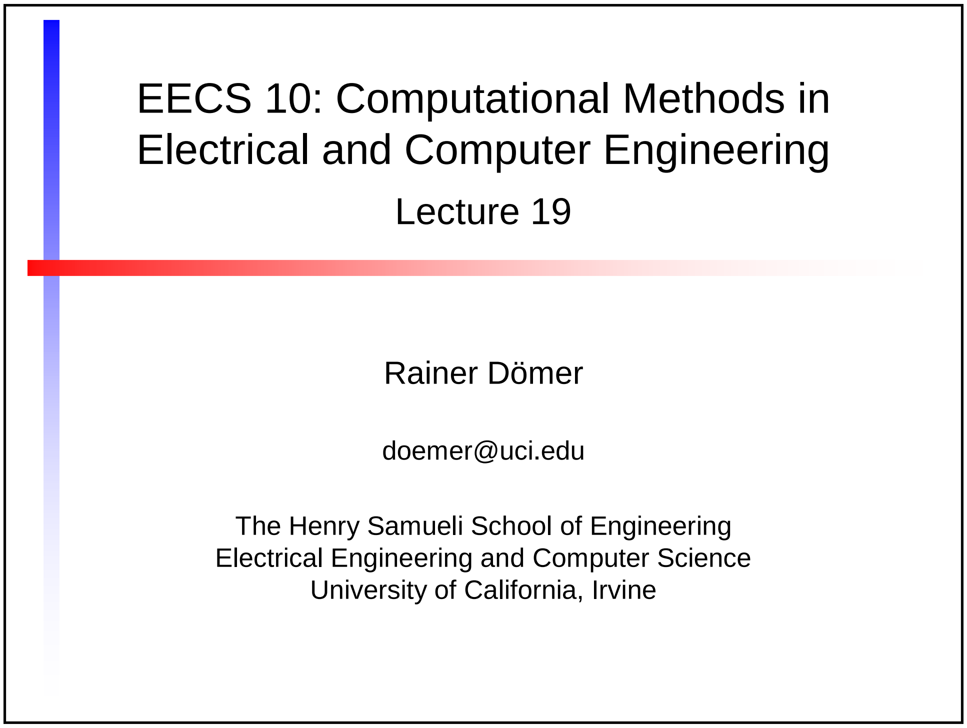

EECS 10: Computational Methods in Electrical and Computer Engineering

Lecture 19

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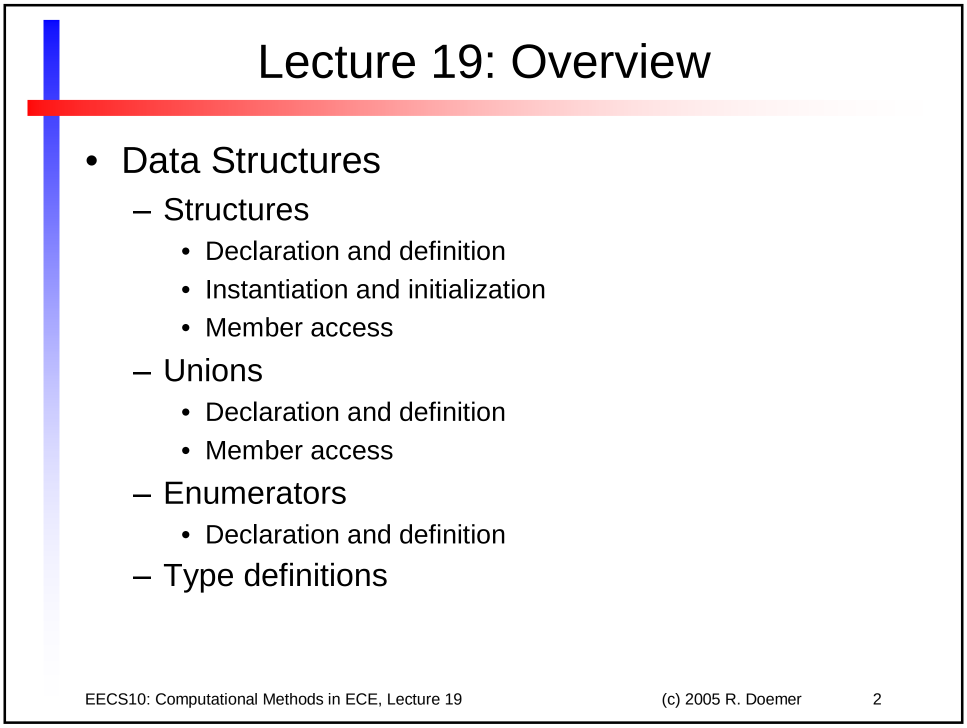
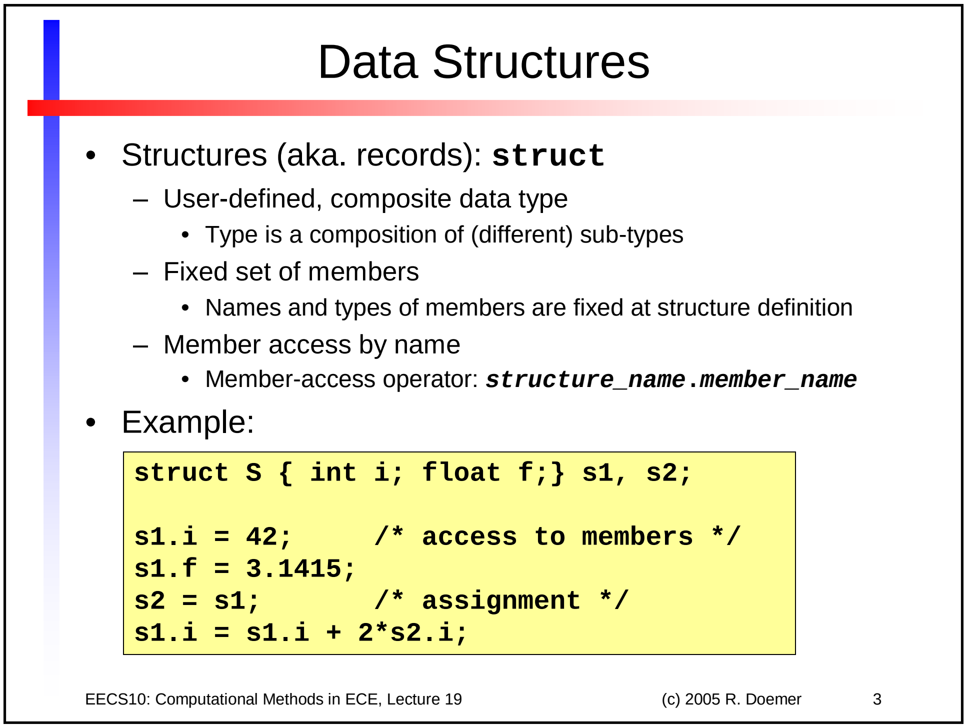


Lecture 19: Overview

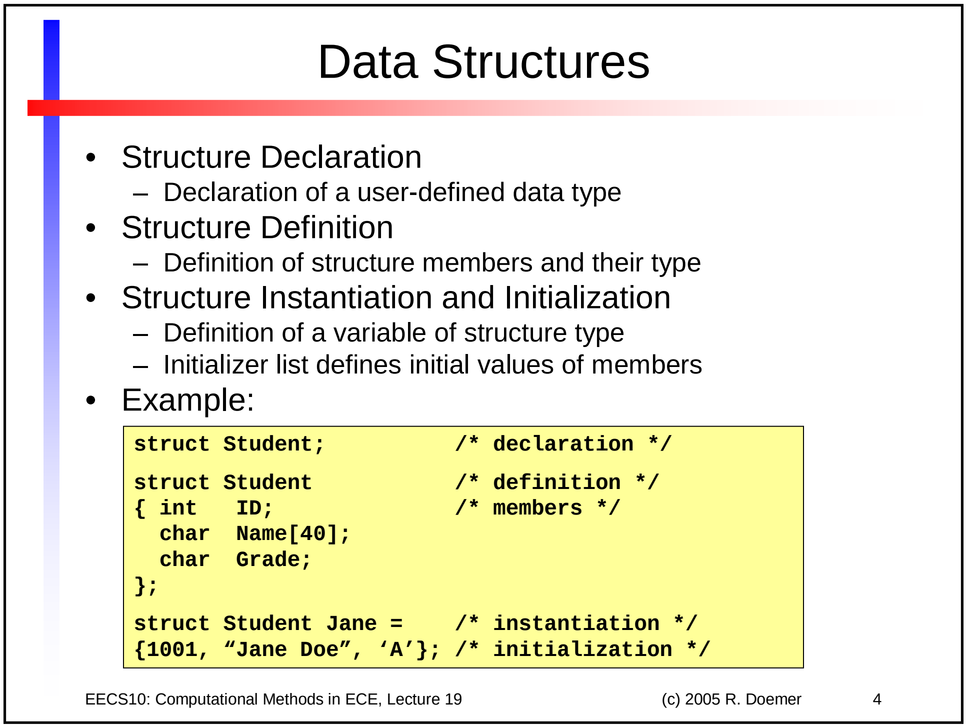
- Data Structures
  - Structures
    - Declaration and definition
    - Instantiation and initialization
    - Member access
  - Unions
    - Declaration and definition
    - Member access
  - Enumerators
    - Declaration and definition
  - Type definitions



Data Structures

- Structures (aka. records): **`struct`**
  - User-defined, composite data type
    - Type is a composition of (different) sub-types
  - Fixed set of members
    - Names and types of members are fixed at structure definition
  - Member access by name
    - Member-access operator: ***`structure_name.member_name`***
- Example:

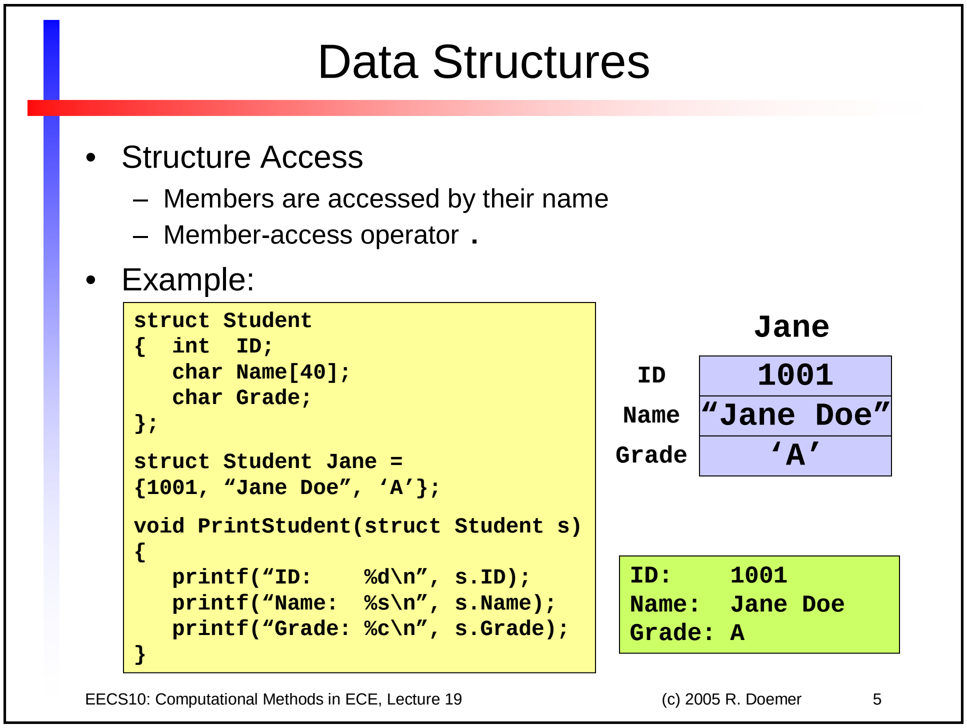
```
struct S { int i; float f;} s1, s2;

s1.i = 42;      /* access to members */
s1.f = 3.1415;
s2 = s1;        /* assignment */
s1.i = s1.i + 2*s2.i;
```



Data Structures

- Structure Declaration
  - Declaration of a user-defined data type
- Structure Definition
  - Definition of structure members and their type
- Structure Instantiation and Initialization
  - Definition of a variable of structure type
  - Initializer list defines initial values of members
- Example:

```
struct Student;           /* declaration */

struct Student            /* definition */
{ int   ID;               /* members */
  char  Name[40];
  char  Grade;
};

struct Student Jane =     /* instantiation */
{1001, “Jane Doe”, ‘A’}; /* initialization */
```



Data Structures

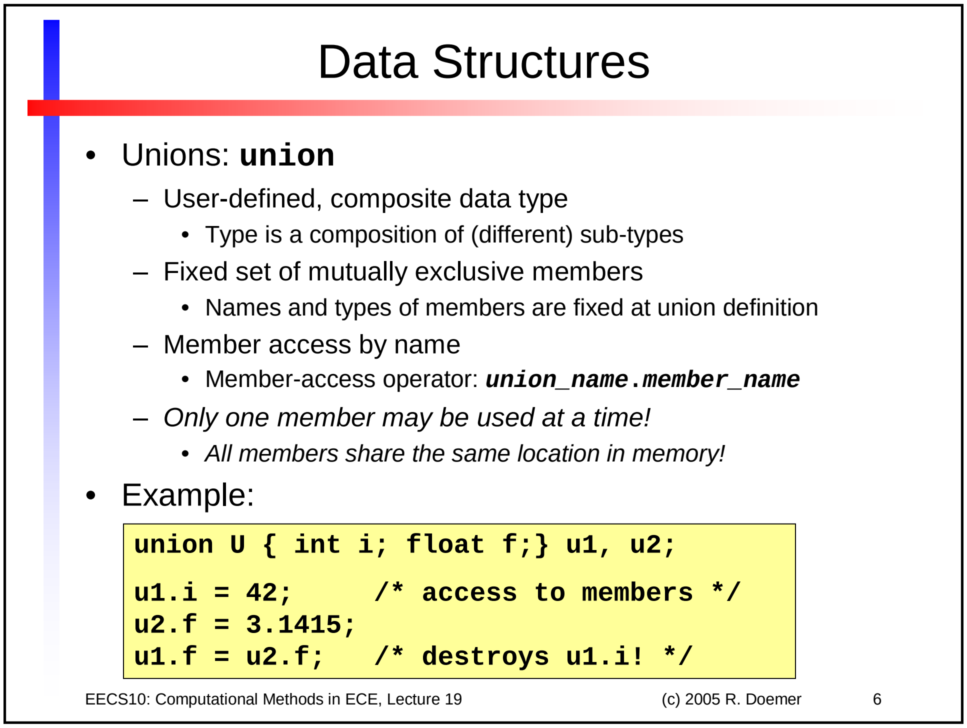
- Structure Access
  - Members are accessed by their name
  - Member-access operator **.**
- Example:

```
struct Student
{  int  ID;
   char Name[40];
   char Grade;
};

struct Student Jane =
{1001, “Jane Doe”, ‘A’};

void PrintStudent(struct Student s)
{
   printf(“ID:    %d\n”, s.ID);
   printf(“Name:  %s\n”, s.Name);
   printf(“Grade: %c\n”, s.Grade);
}
```

Jane

ID	**1001**
Name	**“Jane Doe”**
Grade	**‘A’**

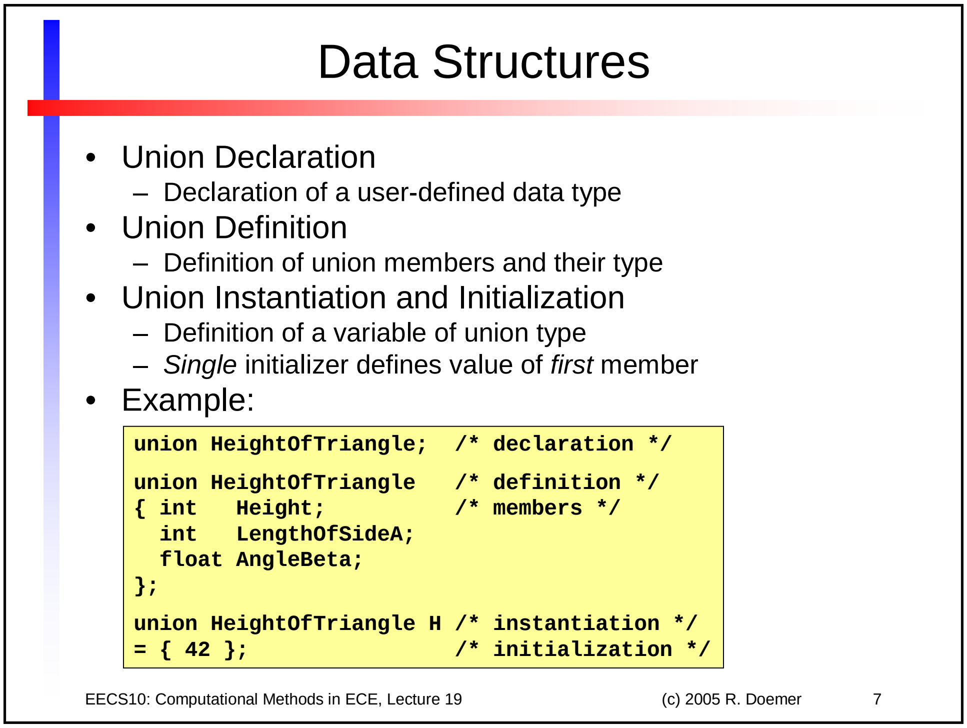
```
ID:    1001
Name:  Jane Doe
Grade: A
```



Data Structures

- Unions: **`union`**
  - User-defined, composite data type
    - Type is a composition of (different) sub-types
  - Fixed set of mutually exclusive members
    - Names and types of members are fixed at union definition
  - Member access by name
    - Member-access operator: ***`union_name.member_name`***
  - *Only one member may be used at a time!*
    - *All members share the same location in memory!*
- Example:

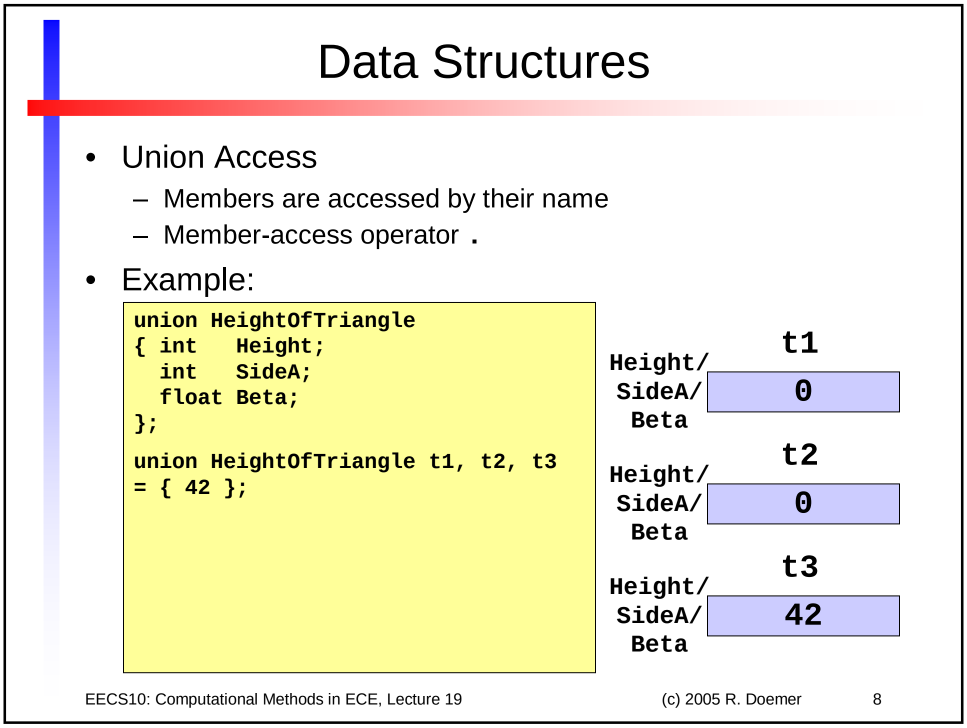
```
union U { int i; float f;} u1, u2;

u1.i = 42;     /* access to members */
u2.f = 3.1415;
u1.f = u2.f;   /* destroys u1.i! */
```



Data Structures

- Union Declaration
  - Declaration of a user-defined data type
- Union Definition
  - Definition of union members and their type
- Union Instantiation and Initialization
  - Definition of a variable of union type
  - *Single* initializer defines value of *first* member
- Example:

```
union HeightOfTriangle;   /* declaration */

union HeightOfTriangle    /* definition */
{ int   Height;           /* members */
  int   LengthOfSideA;
  float AngleBeta;
};

union HeightOfTriangle H /* instantiation */
= { 42 };                /* initialization */
```



Data Structures

- Union Access
  - Members are accessed by their name
  - Member-access operator `.`
- Example:

```
union HeightOfTriangle
{ int   Height;
  int   SideA;
  float Beta;
};

union HeightOfTriangle t1, t2, t3
= { 42 };
```

t1

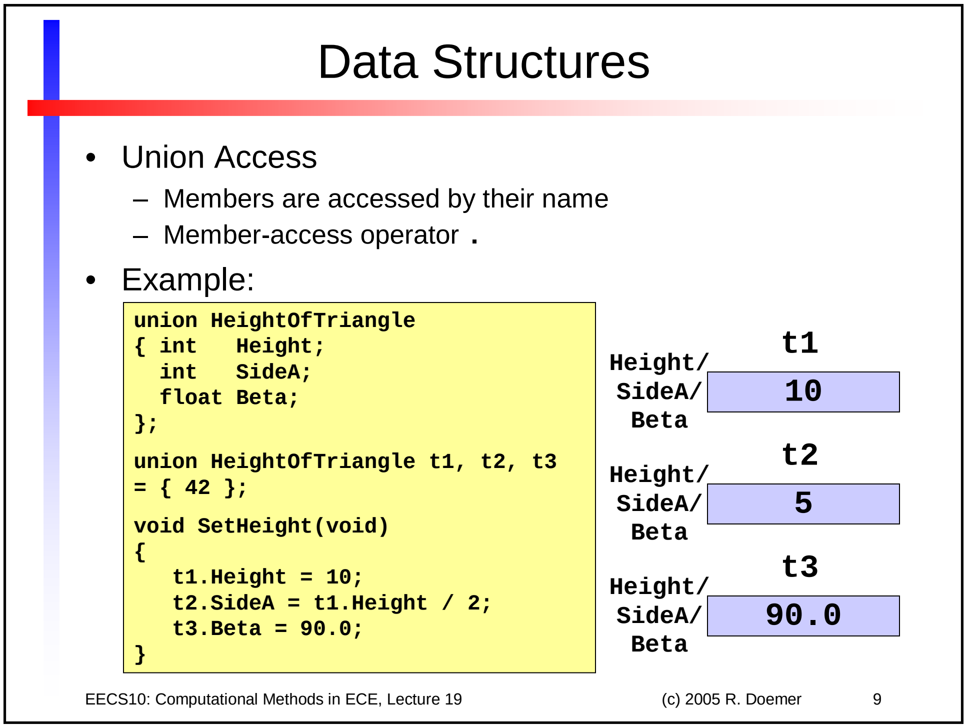
Height/
SideA/
Beta 0

t2

Height/
SideA/
Beta 0

t3

Height/
SideA/
Beta 42

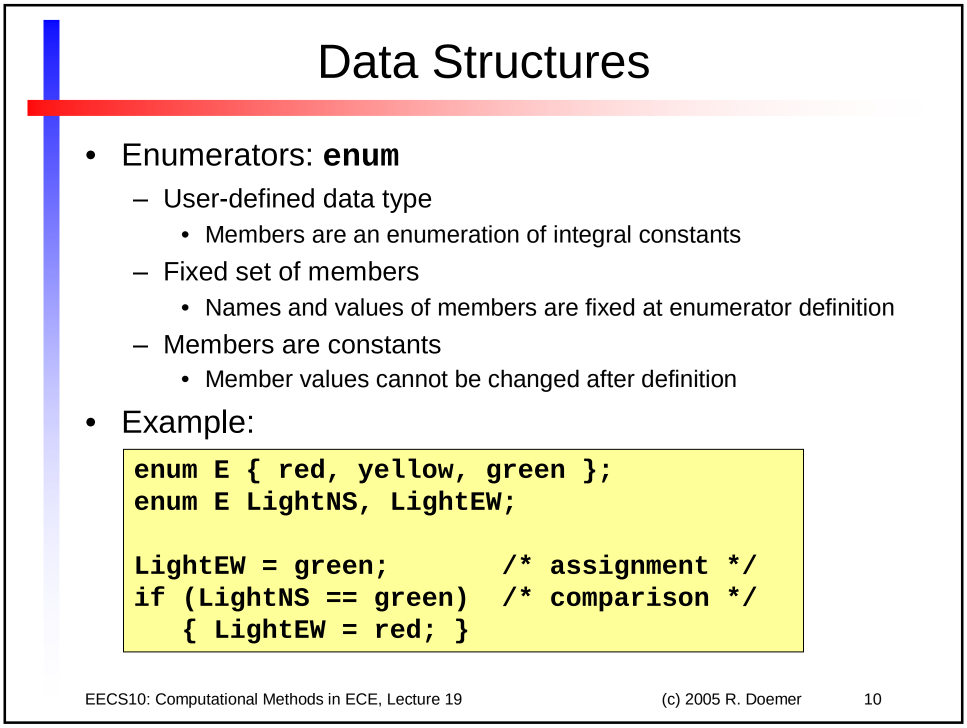


Data Structures

- Union Access
  - Members are accessed by their name
  - Member-access operator **.**
- Example:

```
union HeightOfTriangle
{ int   Height;
  int   SideA;
  float Beta;
};

union HeightOfTriangle t1, t2, t3
= { 42 };

void SetHeight(void)
{
   t1.Height = 10;
   t2.SideA = t1.Height / 2;
   t3.Beta = 90.0;
}
```

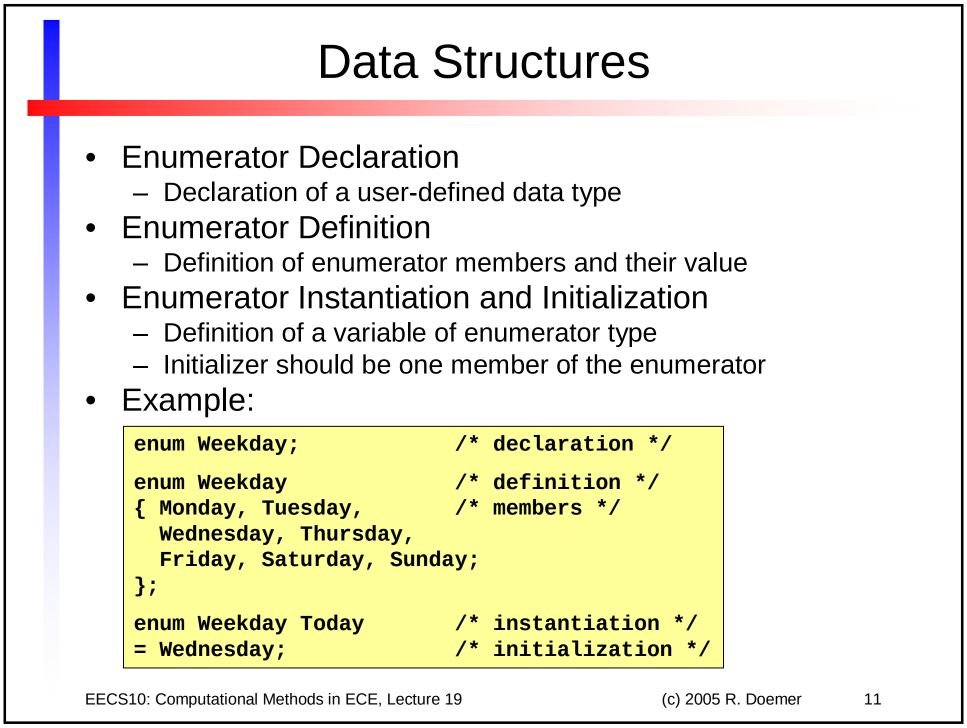
```
         t1
Height/
SideA/  10
Beta

         t2
Height/
SideA/  5
Beta

         t3
Height/
SideA/  90.0
Beta
```



Data Structures

- Enumerators: **enum**
  - User-defined data type
    - Members are an enumeration of integral constants
  - Fixed set of members
    - Names and values of members are fixed at enumerator definition
  - Members are constants
    - Member values cannot be changed after definition
- Example:

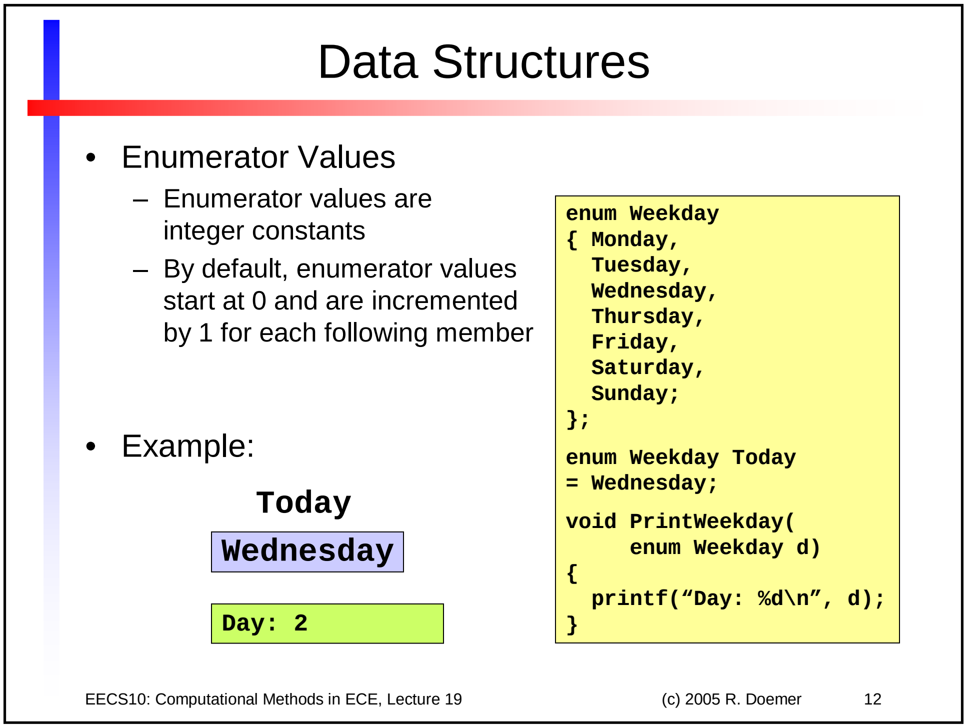
```
enum E { red, yellow, green };
enum E LightNS, LightEW;

LightEW = green;        /* assignment */
if (LightNS == green)  /* comparison */
   { LightEW = red; }
```



Data Structures

- Enumerator Declaration
  - Declaration of a user-defined data type
- Enumerator Definition
  - Definition of enumerator members and their value
- Enumerator Instantiation and Initialization
  - Definition of a variable of enumerator type
  - Initializer should be one member of the enumerator
- Example:

```
enum Weekday;              /* declaration */

enum Weekday               /* definition */
{ Monday, Tuesday,         /* members */
  Wednesday, Thursday,
  Friday, Saturday, Sunday;
};

enum Weekday Today         /* instantiation */
= Wednesday;               /* initialization */
```



Data Structures

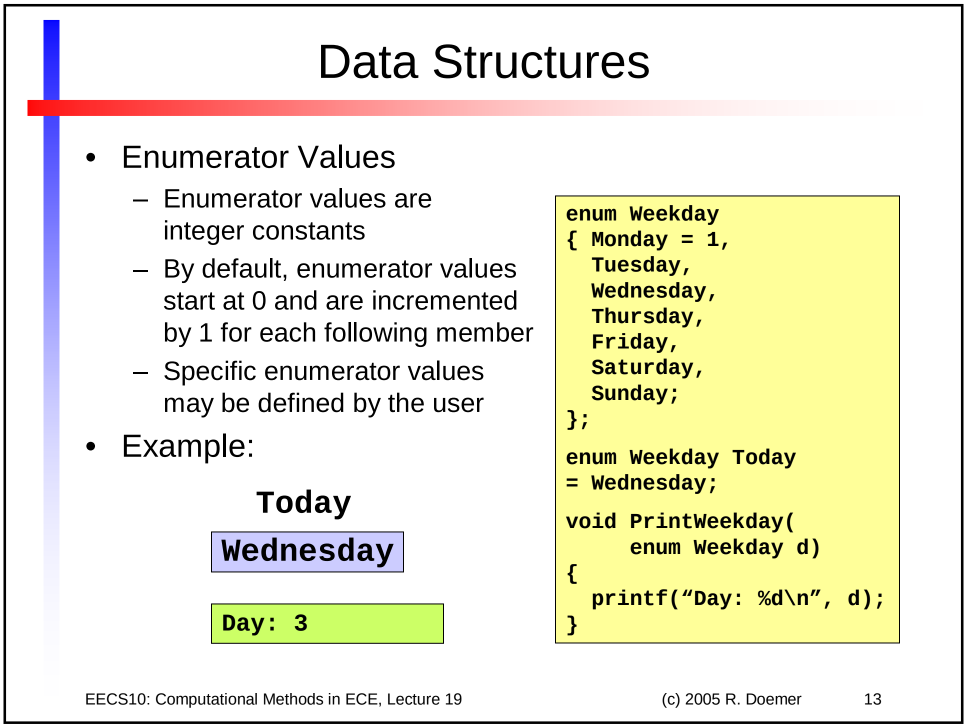
- Enumerator Values
  - Enumerator values are integer constants
  - By default, enumerator values start at 0 and are incremented by 1 for each following member
- Example:

```
enum Weekday
{ Monday,
  Tuesday,
  Wednesday,
  Thursday,
  Friday,
  Saturday,
  Sunday;
};

enum Weekday Today
= Wednesday;

void PrintWeekday(
     enum Weekday d)
{
  printf(“Day: %d\n”, d);
}
```

Today

Wednesday

```
Day: 2
```



Data Structures

- Enumerator Values
  - Enumerator values are integer constants
  - By default, enumerator values start at 0 and are incremented by 1 for each following member
  - Specific enumerator values may be defined by the user
- Example:

Today

Wednesday

```
Day: 3
```

```
enum Weekday
{ Monday = 1,
  Tuesday,
  Wednesday,
  Thursday,
  Friday,
  Saturday,
  Sunday;
};
enum Weekday Today
= Wednesday;
void PrintWeekday(
     enum Weekday d)
{
  printf(“Day: %d\n”, d);
}
```

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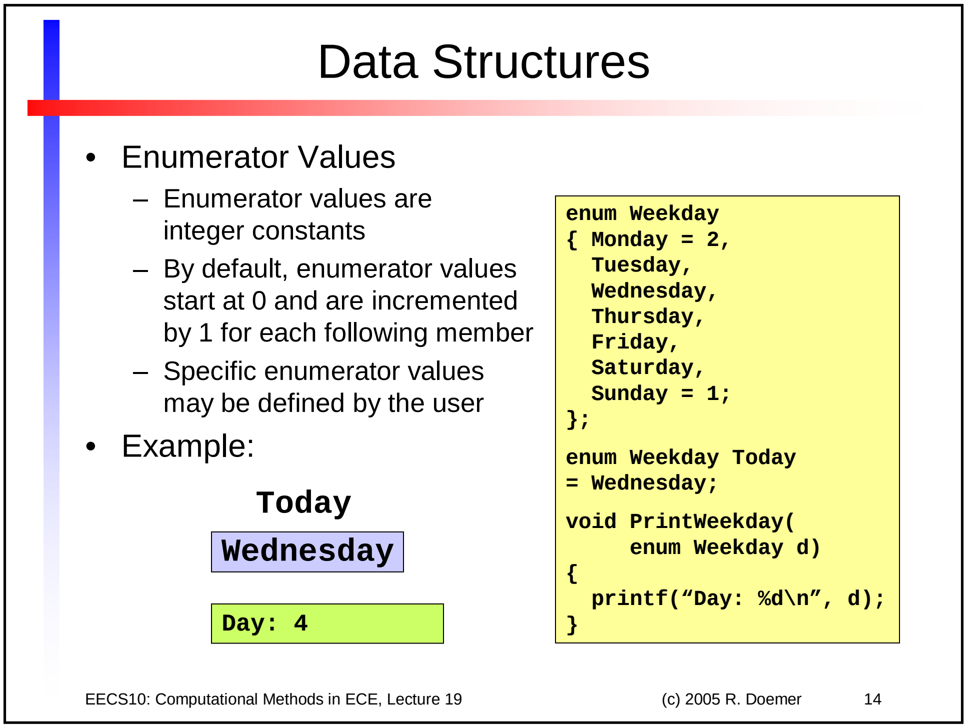

Data Structures

- Enumerator Values
  - Enumerator values are integer constants
  - By default, enumerator values start at 0 and are incremented by 1 for each following member
  - Specific enumerator values may be defined by the user
- Example:

Today

Wednesday

```
Day: 4
```

```
enum Weekday
{ Monday = 2,
  Tuesday,
  Wednesday,
  Thursday,
  Friday,
  Saturday,
  Sunday = 1;
};
enum Weekday Today
= Wednesday;
void PrintWeekday(
     enum Weekday d)
{
  printf(“Day: %d\n”, d);
}
```

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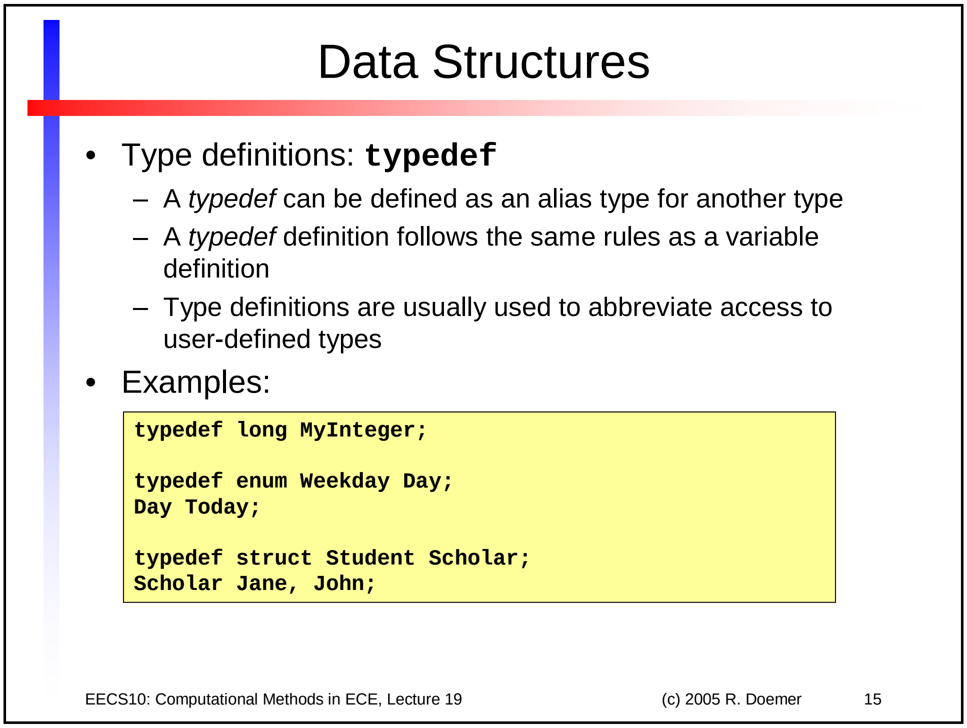

Data Structures

- Type definitions: **`typedef`**
  - A *typedef* can be defined as an alias type for another type
  - A *typedef* definition follows the same rules as a variable definition
  - Type definitions are usually used to abbreviate access to user-defined types
- Examples:

```
typedef long MyInteger;

typedef enum Weekday Day;
Day Today;

typedef struct Student Scholar;
Scholar Jane, John;
```