  - **ODBC**: proprietary (Microsoft) implementation of SQL/CLI
  - OLE DB: high level API
  - ADO: higher level API
  - **JDBC**: CLI for Java

# SQL/CLI

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- SQL/CLI is the library for C
- ODBC differs from SQL/CLI in minor details



# OLE DB

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- ODBC is complicated, so Microsoft proposed OLE DB and ADO
- OLE DB: is a library that provides applications with uniform access to data stored in diverse information sources
  - Not only relational
- OLE DB is based on the Microsoft object model: Component Object Model (COM)

# ADO and ADO.NET

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- ADO: Activex Data Object
- High level interface for OLE DB
- ADO.NET: ADO for the .NET framework
- ADO.NET is independent from OLE DB: there does not exist OLE DB.NET

# .NET Framework

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- The .NET Framework is Microsoft's replacement for COM technology.
- You can code .NET applications in over forty different programming languages. The most popular languages for .NET development are C# and Visual Basic .NET.
- The .NET Framework class library provides the building blocks with which you build .NET applications. This class library is language agnostic and provides interfaces to operating system and application services.

# .NET Framework

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- .NET applications (regardless of language) compile into Intermediate Language (IL), a type of bytecode.
- The Common Language Runtime (CLR) is the heart of the .NET Framework, compiling the IL code on the fly, and then running it.
- In running the compiled IL code, the CLR activates objects, verifies their security clearance, allocates their memory, executes them, and cleans up their memory once execution is finished.