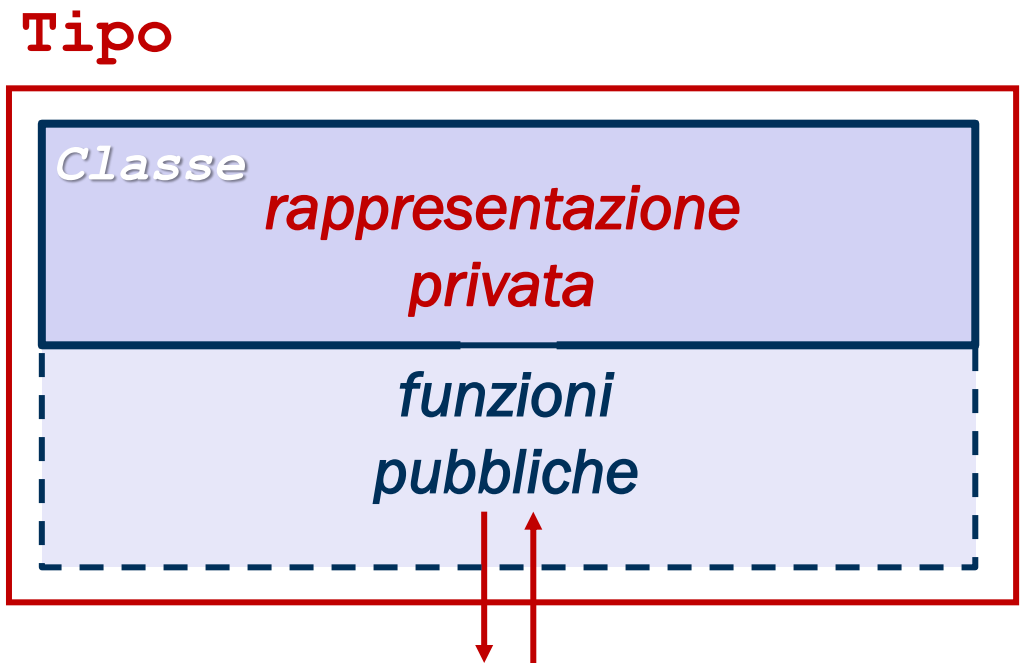
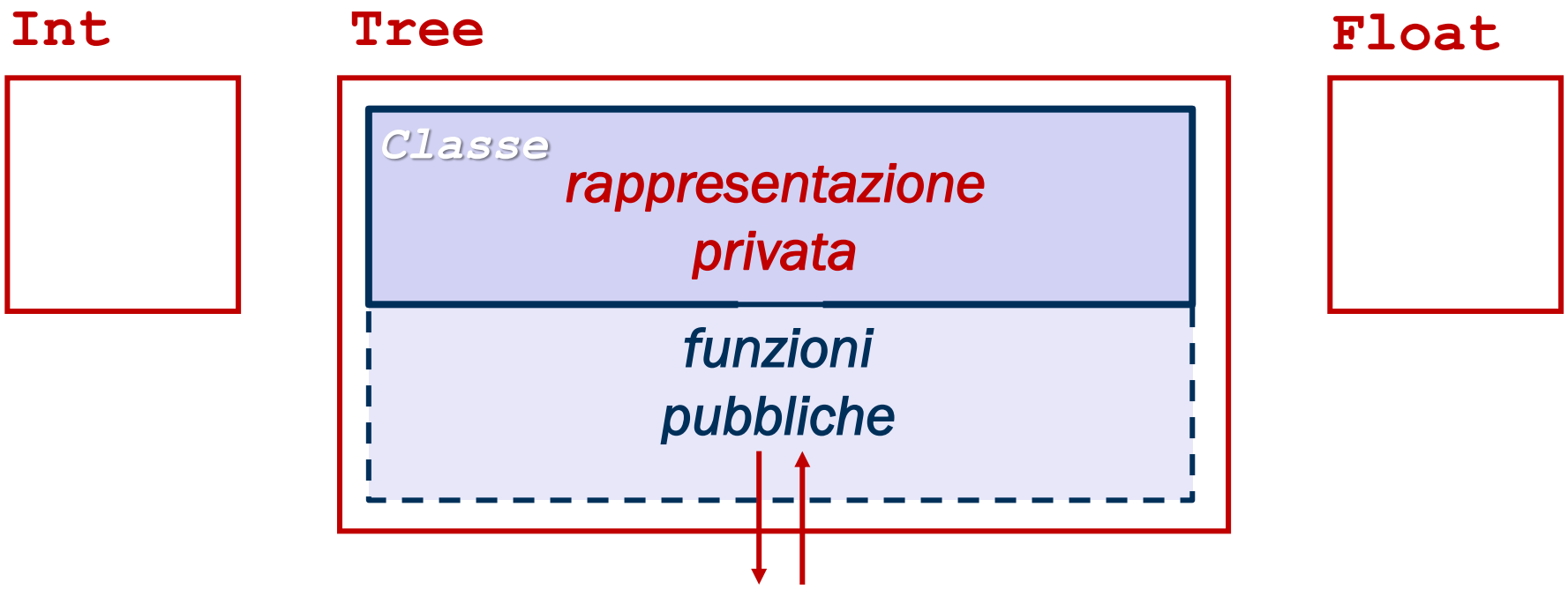
POLITECNICO DI MILANO

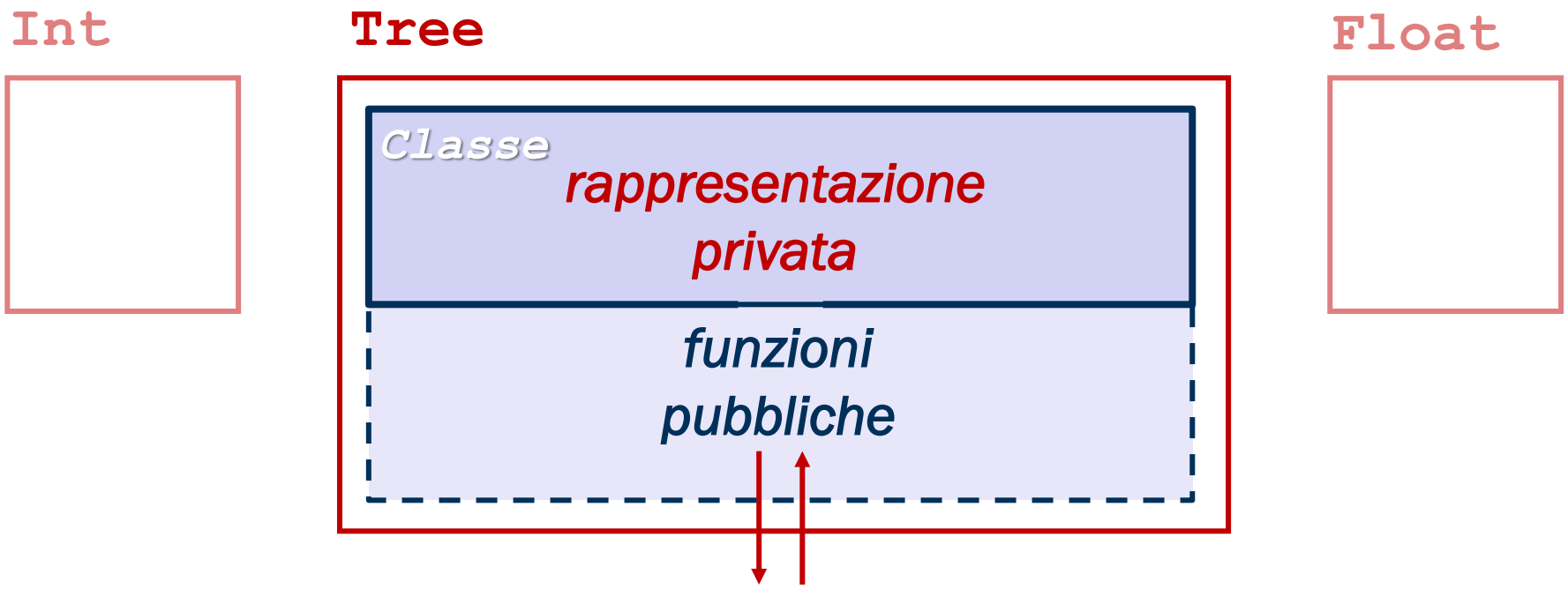
INFORMATICA

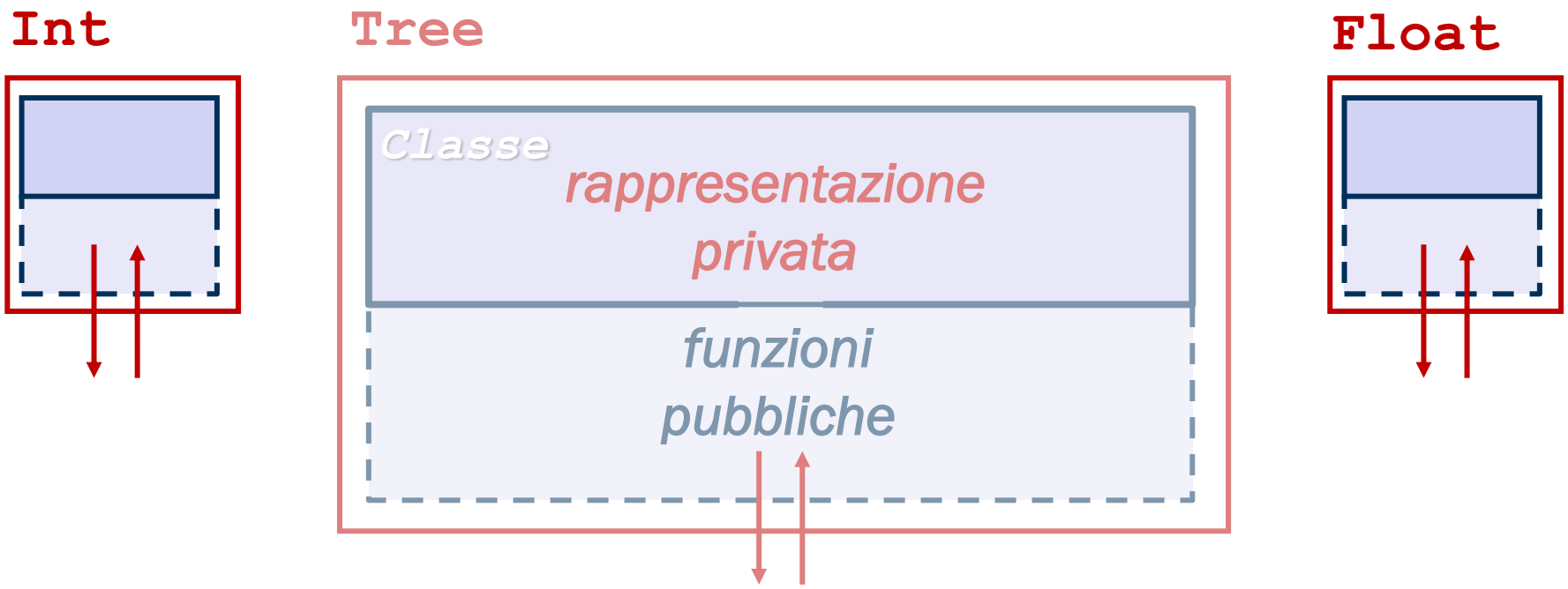
Le classi e i tipi di dato astratti: personalizzazione del linguaggio


Tipo
Classe
rappresentazione
privata
funzioni
pubbliche

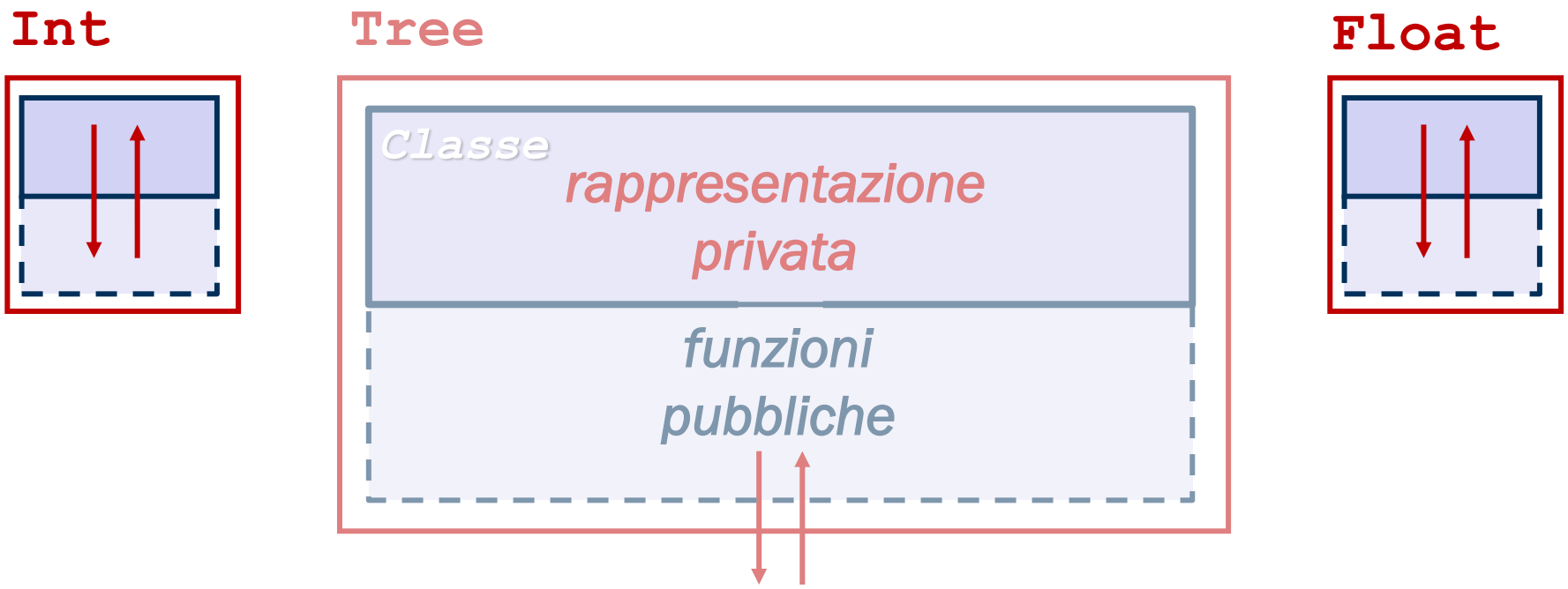

Int
Tree
Float
Classe
rappresentazione
privata
funzioni
pubbliche

Tipo di dato astratto

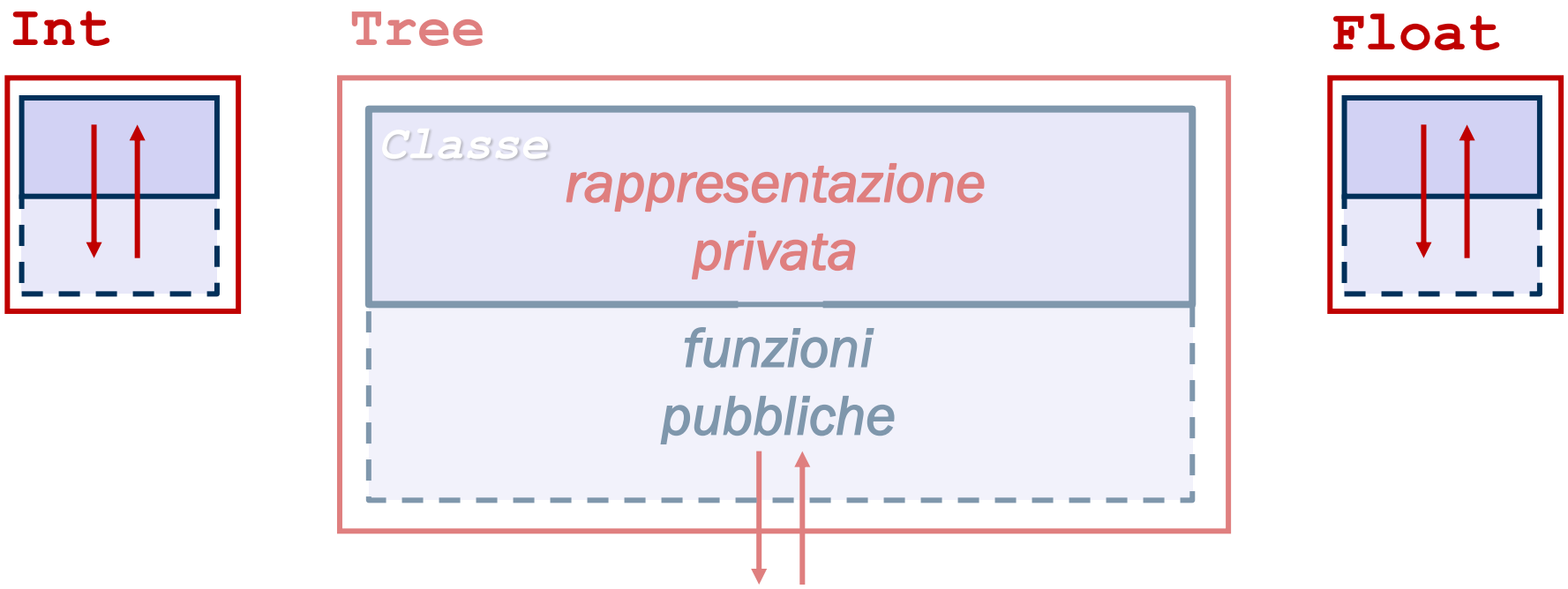




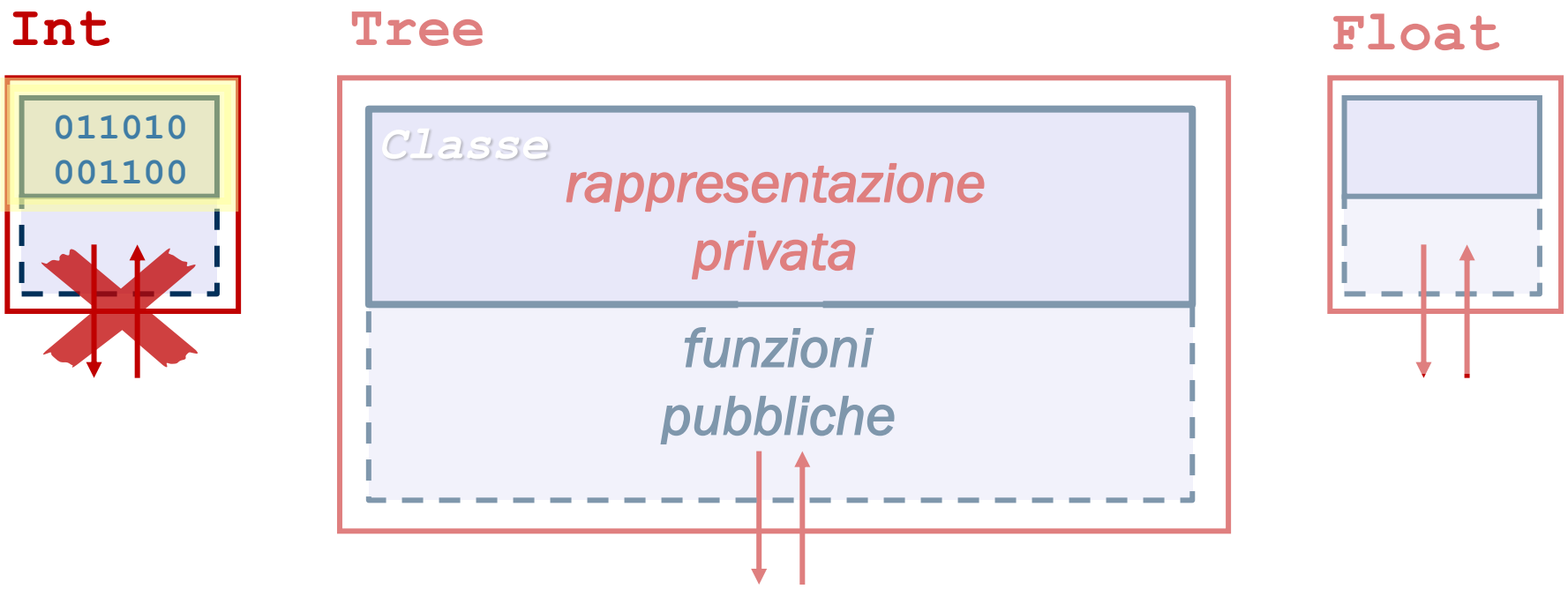
Operazioni predefinite



Operazioni predefinite



Rappresentazione interna inaccessibile


Int
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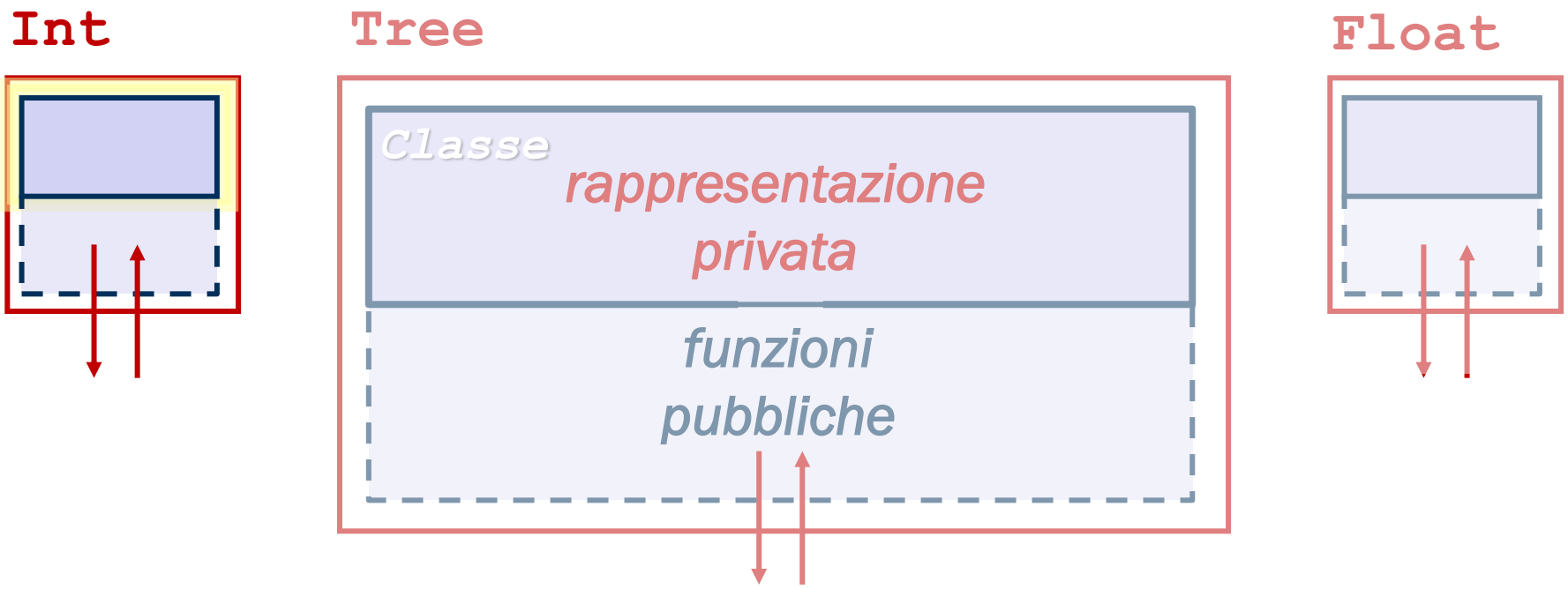
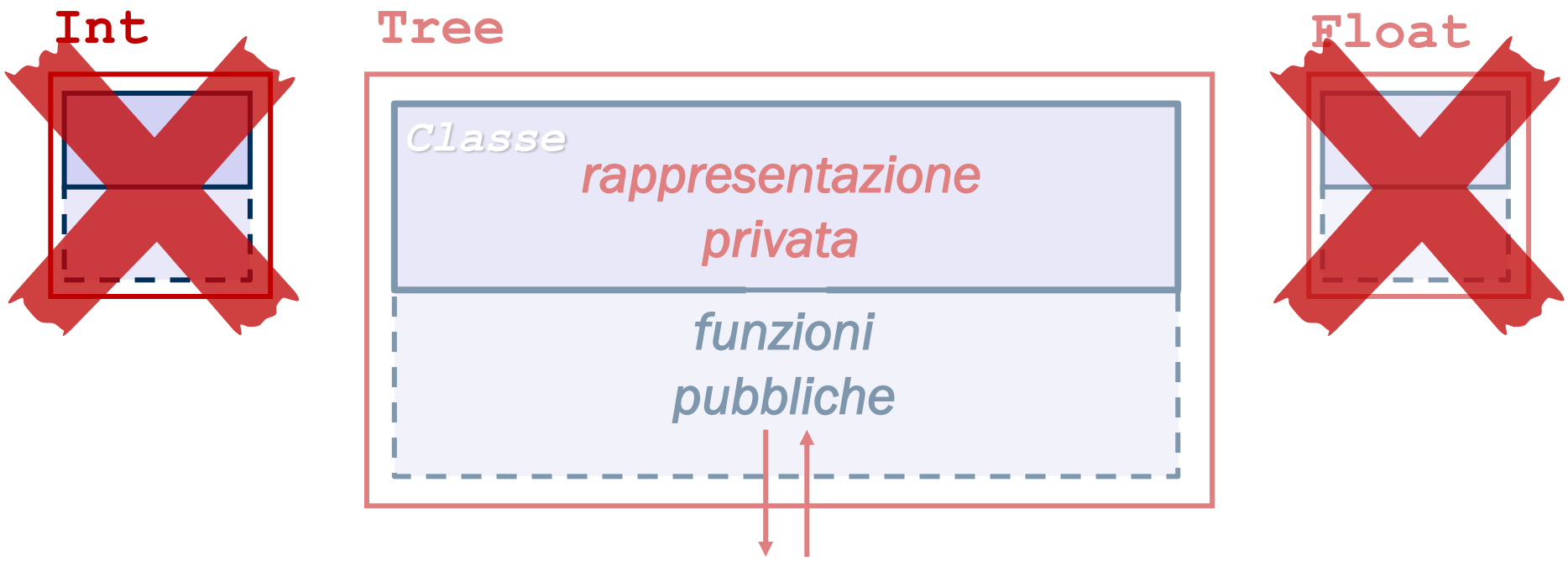
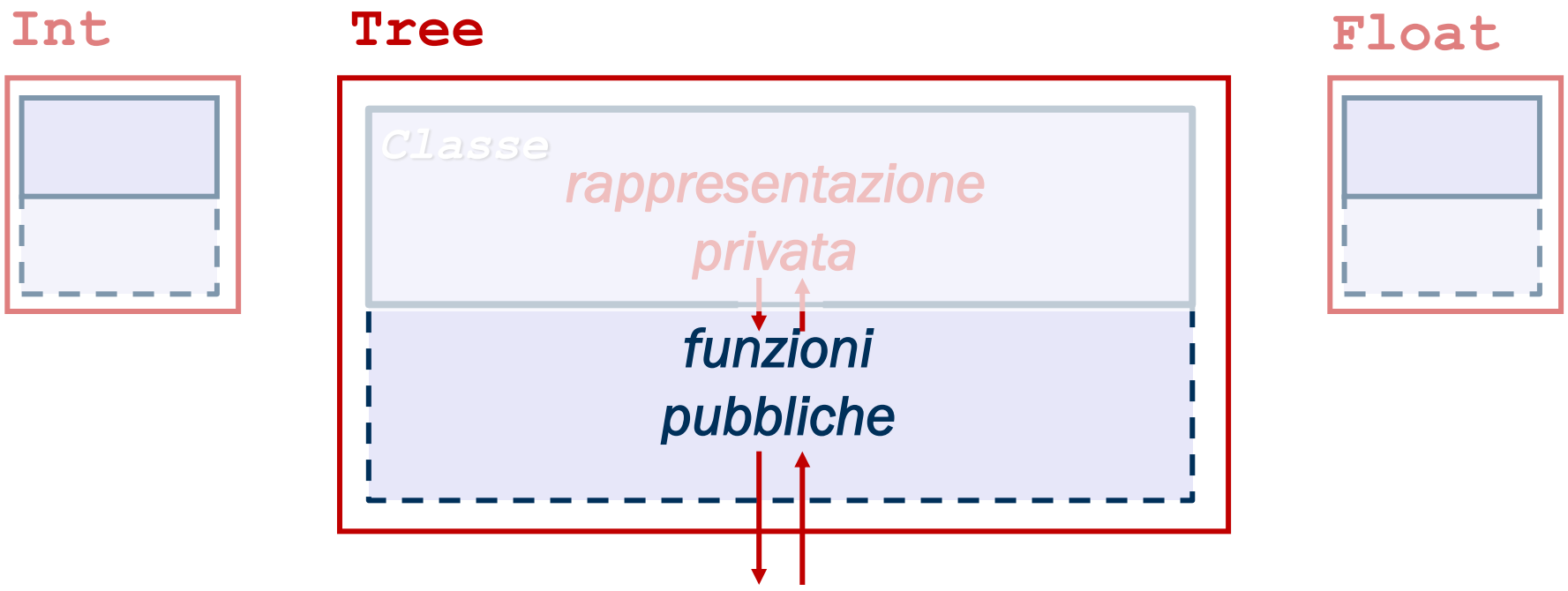
001100
Tree
Classe
rappresentazione
privata
funzioni
pubbliche
Float

Rappresentazione consistente





overflow
underflow


Int
Tree
Classe
rappresentazione
privata
funzioni
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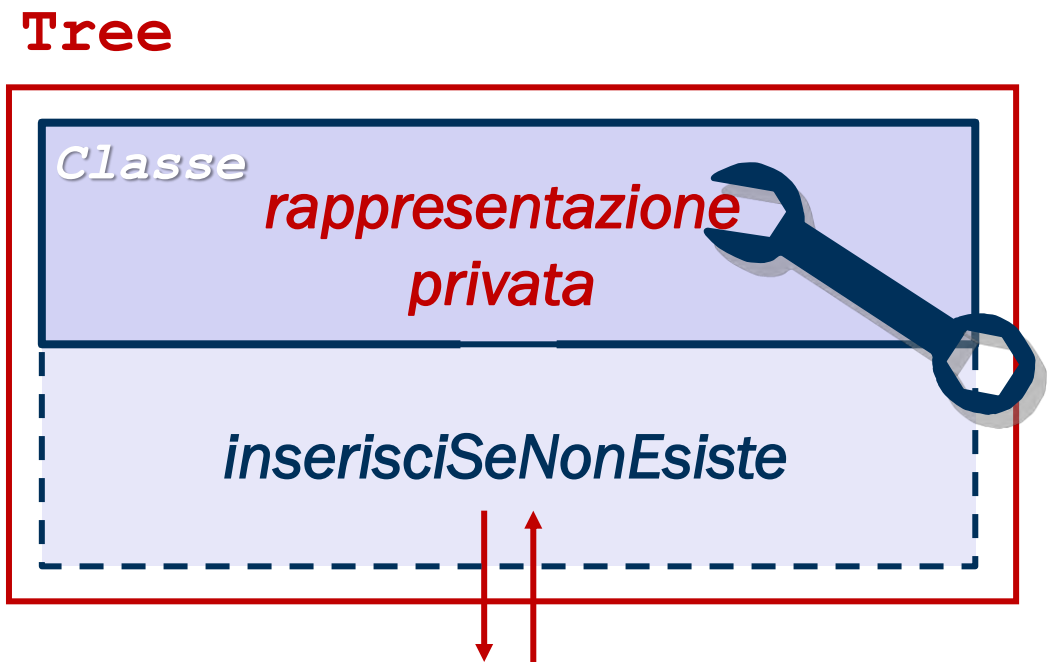
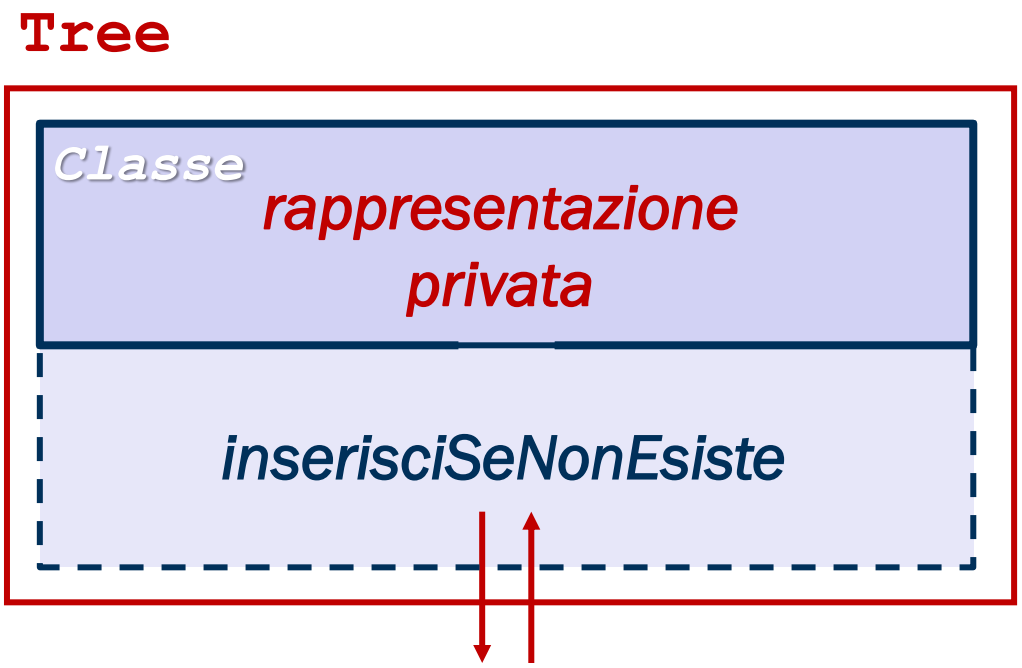
Float




```
cout << " anno di nascita (00-99): ";
cin >> nuovoStudente.dataNascita.anno;
classe.inserisciSeNonEsiste(nuovoStudente);
classe.stampaAlberoRovesciato();
}
```

Funzione membro




```
cout << " anno di nascita (00-99): ";
cin >> nuovoStudente.dataNascita.anno;
classe.inserisciSeNonEsiste(nuovoStudente);
classe.stampaAlberoRovesciato();
}
```

```
class Tree
{
  public:
    Tree();

    void funzioneABC(...);
    void funzioneABC(...);

    ...
  private:
    ...
};
```

```
class Tree
{
  public:
    Tree();

    void funzioneABC(int, char);
    void funzioneABC(TreeNode);

    ...
  private:
    ...
};
```

Overloading

```
class Tree
{
  public:
    Tree();

    void funzioneABC(int, char);
    void funzioneABC(TreeNode);

    ...
  private:
    ...
};
```

Sovraccaricamento

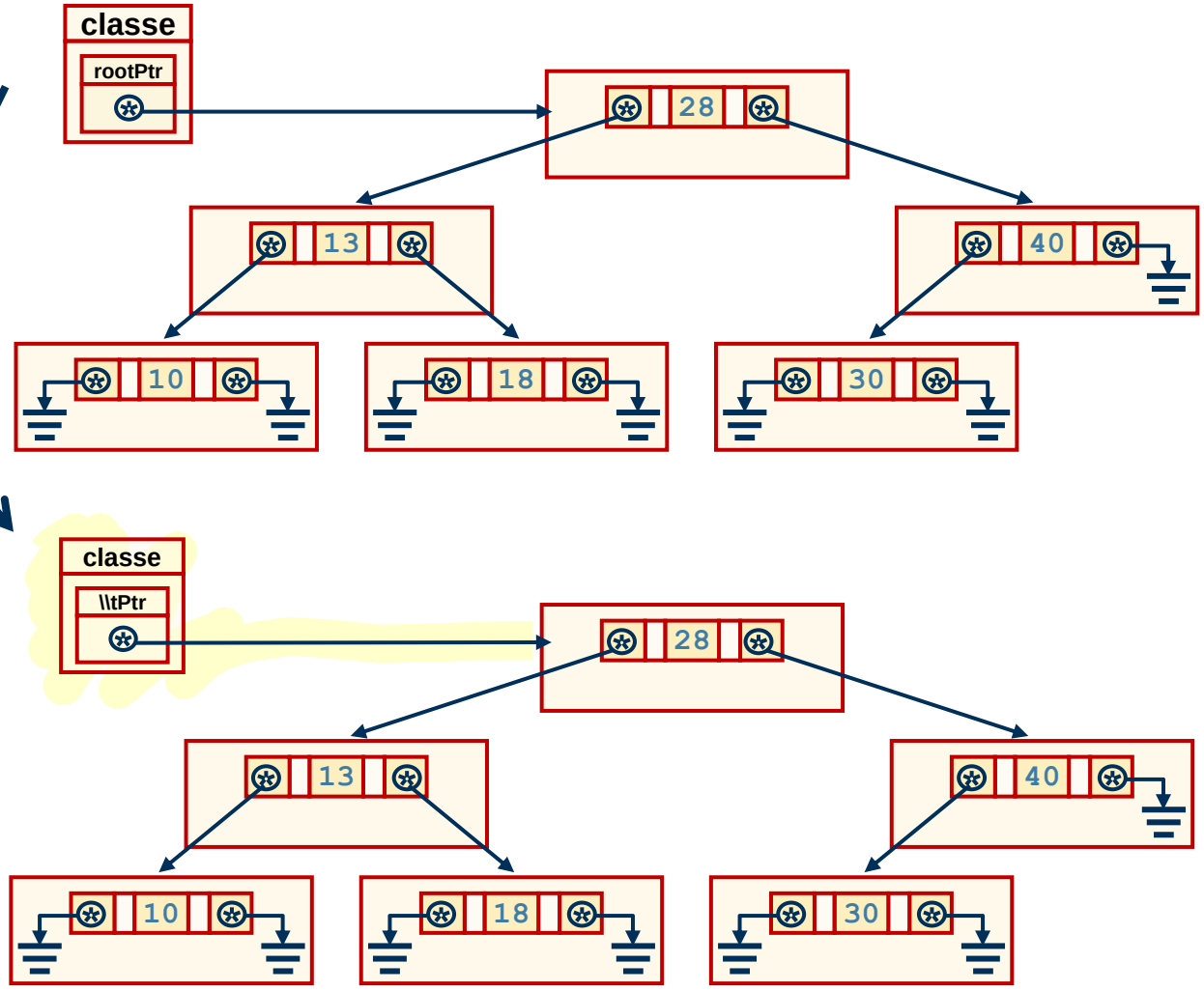
```
class Tree
{
  public:
    Tree();

    void funzioneABC(int, char);
    void funzioneABC(TreeNode);

    ...
  private:
    ...
};
```

```
class Tree
{
  public:
    Tree();
    Tree(...);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
}
```

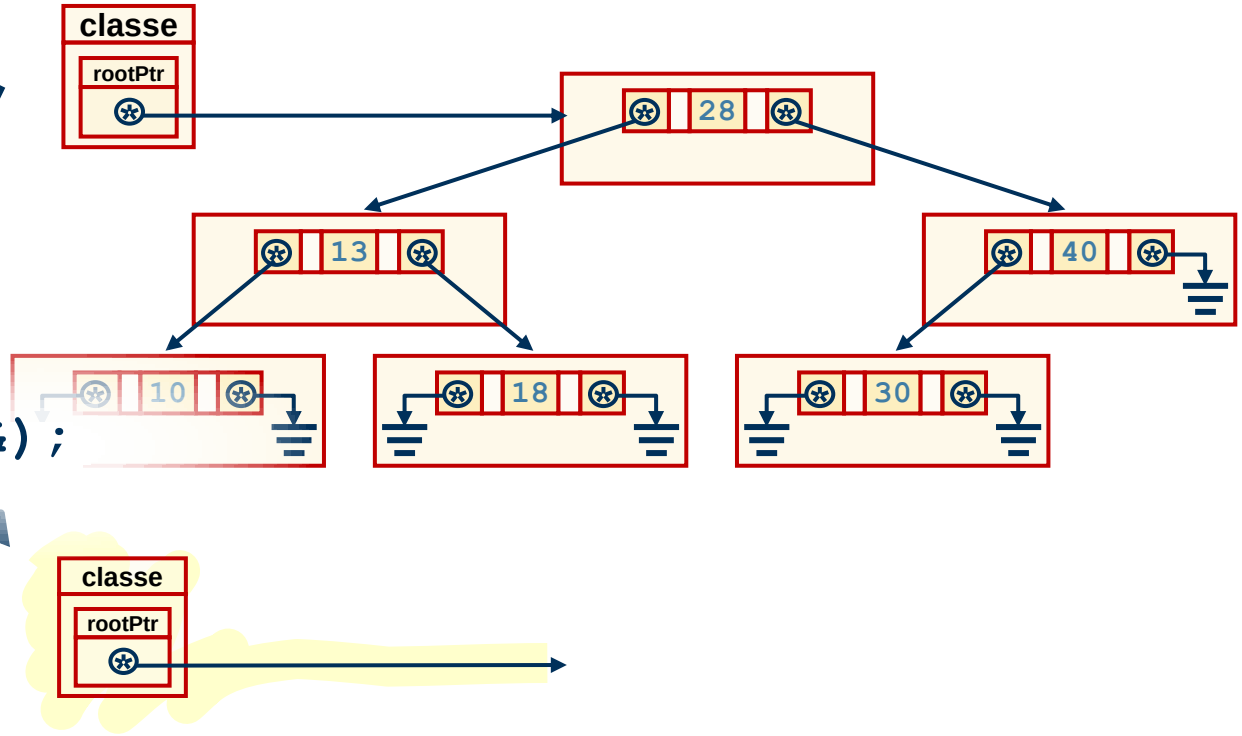
```
class Tree
{
  public:
    Tree();
    Tree(...);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
}
```

Costruttore per copia

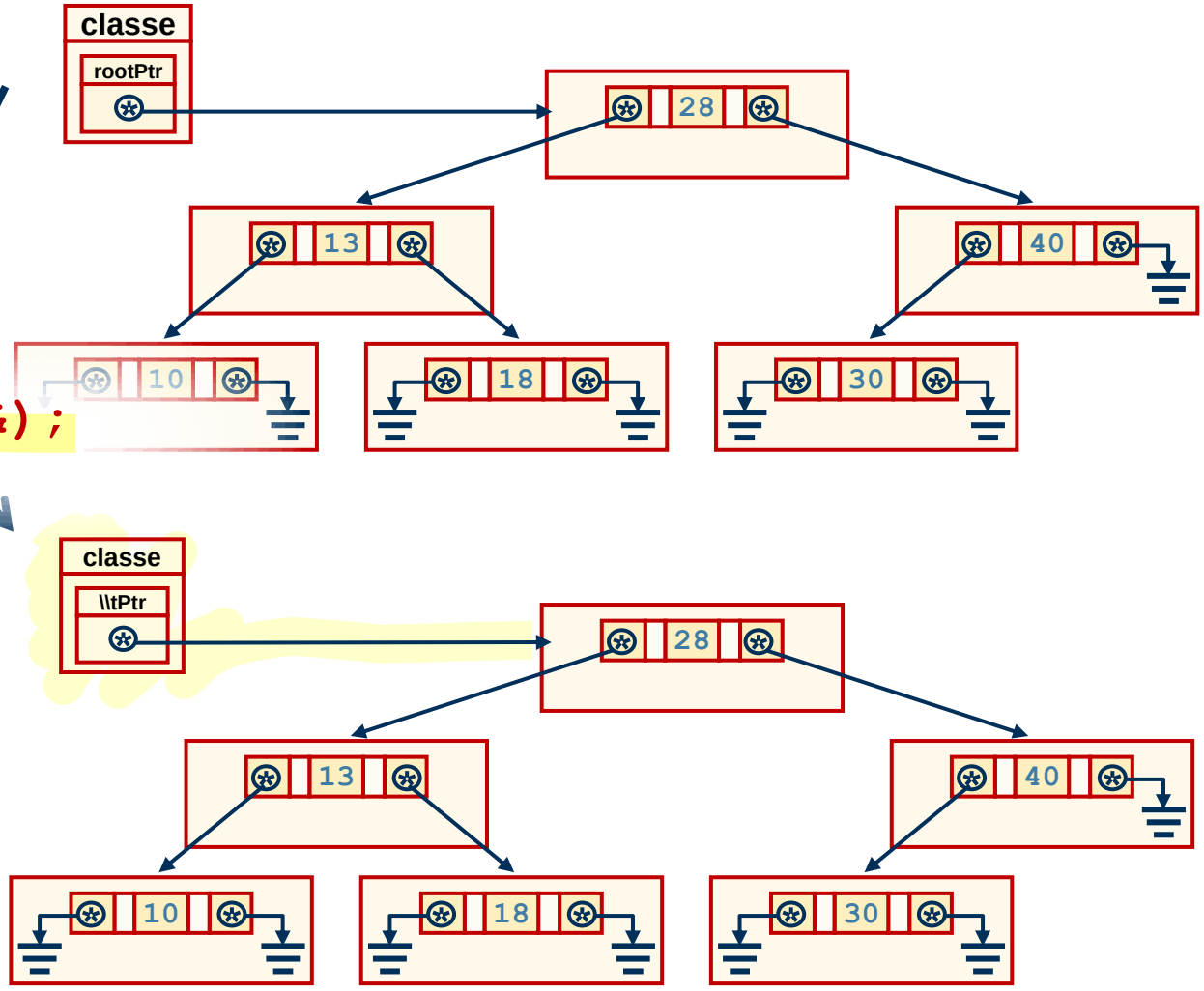
```
class Tree
{
  public:
    Tree();
    Tree(...);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
}
```

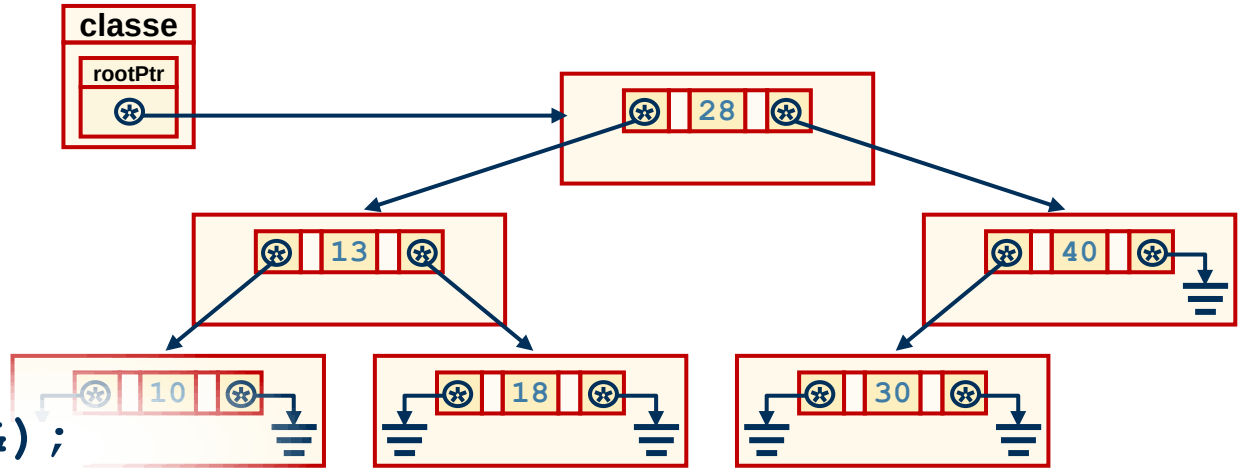


```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
  ...
  Tree classeBis(classe);
}
```



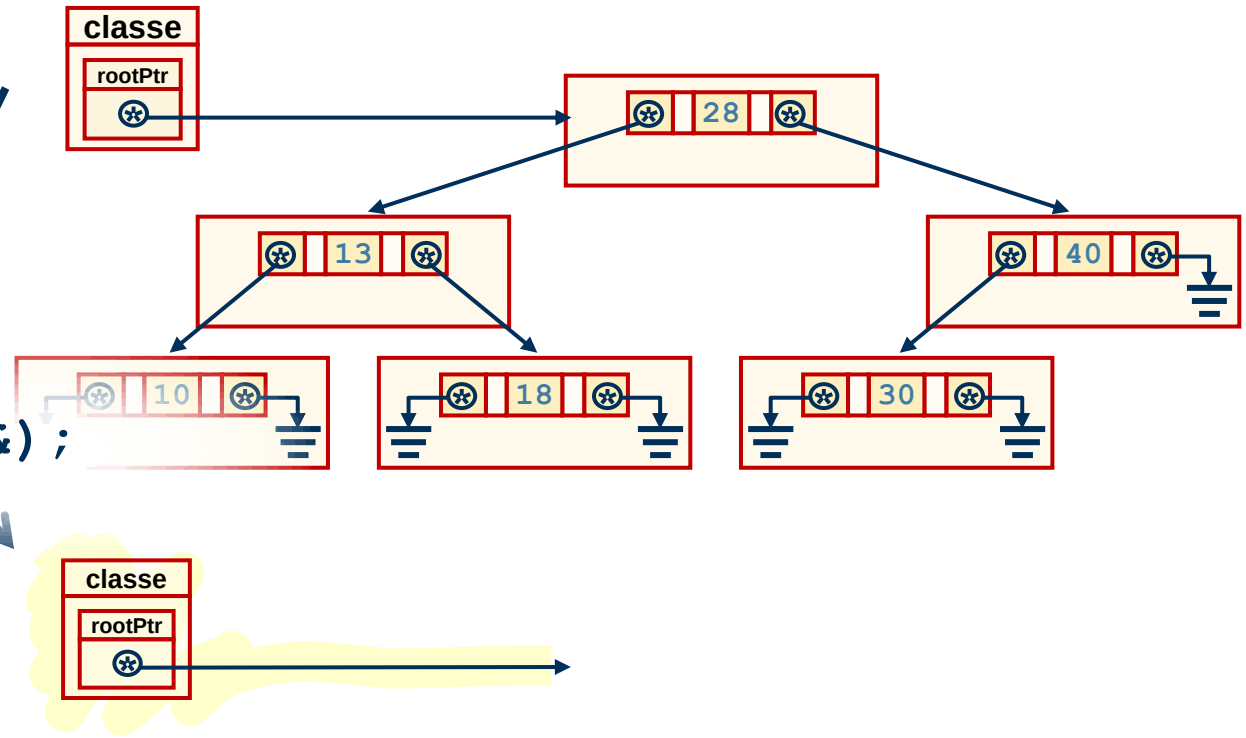
```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};
```



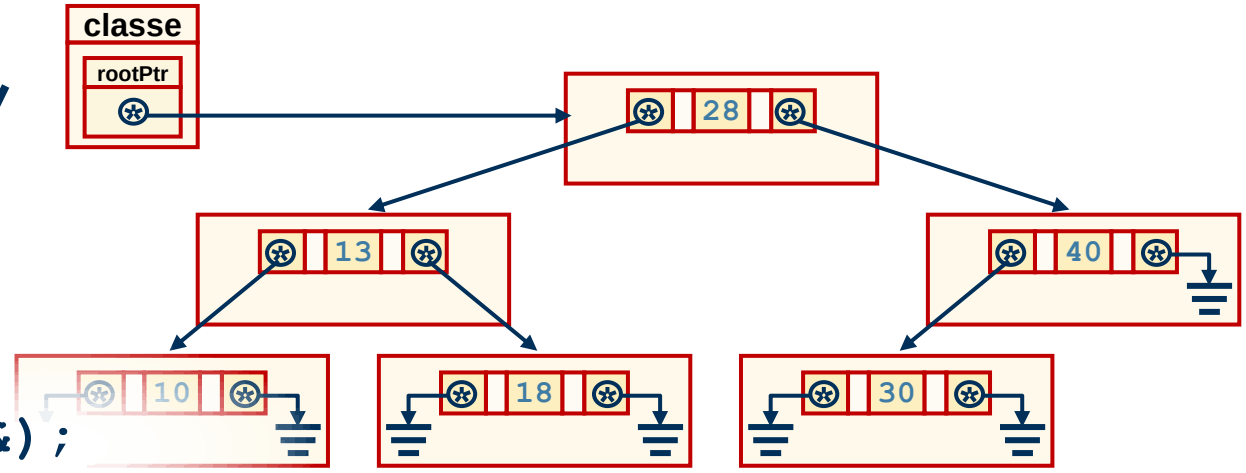


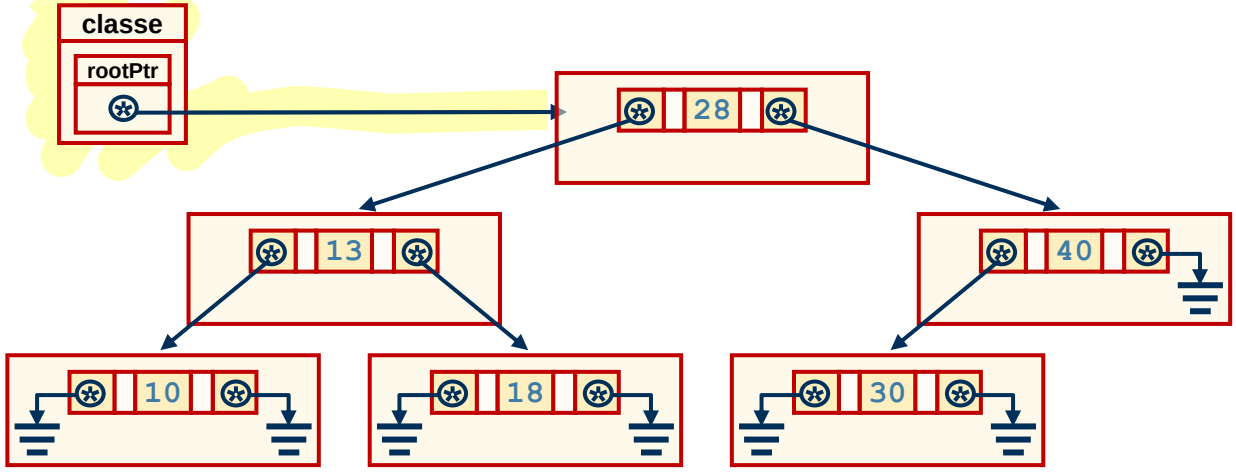

```
class Tree
{
  public:
     Tree();
     Tree(const Tree &);
     ...
  private:
     ...
};z

void main()
{ ...
  Tree classe;
}
```

```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
  ...
  Tree classeBis(classe);
}
```



```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
  ...
  Tree classeBis(classe);
}
```





```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};

void main()
{ ...
  Tree classe;
  ...
  Tree classeBis(classe);
}
```

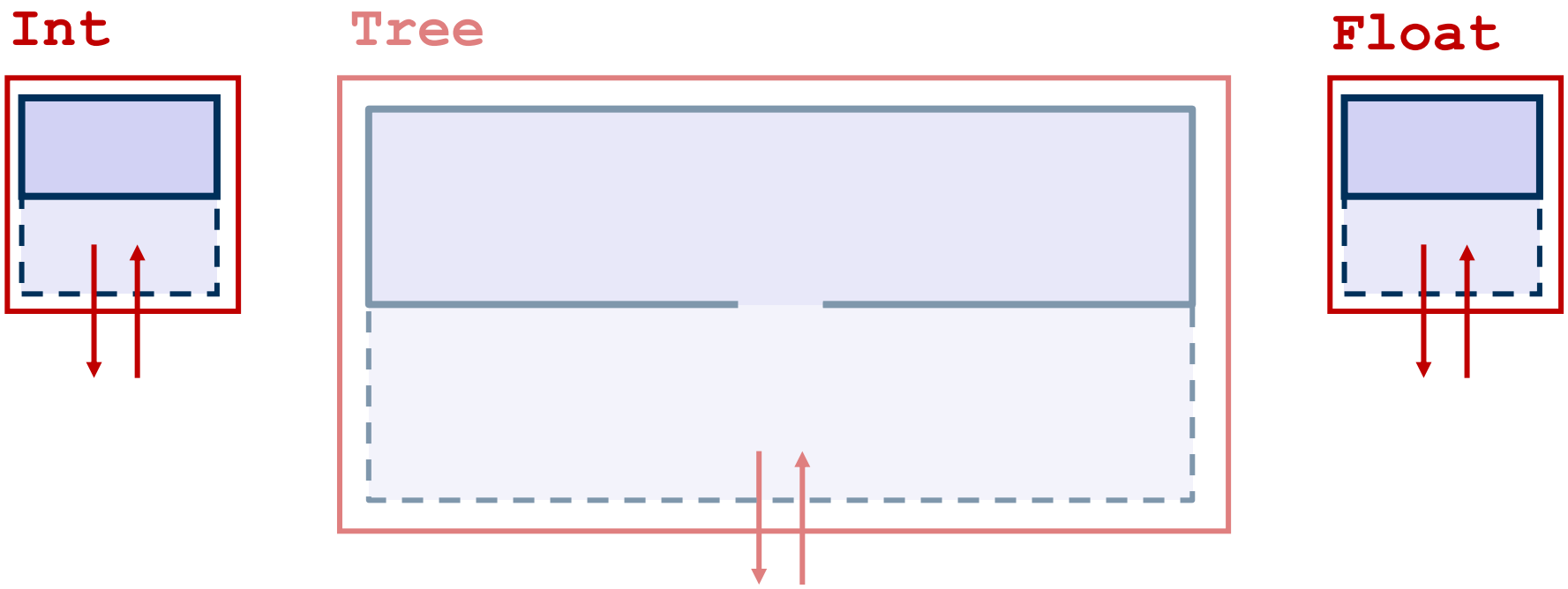
```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    ...
  private:
    ...
};
```

matricola	cognome	nome	sesso	dataNascita		
				giorno	mese	anno
7	Rossi	Marco	M	5	10	75
48	Neri	Anna	F	4	7	75
63	Verdi	Remo	M	5	8	76
84	Gialli	Carla	F	5	11	75

```
class Tree
{
  public:
    Tree();
    Tree(const Tree &);
    Tree(const Studente[]);
    ...
  private:
    ...
};
```

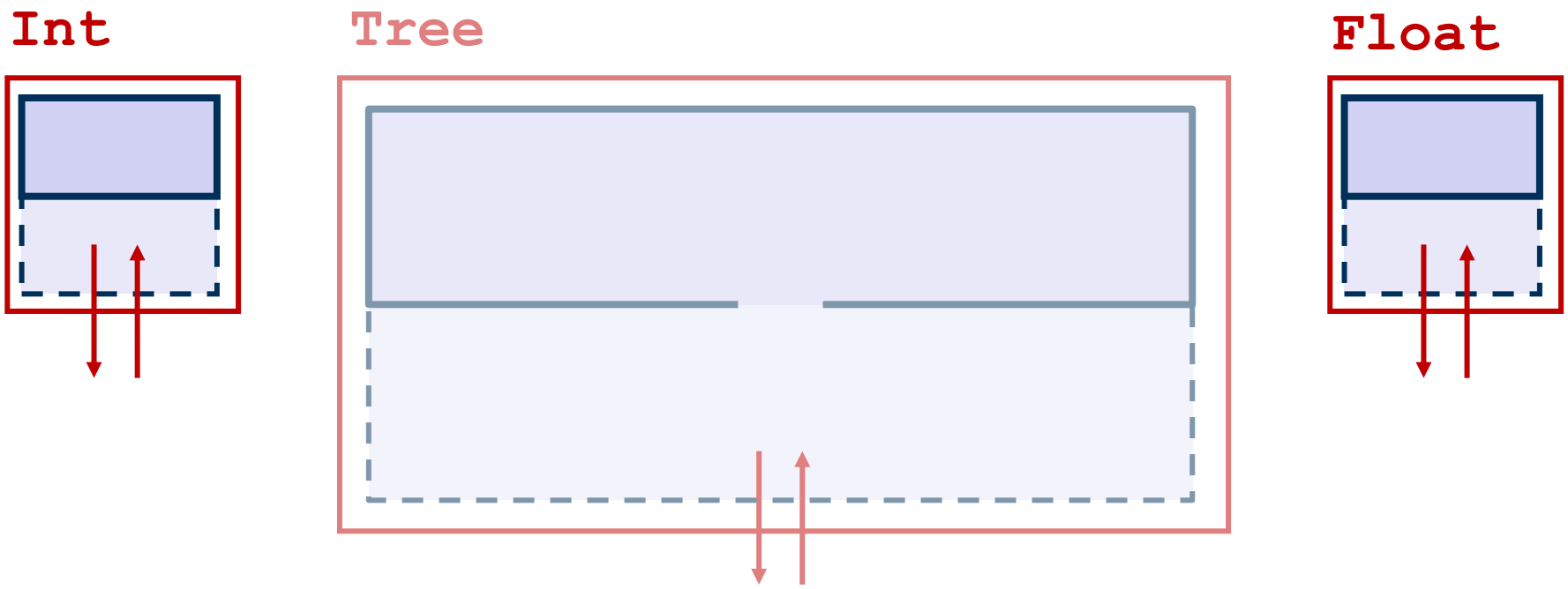
matricola	cognome	nome	sesso	dataNascita		
				giorno	mese	anno
7	Rossi	Marco	M	5	10	75
48	Neri	Anna	F	4	7	75
63	Verdi	Remo	M	5	8	76
84	Gialli	Carla	F	5	11	75

Operatori



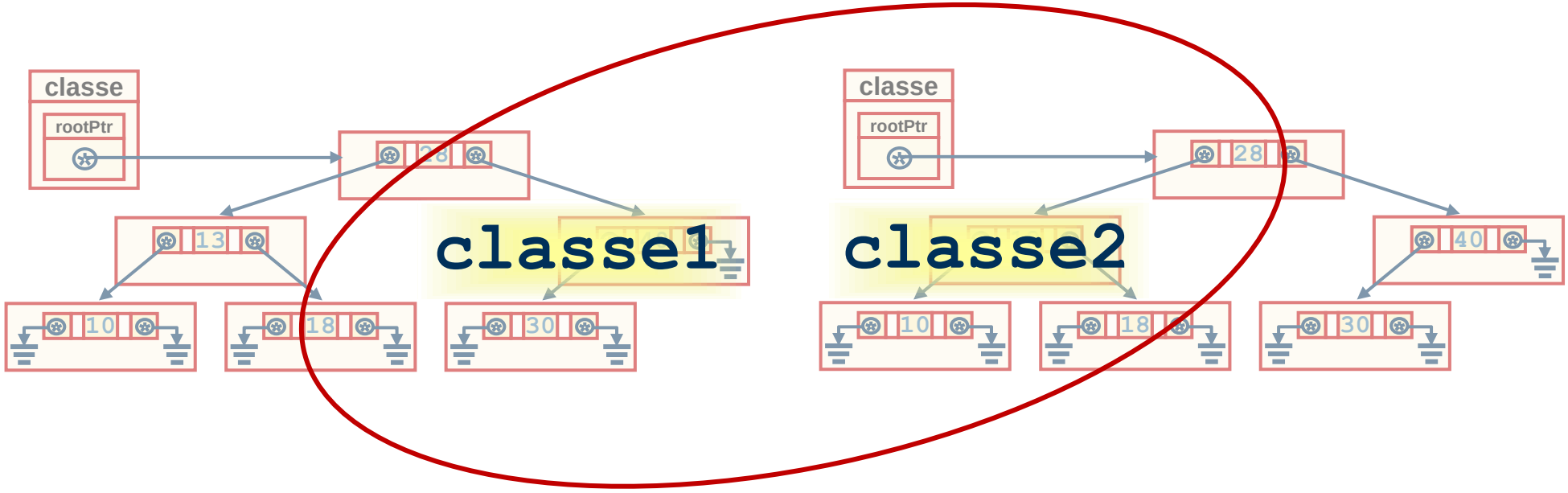

```
a = b + c
```

Overloading di operatori




```
a = b + c
```

Operatore +


classe
rootPtr
28
13
10
18
30
classe1
classe
rootPtr
28
40
10
18
30
classe2

Operatore +

```
classe1 + classe2
```

Sovraccaricare l'operatore +

```
classe1 + classe2
```

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    ...
  private:
    ...
};
```

classe1 + classe2

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

```
classe1 = classe2
```

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

```
classe1.operator+(classe2);
```

```
classe3 = classe1 + classe2
```

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

```
classe1 = classe2
```

Compilatore C++

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

classe3 = classe1 + classe2

?

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

```
classe1.operator+(classe2);
```

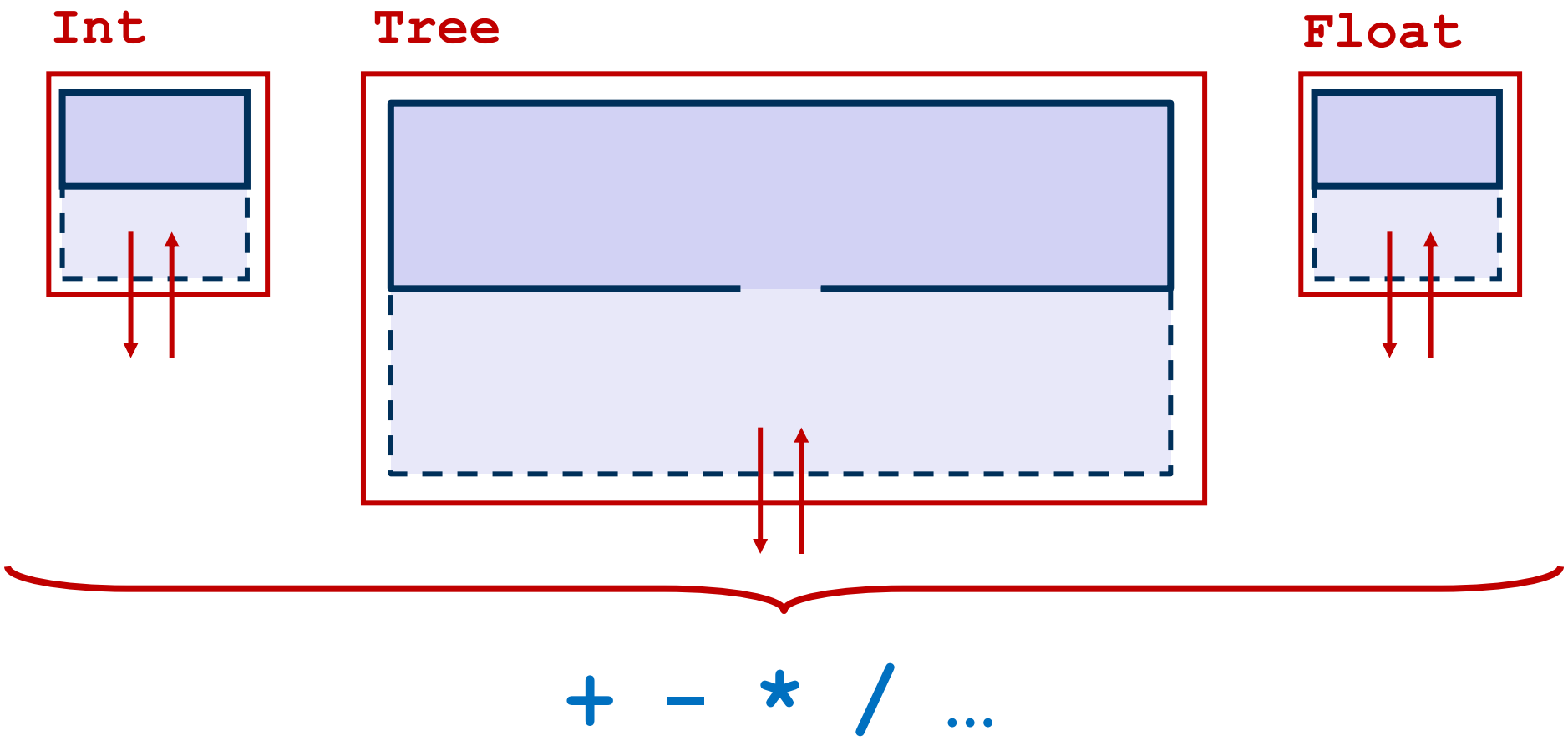
```
classe3 = classe1 + classe2
```

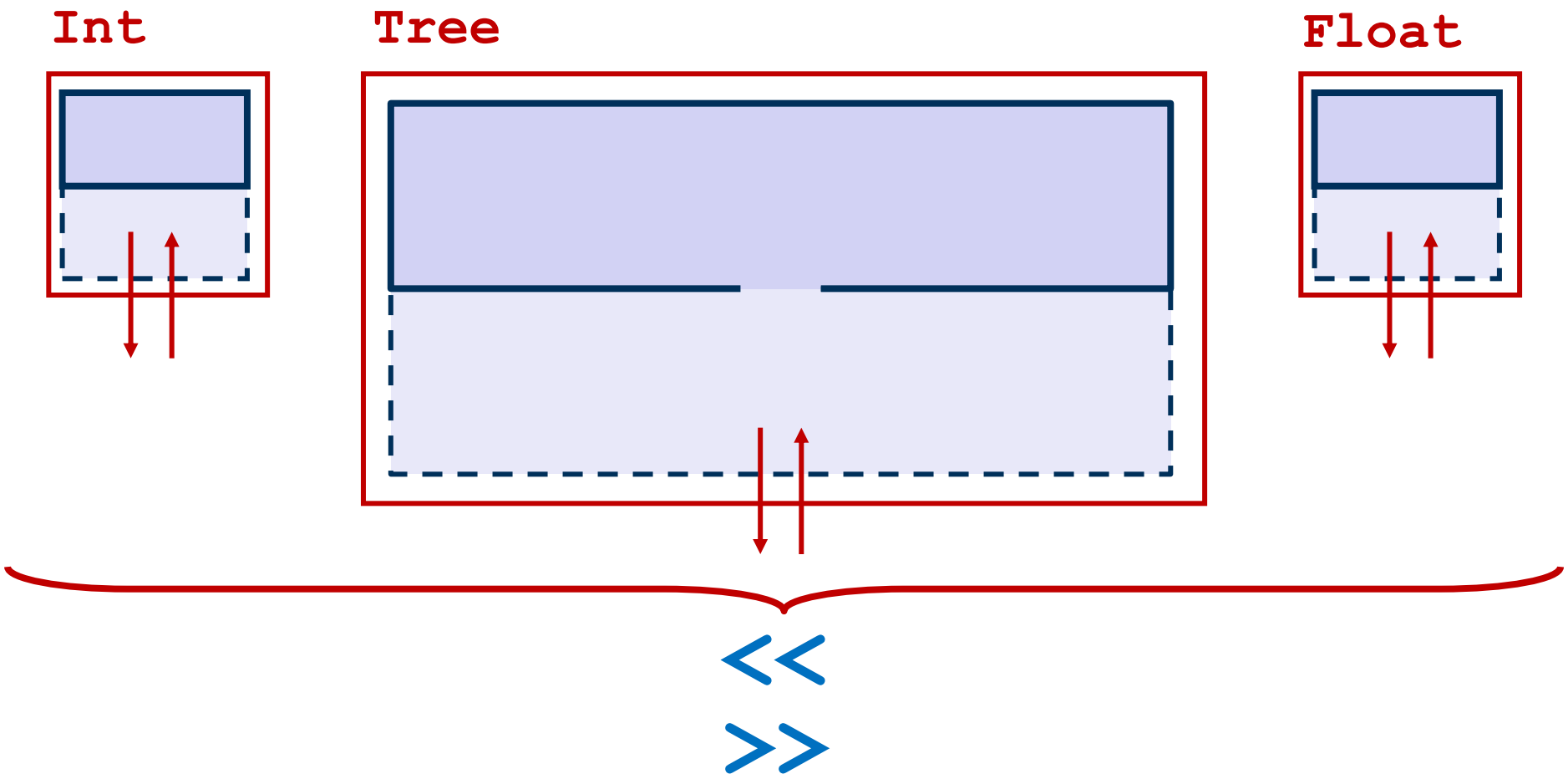
```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ...

  private:
    ...
};
```

```
classe3.operator=(classe1.operator+(classe2));
```

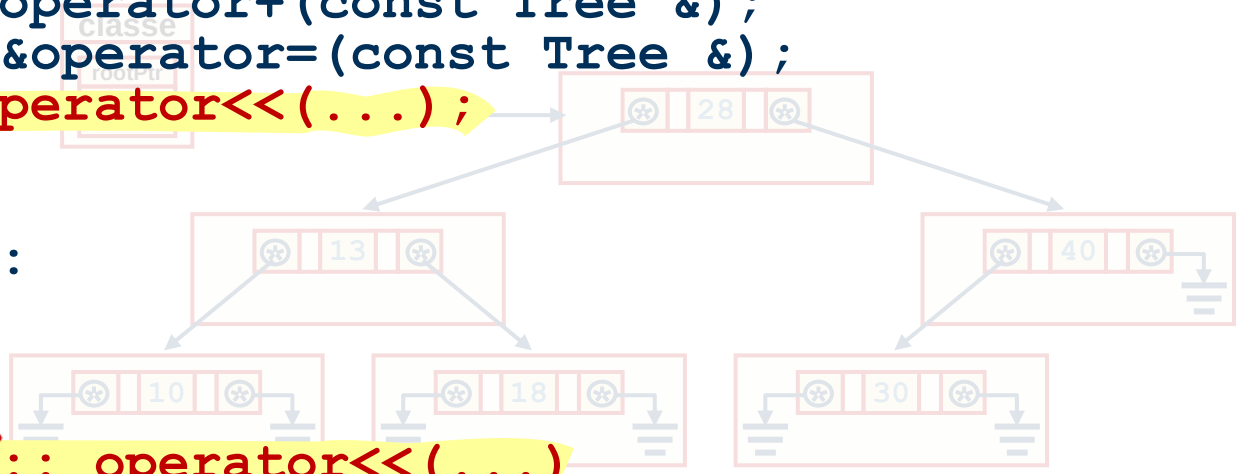
classe3 = classe1 + classe2

Significato "naturale"




Int
Tree
Float
<<
>>

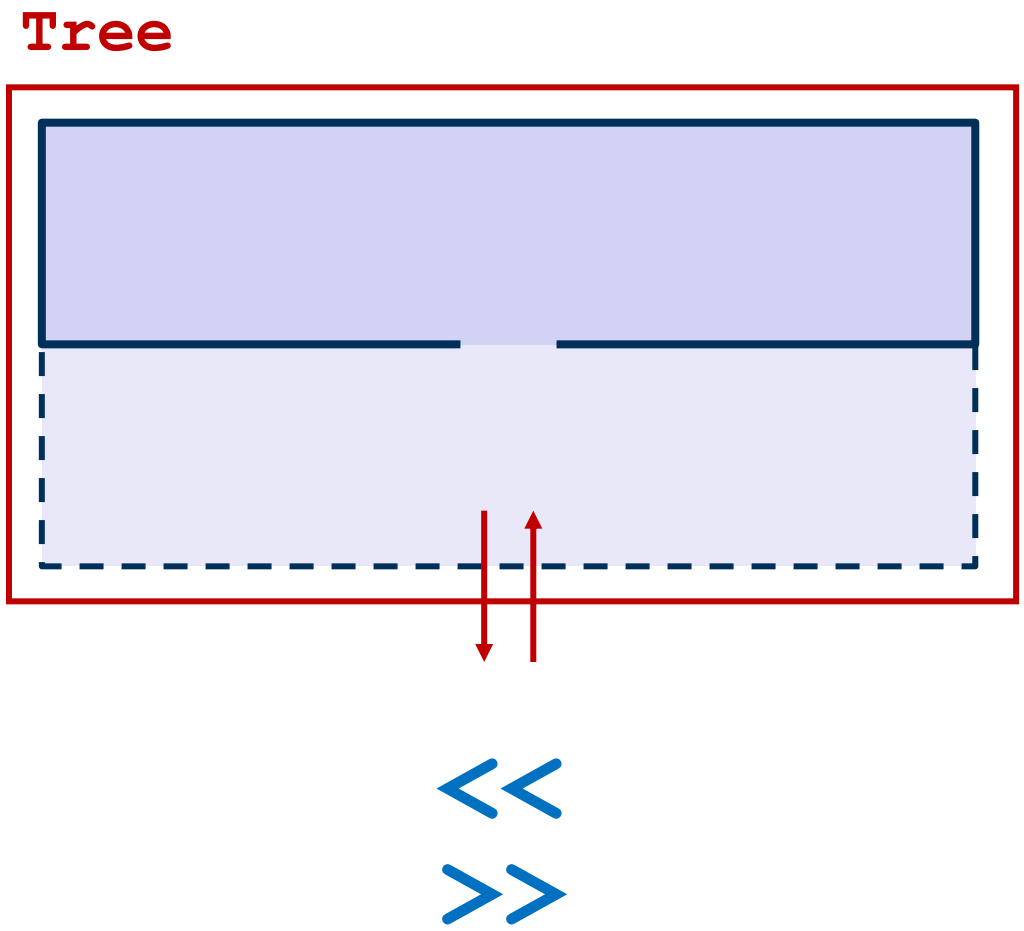
```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ... operator<<(...);
    ...

  private:
    ...
};

... Tree :: operator<<(...)
{
  ...
}
```



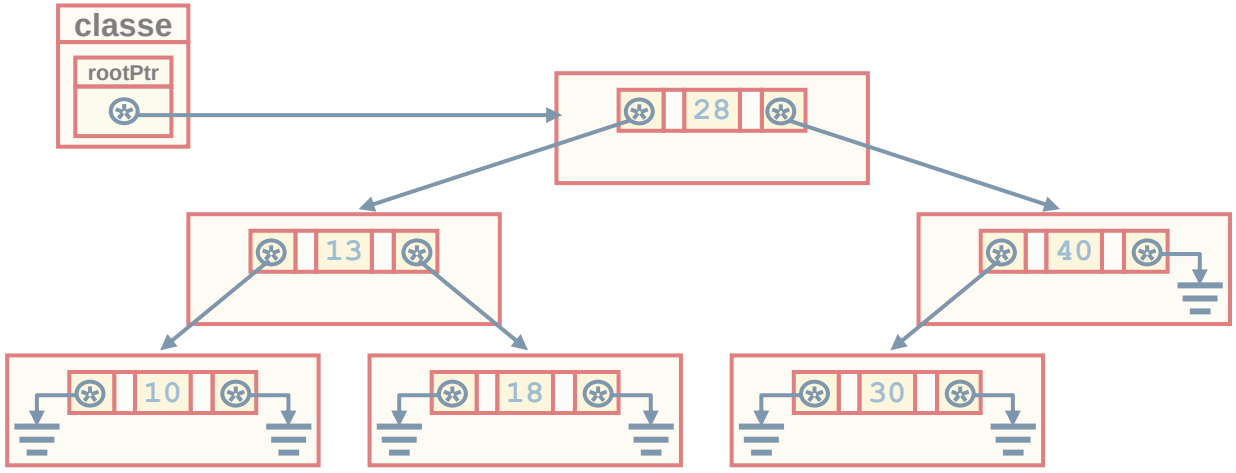
<<

>>

Overloading di << e >>



Operatori binari



<<

>>

Operatori binari

```
cin >> alfa;
cout << beta;
```

operando *operatore* *operando*

```
cin >> alfa;
cout << beta;
```

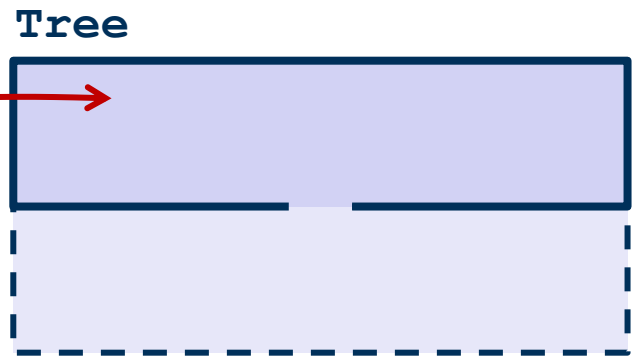
Tree operatore operando

```
cin >> alfa;
cout << beta;
```

Tree operatore operando

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    Tree &operator=(const Tree &);
    ... operator<<(...);
    ...

  private:
    ...
};

... Tree :: operator<<(...)
{
  ...
}
```

```
ostream &operator<<(...)
{
   ...
}

class Tree
{ friend ostream &operator<<(...);
  public:
     Tree();
     ...

  private:
     ...
};
```



```
ostream &operator<<(...)
{
  ...
}

class Tree
{ friend ostream &operator<<(...);
  public:
    Tree();
    ...

  private:
    ...
};
```

cin → istream

cout → ostream

```
ostream &operator<<(...)
{
  ...
}

class Tree
{ friend ostream &operator<<(...);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
ostream &operator<<(  ostream & output, ...)
{
  ...
}

class Tree
{ friend ostream &operator<<(   ostream &, ...);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
  ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
cout << classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
  ...
}

class Tree
{ friend ostream &operator<<(  ostream &,  const Tree &);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
cout << a << b << c;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
operator <<(cout, classe1)
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(  ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
operator <<(cout, classe1)
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
operator <<(cout, classe1)
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
operator <<(cout, classe1)
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

```
operator <<(cout, classe1)
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
}

class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
cout <<  classe1;
```

```
ostream &operator<<( ostream & output, const Tree &tab)
{
  ...
  return output;
}
class Tree
{ friend ostream &operator<<( ostream &, const Tree &);
  public:
    Tree();
    ...

  private:
    ...
};
```

```
cout << classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
   return output;
}
class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

cout

```
cout <<  classe1;
```

```
ostream &operator<<( ostream & output, const Tree &tab)
{
  ...
  return output;
}
class Tree
{ friend ostream &operator<<( ostream &, const Tree &);
  public:
    Tree();
    ...

  private:
    ...
};
```

cout

```
cout << classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
   return output;
}
class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

cout

```
cout <<  classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
   return output;
}
class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

cout

```
cout << classe1;
```

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
   return output;
}
class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...

  private:
     ...
};
```

cout

cout << classe1;

```
ostream &operator<<(  ostream & output,  const Tree &tab)
{
   ...
   return output;
}
class Tree
{ friend ostream &operator<<(   ostream &,  const Tree &);
  public:
     Tree();
     ...
  private:
     ...
};
```

cout

cout

```
(cout << classe1) << classe2;
```

```
cout << classe1 << classe2 << classe3;
```

```
cout << classe1 << classe2 << classe3;
```

```
classe1 + classe2 + classe3
```

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    ...

  private:
    ...
};
```

`classe1 + classe2 + classe3`

```
class Tree
{
  public:
    Tree();
    Tree operator+(const Tree &);
    ...

  private:
    ...
};
```

classe1 + classe2 + classe3

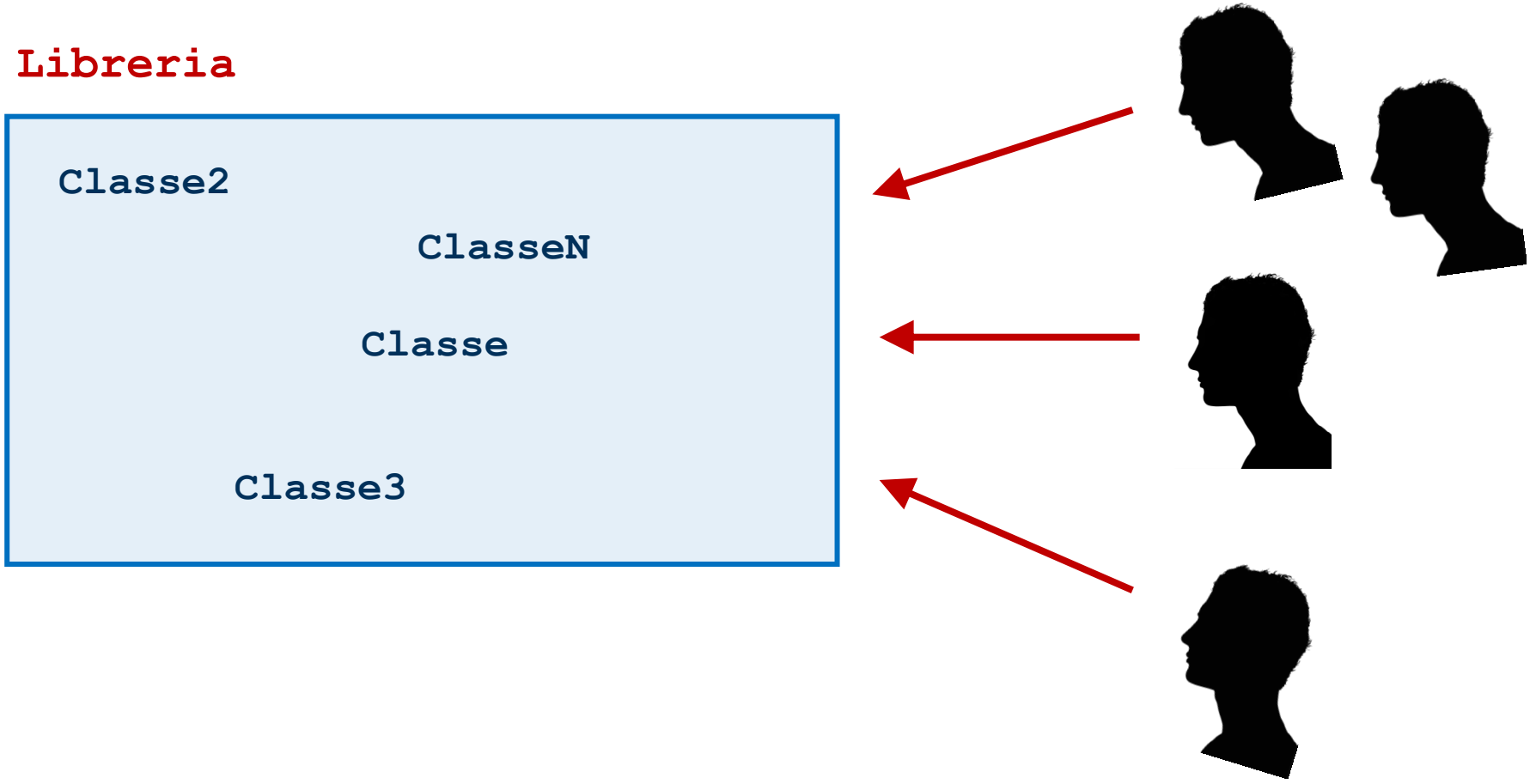
Conclusioni

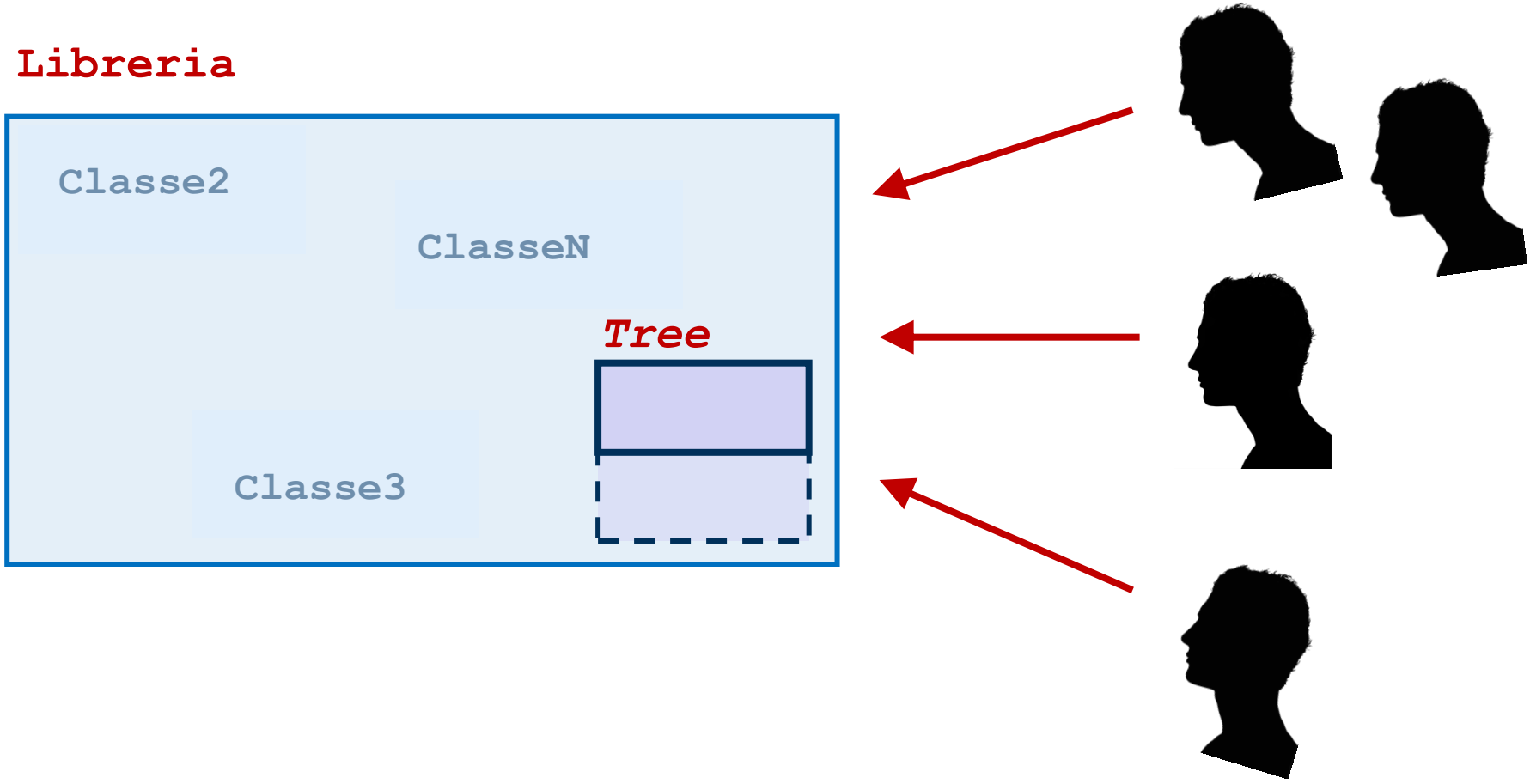
1. inserisci 4 monete da 100 lire
2. tira il cassetto corrispondente alla marca desiderata
3. estrai il pacchetto
4. richiudi il cassetto
5. ritira il resto
6. fine


```
class Tree
{
  public:
    Tree();
    void inserisciSeNonEsiste(Studente);
    void inOrderTraversal();
    void stampaAlbertoRovesciato();
  private:
    TreeNode *rootPtr;
  //funzioni di servizio
    void inserisciConRicorsione(TreeNode *&, Studente);
    void recursiveInOrder(TreeNode *);
    void stampaRovesciatoRicorsiva(TreeNode *, int);
};

Tree :: Tree();
{
  rootPtr = 0;
}

void  Tree :: inserisciSeNonEsiste(Studente nuovoStudente)
{
  inserisciConRicorsione(rootPtr, nuovoStudente);
}

voit Tree :: inserisciConRicorsione(TreeNode *& ptr,
                                    Studente nuovoStudente)
{ if (ptr == 0)
    { ptr = new TreeNode(NuovoStudente);
    }
  else if (nuovoStudente.matricola < ptr->datiStud.matricola
    inserisciConRicorsione(ptr->leftPtr, nuovoStudente);
  else if (nuovoStudente.matricola > ptr->datiStud.matricola
    inserisciConRicorsione(ptr->rightPtr, nuovoStudente);
  else
   cout << "studente di matricola " << nuovoStudente.matricola
        << " già presente" << endl;
}
```

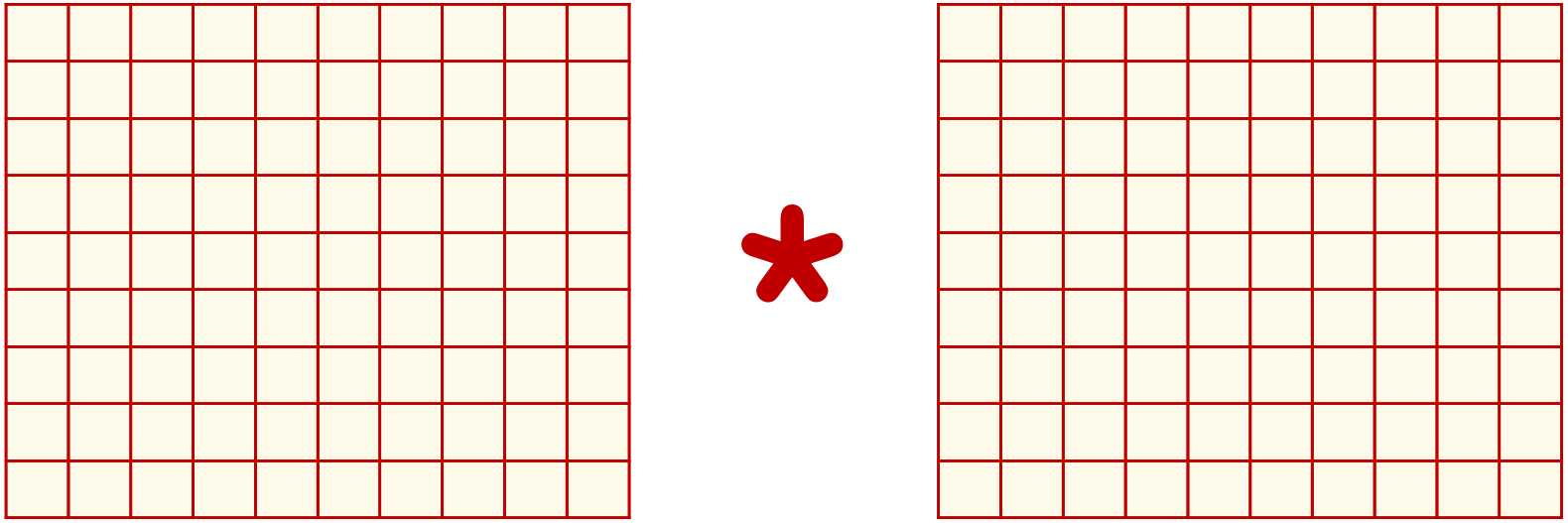
Classe

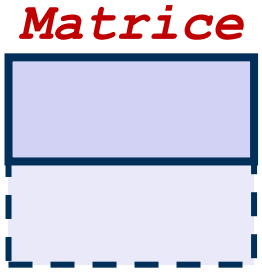
```
class Tree
{
  public:
    Tree();
    void inserisciSeNonEsiste(Studente);
    void inOrderTraversal();
    void stampaAlbertoRovesciato();
  private:
    TreeNode *rootPtr;
  //funzioni di servizio
    void inserisciConRicorsione(TreeNode *&, Studente);
    void recursiveInOrder(TreeNode *);
    void stampaRovesciatoRicorsiva(TreeNode *, int);
};

Tree :: Tree();
{
  rootPtr = 0;
}

void  Tree :: inserisciSeNonEsiste(Studente nuovoStudente)
{
   inserisciConRicorsione(rootPtr, nuovoStudente);
}

voit Tree :: inserisciConRicorsione(TreeNode *& ptr,
                                    Studente nuovoStudente)
{ if (ptr == 0)
     { ptr = new TreeNode(NuovoStudente);
     }
  else if (nuovoStudente.matricola < ptr->datiStud.matricola
    inserisciConRicorsione(ptr->leftPtr, nuovoStudente);
  else if (nuovoStudente.matricola > ptr->datiStud.matricola
    inserisciConRicorsione(ptr->rightPtr, nuovoStudente);
  else
   cout << "studente di matricola " << nuovoStudente.matrico
        << " già presente" << endl;
}
```

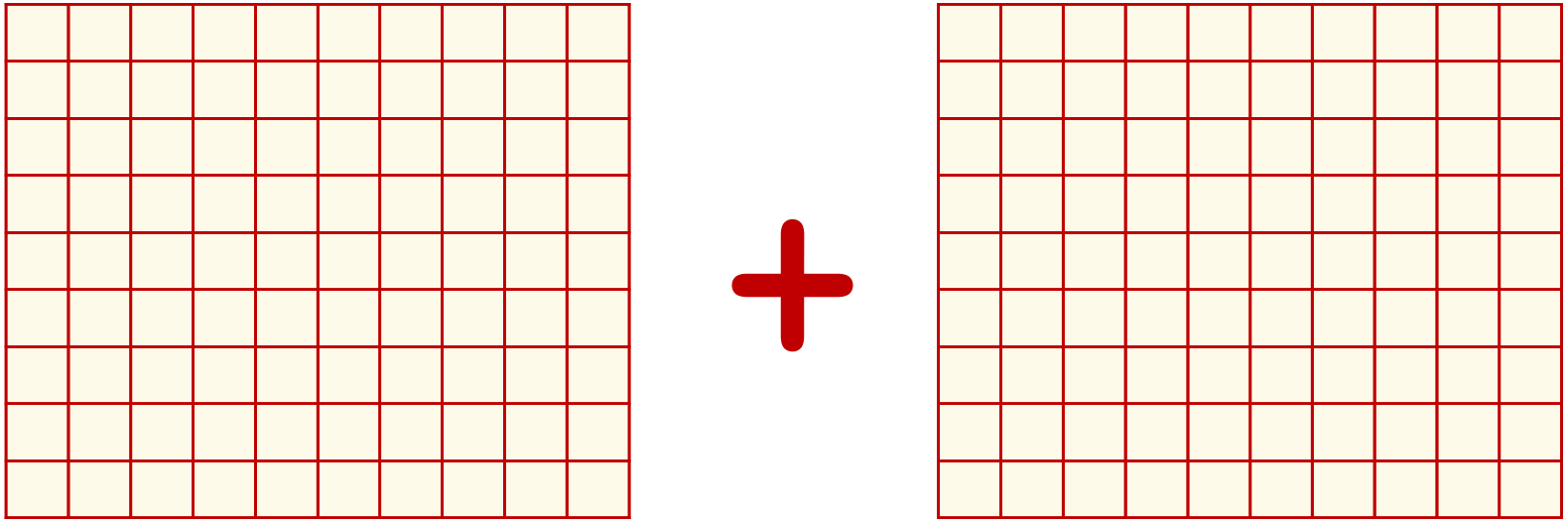

Libreria
Classe2
ClasseN
Classe
Classe3

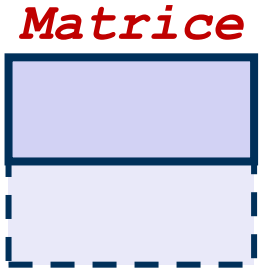

Libreria
Classe2
ClasseN
Tree
Classe3

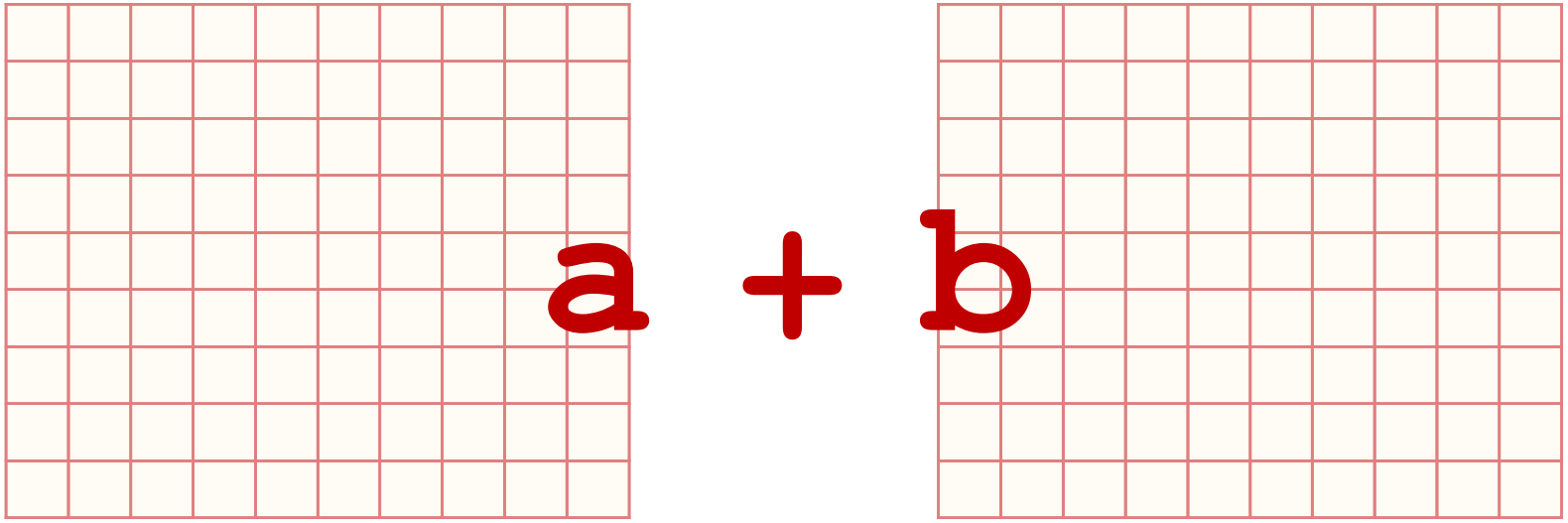
Matrici

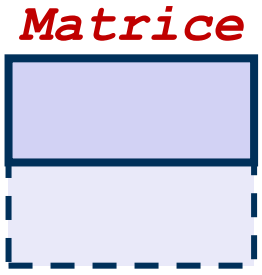


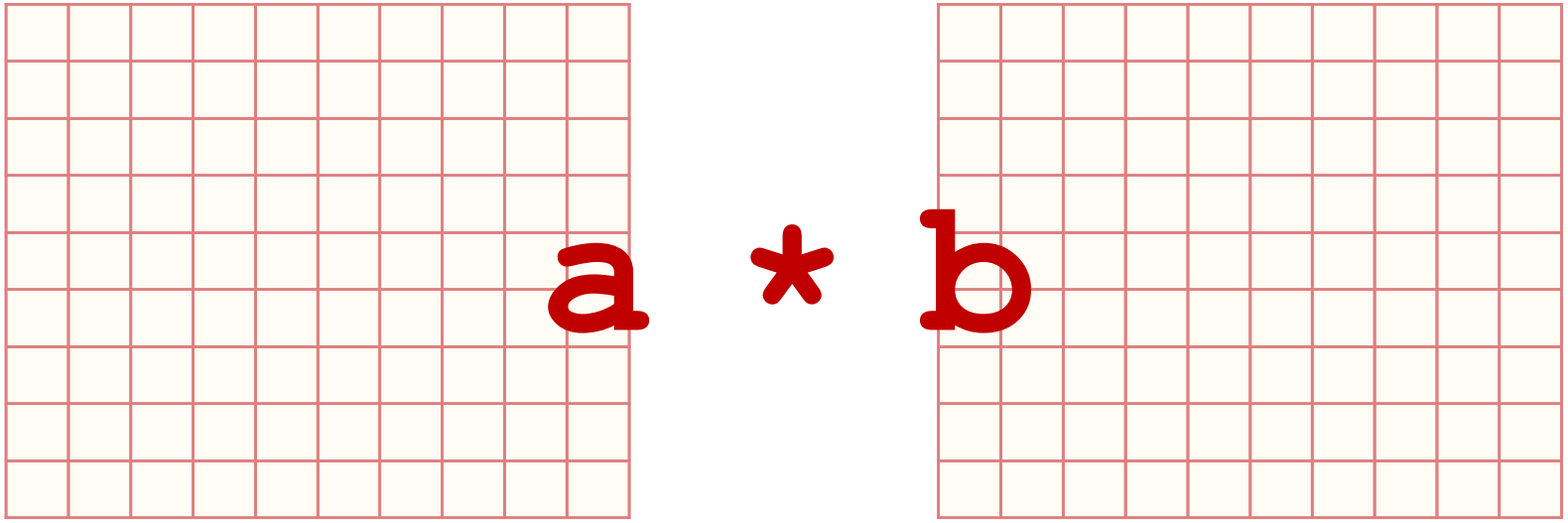


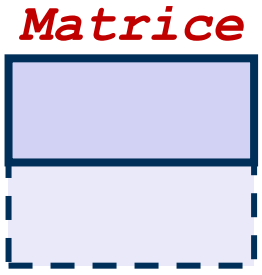



Matrice


a + b


Matrice


a * b


Matrice

Uso "naturale"