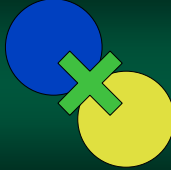


# Relations in Computer Science

Part 5

1



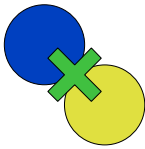
# Cross Products & Databases

SQL is set notation

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## Cross Products & Databases

- We are in the "Information Age" where knowledge is now computerized
- Information is stored in databases
- These systems are based on tuples and sets



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## Fields

- *Fields* contain the smallest unit of data
  - e.g. Number, Text
  - So, each can be seen as a tuple (it can be a set, but rarely so)
- Each field has a unique field name
  - Name
  - Age
  - etc....

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## Records

- A *record* is a set of data fields
  - represents a logical group of data
  - these include related numbers, text, images, etc...
- Examples
  - Course: department, number, section
  - Student: name, age, class
  - Computer: brand, speed, cost, etc...

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## Database Example

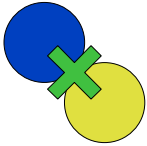
First	Last	Major	Greek
Peter	Griffen	Und	Tappa Kegga Bru
Joe	Gunchy	CSc	Cuppa Kappa Chino
Rick	Sanchez	Sci	elta Phart
Eric	Cartman	Bus	Eta Lotta Pi

Record

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## Relationships & Cardinality



- *Relational Databases* allow the user to query multiple related tables
- Related tables are *joined* which performs a **cross product** on two tables
- Restrictions are used to eliminate unneeded records

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## Locating Specific Data

- A *query language* is used to:
  - locate information
  - sort records
  - change data in records
- Examples:
  - SQL (Structured Query Language)
  - Natural language queries – not used often

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## SQL Inner Join

```
SELECT Student.name,  
       Course.grade  
FROM Student  
INNER JOIN Course  
ON Student.sid = Course.sid  
WHERE Course.department = "csc"
```

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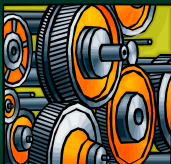
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## SQL Inner Join - Sets (simplified)

```
{ (s_name, c_grade) |  
  s ∈ Student and  
  c ∈ Course and  
  s_sid = c_sid and  
  c_department = "csc" }
```

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## Abstract Data Types

What *int* really means

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## Application of Sets

- An *abstract data type (ADT)* defines:
  - a set of possible values **and**
  - operations (functions) that can be performed on those values
- These are the basis for all classes and data structures in programming languages



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## Integer Example

- In the code below, `int` is an ADT (found in most programming languages)
- It declares a variable `n` of type `int`
- `n` represents a value from `int`'s set of values

```
int n;
```

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## Domain of 'int'

- `int` is defined (normally) as 32-bit
- So, the set is  $\{-2^{31}, \dots, (2^{31} - 1)\}$
- Also note: `int`  $\subset$  `Z`
  - this means that it cannot store any integer
  - ... just within a small range subset of `Z`

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## What Java's notation means

- When you declare a variable, you are stating that it is a member of a set
- In the example below, the two statements mean same thing: set notation vs. Java notation

```
n ∈ int
```

Set notation

```
int n;
```

Java notation

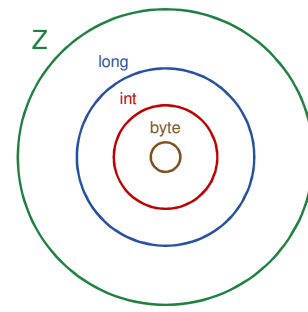
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## Java Integer Sets



2/18/2020

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## Possible Set Violation

```
void test(int x)
{
    ...
}
```

```
int main()
{
```

```
    long n;
    test(n);
```

long is a superset of int

int may not be able to store n

2/18/2020

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## No Set Violation

```
void test(long x)
{
    ...
}
```

```
int main()
{
```

```
    int n;
    test(n);
}
```

2/18/2020

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## Operations

- ADT also defines that  $n$  can be manipulated by via functions  $+$ ,  $-$ ,  $\times$ ,  $\div$
- Sometimes, programming languages are different (division for example)

```
 $\div : \mathbb{Z}, \mathbb{Z} \rightarrow \mathbb{Z}$  in Java, C++, C#
 $\div : \mathbb{Z}, \mathbb{Z} \rightarrow \mathbb{R}$  in Visual Basic
```

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## Functions



Notation varies, but logic the same

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## Functions

- Many programming languages support customized functions
- The format often mirrors the notation used in discrete mathematics



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## C Family

- C programming language family includes: C, C++, Java, and C#
- The notation is very terse, but includes all the same information

```
name : int  $\rightarrow$  int
```

Discrete math

```
int name(int n)
```

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## Visual Basic

- Visual Basic evolved from the original BASIC programming language
- The notation is far more verbose

```
name : Integer  $\rightarrow$  Integer
```

```
Function name(n As Integer) As Integer
```

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## Pascal

- Pascal was very popular in the 1980's and 90's
- Created many concepts that were integrated into other languages

```
name : integer  $\rightarrow$  integer
```

```
function name(n : integer) : integer
```

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## Fortran

- Fortran was the first third-generation programming language
- It has evolved over 50 years

```
name : integer → integer  
  
function name(n) result(x)  
    integer, intent(in) :: n  
    integer :: x
```

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## Swift

- Swift was created by Apple to replace older Objective-C
- Influenced by multiple languages

```
name : Int → Int  
  
func name(n : Int) -> Int
```

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## Swift

- Swift was created by Apple to replace older Objective-C
- Influenced by multiple languages

```
name : Int → Int  
  
func name(n : Int) -> Int
```

An arrow!

OMG! An arrow!

Wow! Correct notation!

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