OBJECT RELATIONAL MAPPING (ORM)

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What Is It?

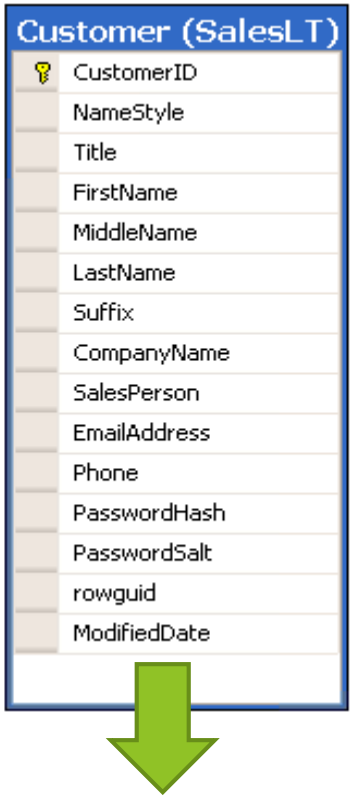
- Wikipedia: …”technique for converting data between incompatible type systems in object-oriented programming languages. This creates, in effect, a ‘virtual object database’ that can be used from within the programming language”
- “Maps” set based data to objects useable by Object Oriented languages.
- This creates, in effect, a "virtual object database" that can be used from within the programming language.

What Is An ORM

Google Translate

Break through language barriers.

What Is An ORM?



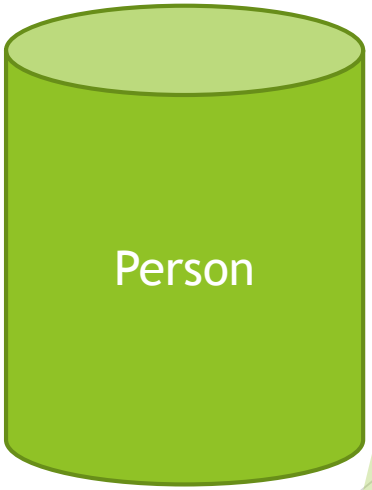

```
Console.WriteLine("Hello {0} {1}!\r", customer.FirstName, customer.LastName);
```

Object Impedance Mismatch

Wikipedia defines this as: "…conceptual and technical difficulties that are often encountered when a relational database management system (RDBMS) is being used by a program written in an object-oriented programming language or style; particularly when objects or class definitions are mapped in a straightforward way to database tables or relational schemata."

Data as OO Objects

- Data management tasks act on object-oriented (OO) objects that are almost always non-scalar values.
- Person (
  attribute integer id,
  attribute string name,
  relationship Dept works_in,
  attribute Set <string> phones
)



Data in Relational Model

Person Table

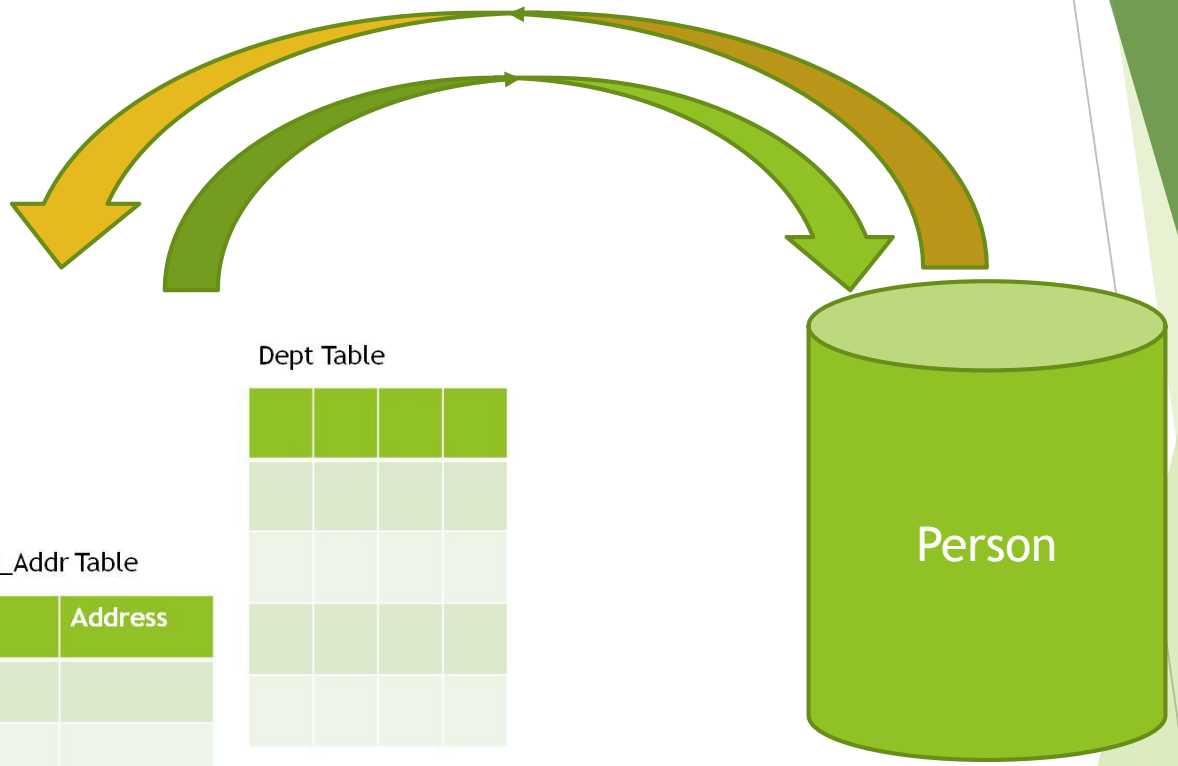
id	name		

Person_Addr Table

id	Address

Dept Table

Problem


Person Table
id
name
Person_Addr Table
id
Address
Dept Table
Person

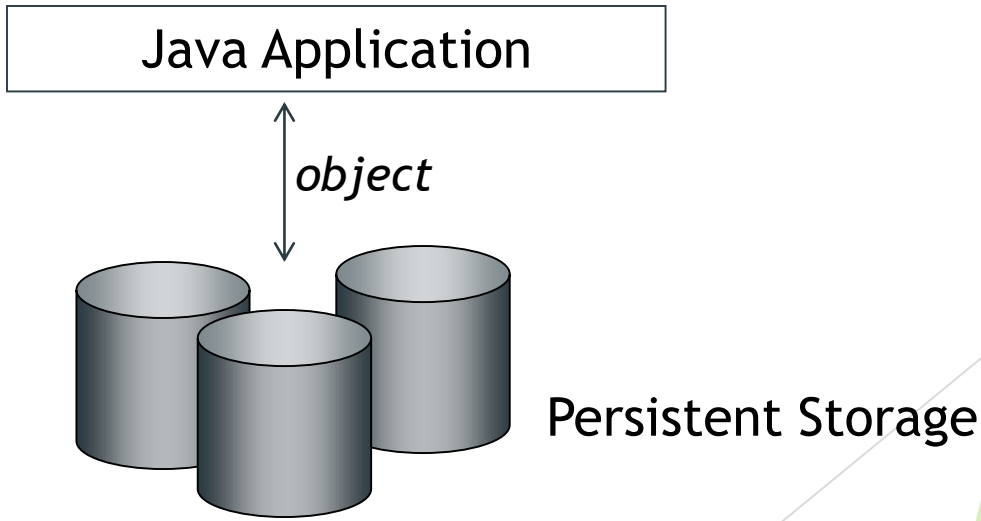
Solution

- Use Non Object-Oriented Programming Language
- Use Object-Oriented Database
- Use XML-like database
- Use NoSQL Database
- Use Object-Relational Mapping

NoSQL DEFINITION:
Next Generation Databases mostly addressing some of the points: being **non-relational, distributed, open-source** and **horizontally scalable**.

Goal

- Applications need to save data to persistent storage.
- Persistent storage can be database, directory service, or other.
- For O-O programming, we'd like to save and retrieve *objects* to/from storage.



Object-Relational Mapping

Purpose:

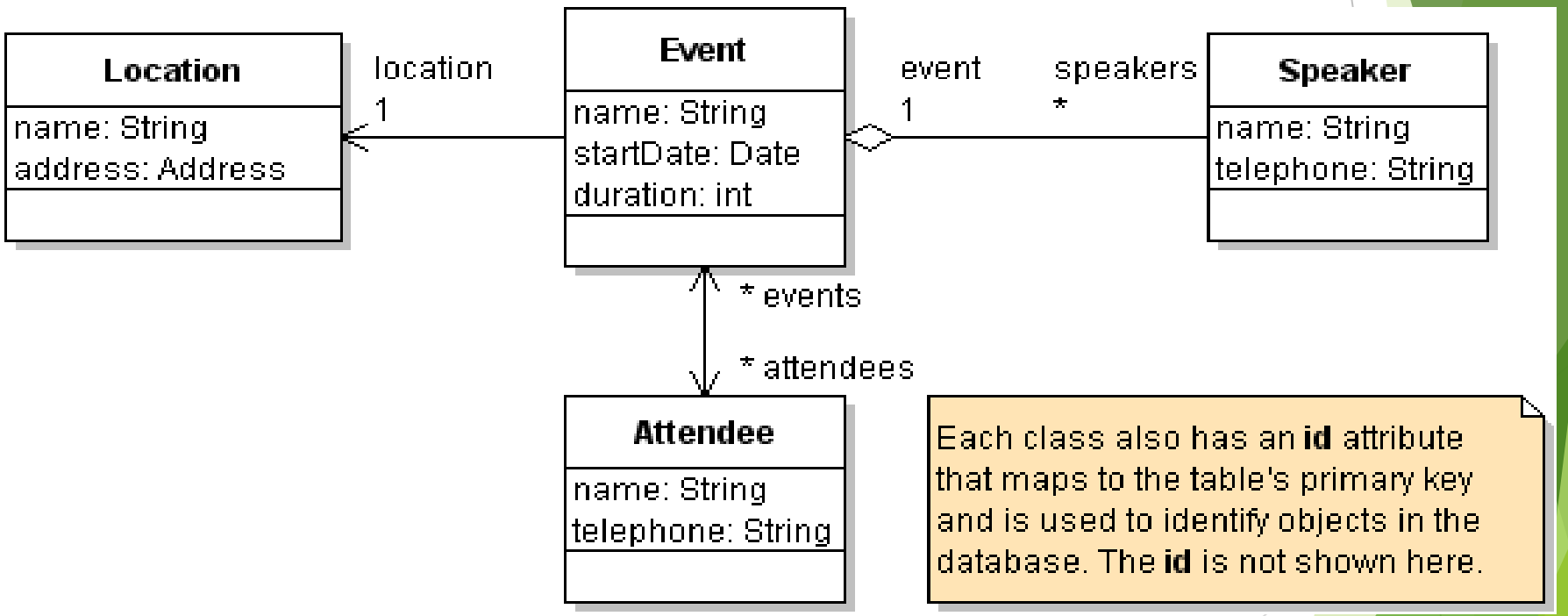
- save object as a row in a database table
- retrieve data from tables and create objects
- save and recreate *associations* between objects

Design Goals:

- separate object-relational mapping services from the rest of our program
- minimize the impact of changing database vendor or database schema

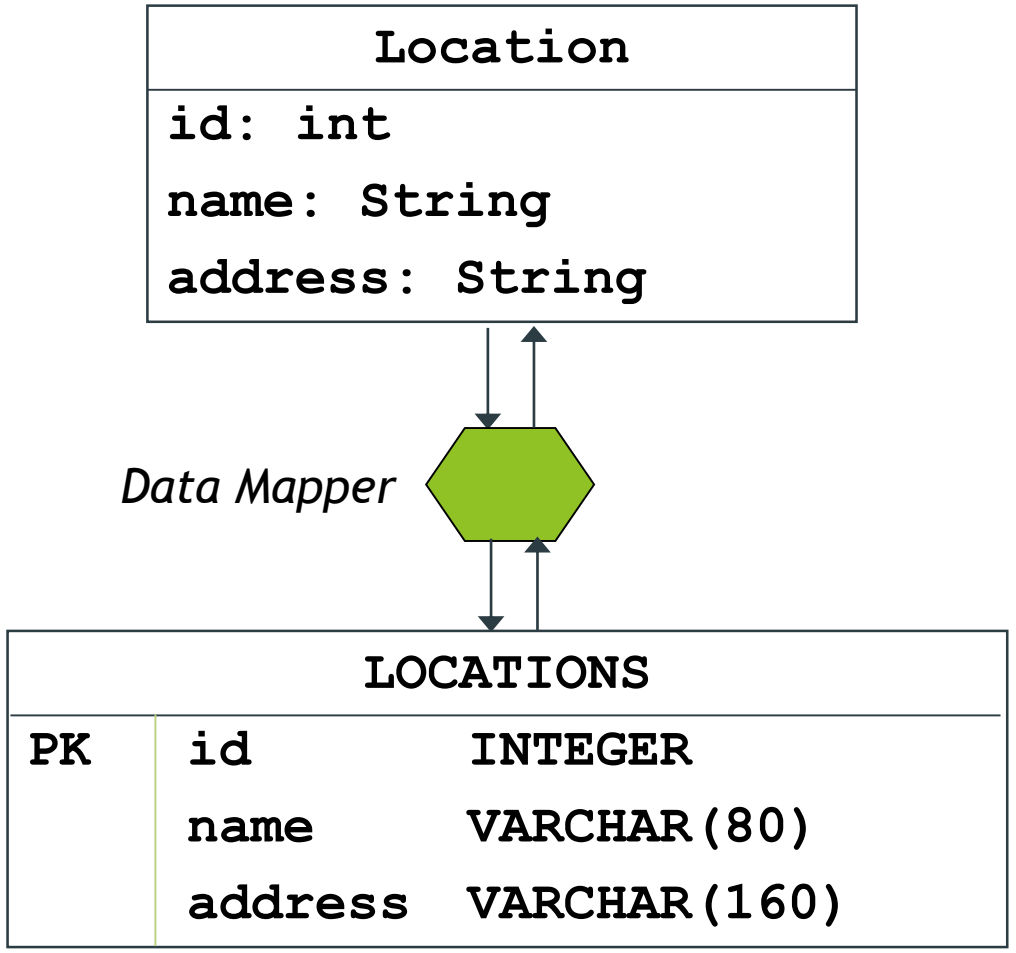
An Example

An Event Manager application with these classes:



Object-Relational Mapping

Map between an object and a row in a database table.



Class

should have an identifier attribute

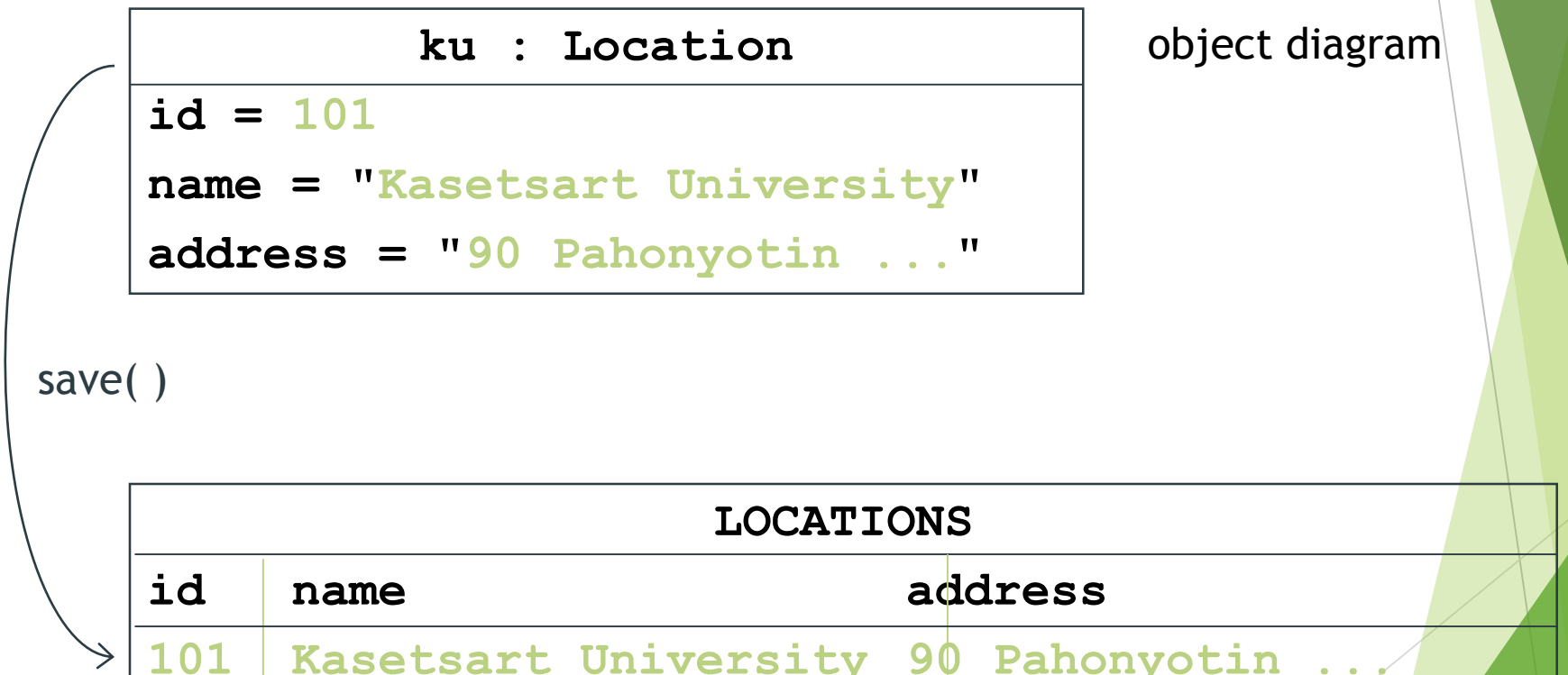
Data Mapper

convert object to table row data,
convert data types,
instantiates objects

Database Table

identifier is usually the primary key of table

Mapping an Object



O-R Mapping Code for Location (1)

```
Location ku = new Location( "Kasetsart University" );
ku.setAddress( "90 Pahonyotin Road; Bangkok" );
// save the location
dataMapper.save( location );
```

Issues:

- data mapper should choose a unique ID for persisted objects
- what happens if same data is already in the table?

O-R Mapping Code for Location (2)

```
// retrieve the location
Location ku1 = dataMapper.find( "Kasetsart University" );
Location ku2 = dataMapper.find( "Kasetsart University" );
```

- how to we tell find what field to search for? id? name?
- our code does same find twice, does mapper return the same object?

  (ku1 == ku2) => true or false?

```
// update the address
ku1.setAddress( "Kampaengsaen Road; Kampaengsaen" );
```

- is the address updated automatically in the database?

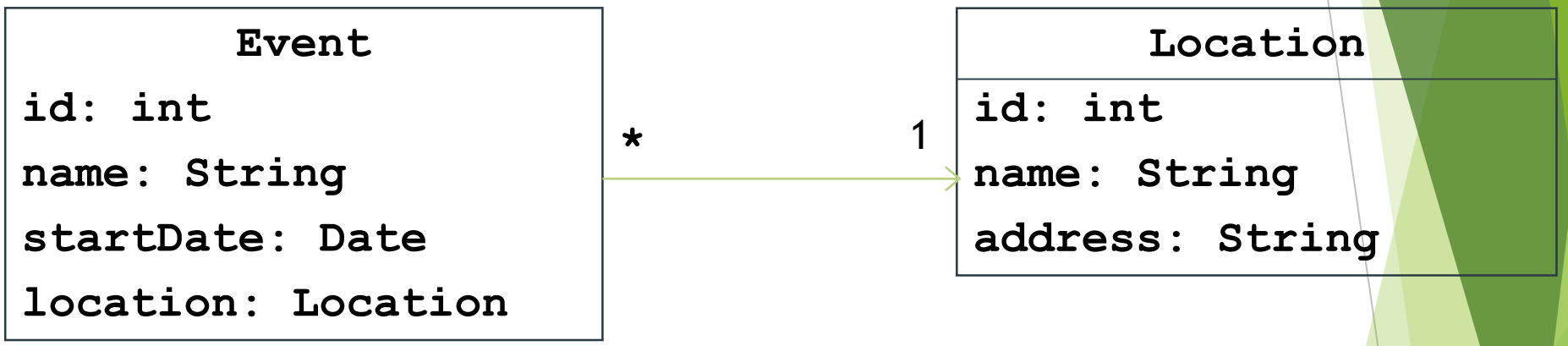
Transparent Persistence

With *transparent persistence*, any changes to a persistent object are automatically propagated to the database.

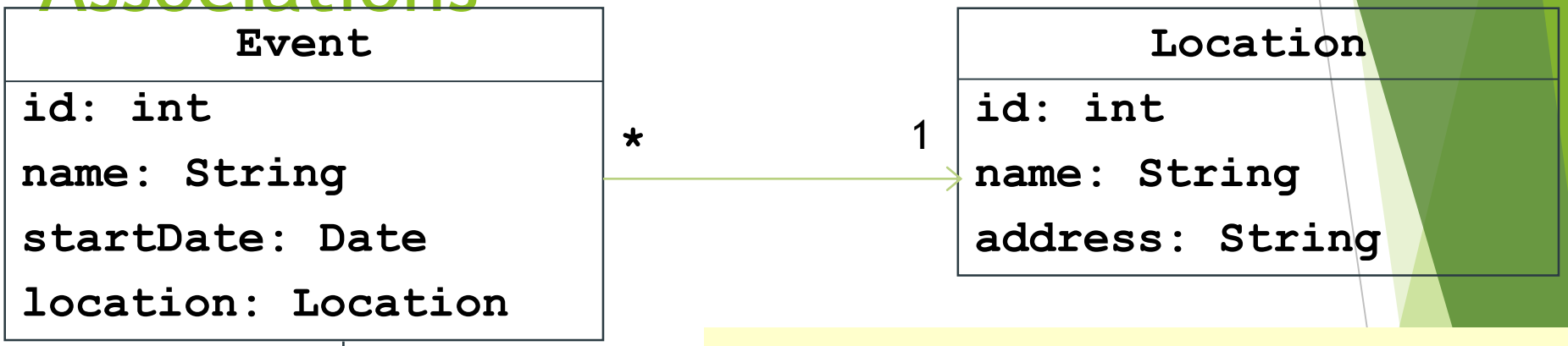
```
Location ku = new Location( "Kasetsart University" );
ku.setAddress( "90 Pahonyotin Road; Bangkok" );
// save the location
dataMapper.save( ku );
// change the address
ku.setAddress( "Kampaengsaen, Nakorn Pathom" );
```

LOCATIONS		
id	name	address
101	Kasetsart University	Kampaengsaen ...
102	Seacon Square	120 Srinakarin ...

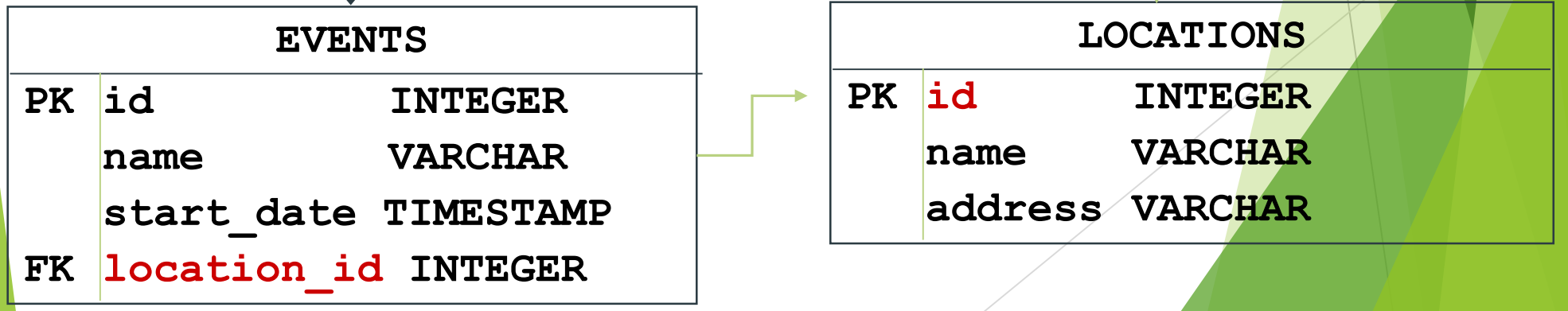
O-R Mapping of n-to-1 Associations



O-R Mapping of n-to-1 Associations



The Data Mapper converts a n-to-1 association to a foreign key relation (persist) or foreign key to object (retrieve).



O-R Mapping Code for Event

```
Event event = new Event( "Java Days" );
Location ku = new Location( "Kasetsart University" );
ku.setAddress( "90 Pahonyotin Road; Bangkok" );
event.setLocation( ku );
event.setStartDate( new Date(108,Calendar.JULY, 1) );
// save the event
dataMapper.save( event );
```

- when we save the event, does dataMapper save the location, too?

O-R Mapping Code for Event

```
// retrieve the event
Event evt = dataMapper.find( "Java Days" );
Location location = evt.getLocation( ); // null?
```

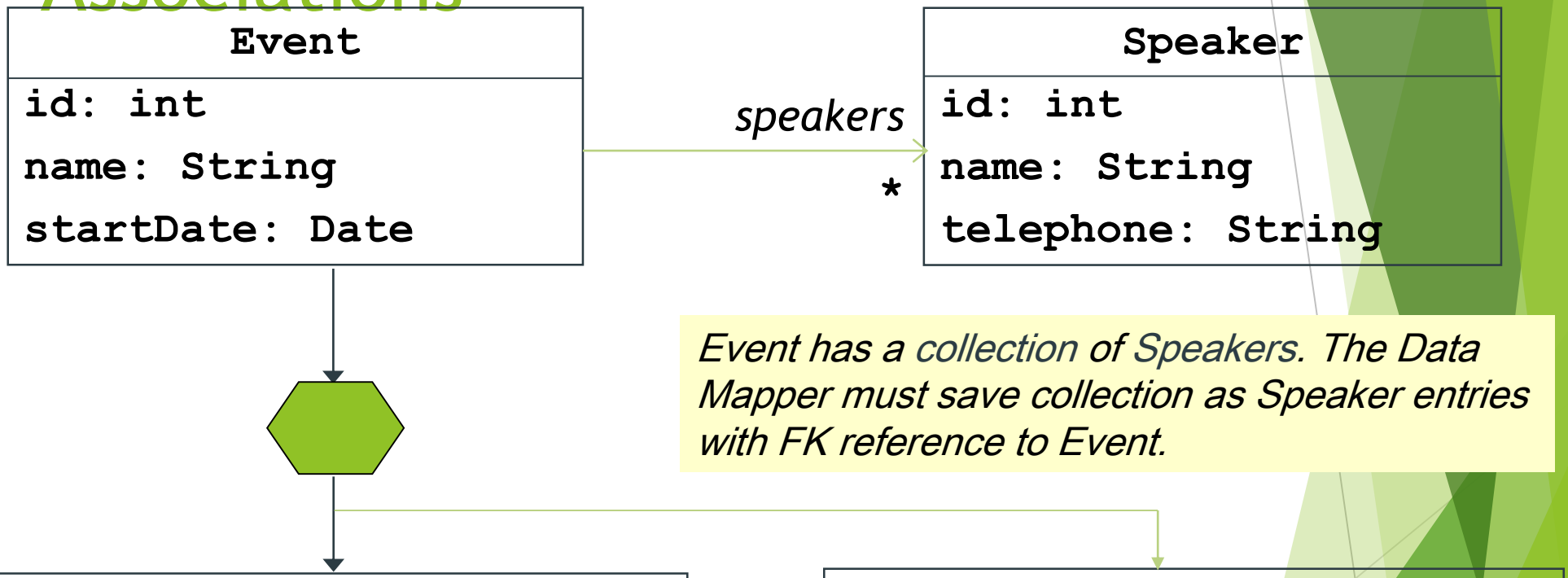
- when we get the event, does the dataMapper create the location, too?

```
// delete the event
Event evt = dataMapper.find( "Java Days" );
dataMapper.delete( evt );
```

- does the dataMapper delete the location, too?
- what if other events (still in database) also refer to this location?

O-R Mapping of 1-to-n Associations

O-R Mapping of 1-to-n Associations



O-R Mapping Code for Collections (1)

```
Event event = new Event( "Java Days" );
event.setLocation( ku );
// add event speakers
Speaker gosling = new Speaker( "James Gosling" );
Speaker yuen = new Speaker( "Prof. Yuen" );
event.getSpeakers().add( gosling );
event.getSpeakers().add( yuen );
// save the event
dataMapper.save( event );
```

Issues:

- same issues as many-to-1 association

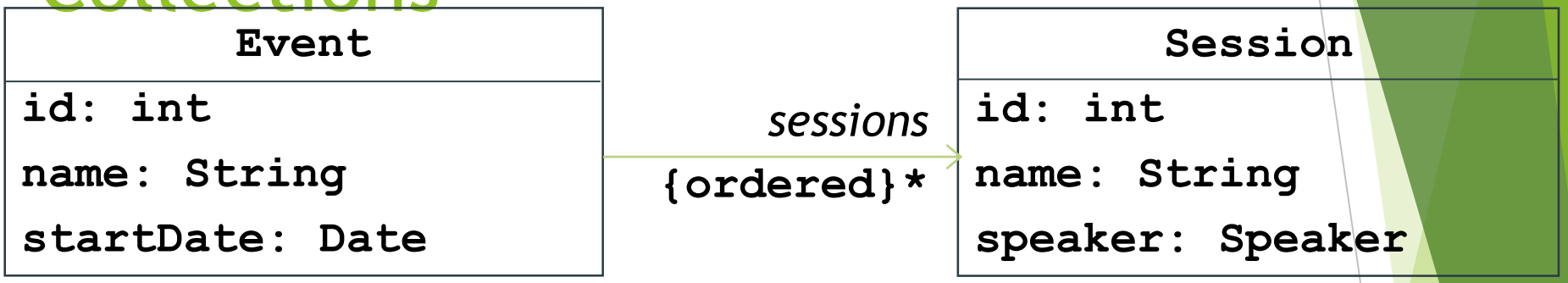
O-R Mapping Code for Collections (2)

```
// retrieve the event
Event evt = dataMapper.find( "Java Days" );
Set speakers = evt.getSpeakers( );
out.println( "Speakers for " + evt.getName( ) );
for( Speaker spkr : speakers ) out.print( spkr.getName() );
```

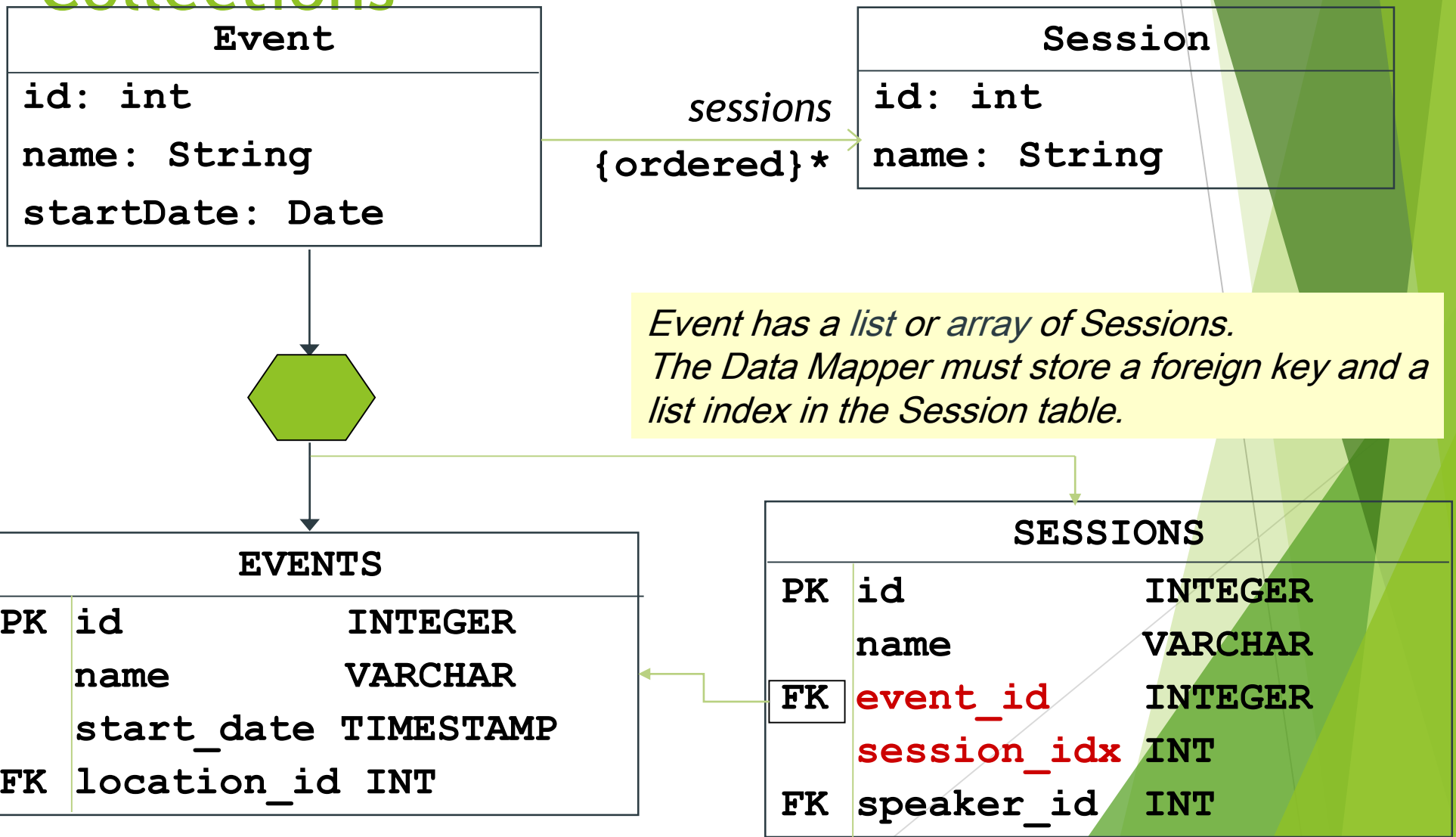
- what kind of collection does dataMapper return?
- can we use *any* collection we want in the Event class?

```
public class Event {
    private Set speakers = new _____;  // ? what kind of collection ?
    public setSpeakers( Set speakers ) { this.speakers = speakers; }
```

O-R Mapping of Ordered Collections



O-R Mapping of Ordered Collections

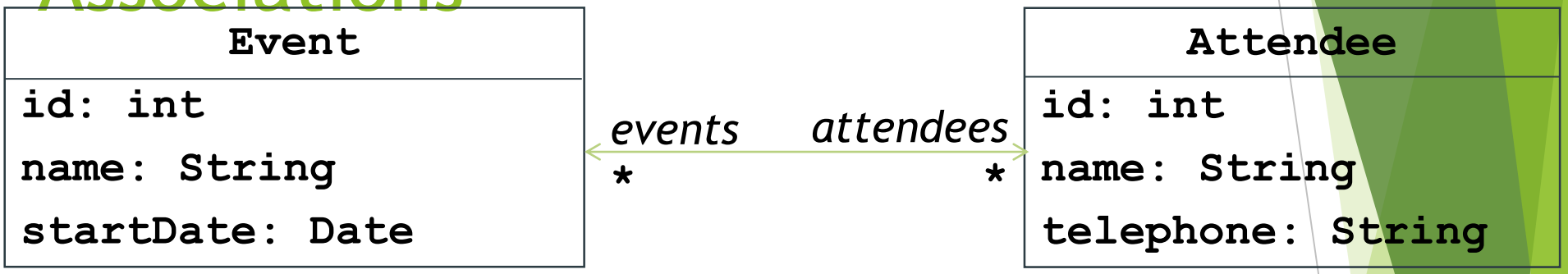


O-R Mapping Code for a List

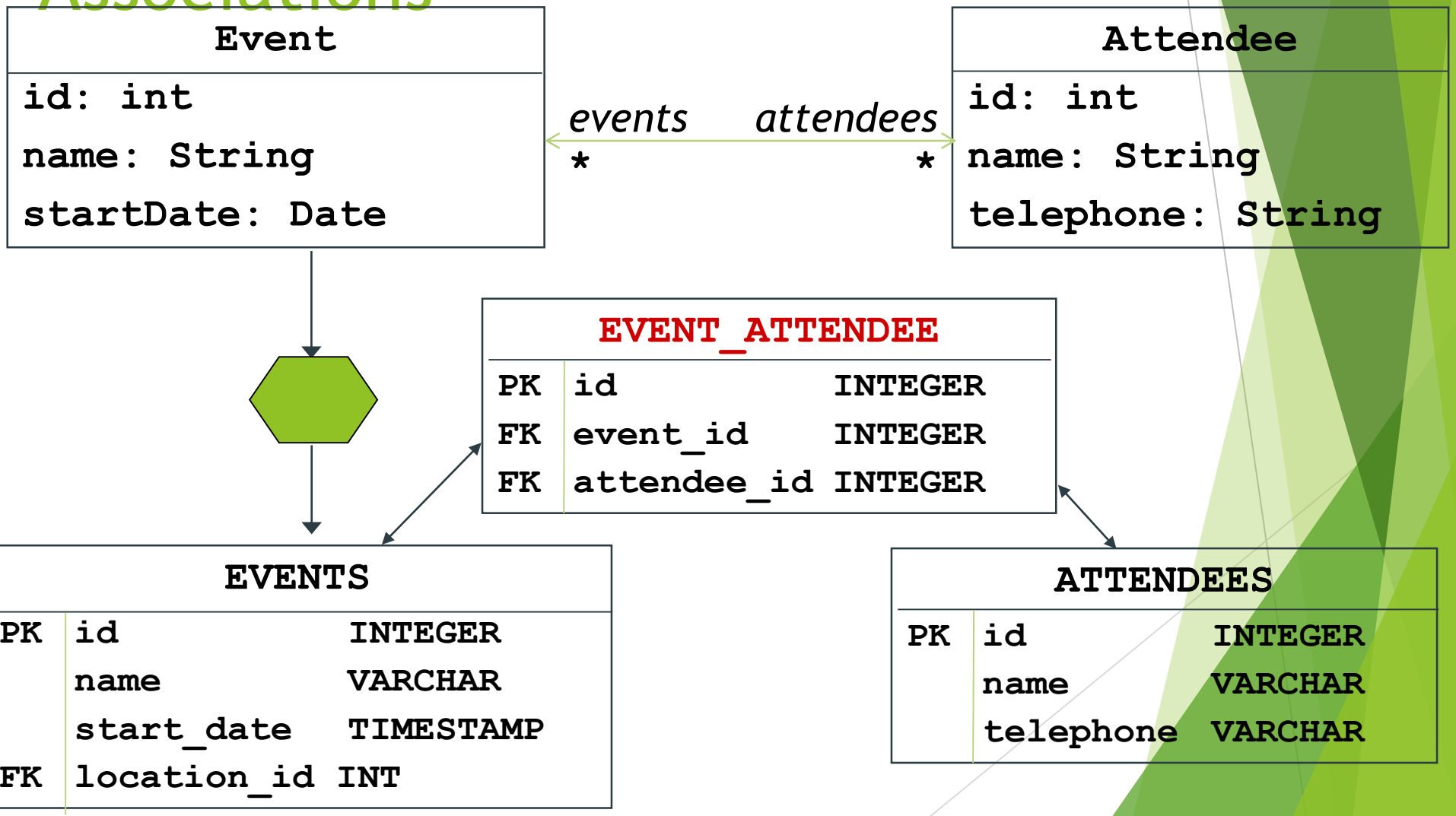
```
// add sessions to the event we already saved
Event event = dataMapper.find( "Java Days" );
Speaker gosling = dataMapper.find( "James Gosling" );
Session opening = new Session( "Opening Ceremony" ) );
opening.setSpeaker( gosling );
// make opening be the 1st session (sessions is a List)
event.getSessions().add( 0, opening );
... add more sessions ...
// update the event
dataMapper.update( event );
```

- does dataMapper use the existing data for gosling in the new Session?
- what if our update *changes the indices* of other objects in the list?

O-R Mapping of m-to-n Associations



O-R Mapping of m-to-n Associations



Design of a Data Mapper

Problem:

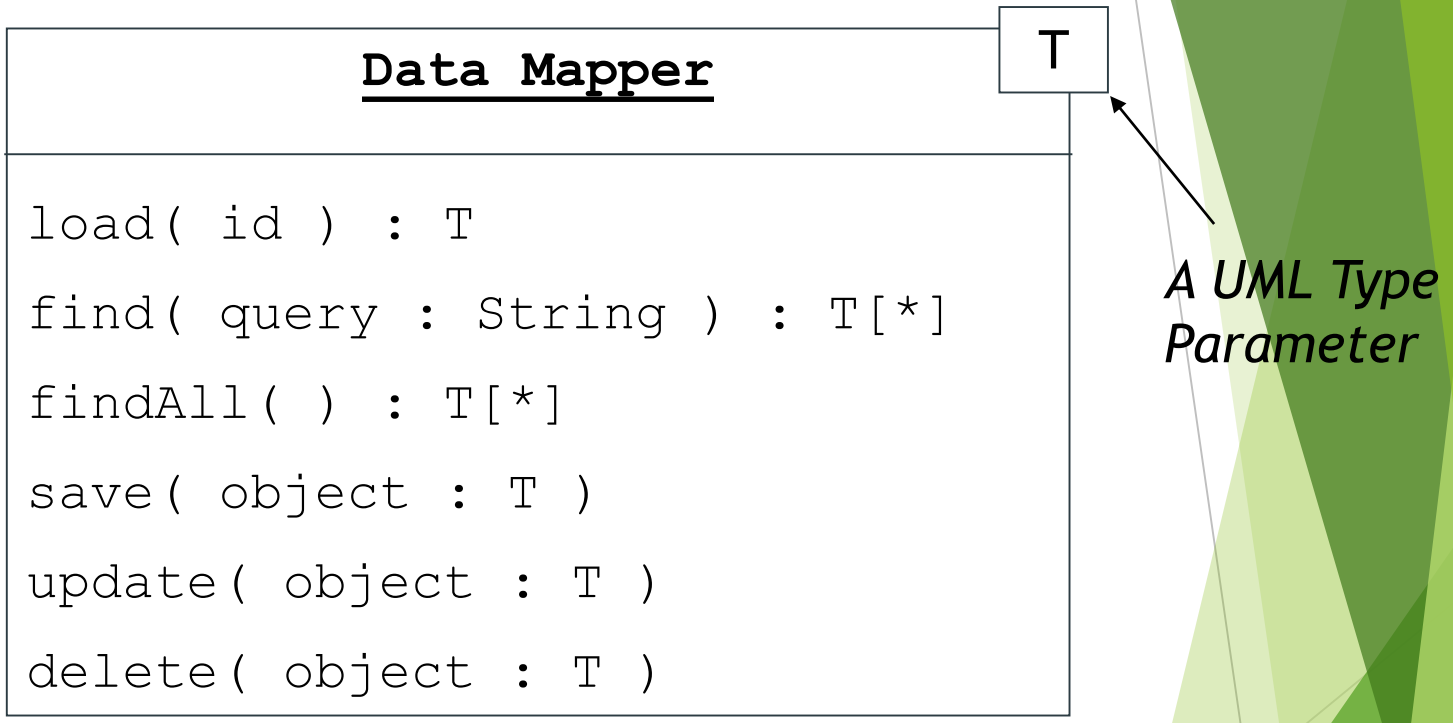
- What behavior do we need for a data mapper?
- What operations should it perform?

Object-Relational Operations: CRUD

Common O-R operations are:

- **C**reate - save (persist) a new object in the database
- **R**etrieve an object from the database
- **U**pdate data for an object already saved in database
- **D**elete object's data from the database

Design Model for Data Mapper



The method to "load" an Object by its identifier is sometimes named:

`load( id )` the Hibernate method name and Spring name

`find( id ), findById( id )`

`get( id )` similar to load(id) but no exception if id is not found

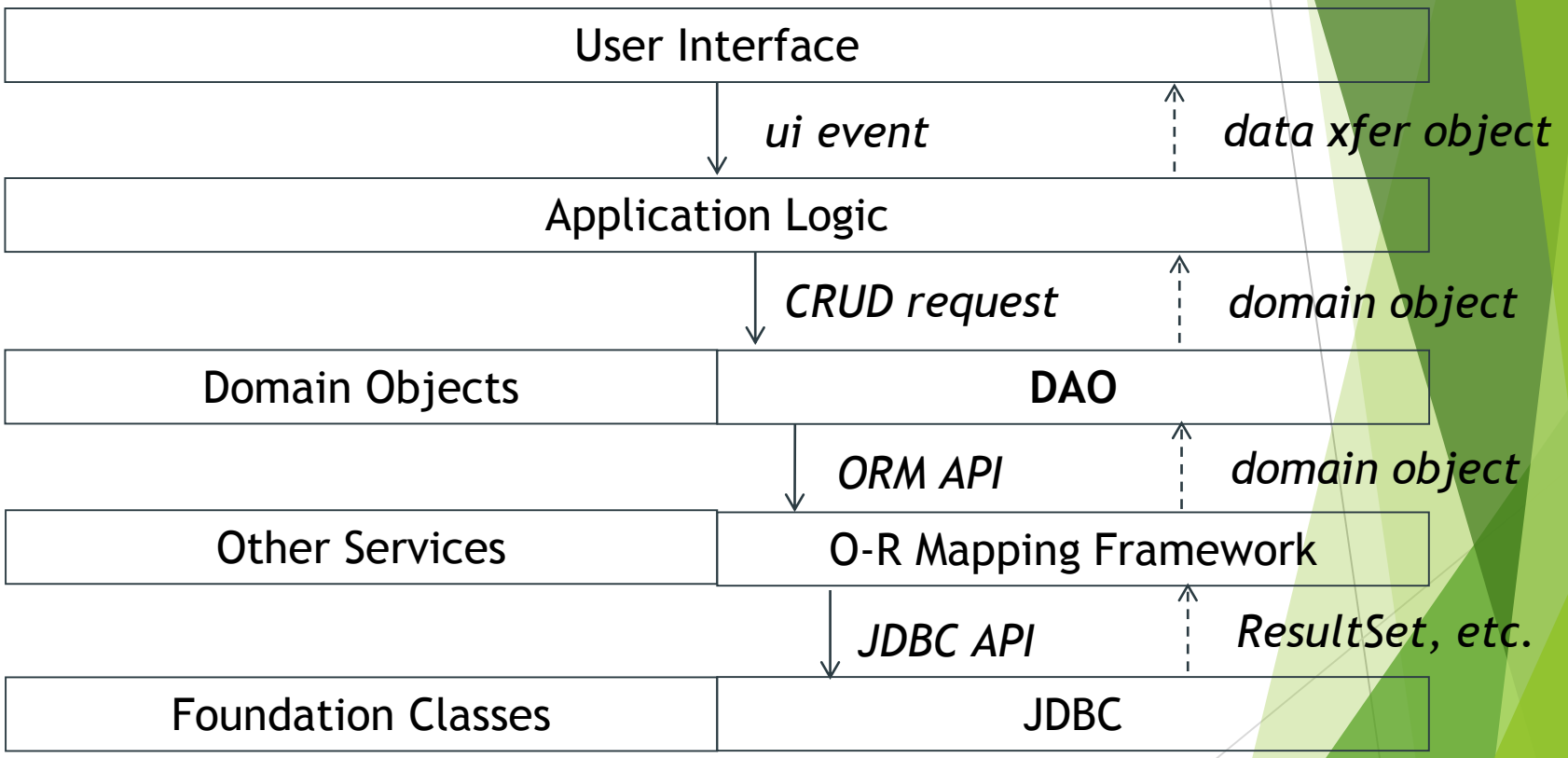
A Data Mapping for Event Class

Data Mapper is also called "Data Access Object" (DAO).

- Hibernate uses the term data access object.
- We use DAO in data mapper names, e.g. **`EventDao`**.

EventDao
`findById( id: int ) : Event`
`find( query: String ) : Event[*]`
`save( evt: Event )`
`update( evt: Event )`
`delete( evt: Event )`

Layered Design



What's Next?

The Choices:

1. Write the OR Mapping yourself using Java and JDBC
   - SQL Fundamentals
   - JDBC Fundamentals
   - Configure Database

2. Use an existing O-R Framework
   - Compare O-R frameworks
   - Learn to use one framework
   - Configure Database

Persistence Frameworks

- Hibernate - widely used open-source persistence framework for Java. Persistence of POJOs, uses mapping files and object-query language to decouple Java from database. NHibernate for .Net languages.
- iBatis - simple, uses SQL maps. Database schema not transparent to Java code.
- Entity Enterprise JavaBeans - uses EJB container services to perform persistence. Resource hog.
- Cayenne - Apache project, has GUI modeler that eliminates need to write xml files. Can reverse engineer database or generate database schema & Java code.
- TopLink (Oracle), Torque (Apache DB), Castor, ...

Standards and APIs

- Java Data Objects (JDO) - transparent persistence of POJOs; defines query language (JDOQL) and standard for XML descriptors.
  - implementations: Kodo, JPOX
- Java Persistence API (JPA) - part of the EJB 3.0, defines OR standard, query language (JPQL), and standalone POJO or EJB server-based persistence.
  - implementations: TopLink Essentials (Glassfish project), OpenJPA. Hibernate is JPA compliant.

Article: *Adopting a Java Persistence Framework, http://today.java.net/pub/a/today/2007/12/18/adopting-java-persistence-framework.html*