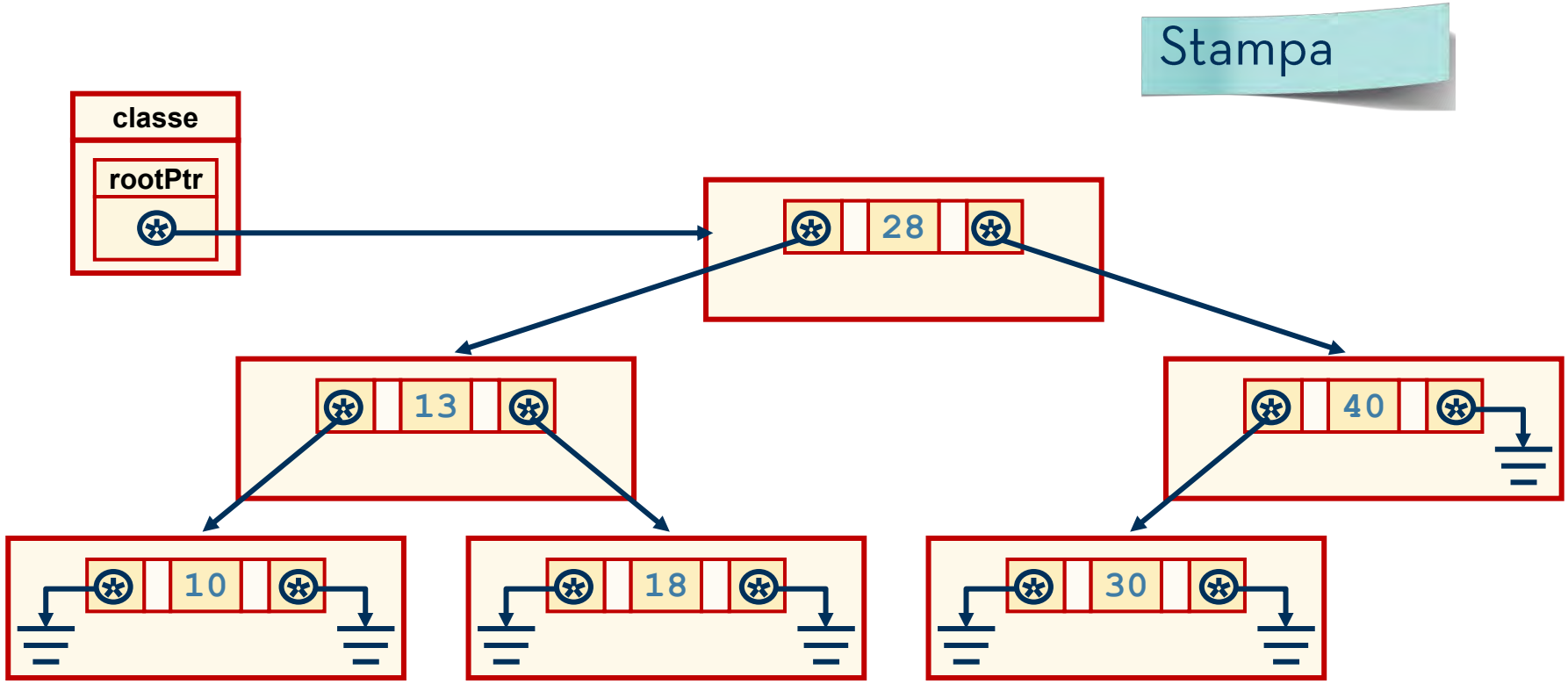
POLITECNICO DI MILANO

INFORMATICA

Attraversamento di alberi binari: ricorsione e iterazione, pile e code


Stampa
classe
rootPtr
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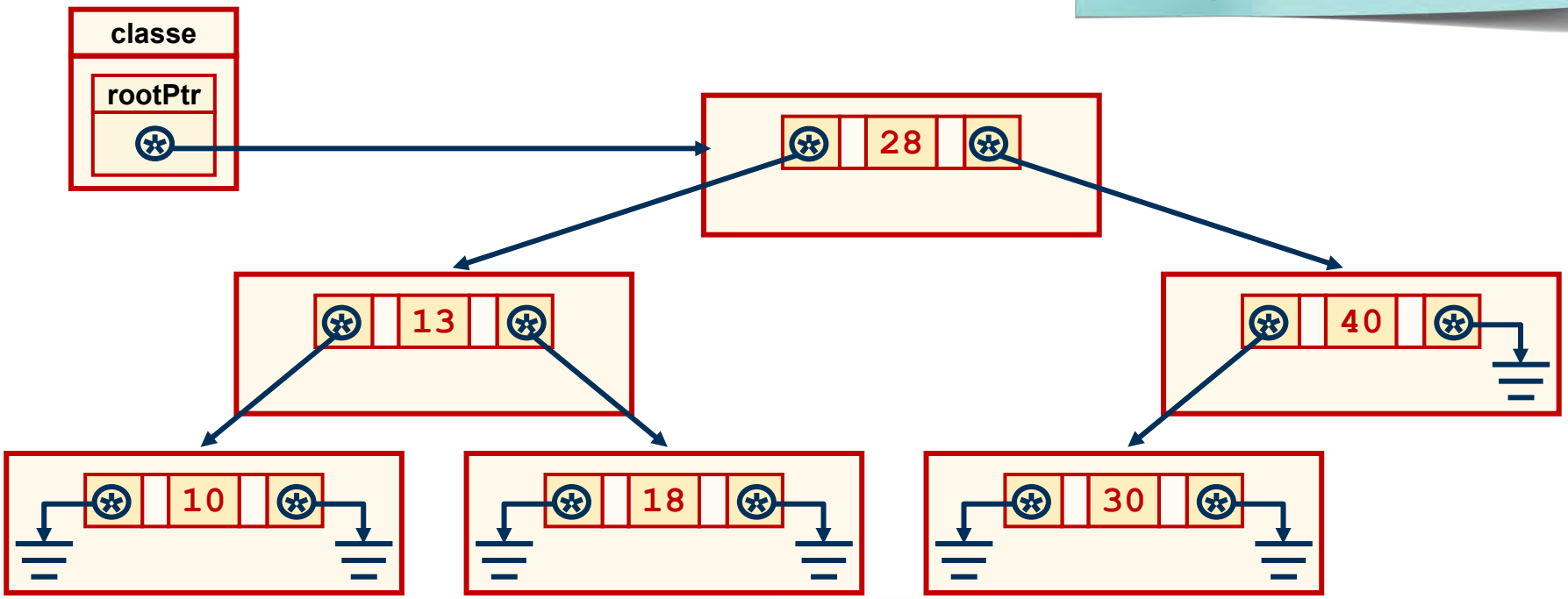
Stampa della matricola



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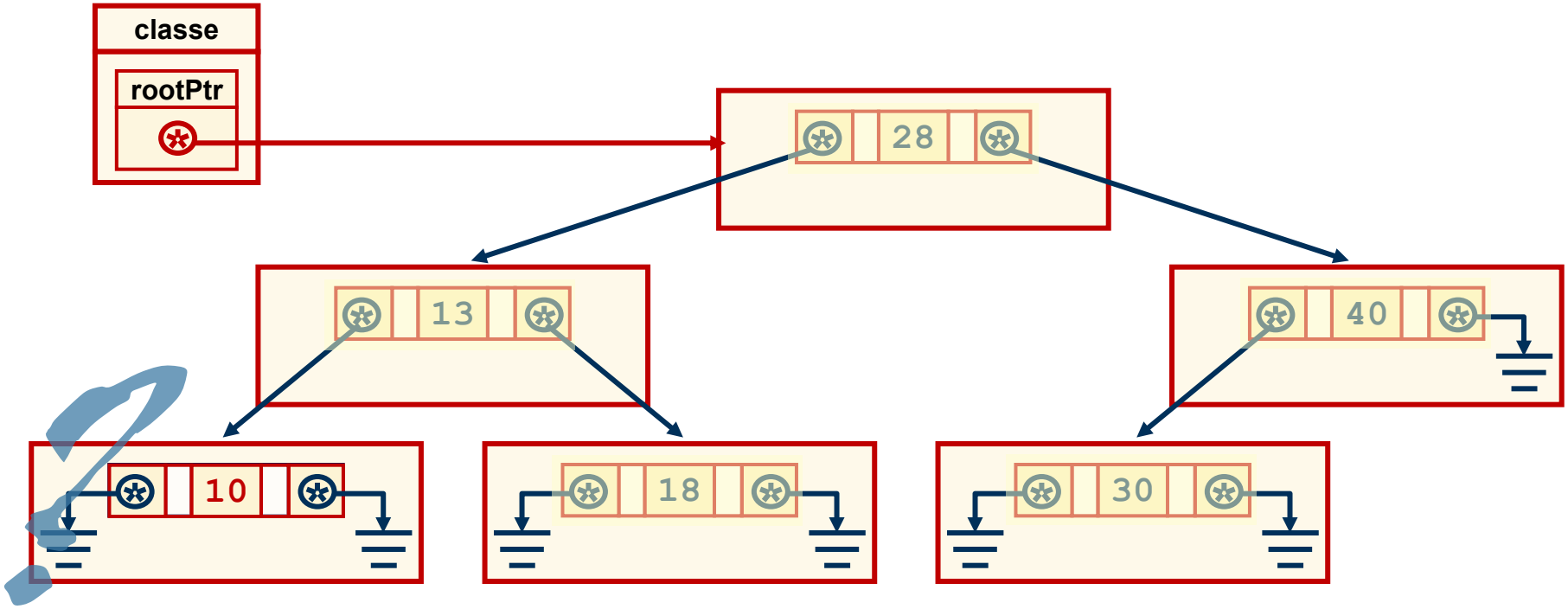
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rootPtr
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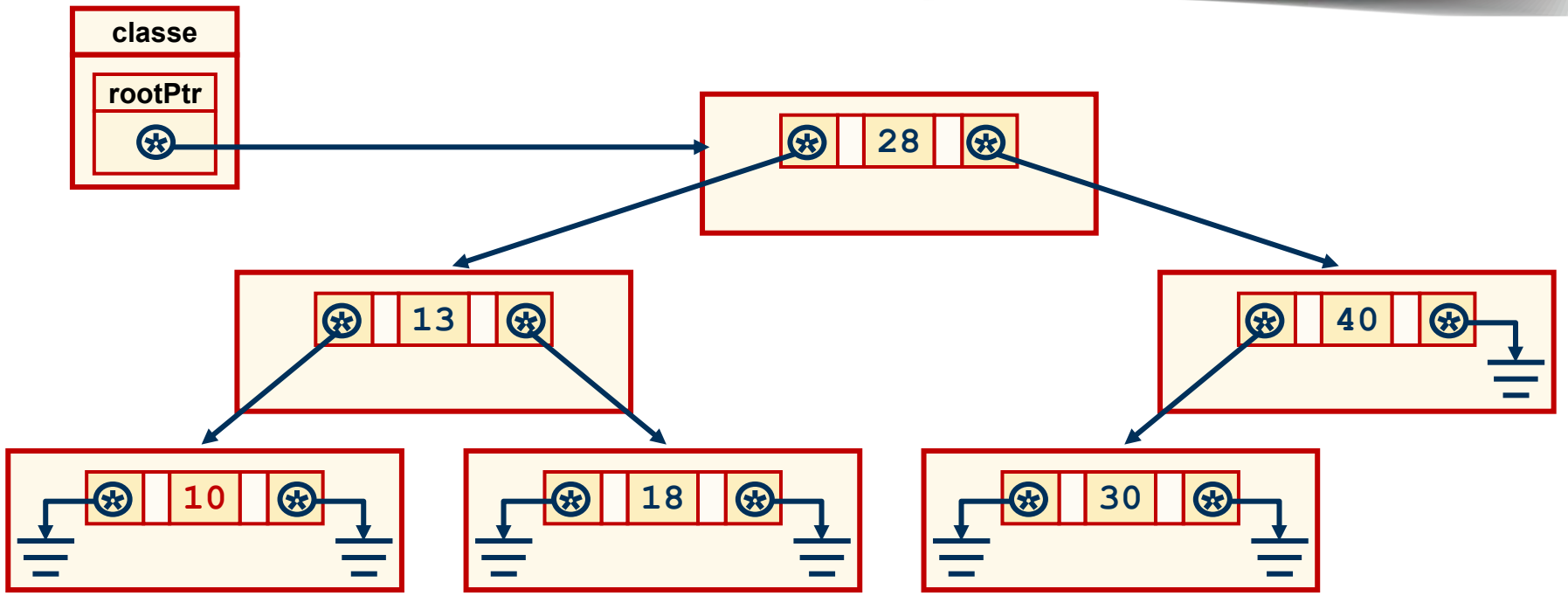
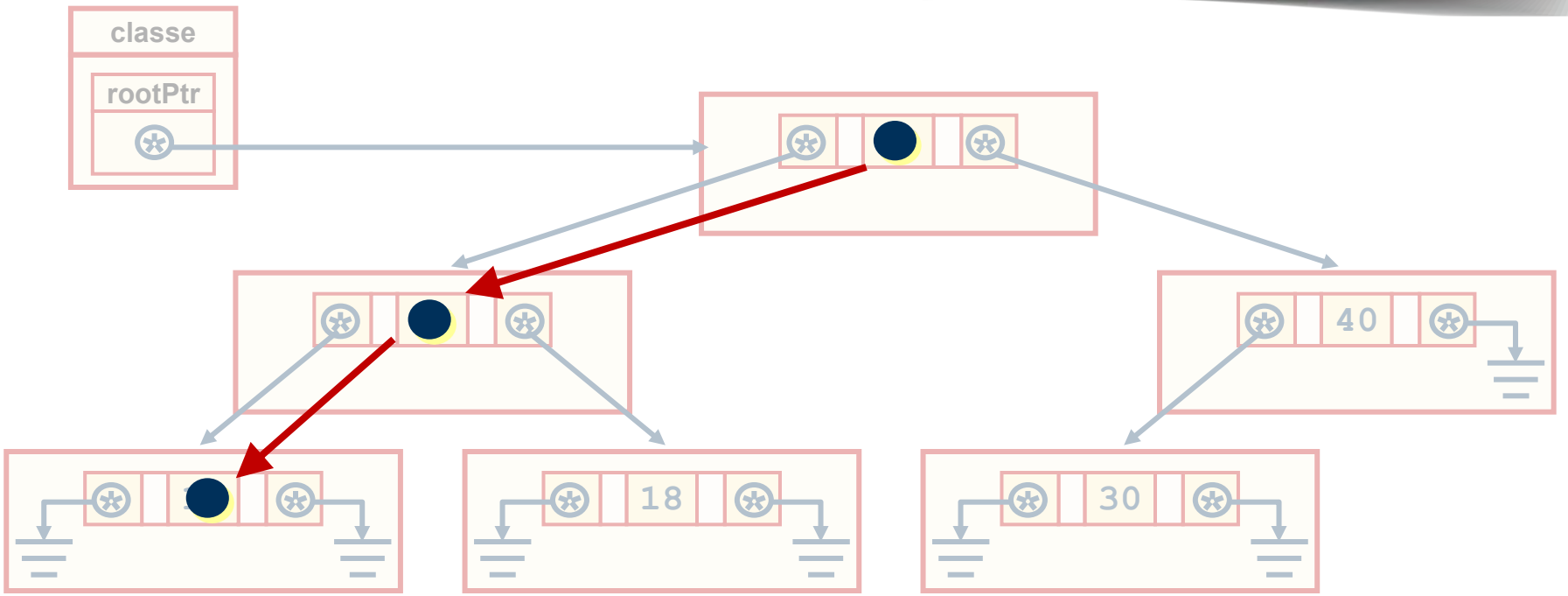
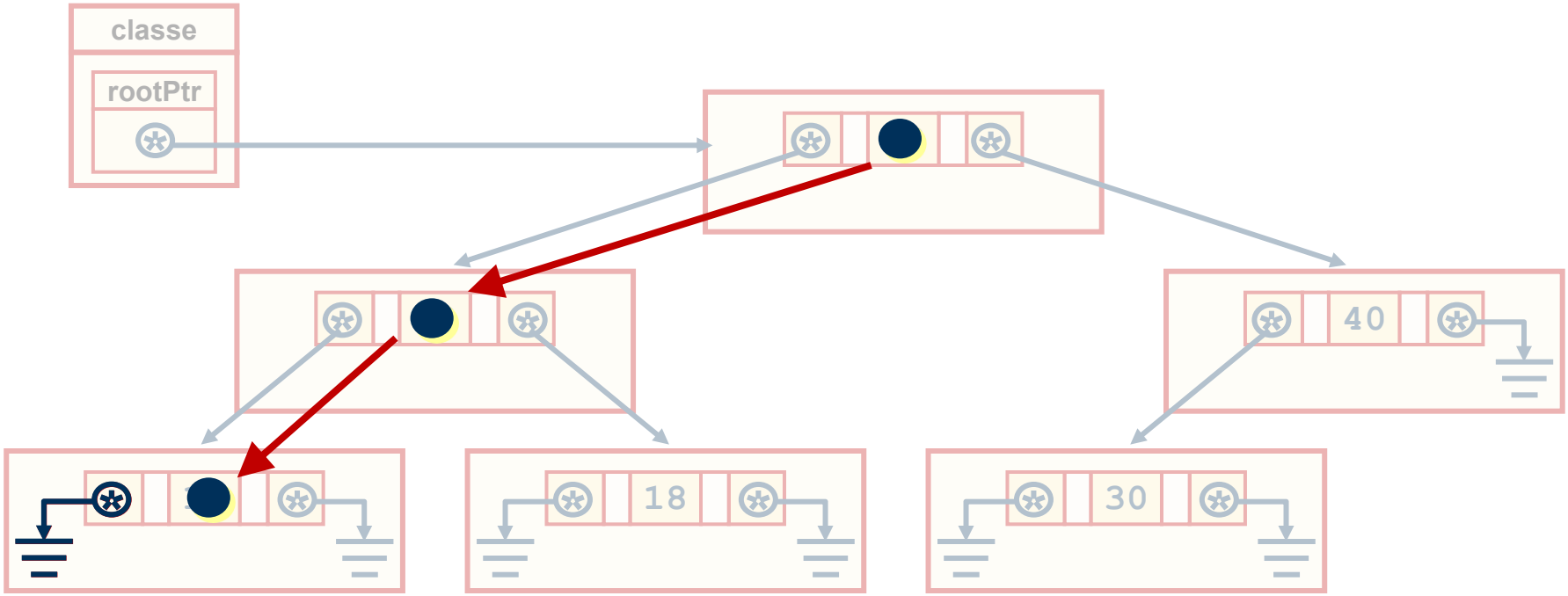
Valore a matricola minima



Valore a matricola minima

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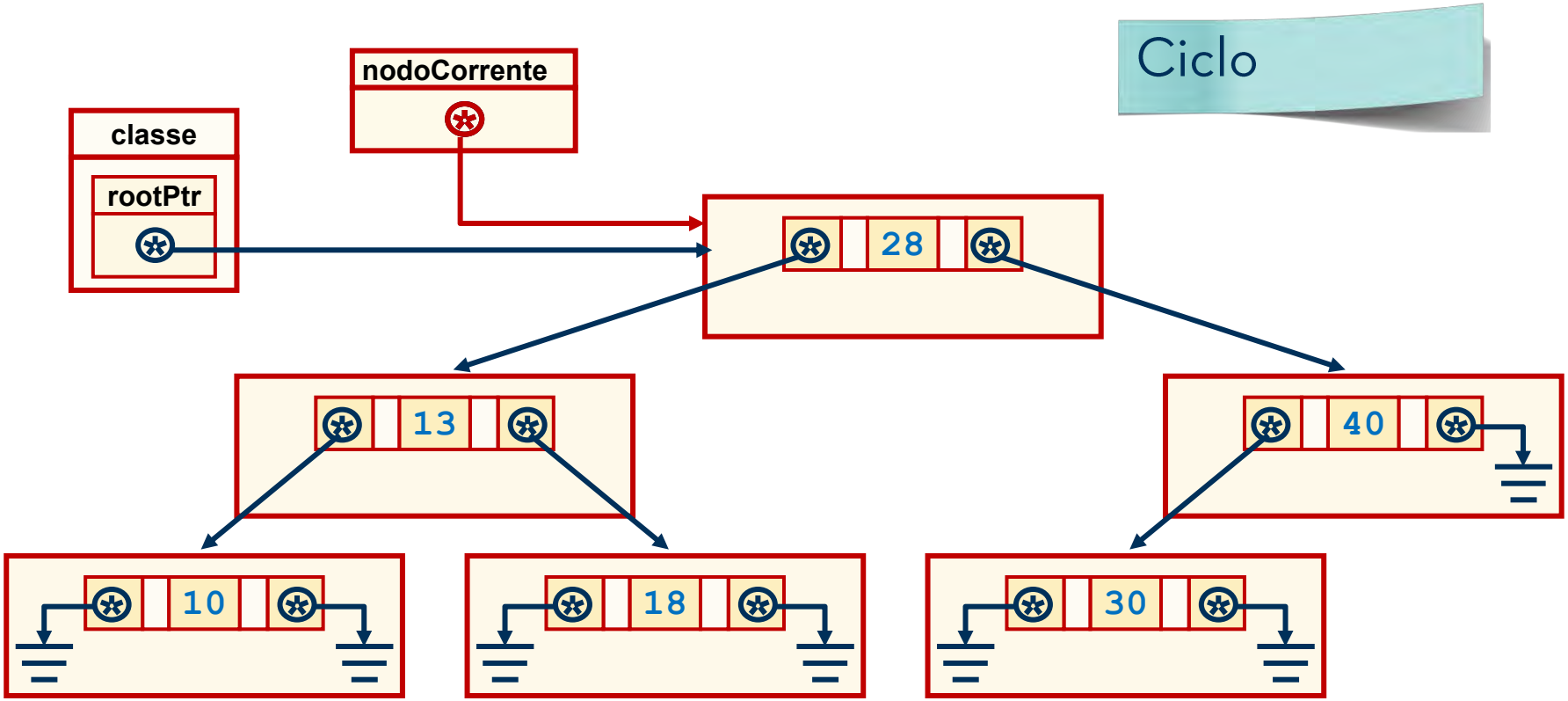
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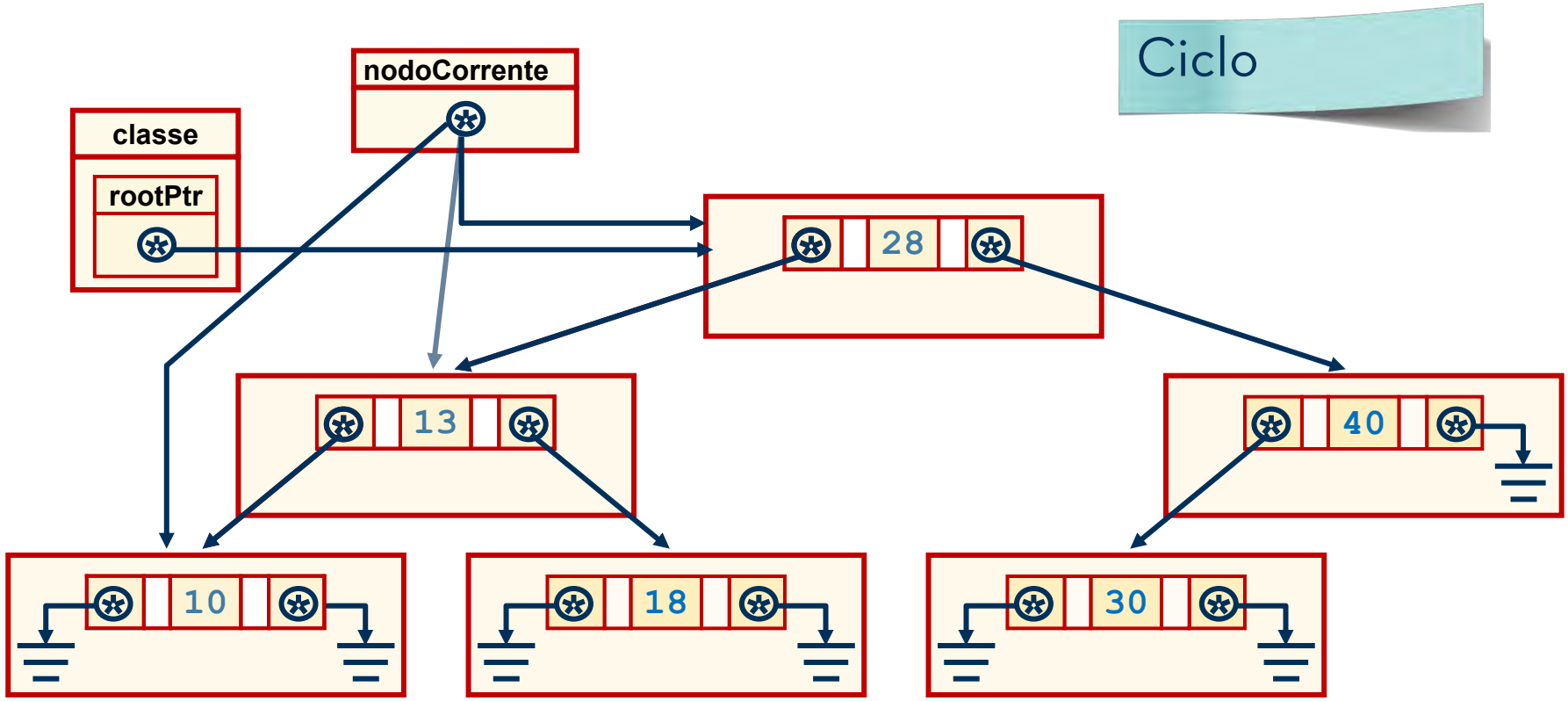
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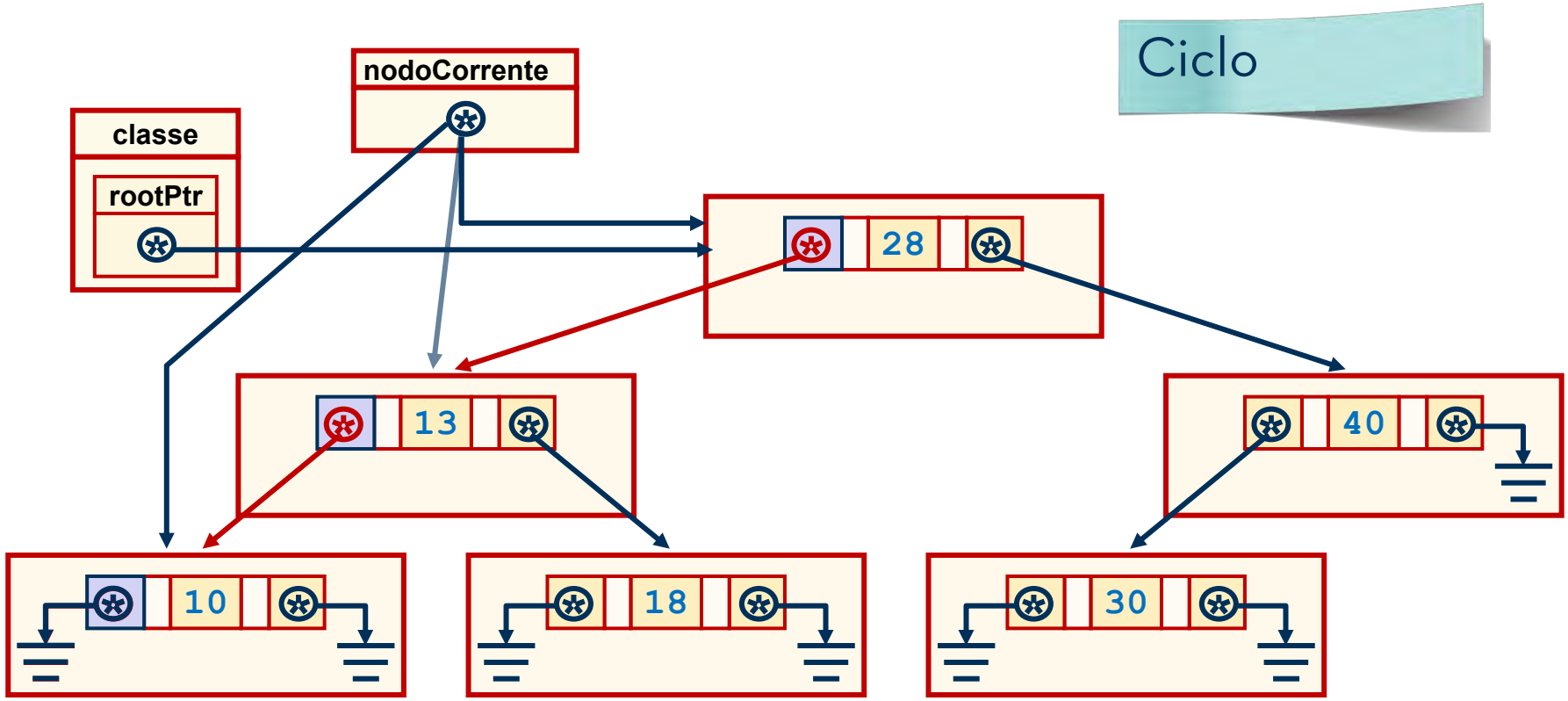
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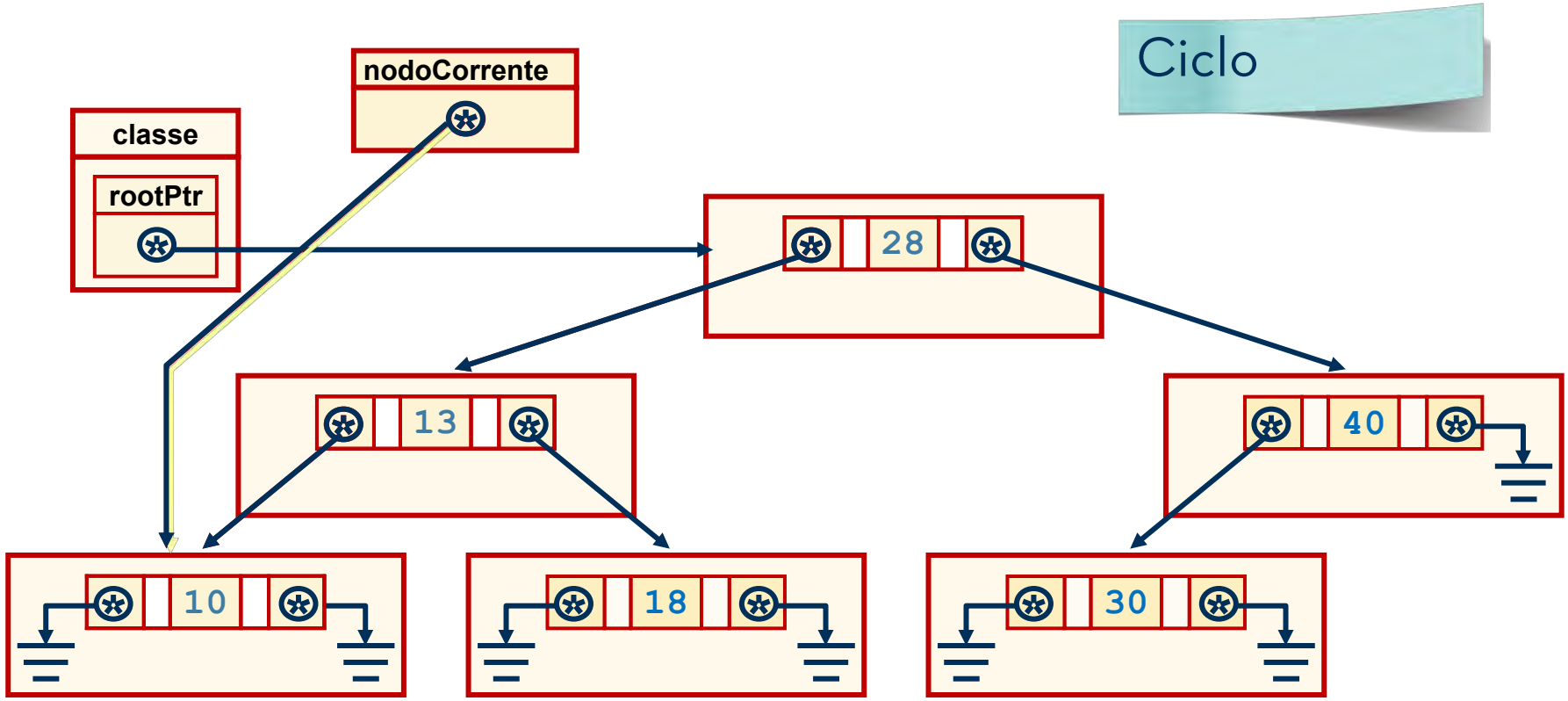
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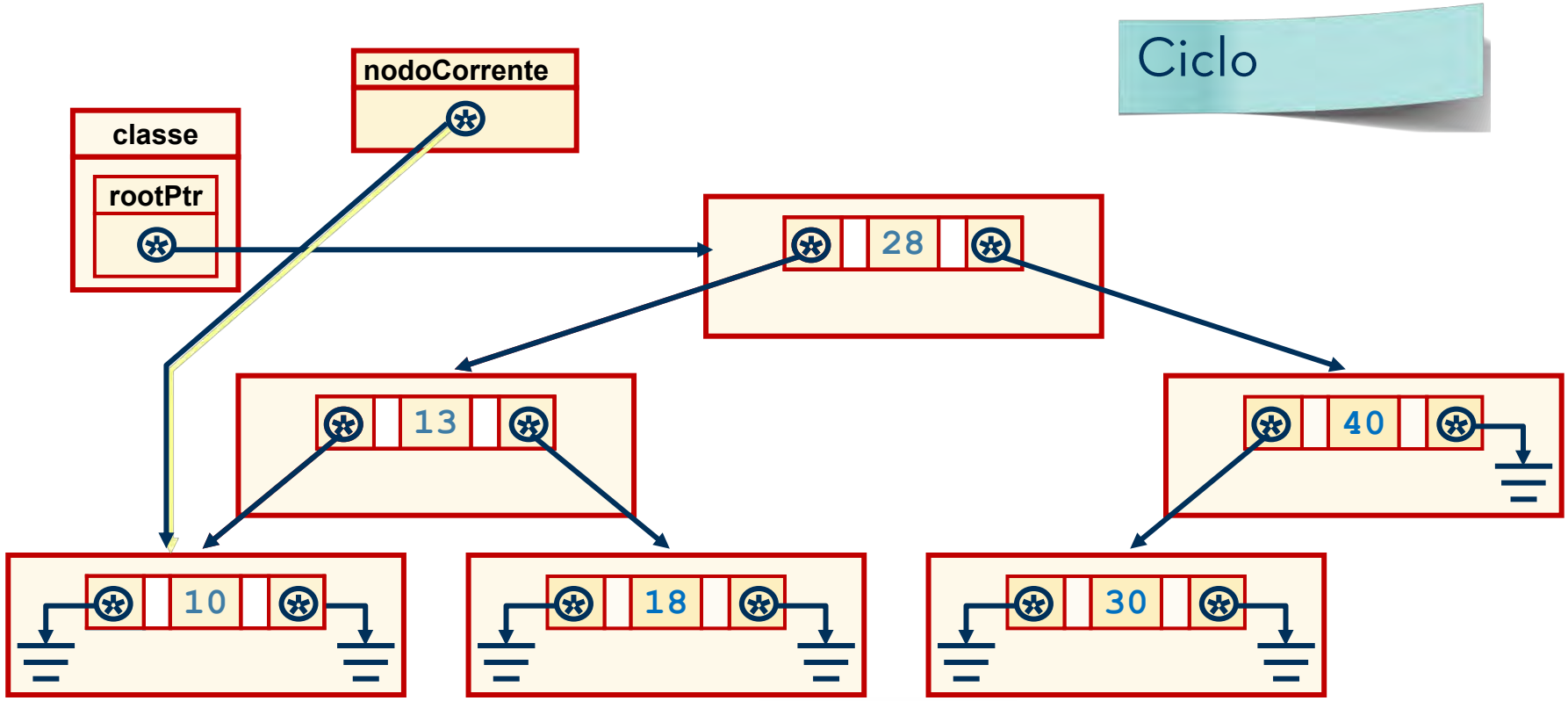
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classe
rootPtr
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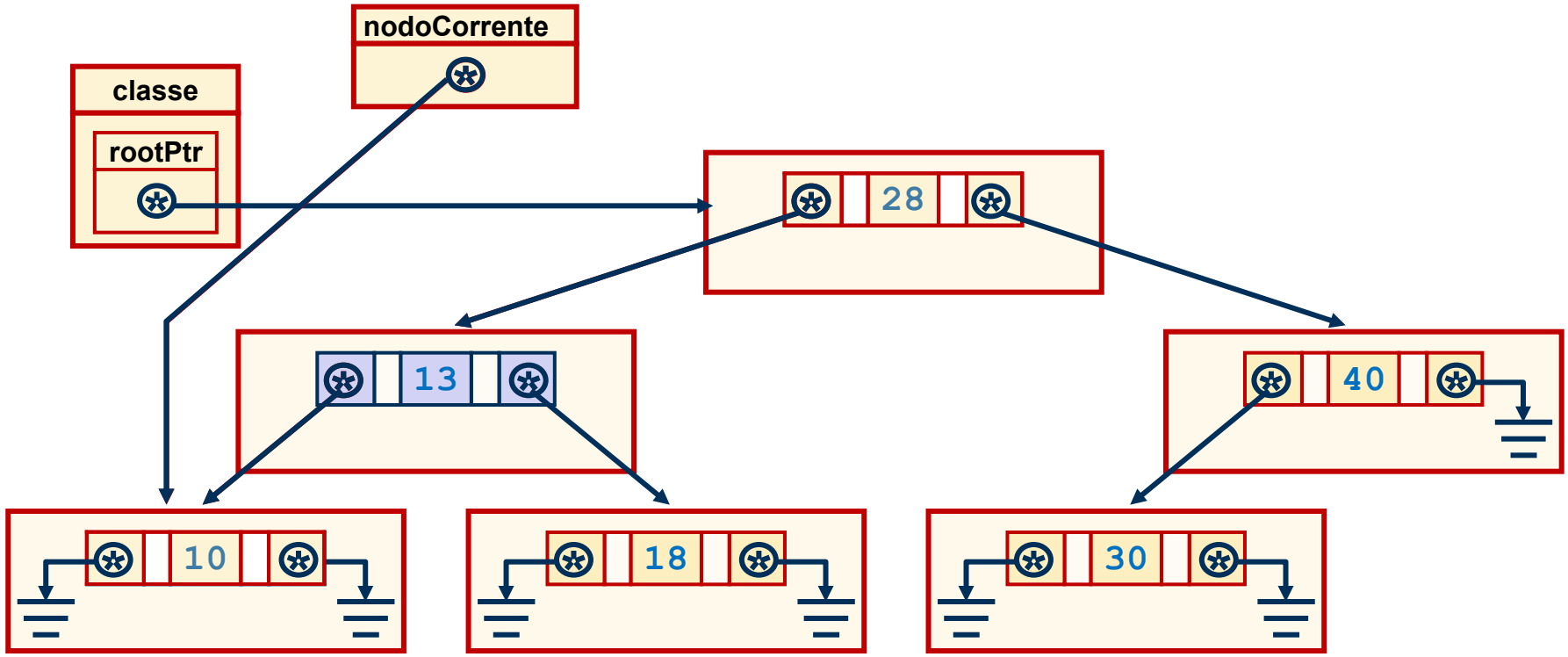
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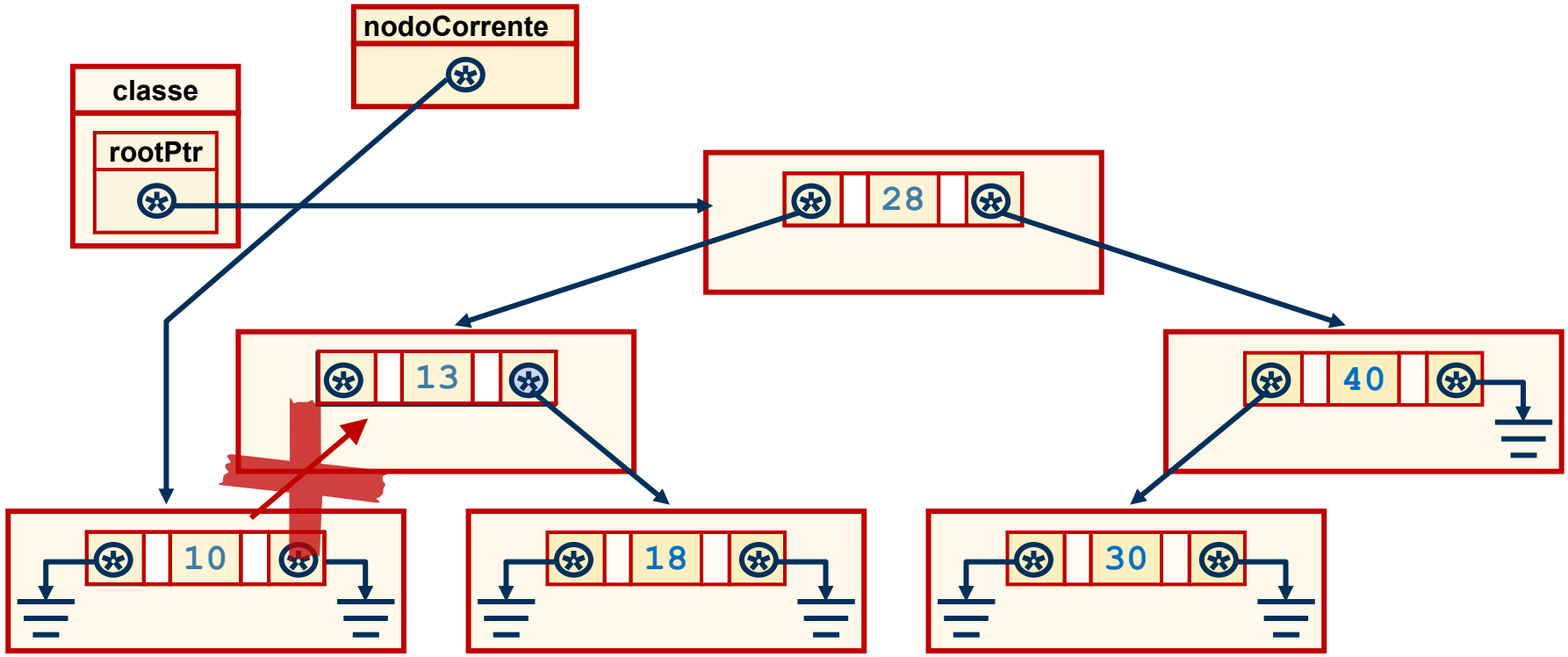
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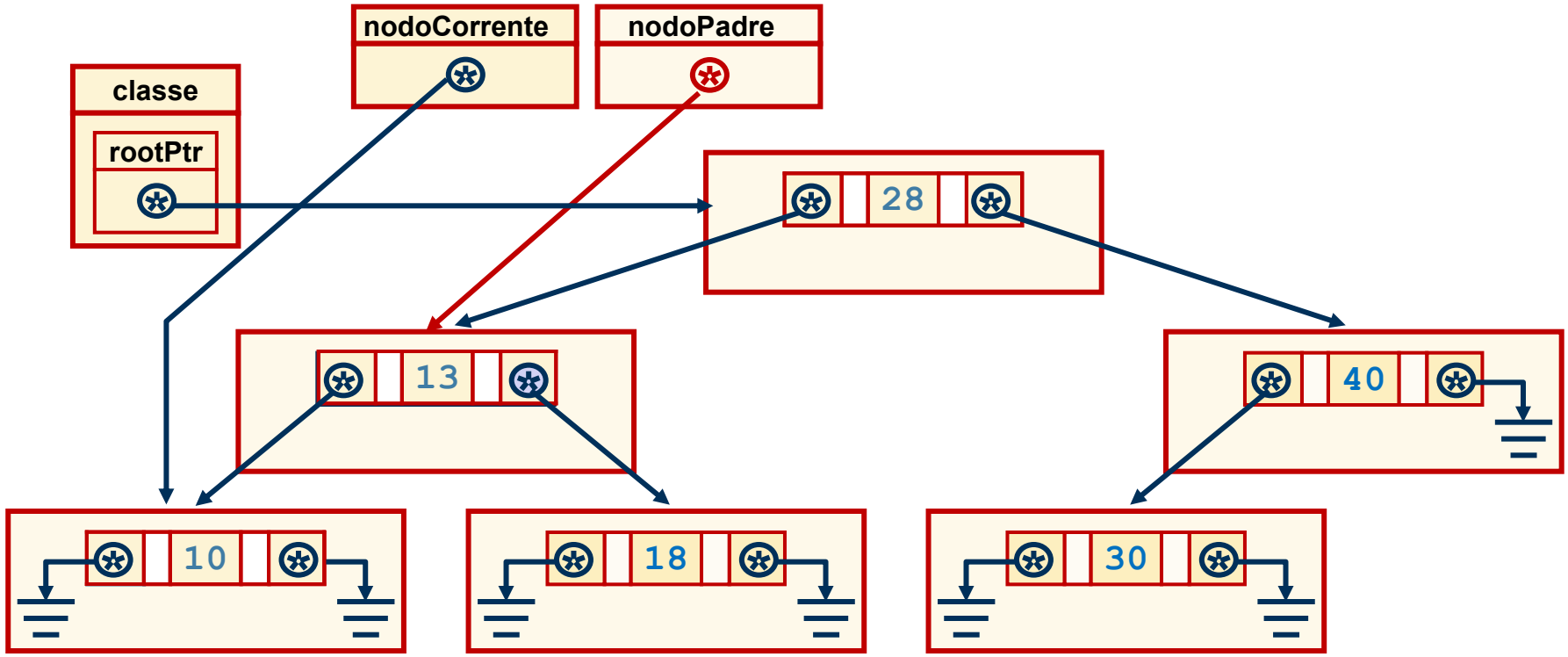
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nodoPadre
classe
rootPtr
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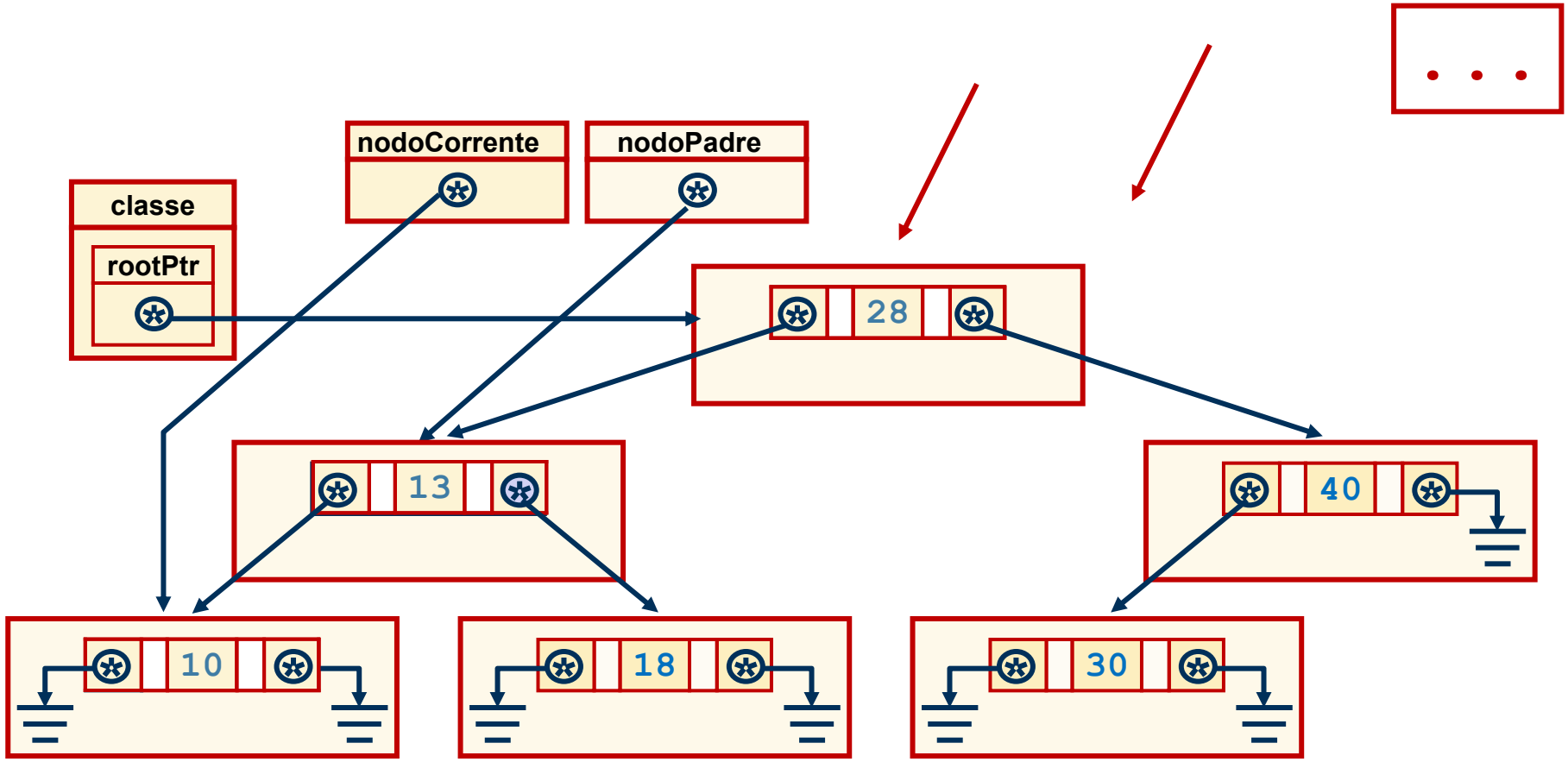
. . .
nodoCorrente
nodoPadre
classe
rootPtr
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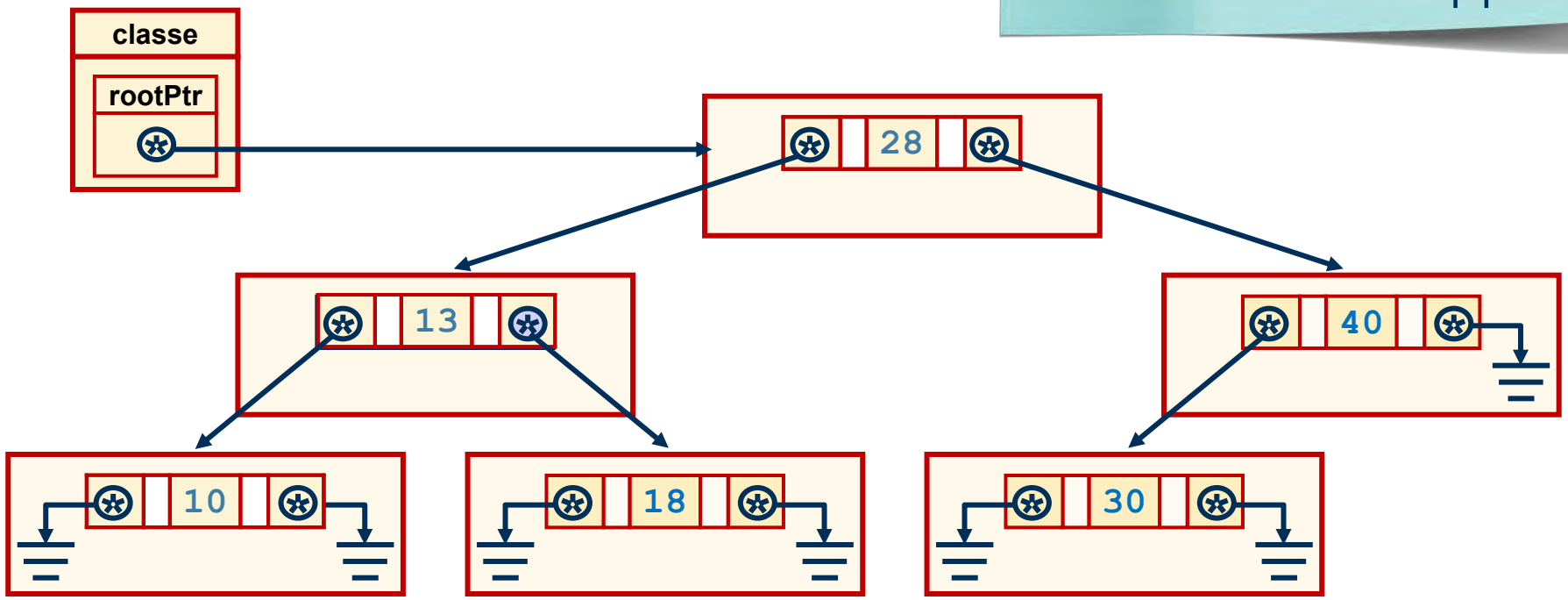
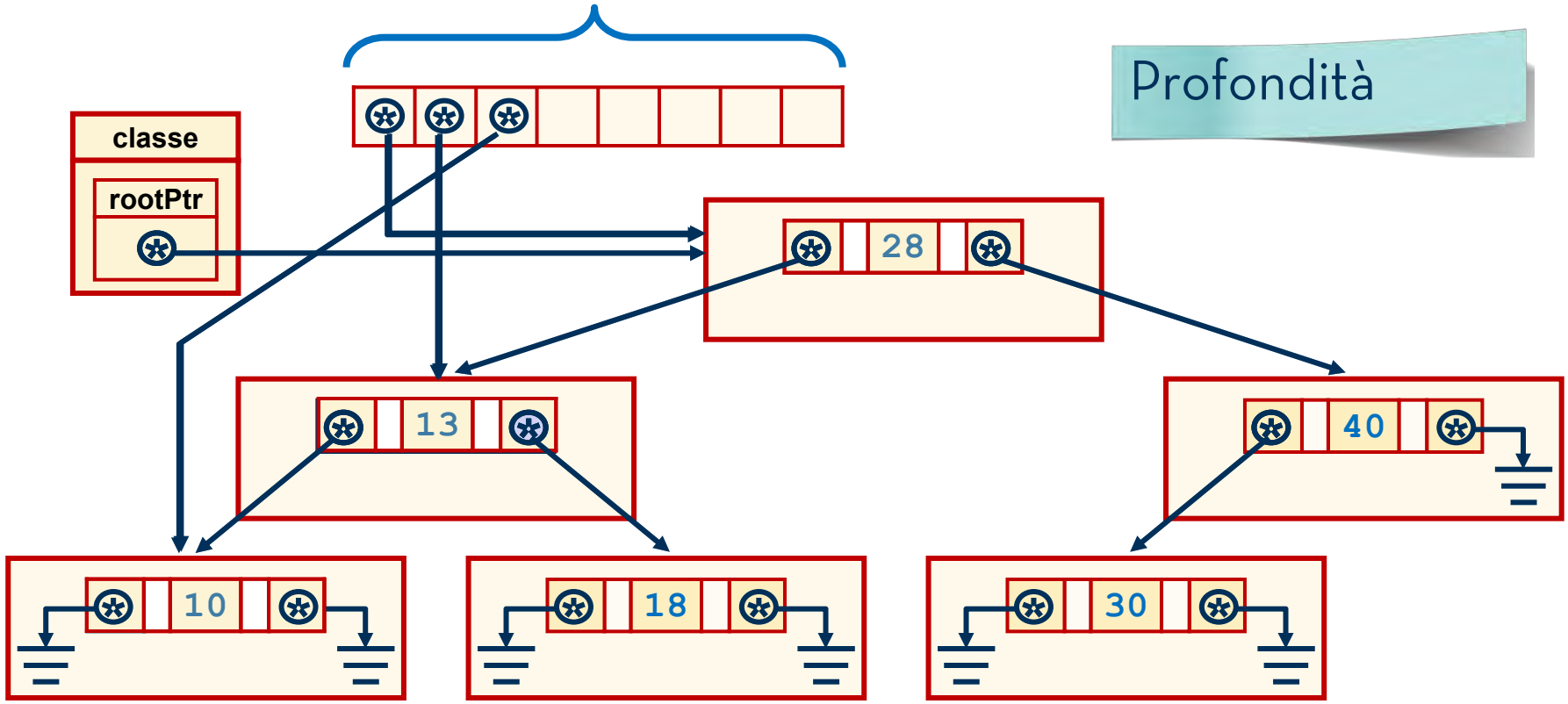
Struttura dati di supporto




Profondità
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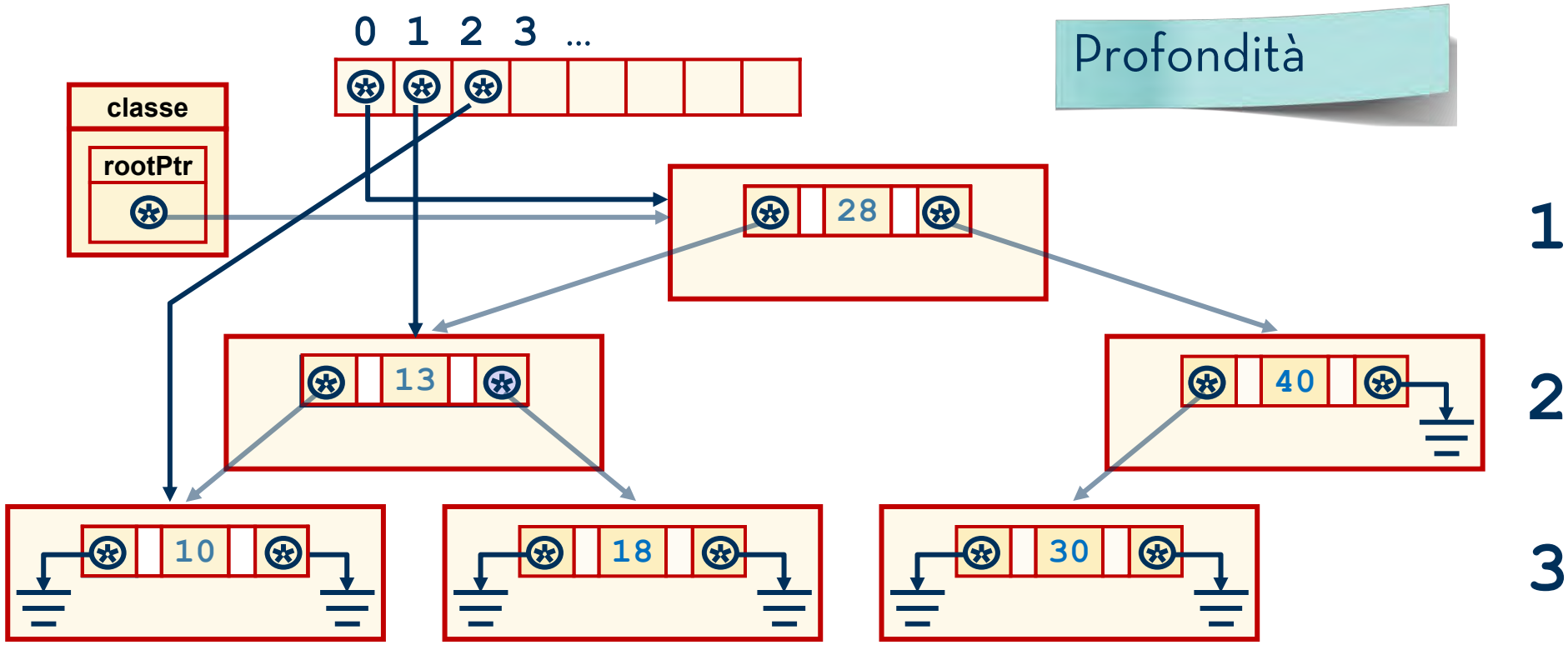
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rootPtr
Profondità
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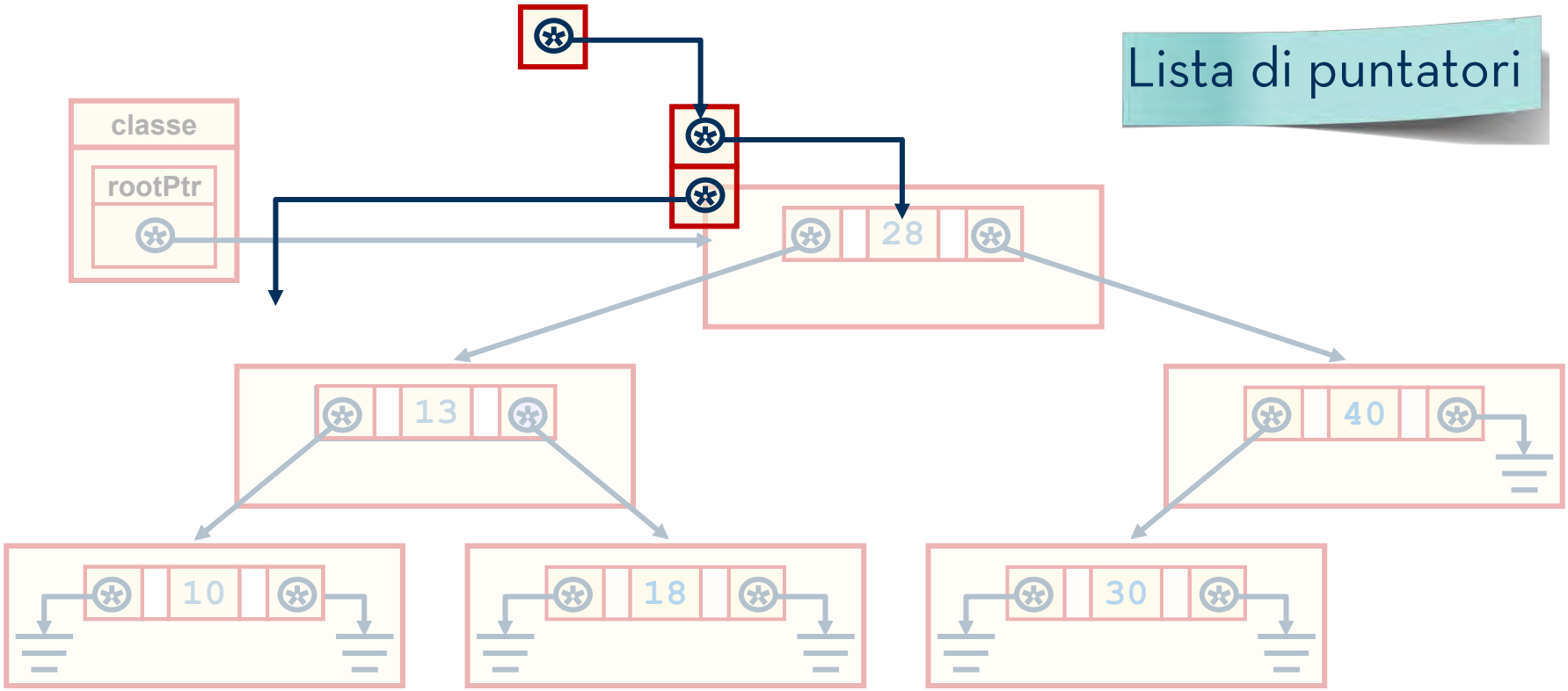
Lista di puntatori
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rootPtr
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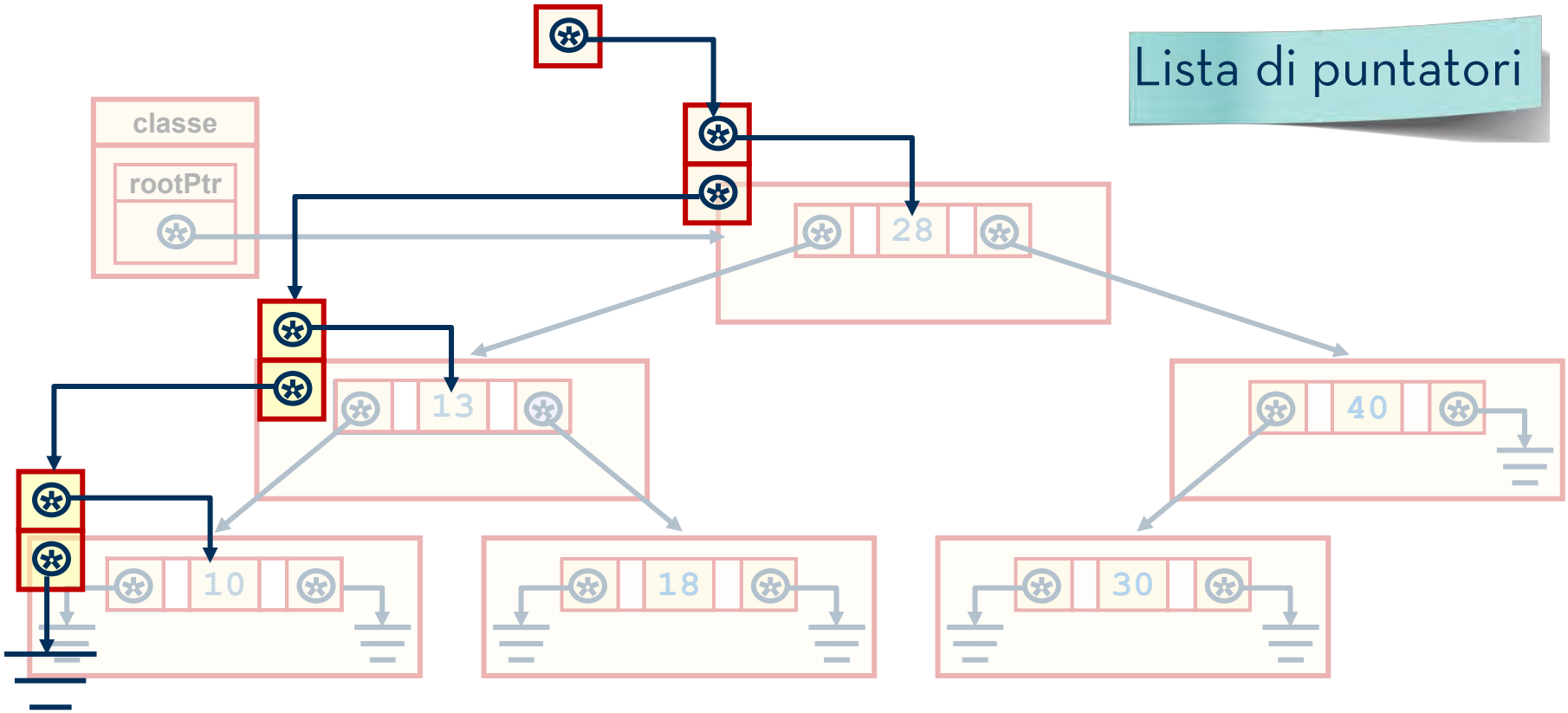
Lista di puntatori
classe
rootPtr
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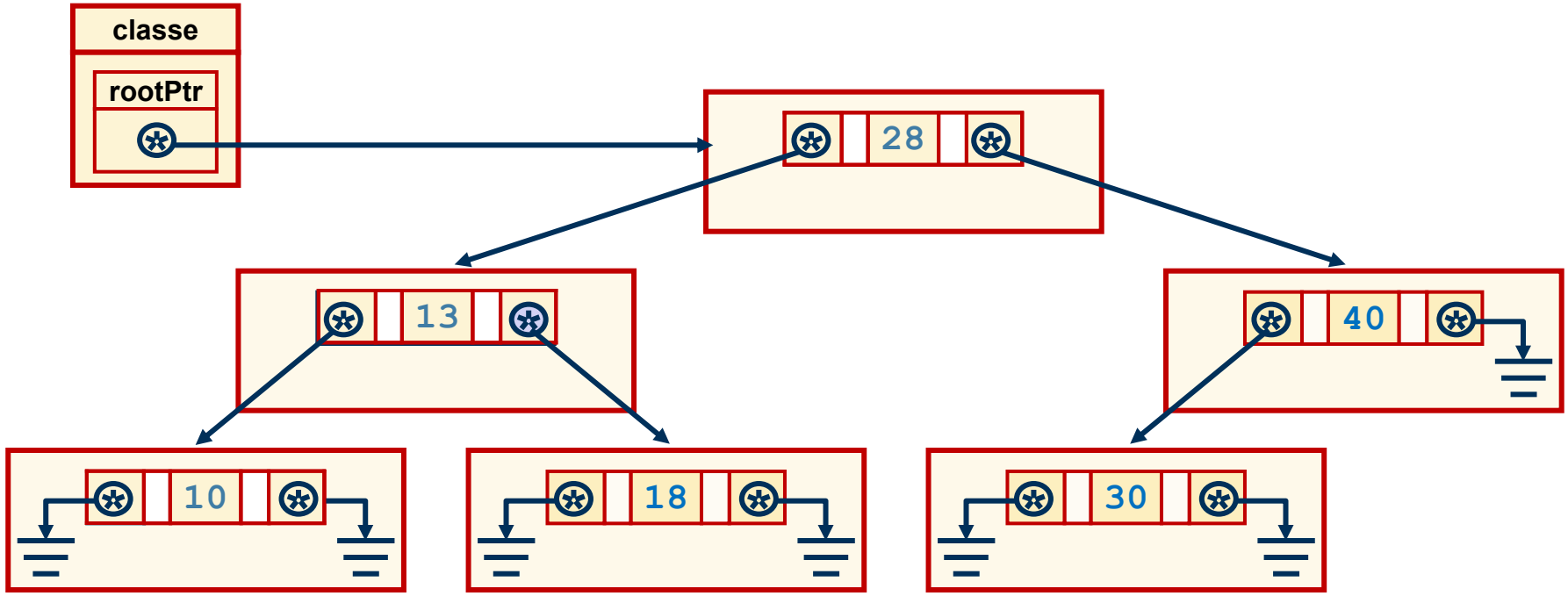
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rootPtr
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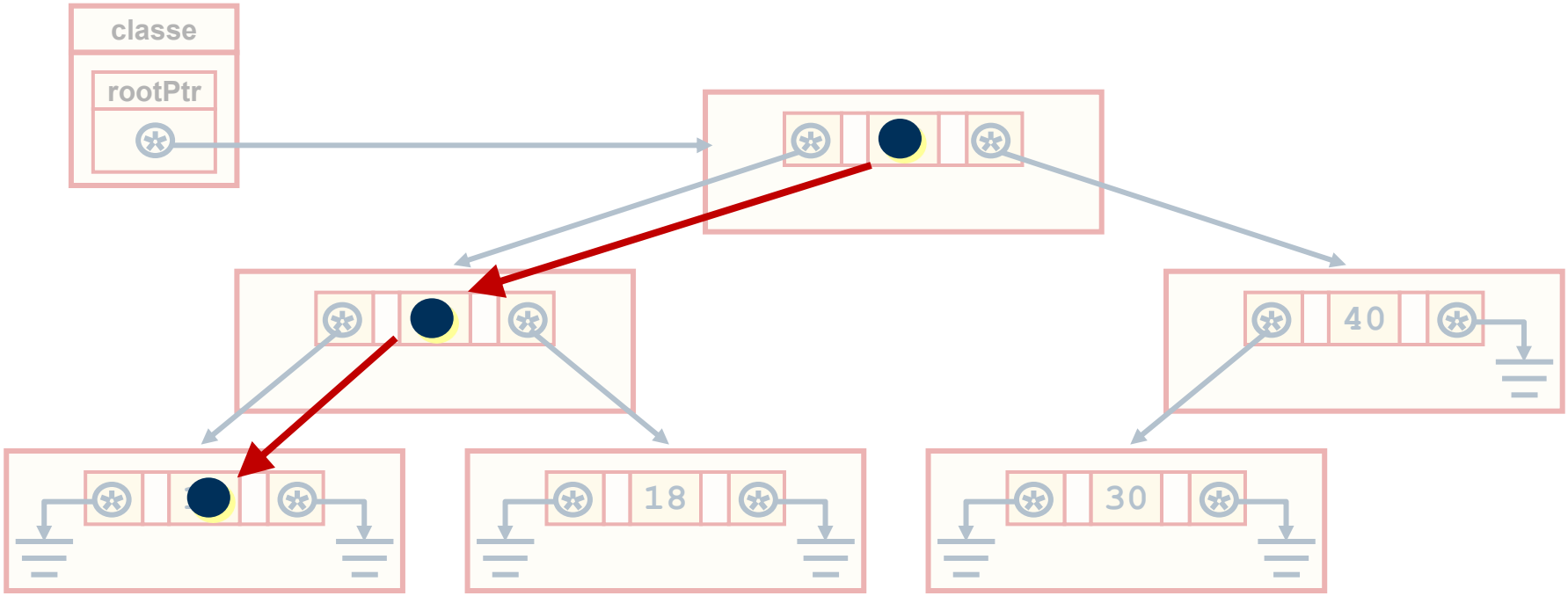
classe
rootPtr
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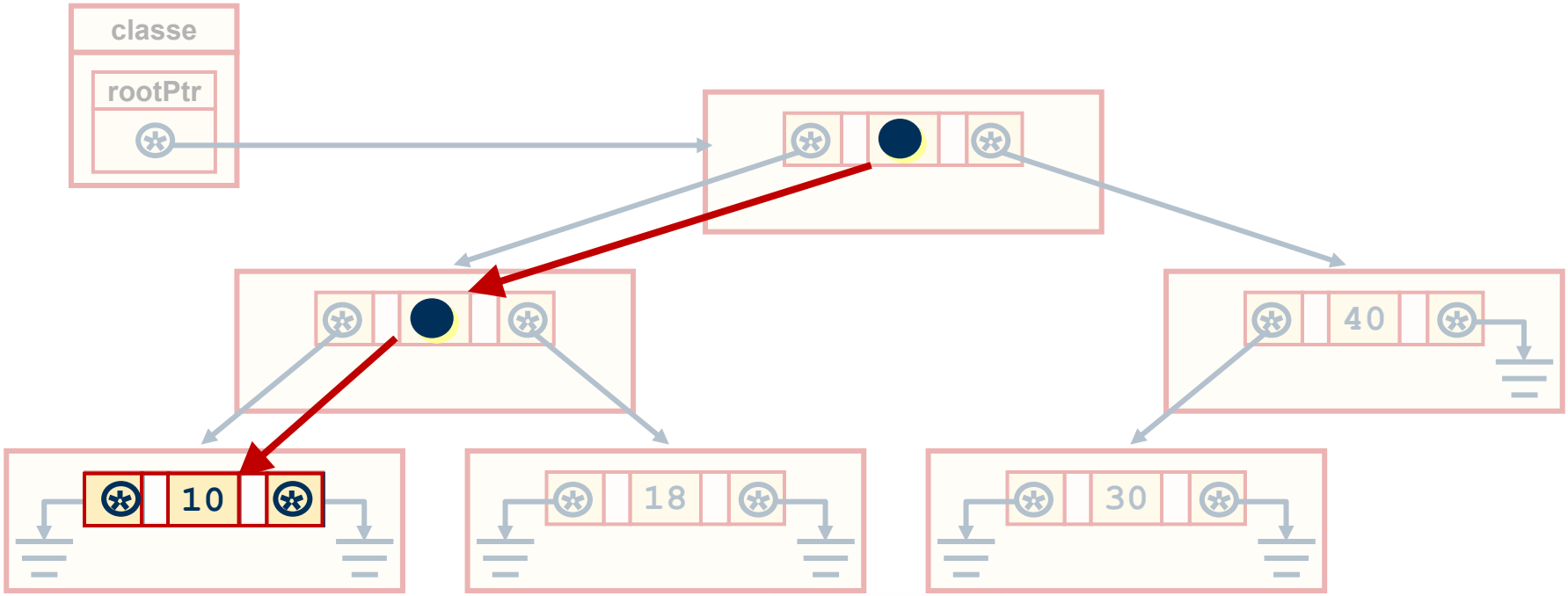
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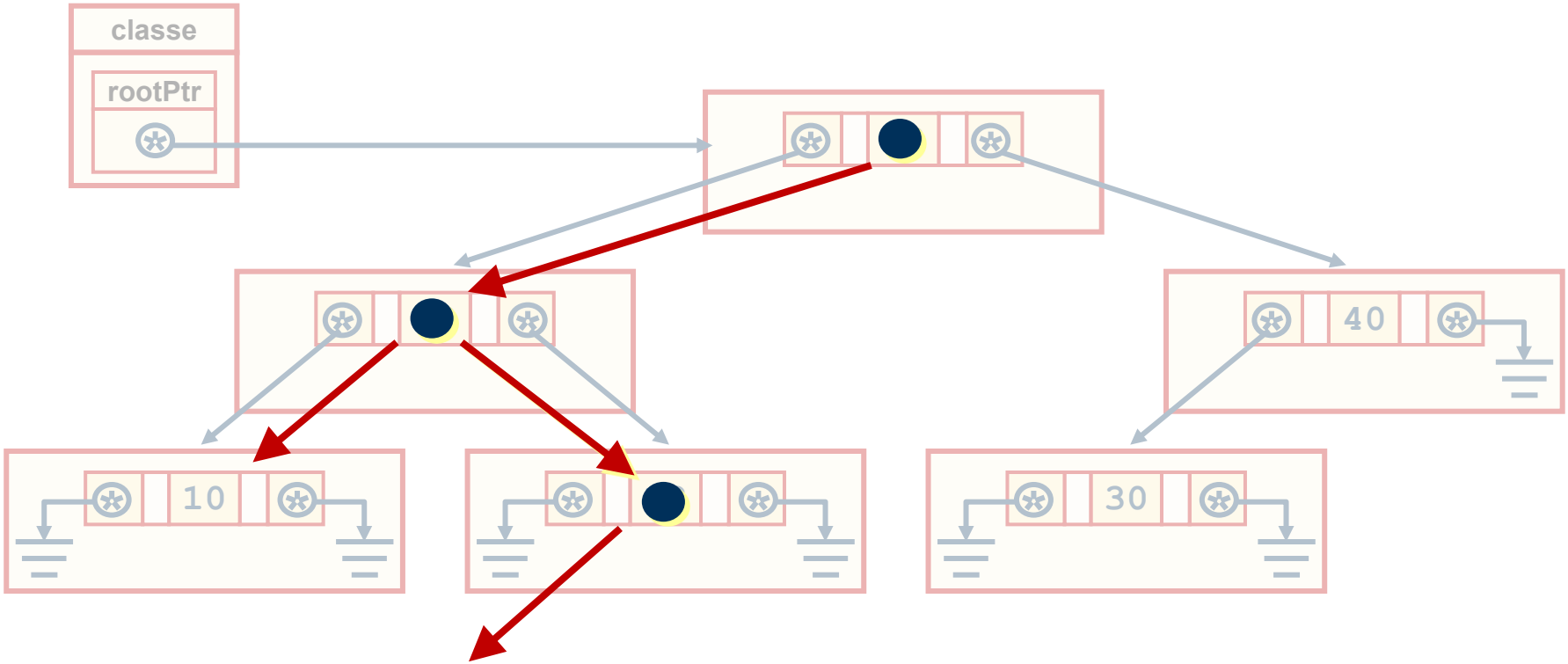
classe
rootPtr
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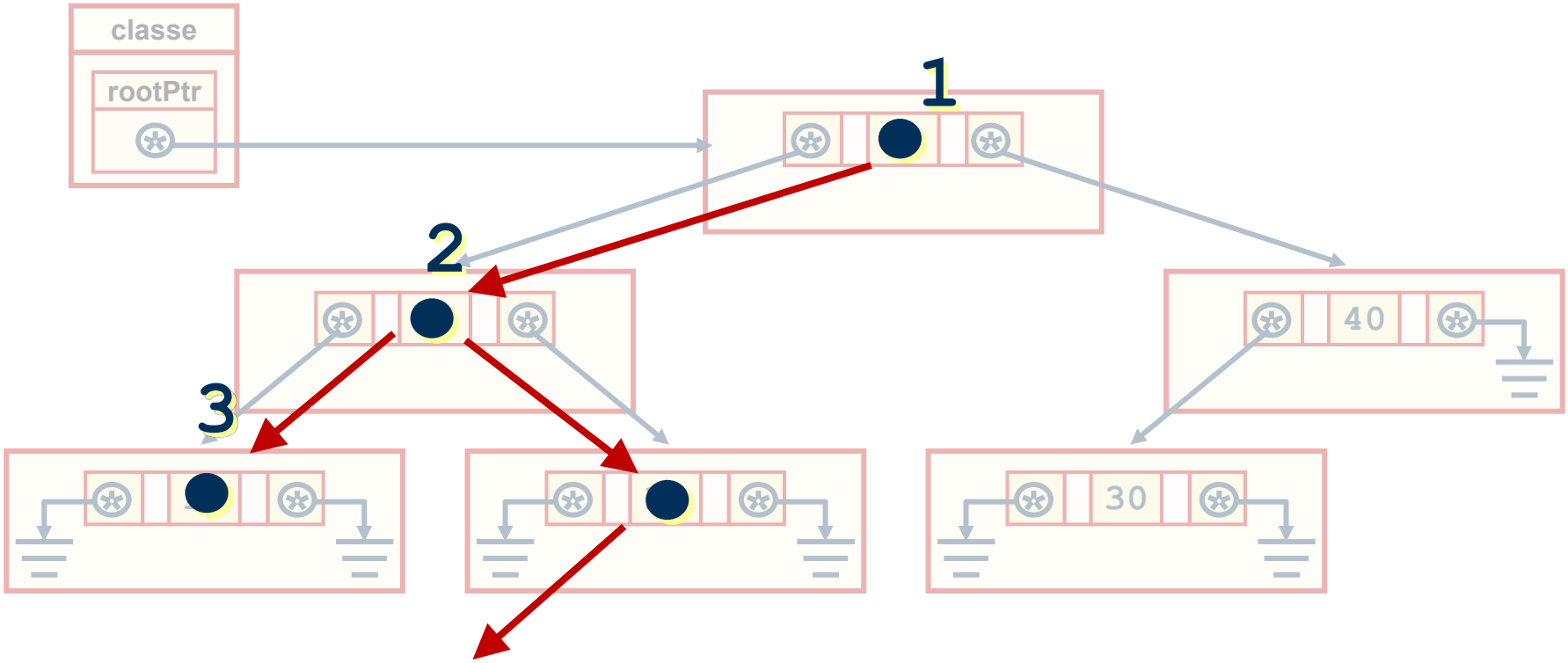
classe
rootPtr
1
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40
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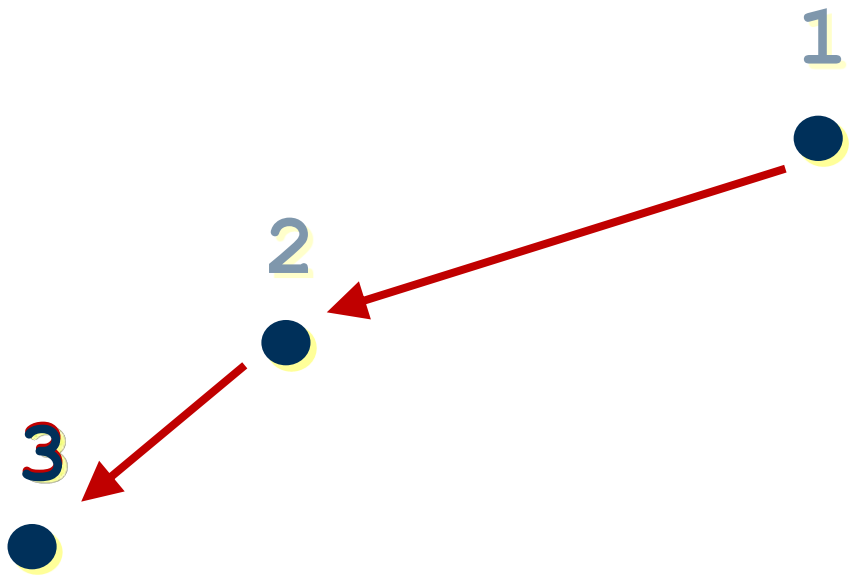
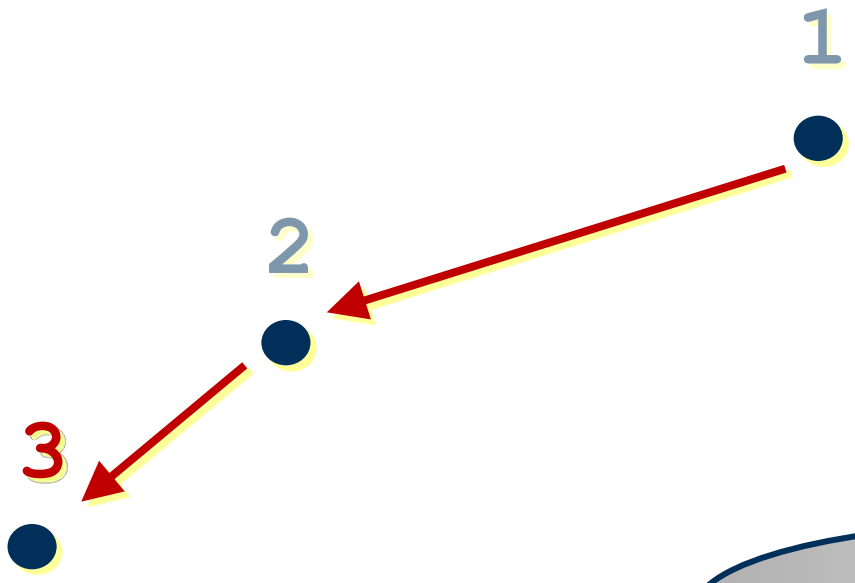


Last In First Out

Strutture a pila



Last
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First
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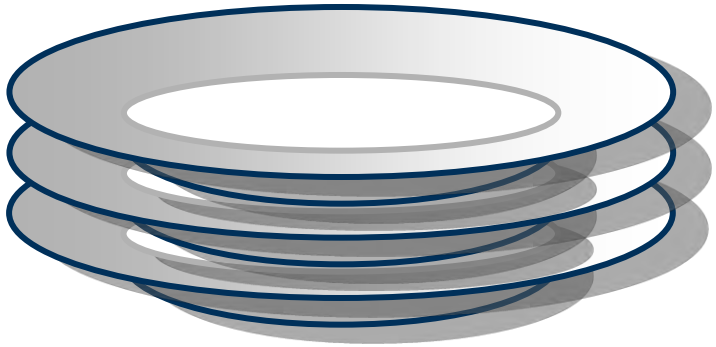

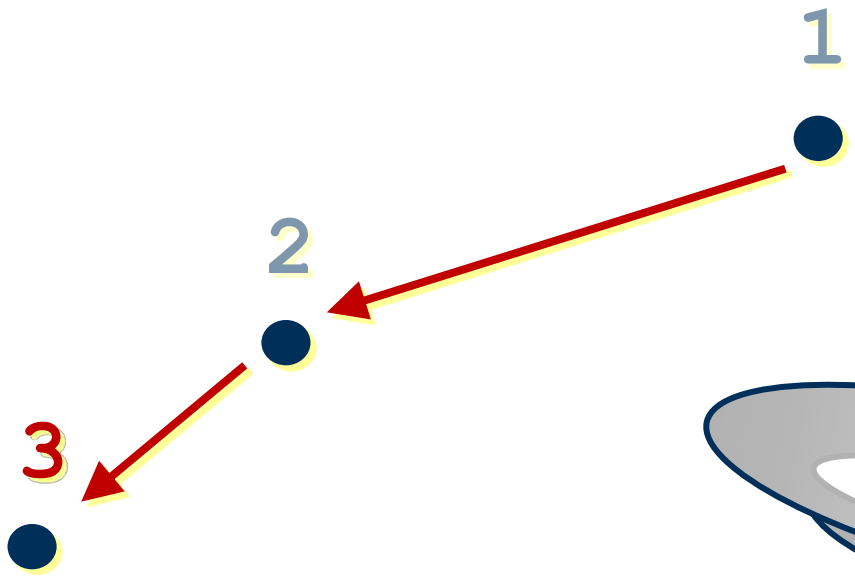

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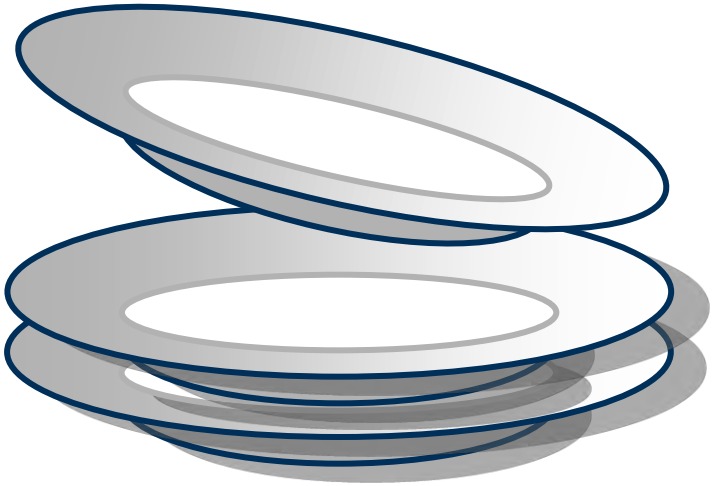
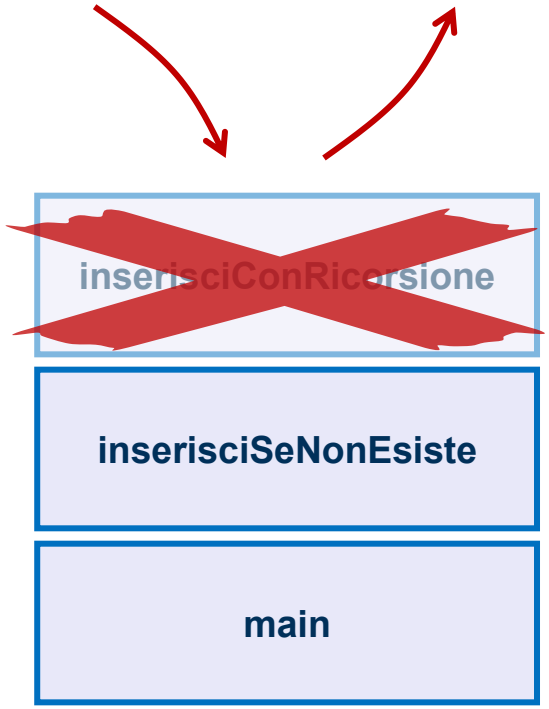
First
Out





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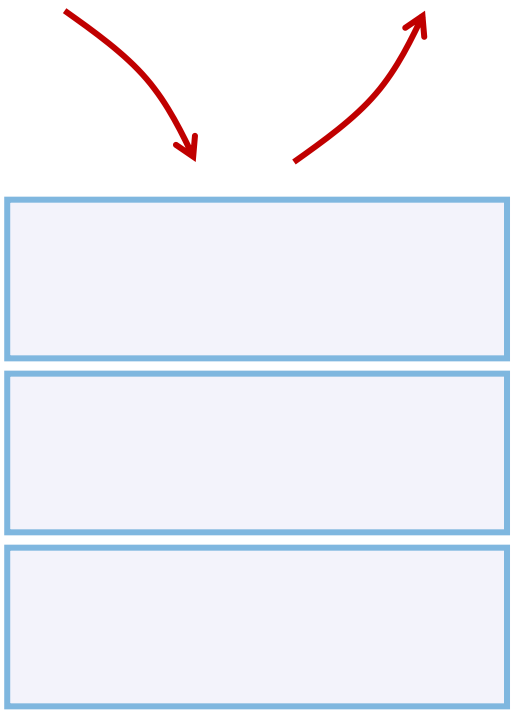

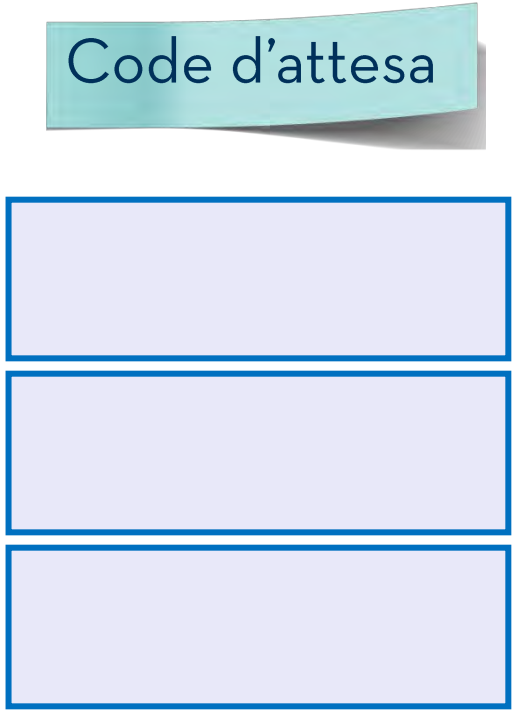

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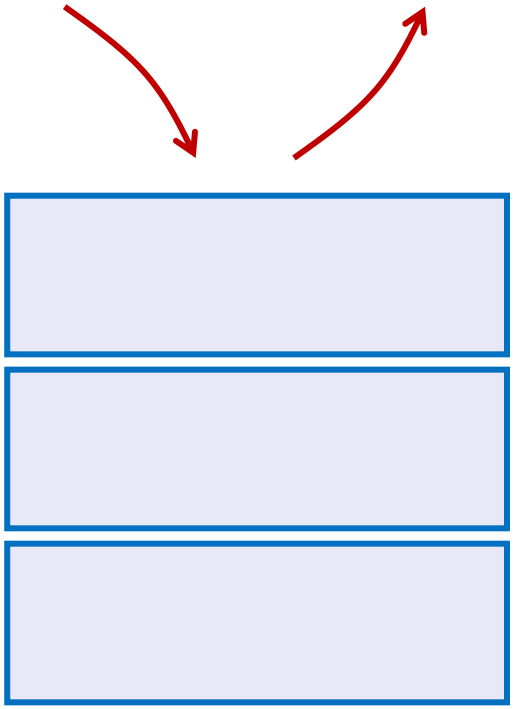

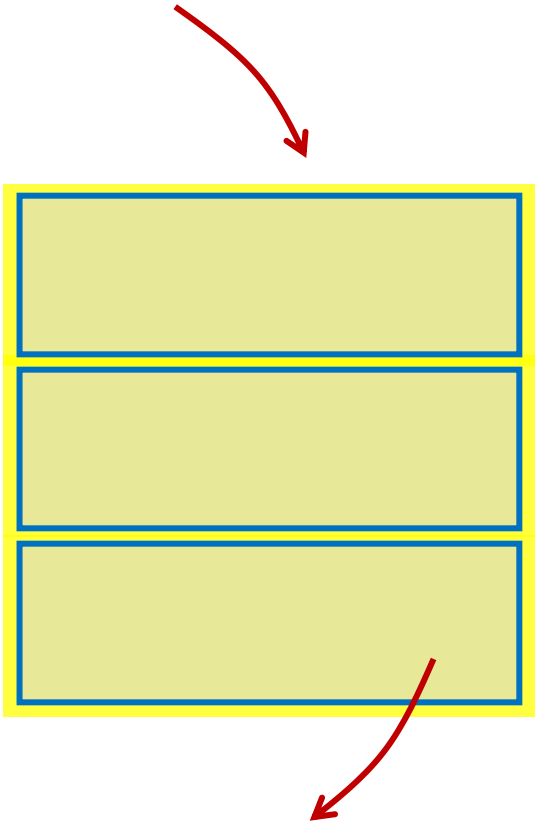

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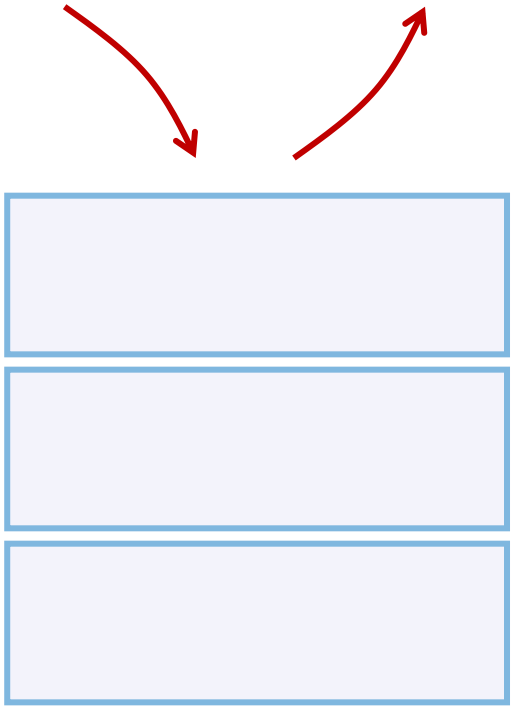

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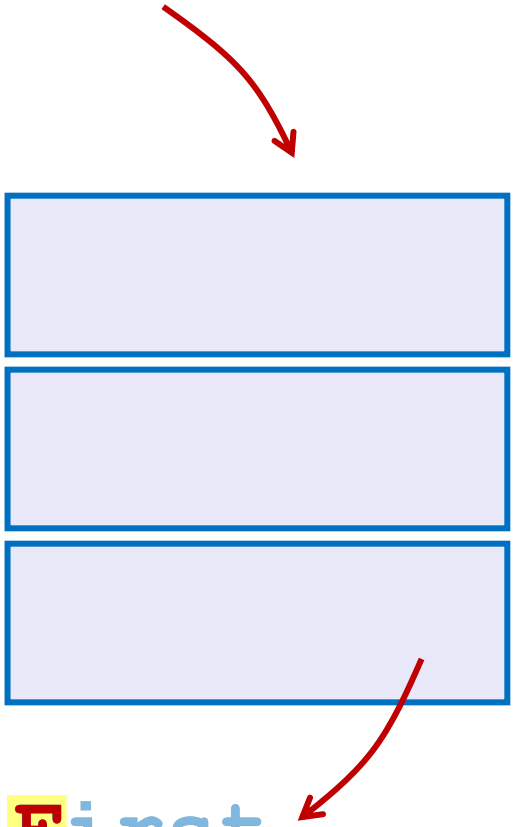

First
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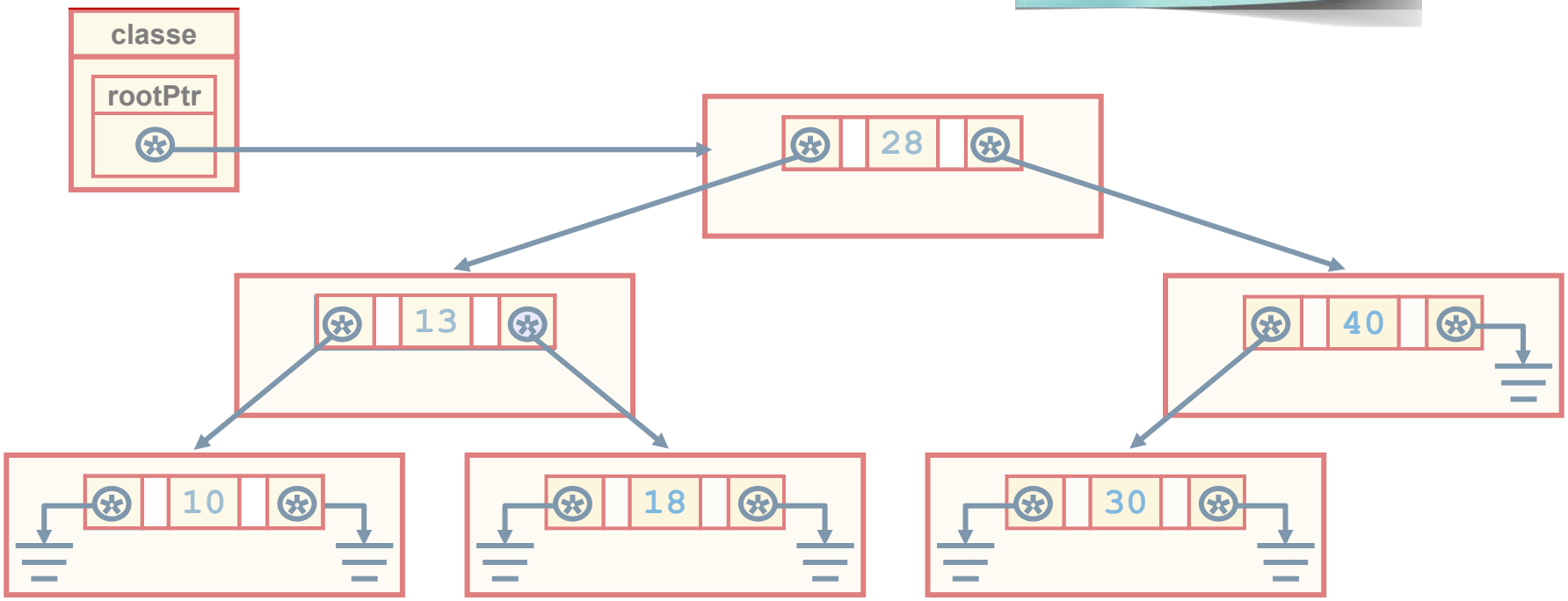
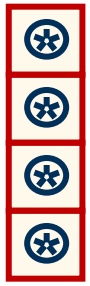
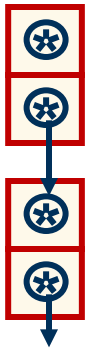
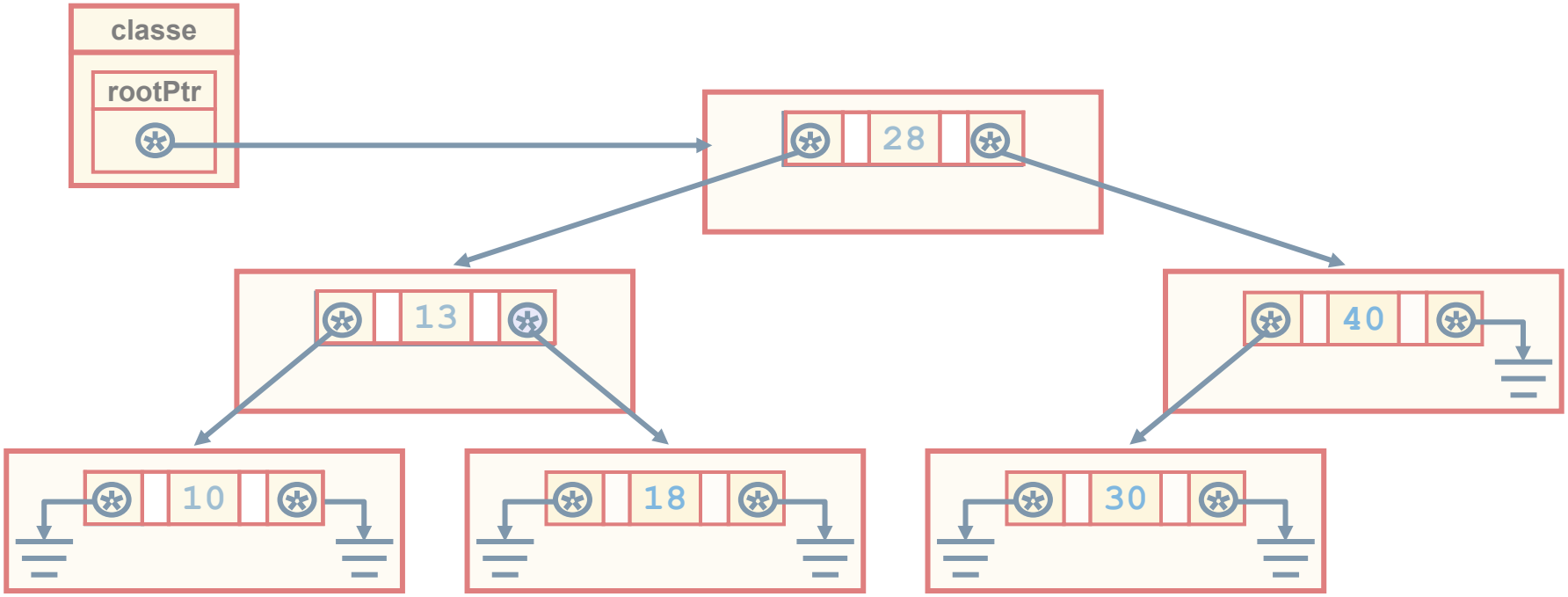
Out

Struttura a pila








classe
rootPtr
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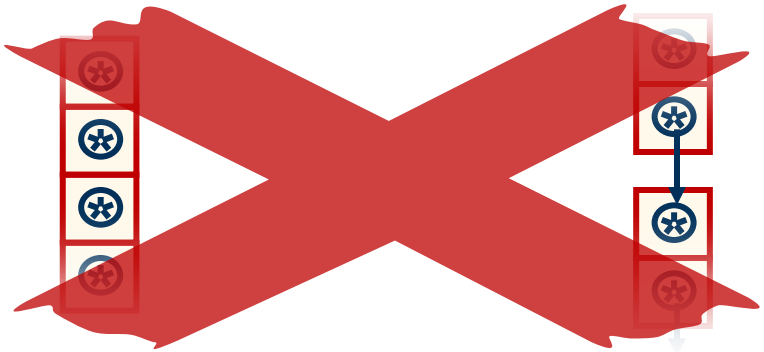
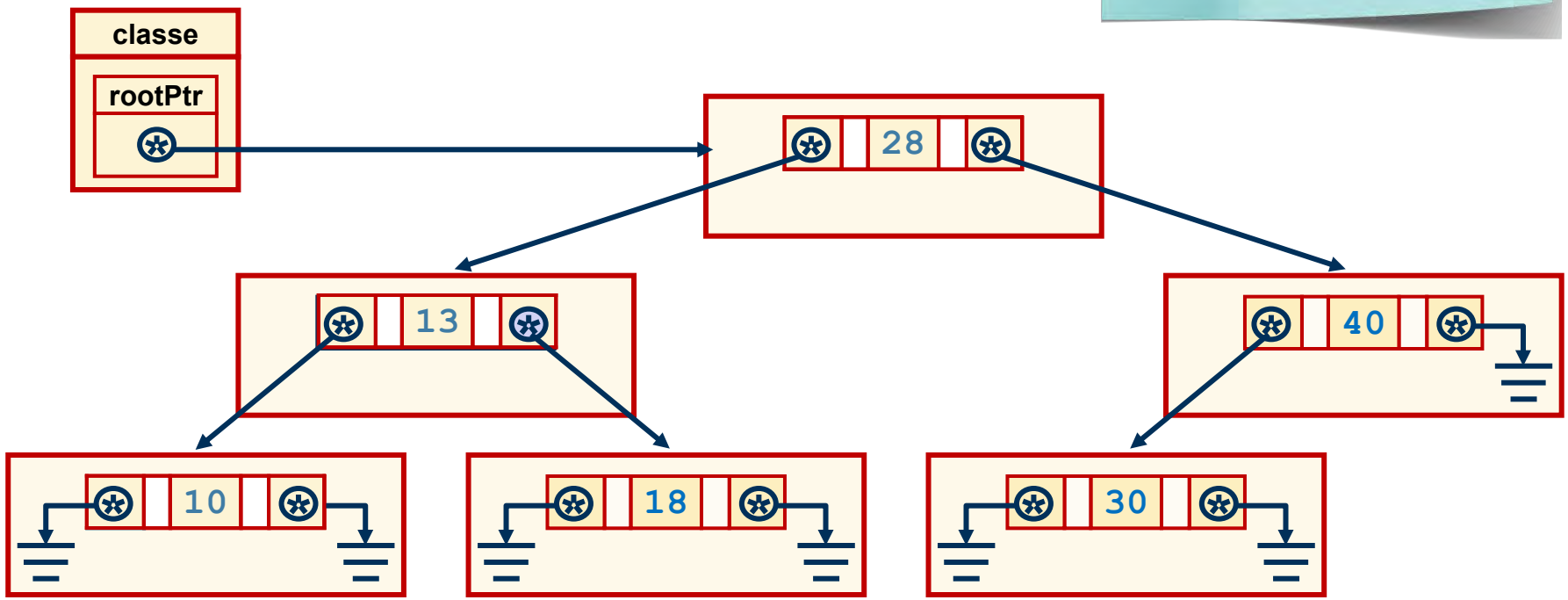
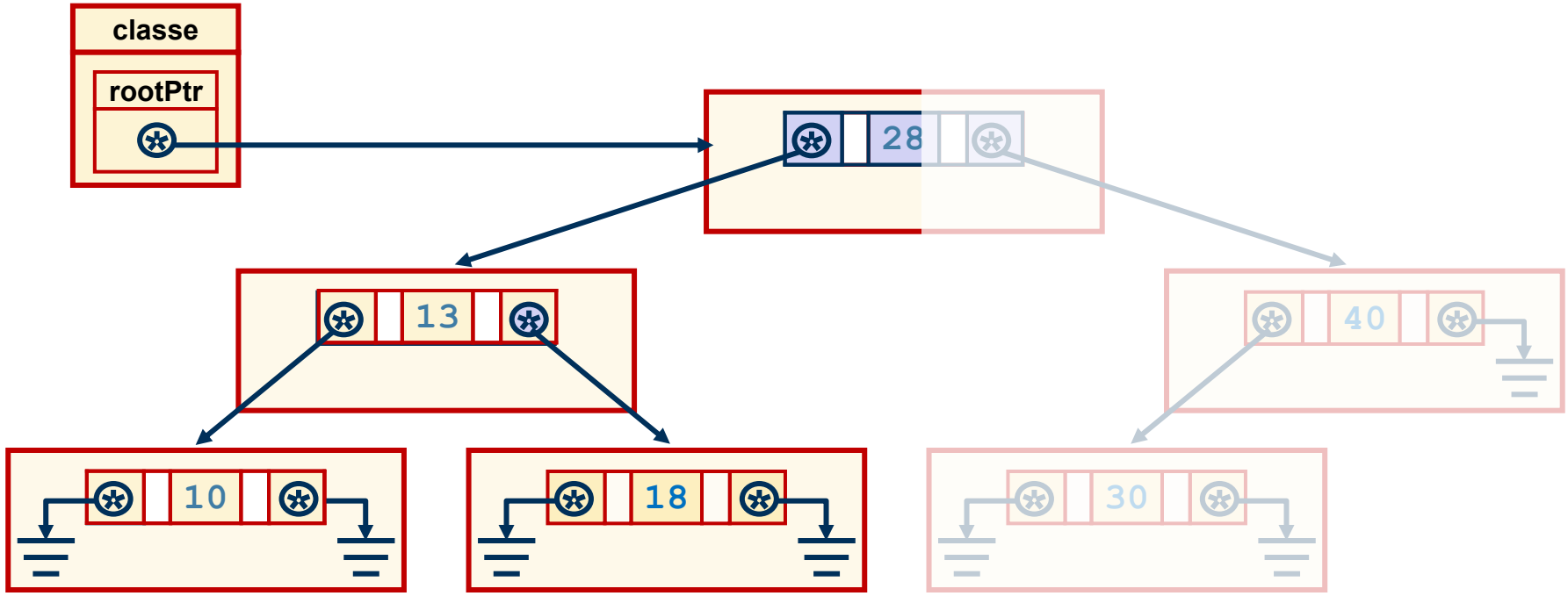
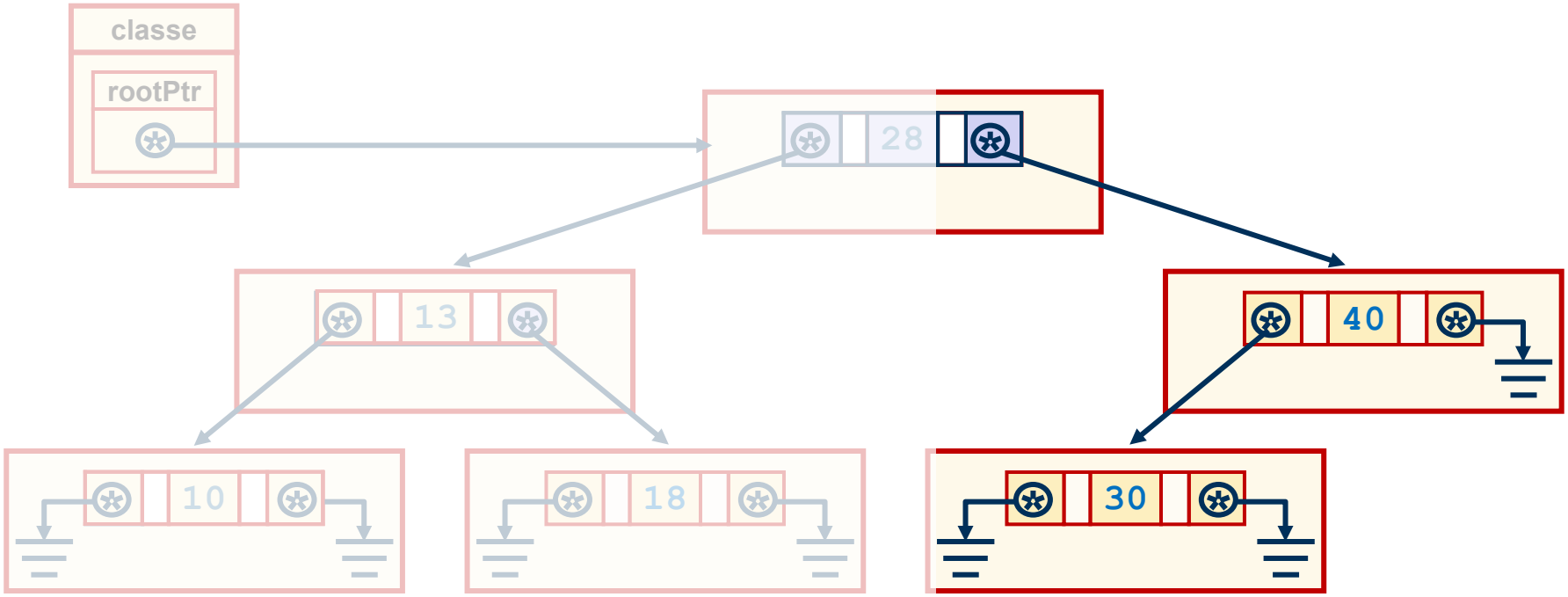


Funzione ricorsiva

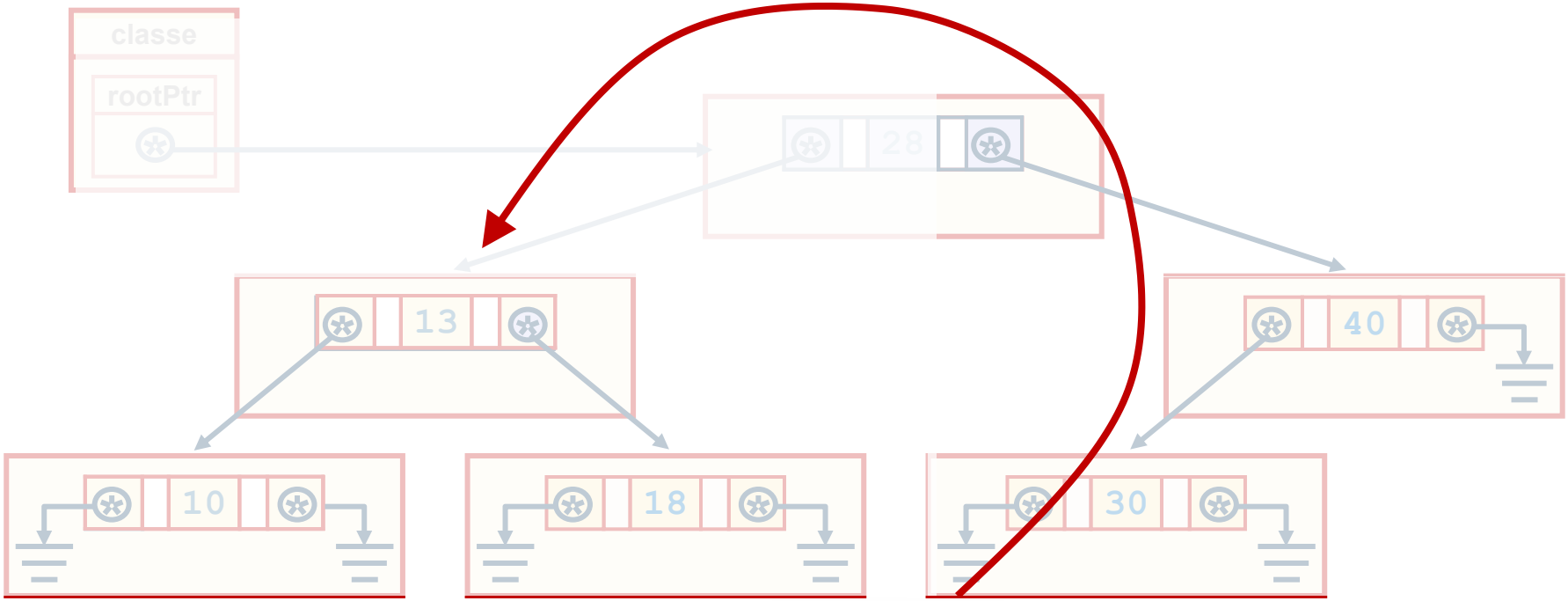




a matricola inferiore



a matricola superiore



sottoalbero sinistro → *radice* → *sottoalbero destro*

```
void Tree :: recursiveInOrder(TreeNode *ptr)
{
  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

```
void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

void Tree :: recursiveInOrder(TreeNode *ptr)
{
  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
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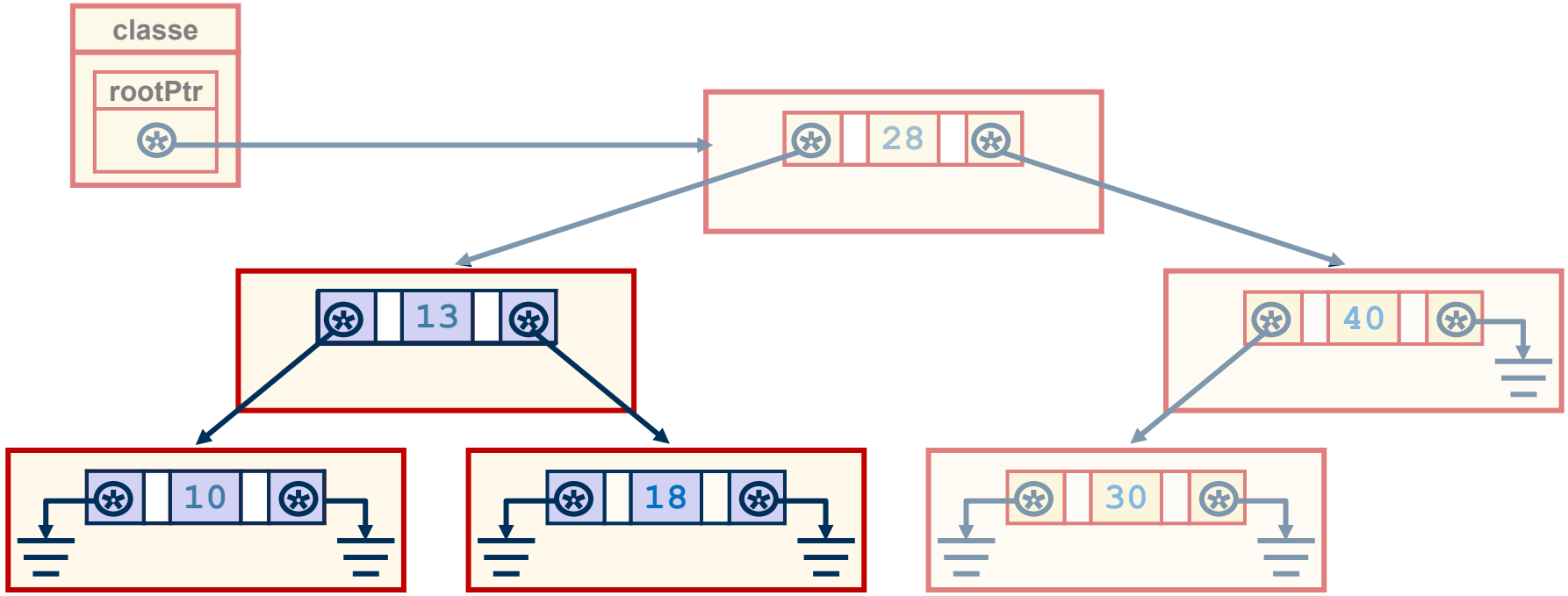
```


classe
rootPtr
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void Tree :: recursiveInOrder(TreeNode *ptr)
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{
  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

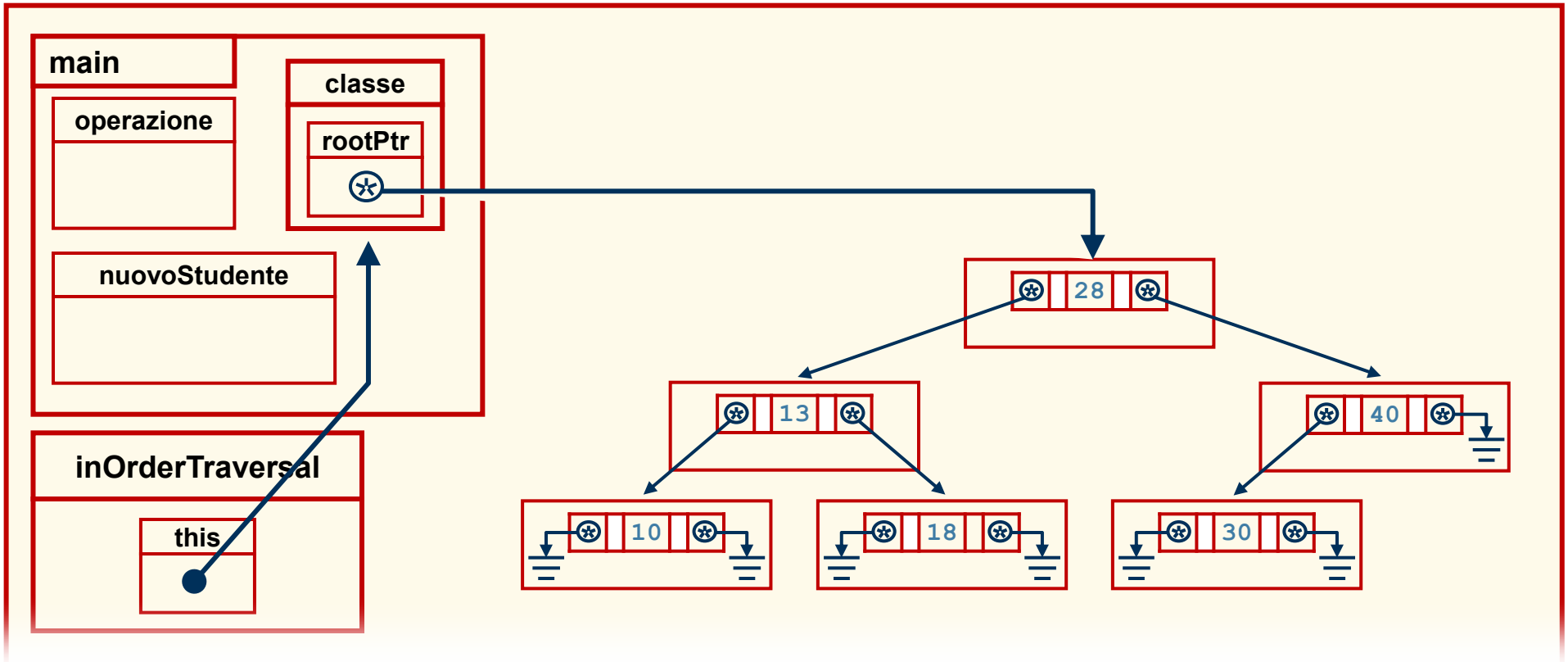
Doppia chiamata ricorsiva

```
void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

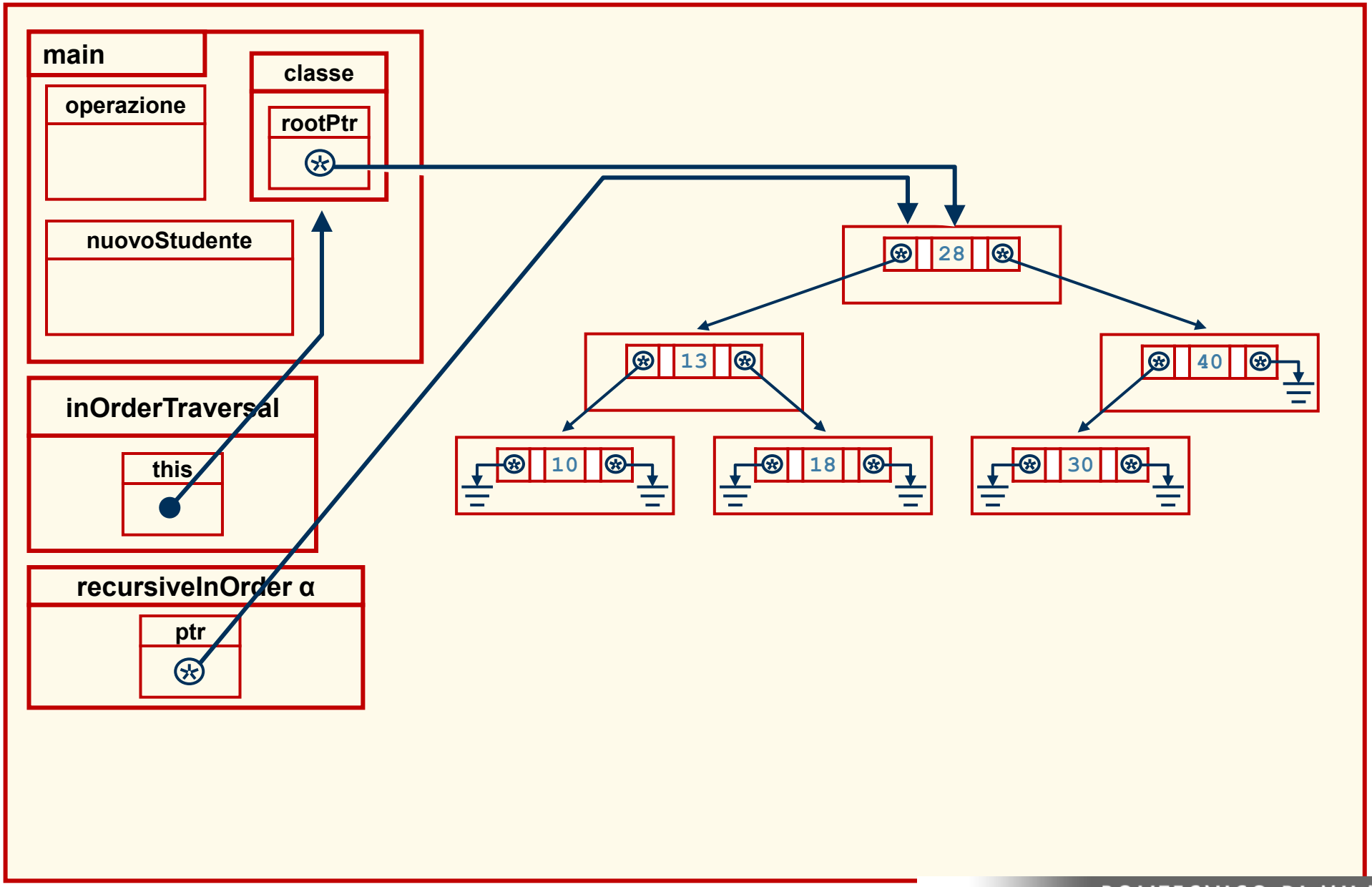
void Tree :: recursiveInOrder(TreeNode *ptr)
{
  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

```
void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

void Tree :: recursiveInOrder(TreeNode *ptr)
{
  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```




```
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);        α
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);        β
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);       γ
      }
}
```


main
operazione
classe
rootPtr
nuovoStudente
inOrderTraversal
this
recursiveInOrder α
ptr
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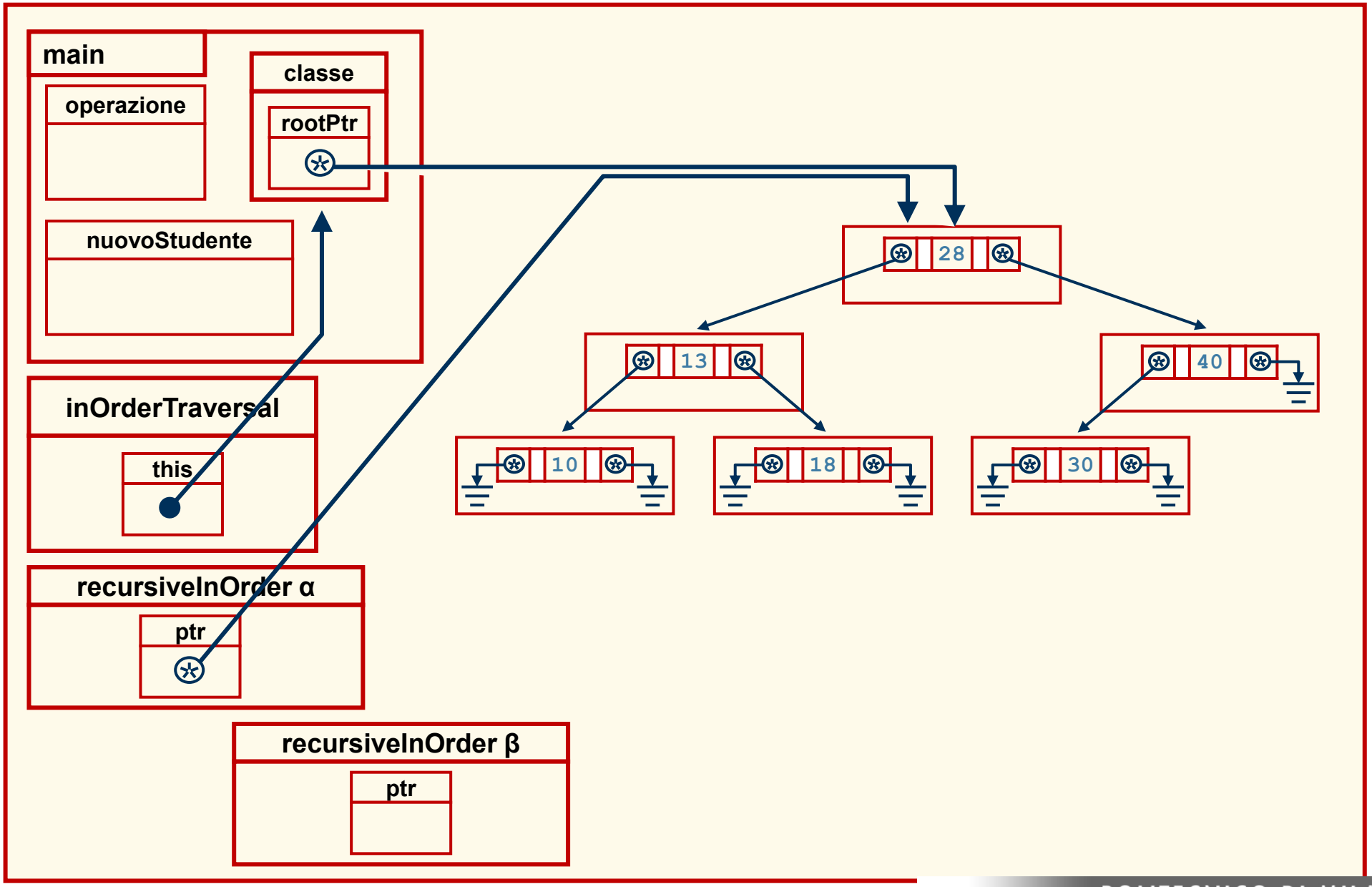
main
operazione
classe
rootPtr
nuovoStudente
inOrderTraversal
this
recursiveInOrder α
ptr
recursiveInOrder β
ptr
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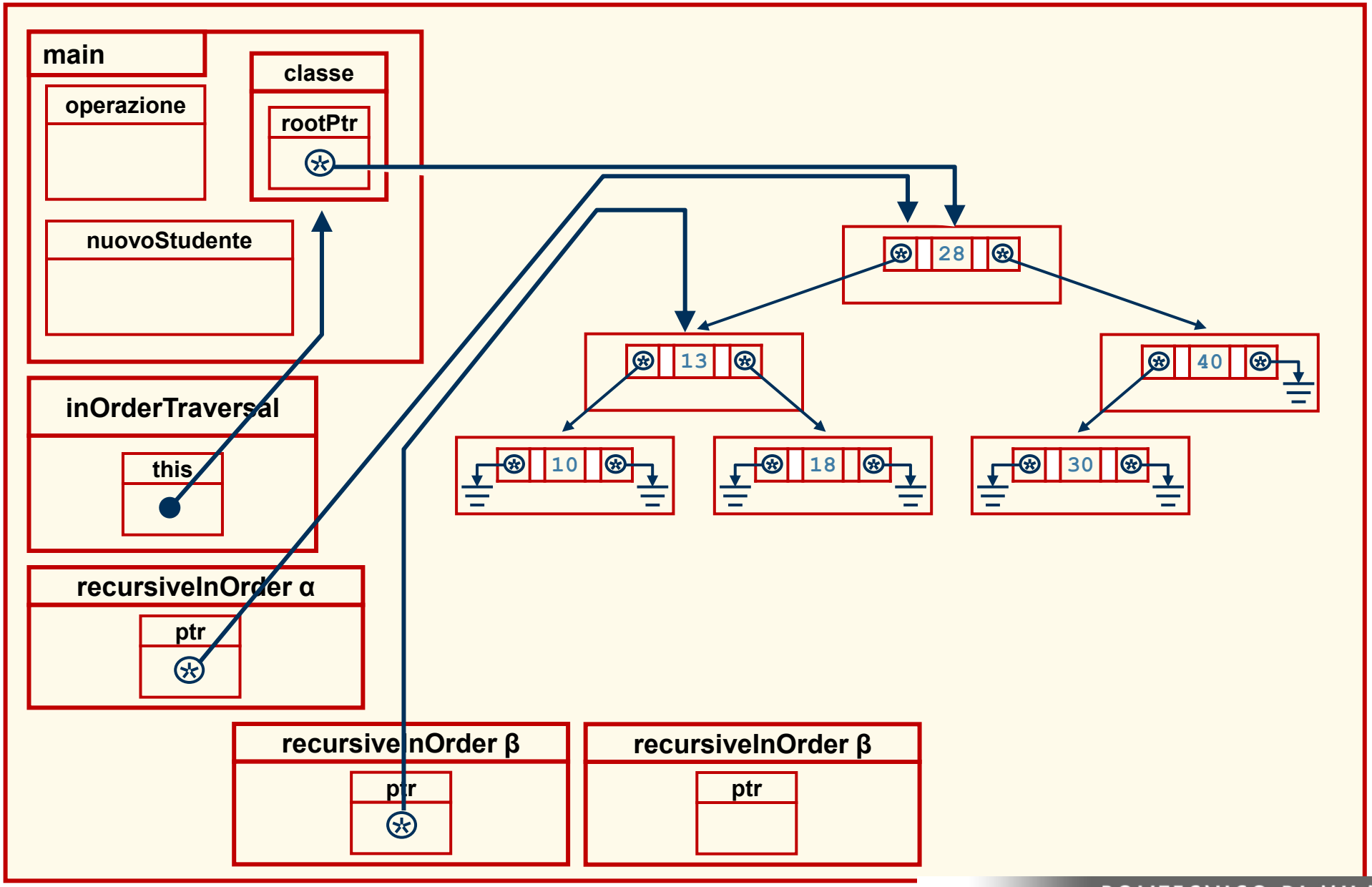
main
operazione
classe
rootPtr
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inOrderTraversal
this
recursiveInOrder α
ptr
recursiveInOrder β
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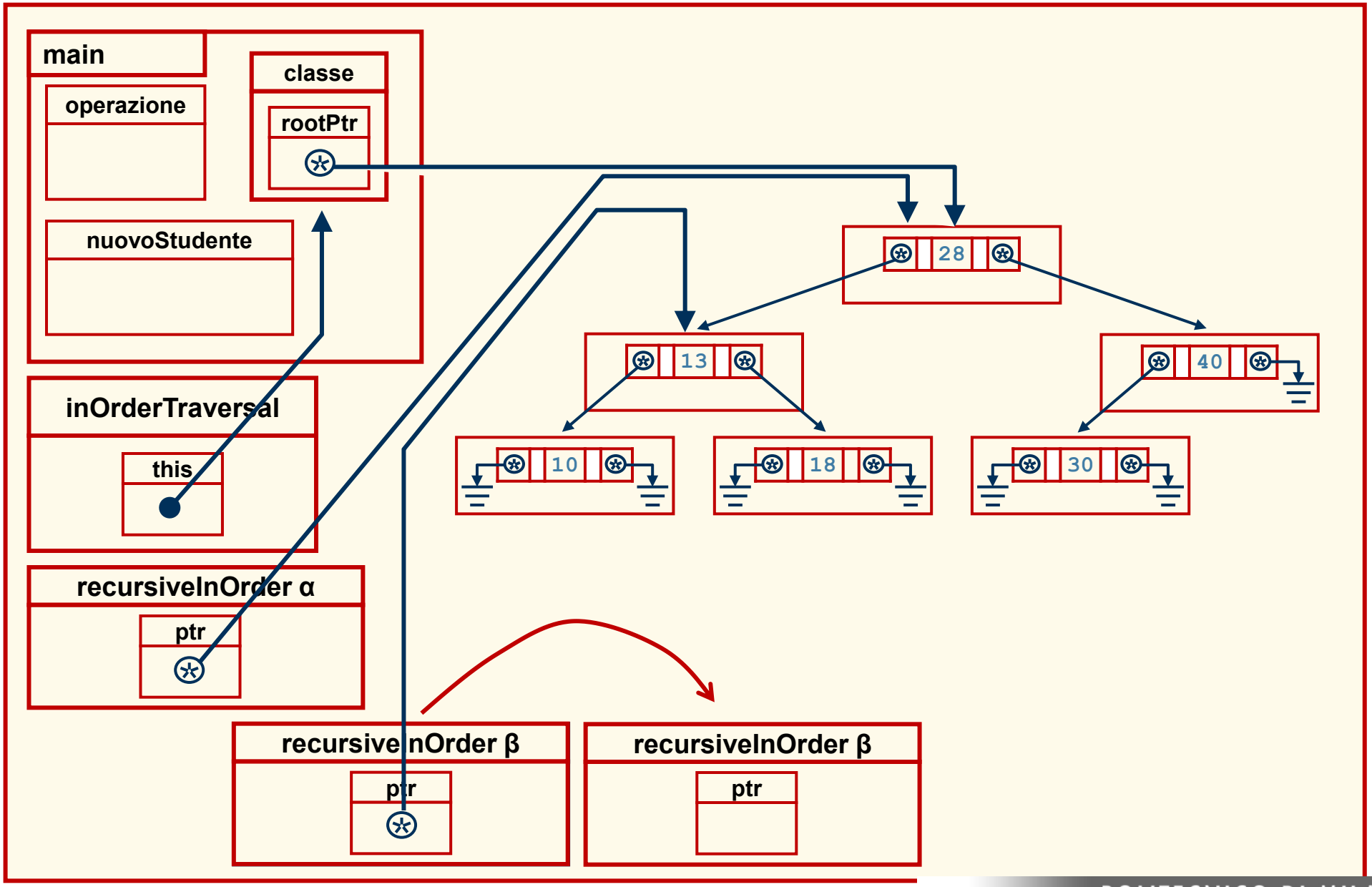
recursiveInOrder β
ptr


main
operazione
classe
rootPtr
nuovoStudente
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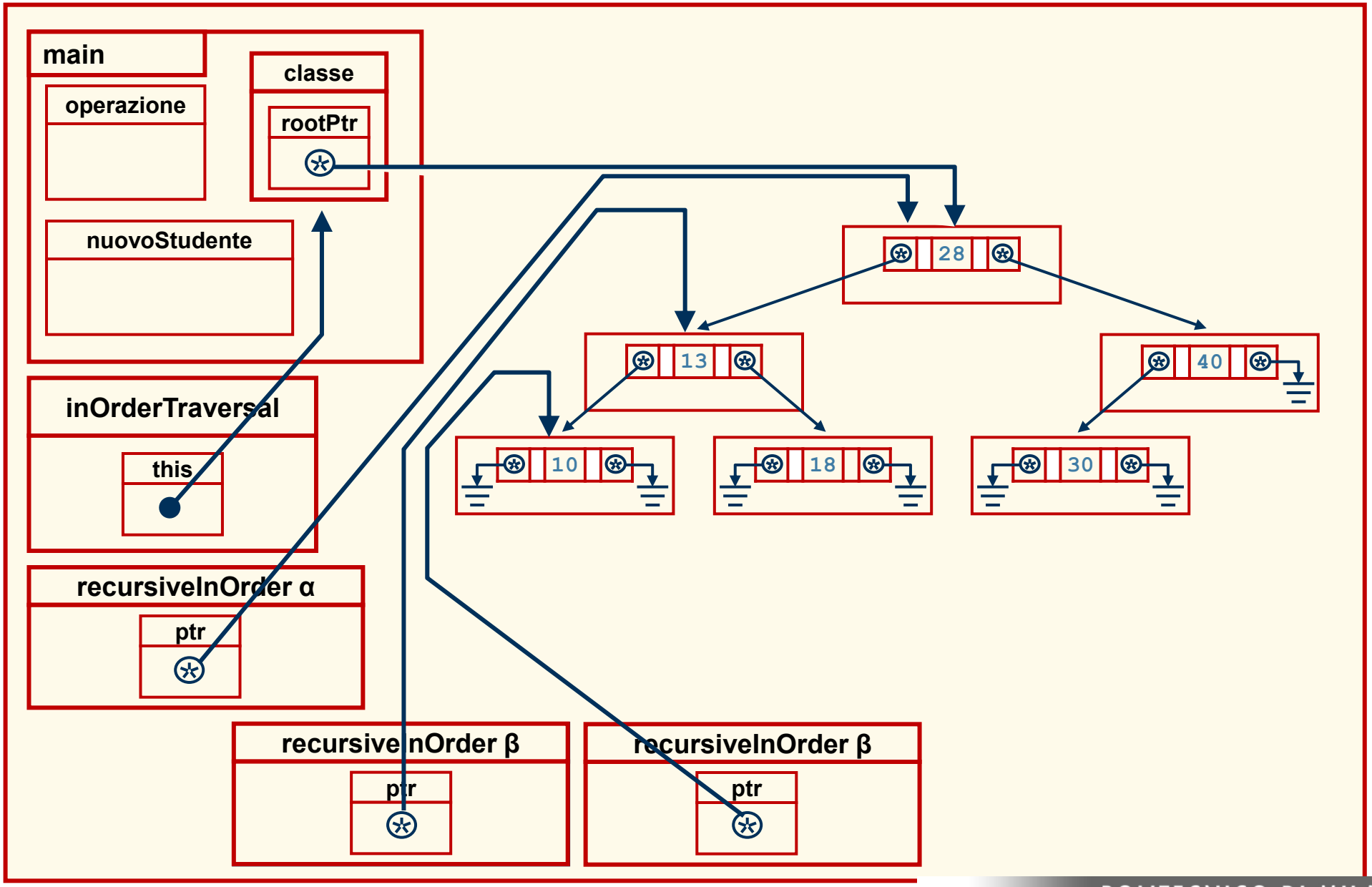
inOrderTraversal
this
recursiveInOrder α
ptr
recursiveInOrder β
ptr
recursiveInOrder β
ptr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operazione
classe
rootPtr
nuovoStudente
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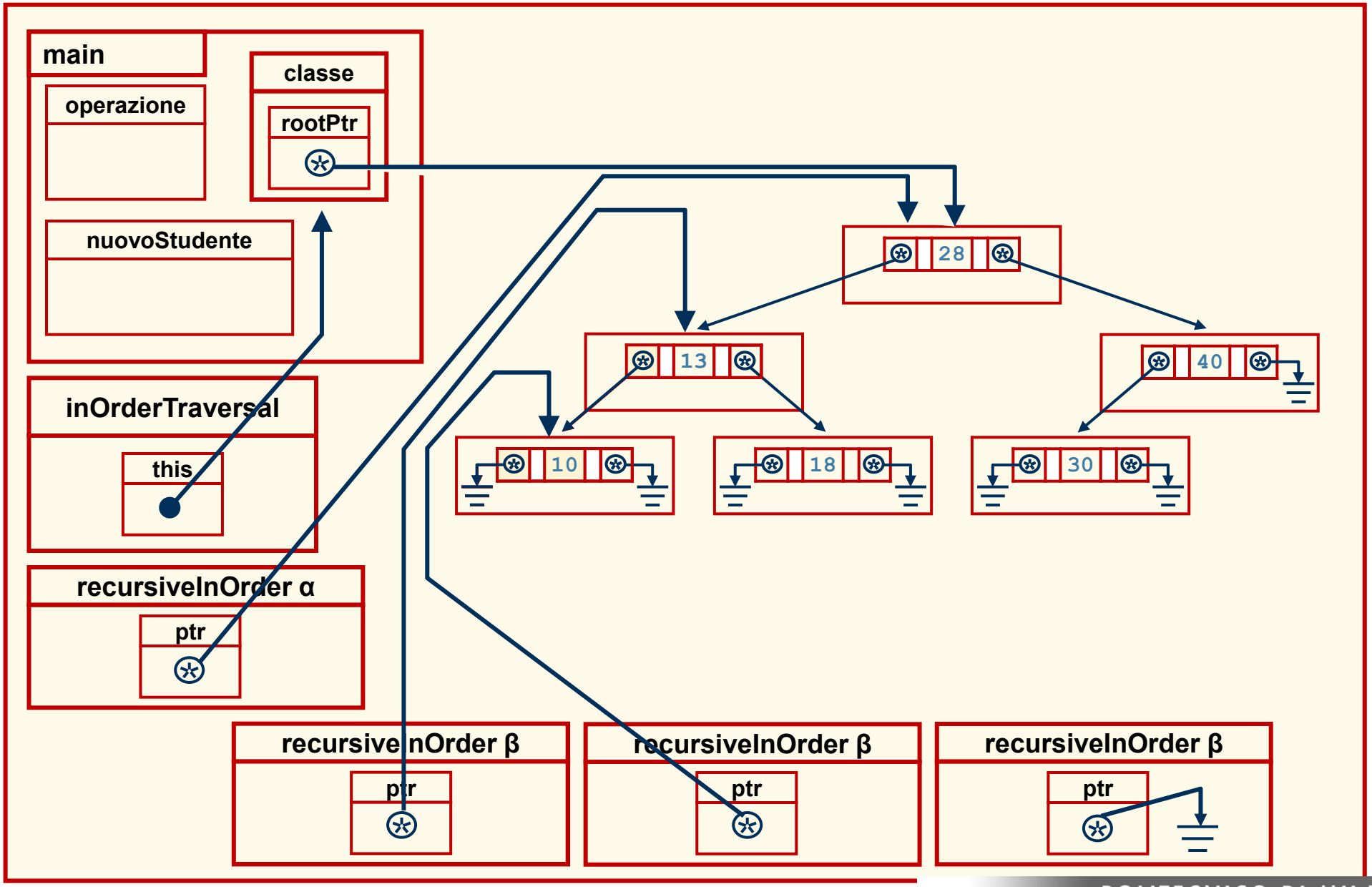
inOrderTraversal
this
recursiveInOrder α
ptr
recursiveInOrder β
ptr
recursiveInOrder β
ptr


main
operazione
classe
rootPtr
nuovoStudente
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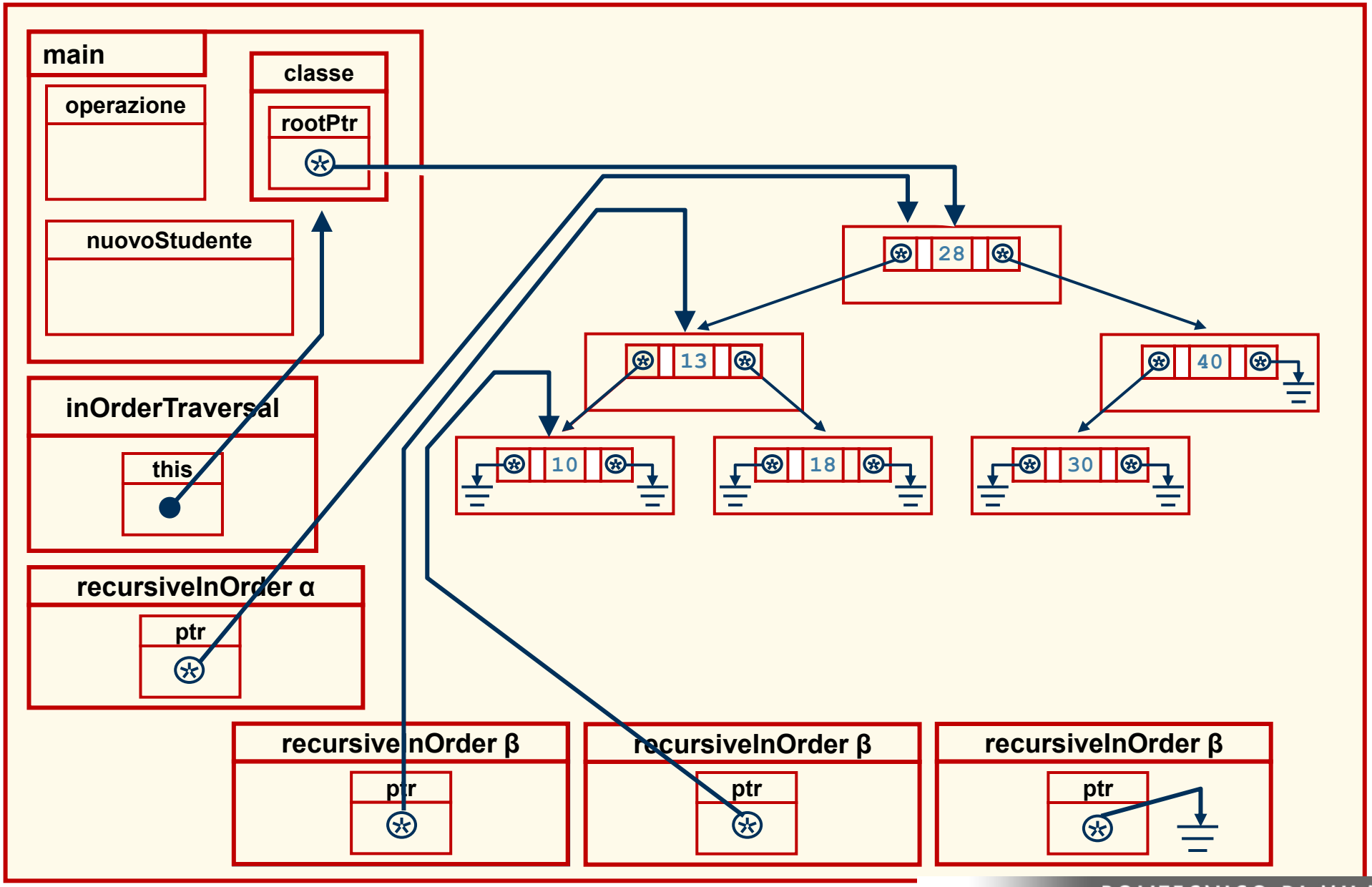
inOrderTraversal
this
recursiveInOrder α
ptr
recursiveInOrder β
ptr
recursiveInOrder β
ptr
recursiveInOrder β
ptr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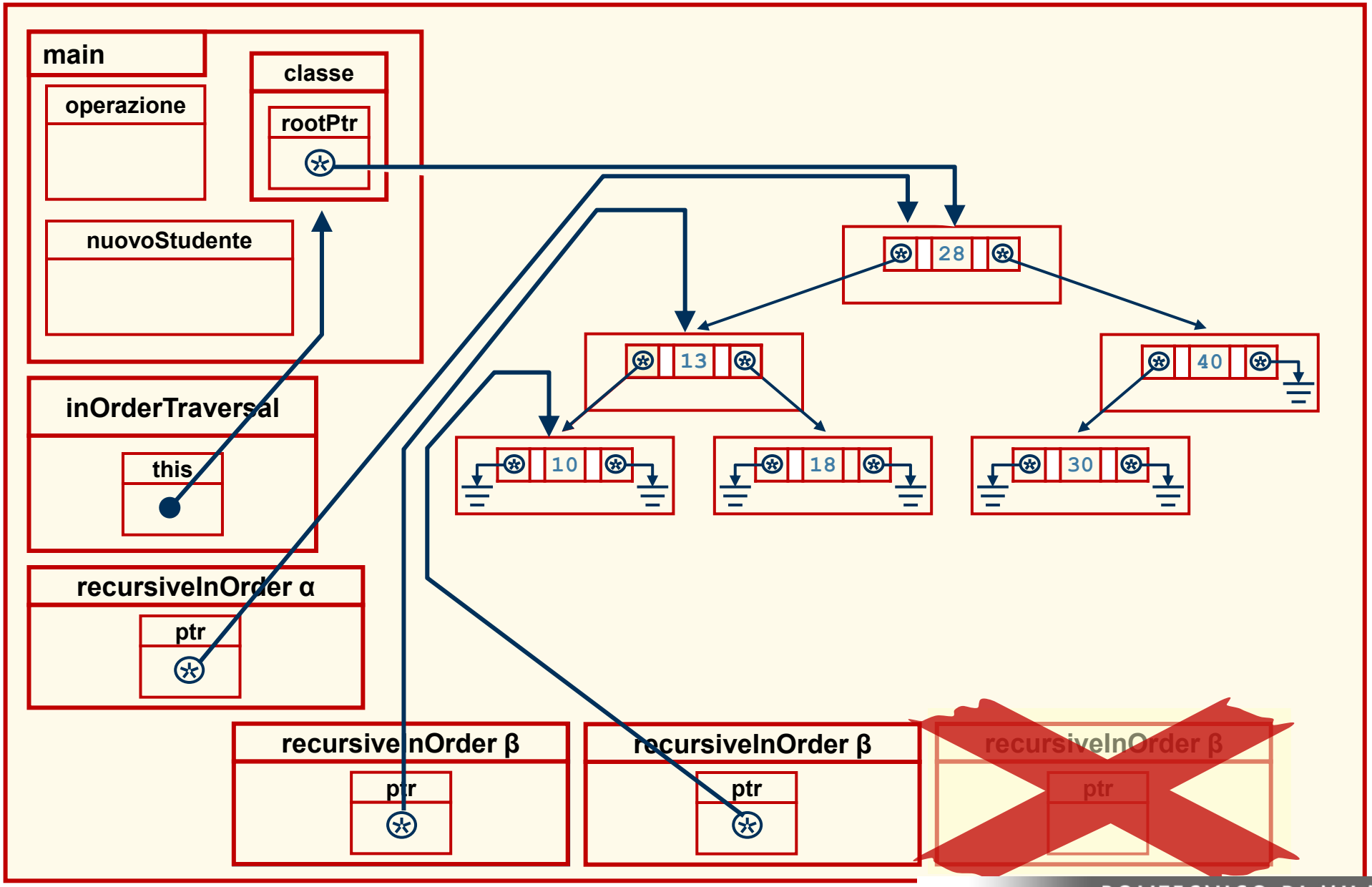
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recursiveInOrder α
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recursiveInOrder β
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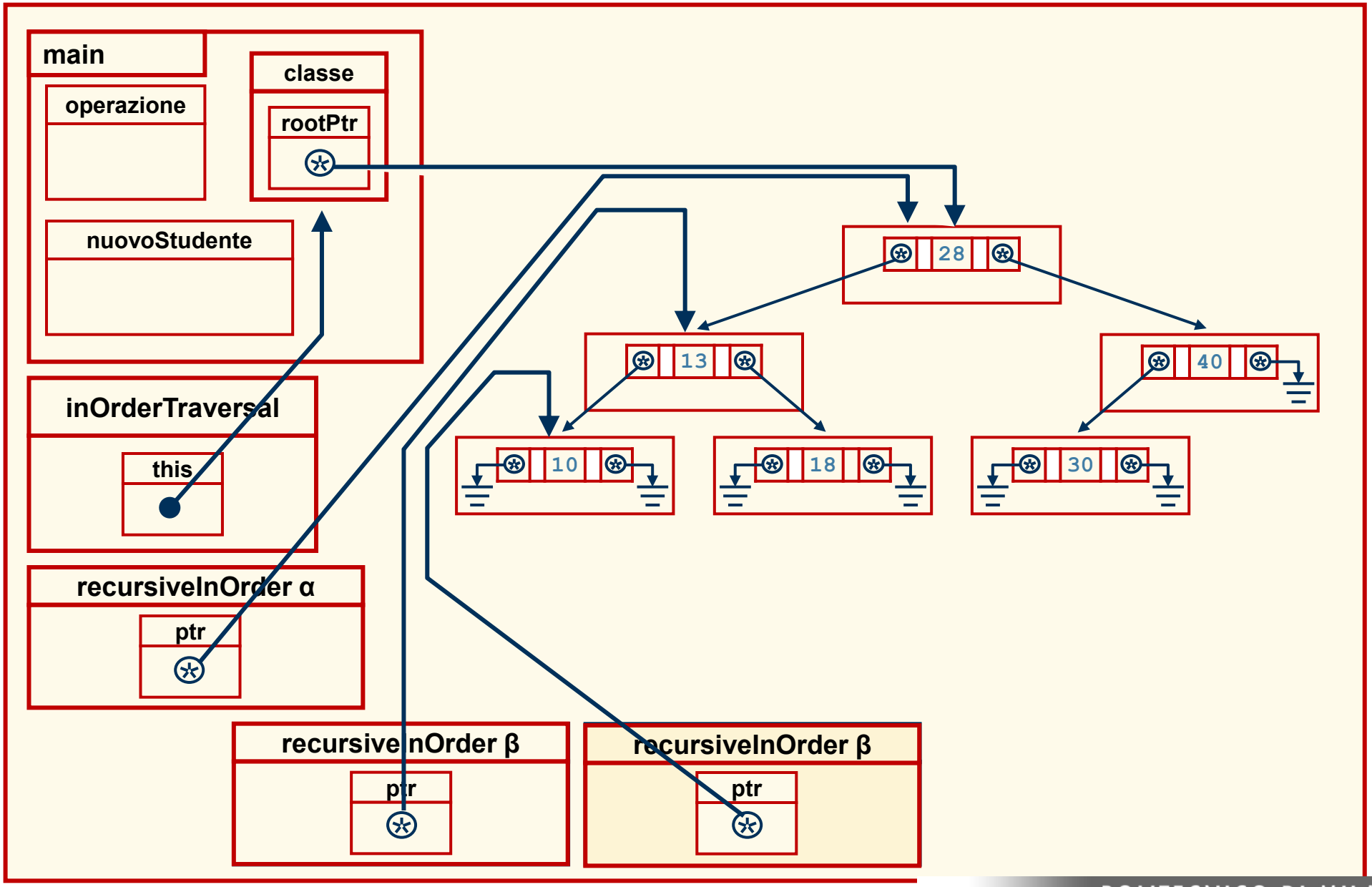
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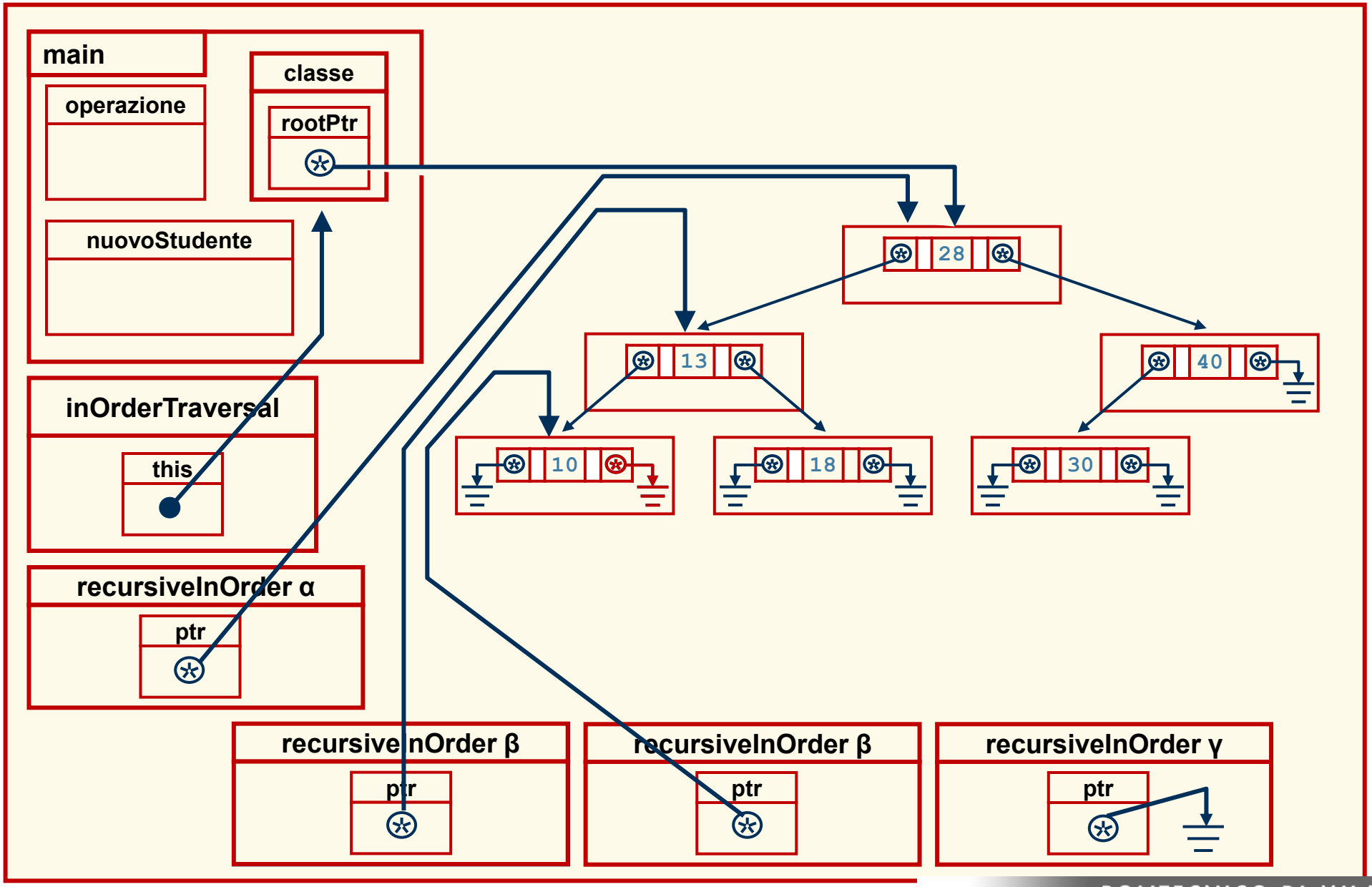
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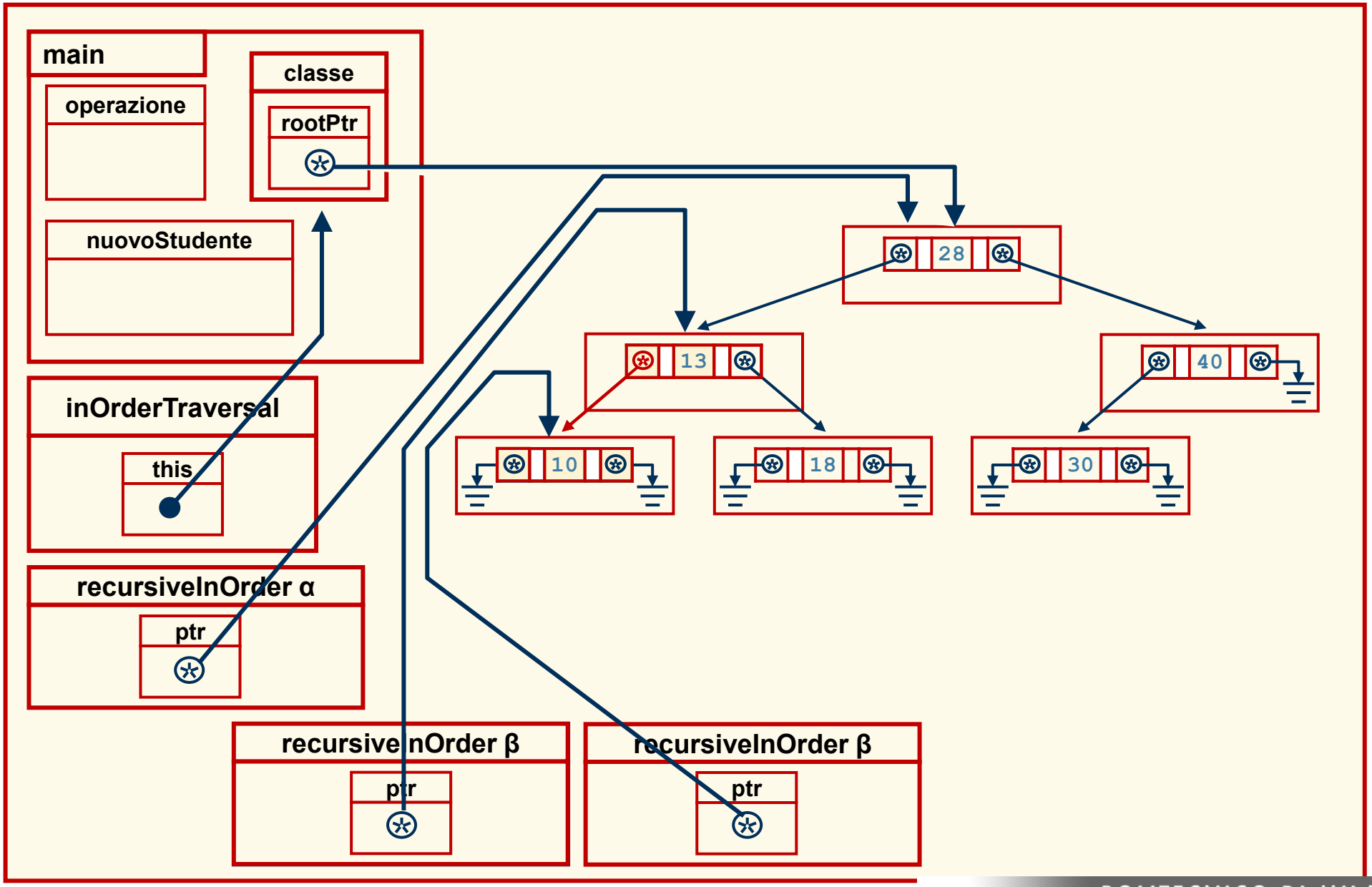
ptr
recursiveInOrder γ
ptr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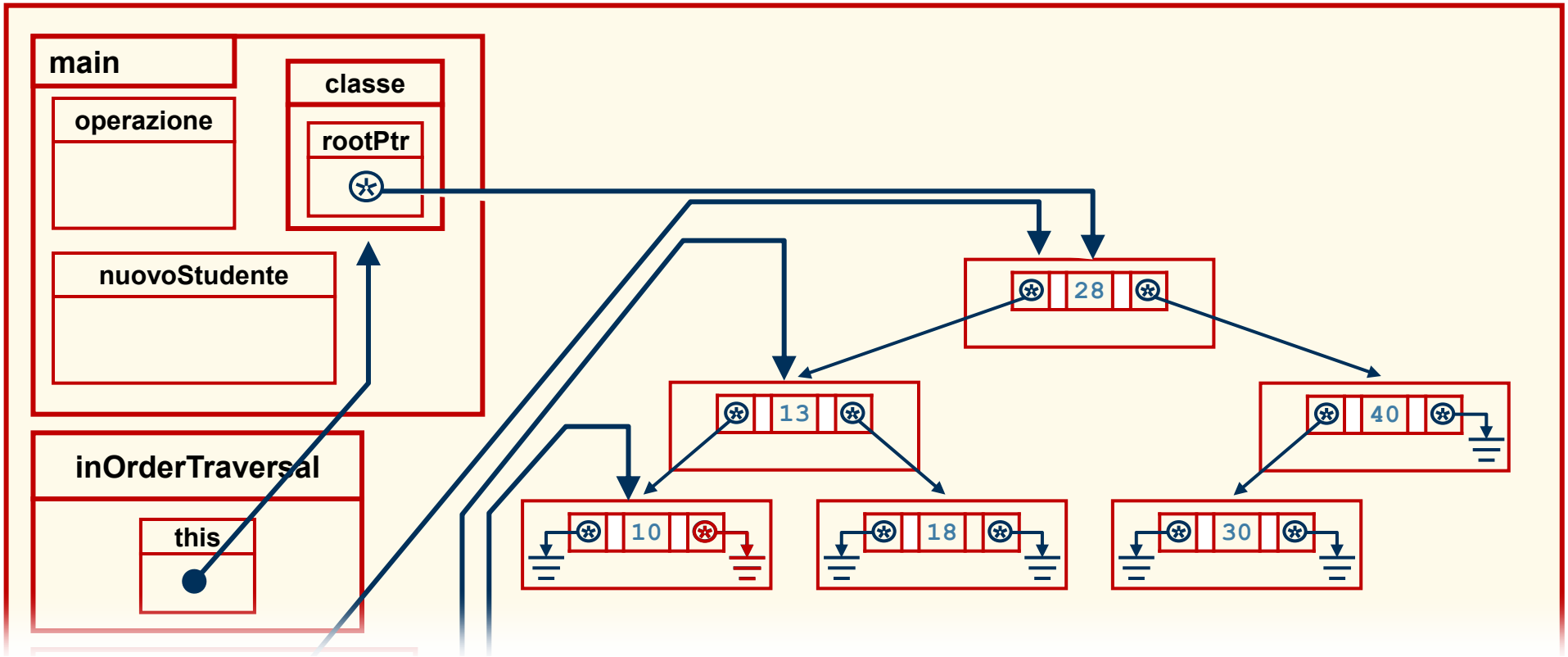
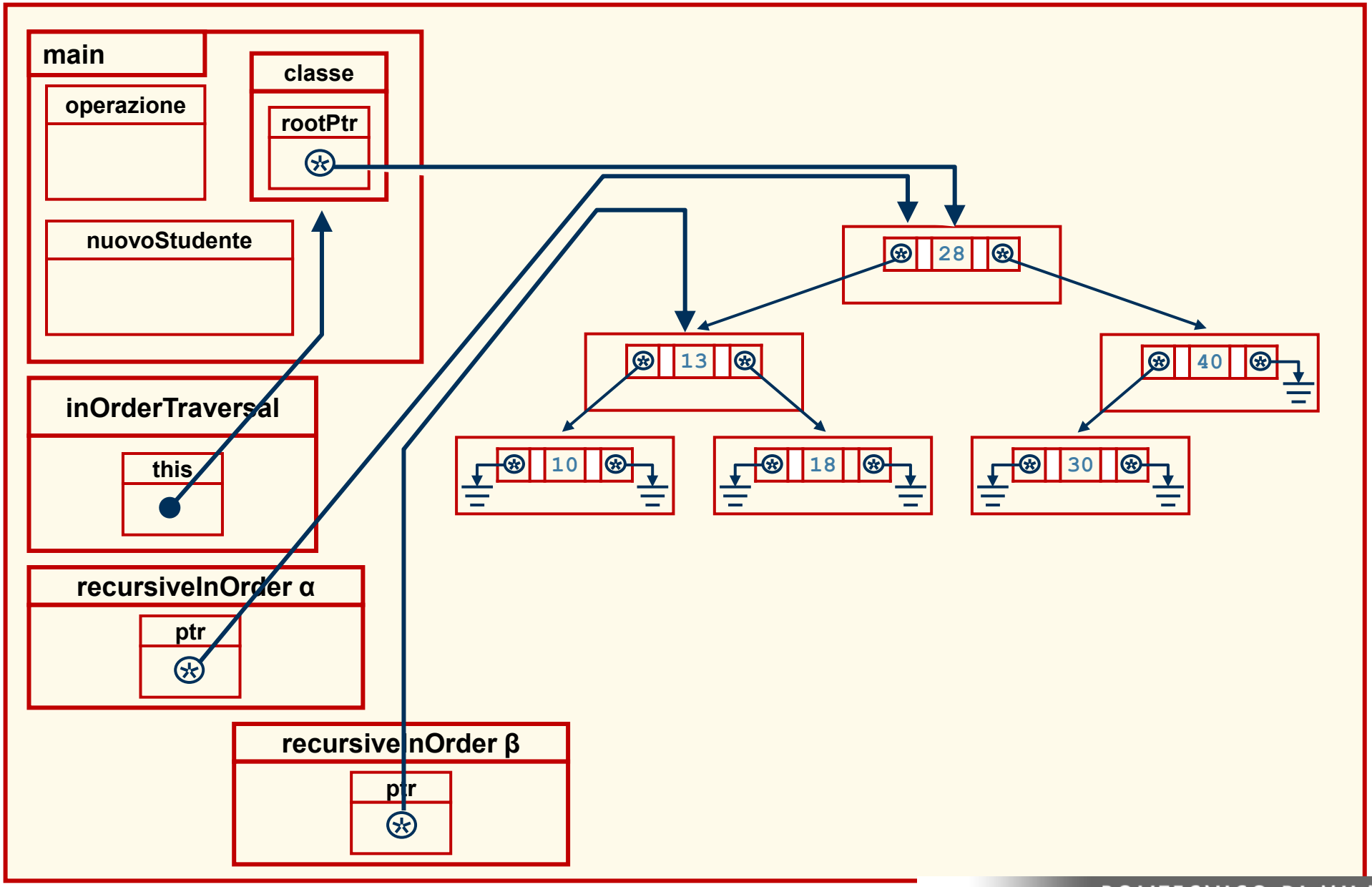
this
recursiveInOrder α
ptr
recursiveInOrder β
ptr
recursiveInOrder β
ptr




```
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);      α
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);      β
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);      γ
      }
}
```


main
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recursiveInOrder α
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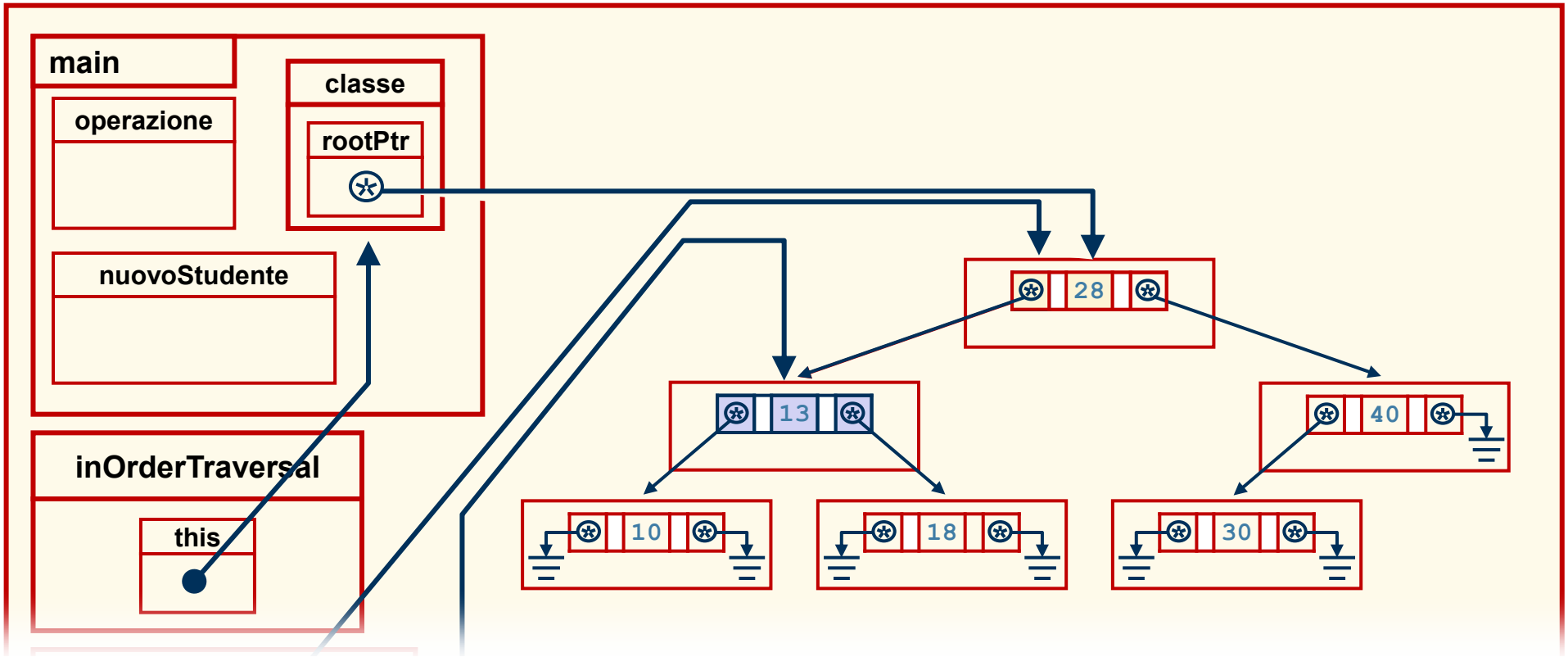


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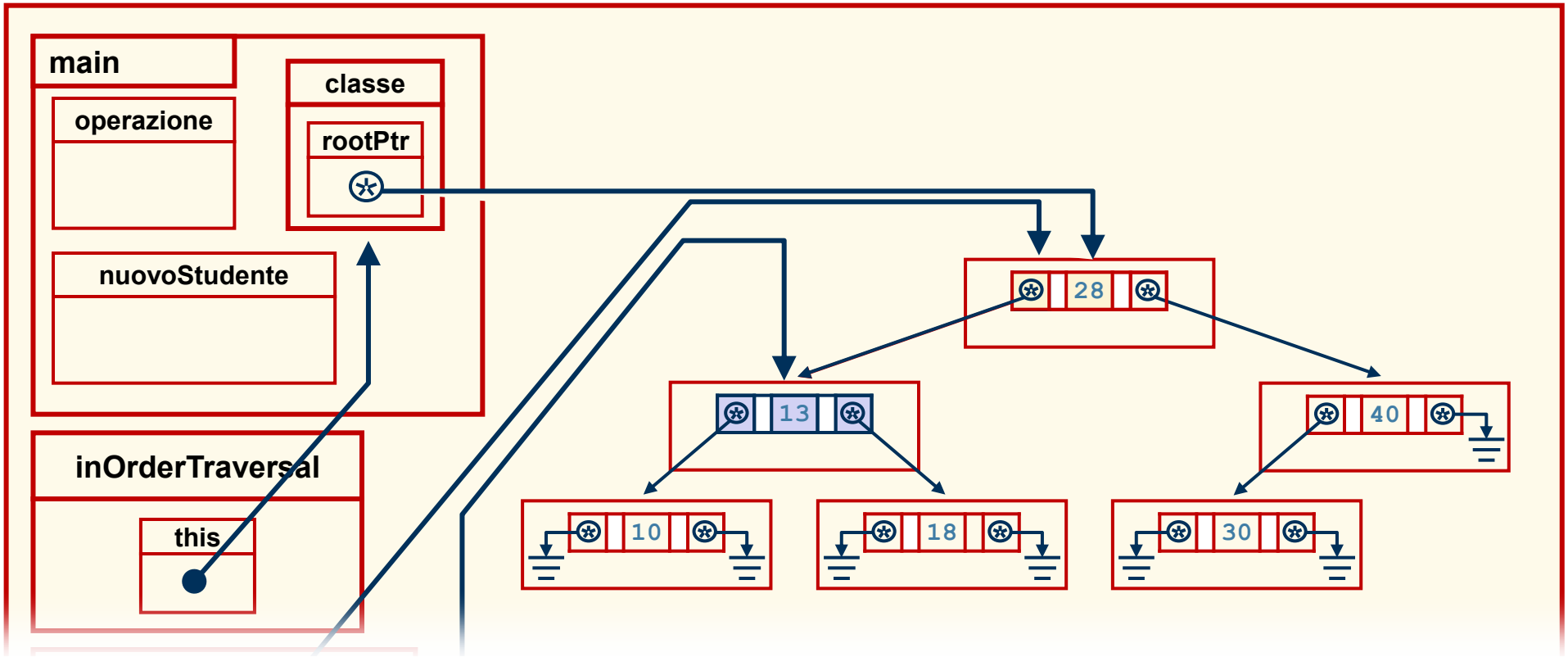
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);      α
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);      β
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);      γ
      }
}
```

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void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
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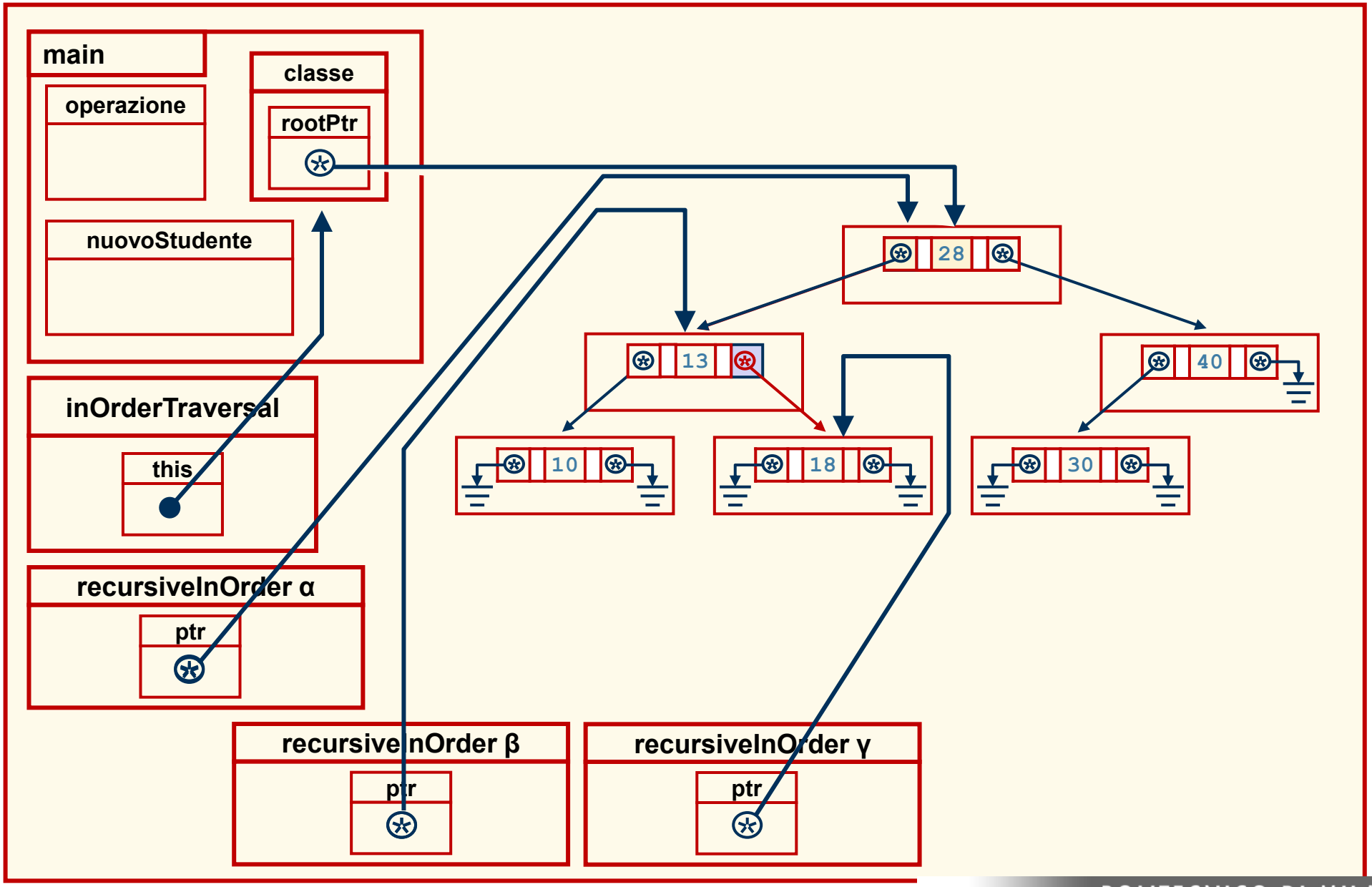
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);      γ
      }
}
```


main
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recursiveInOrder γ
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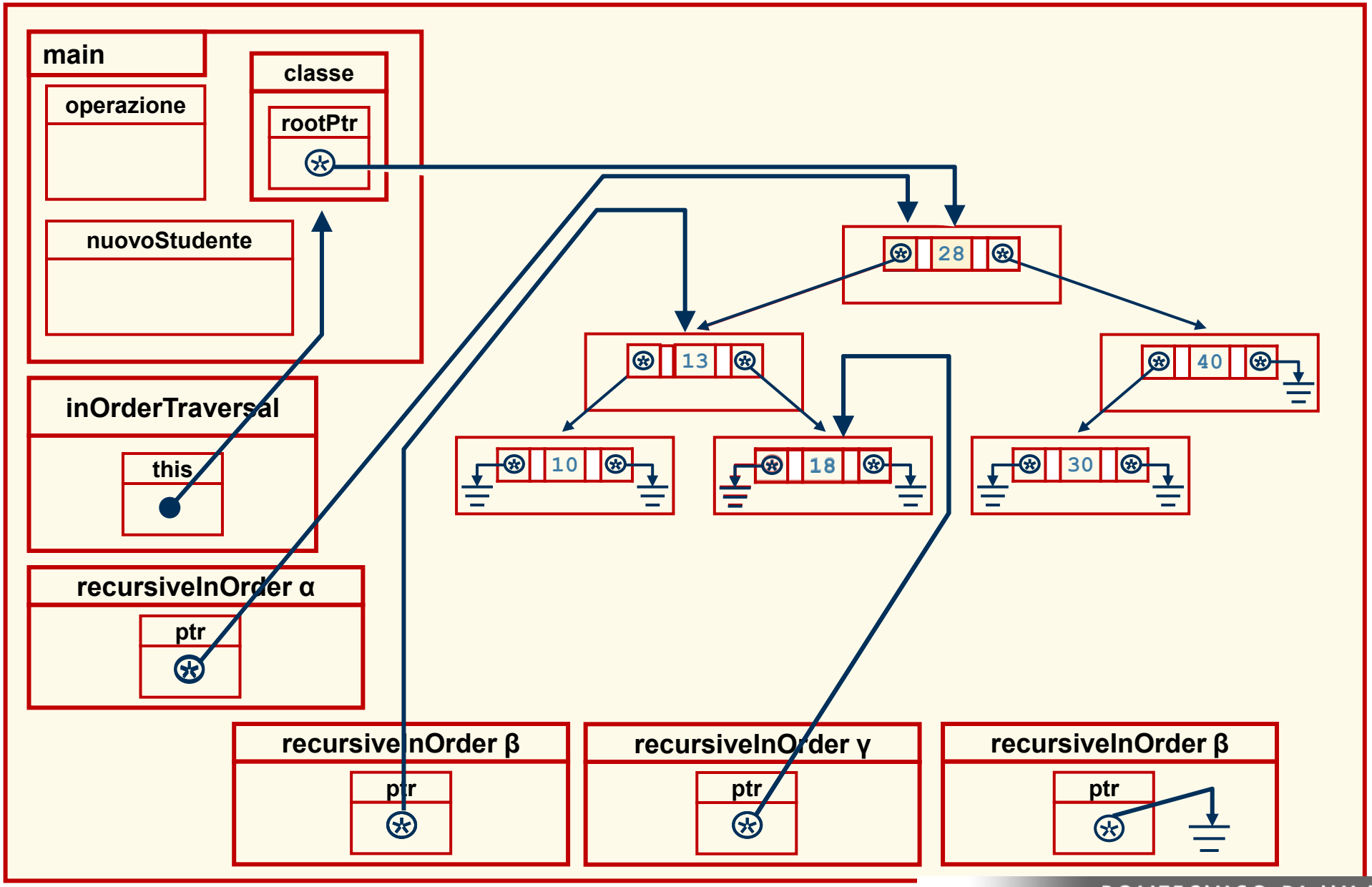
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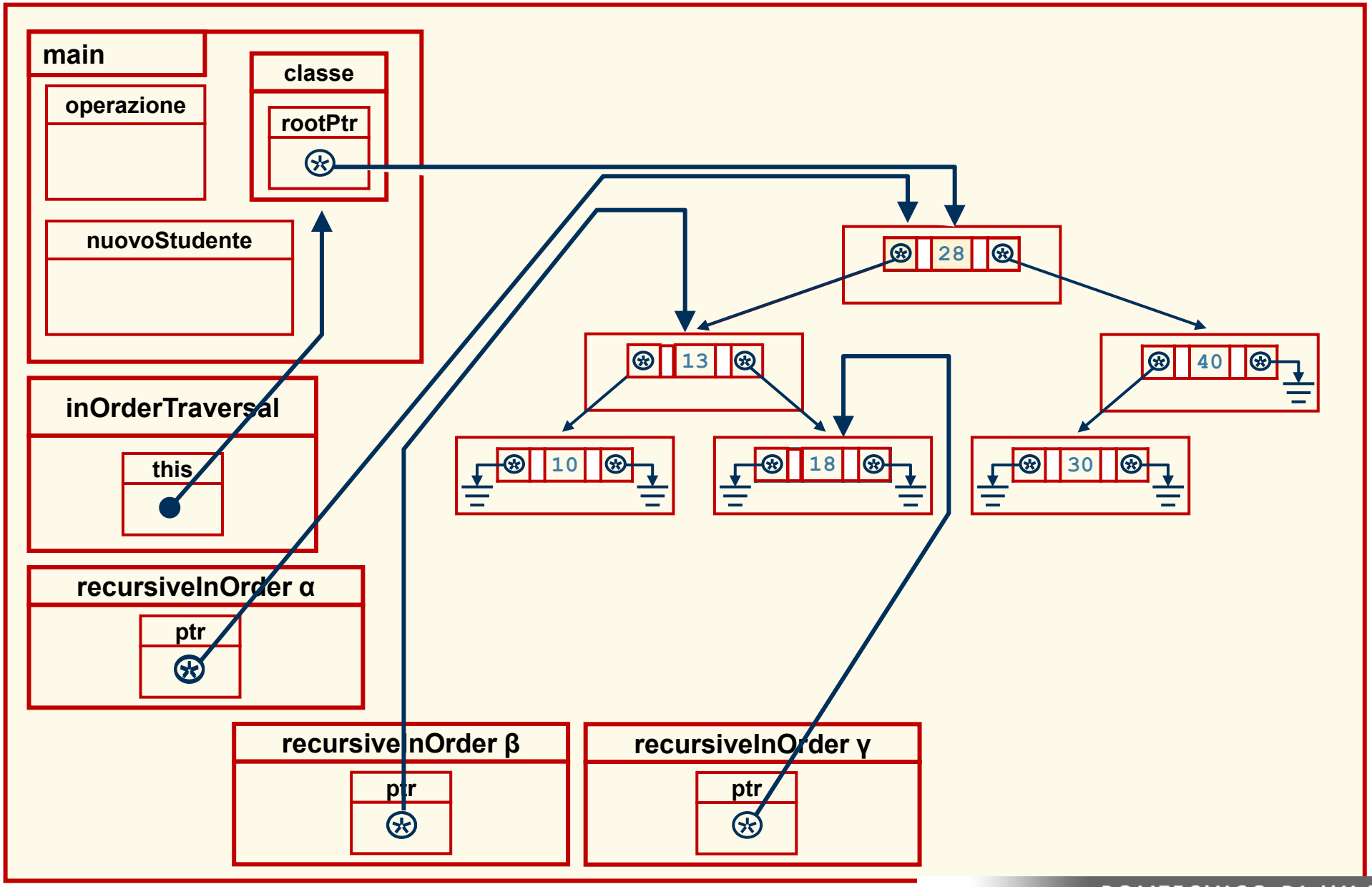
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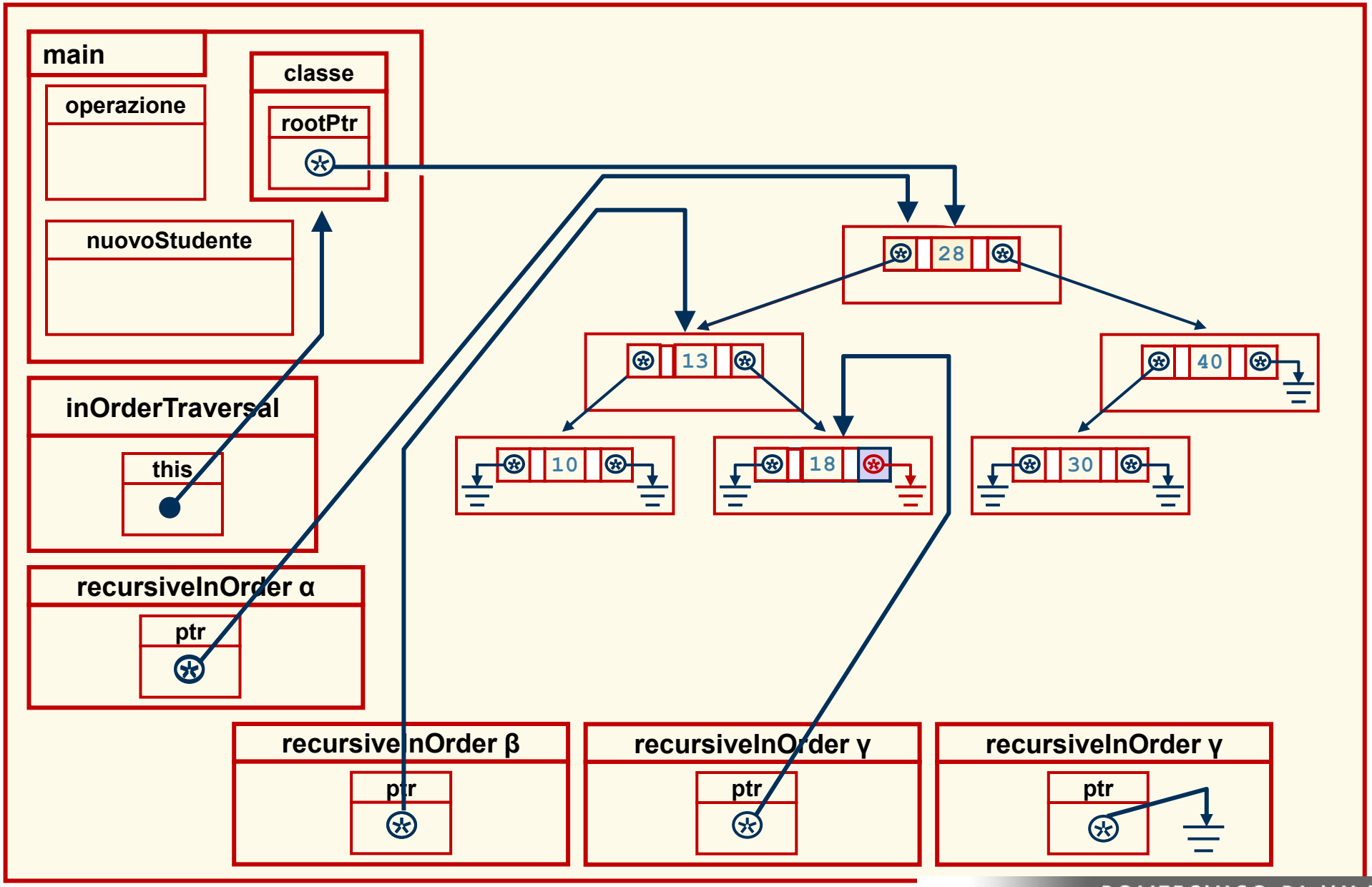
main
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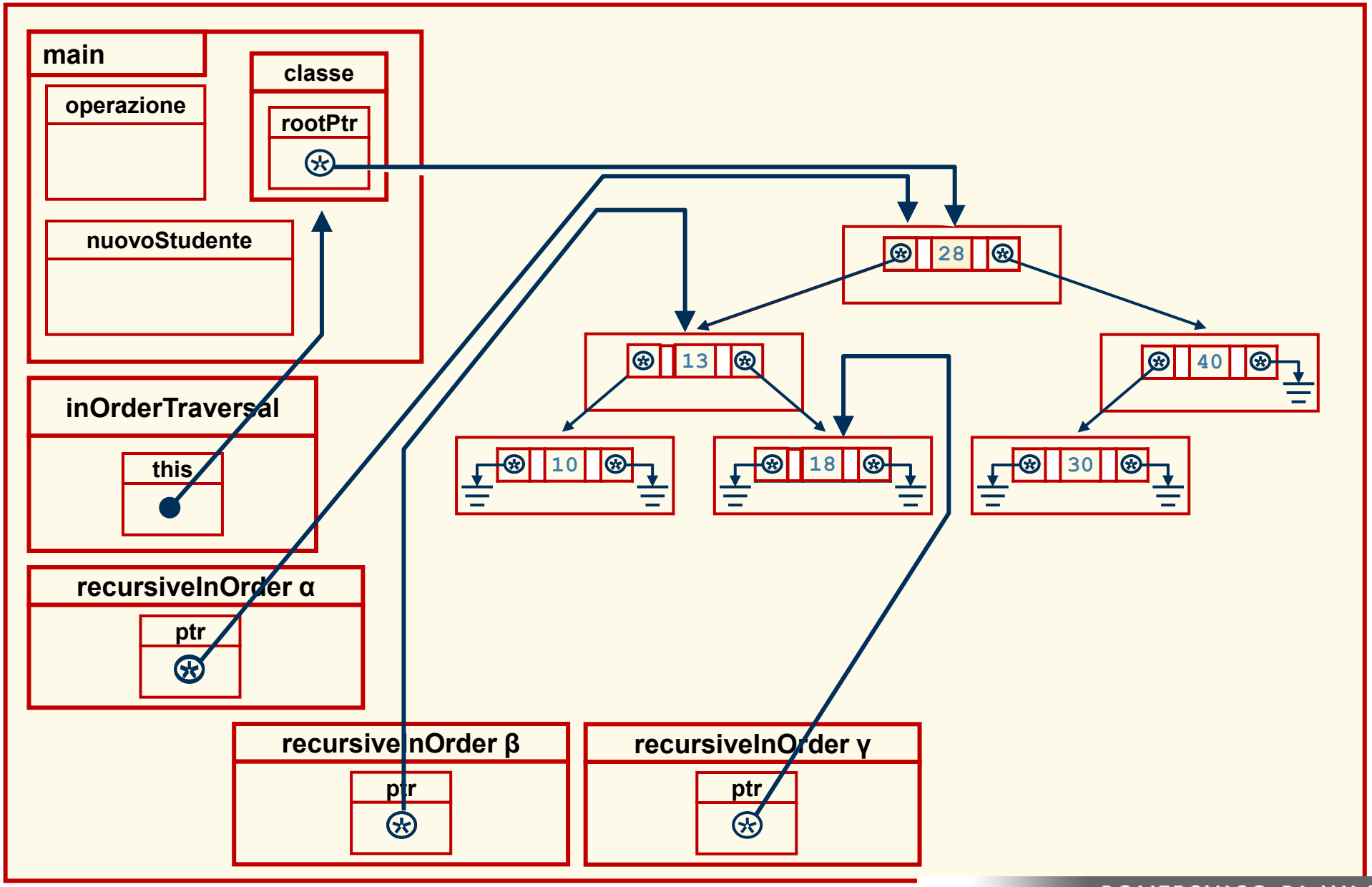
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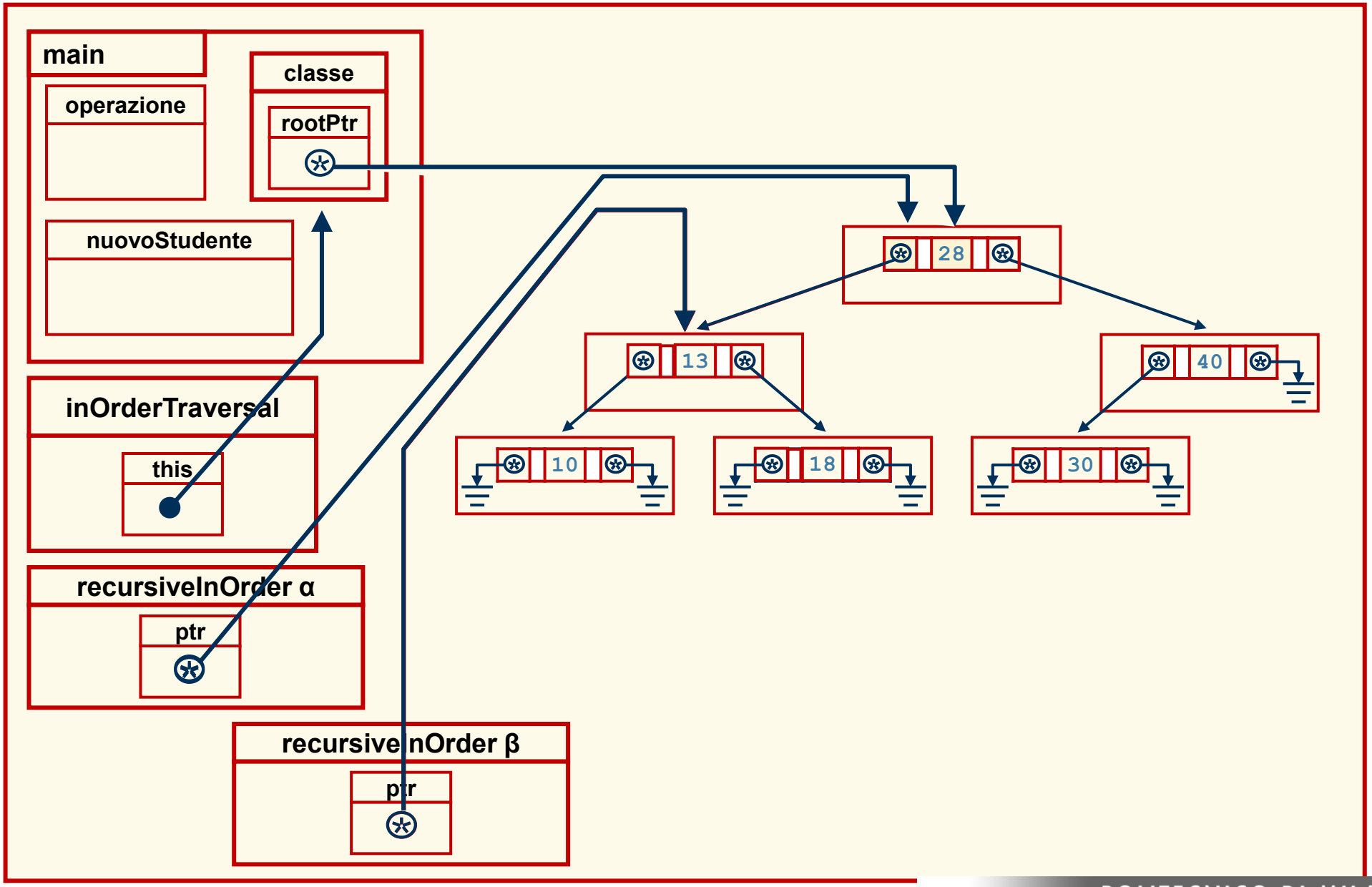
main
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rootPtr
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inOrderTraversal
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recursiveInOrder α
ptr
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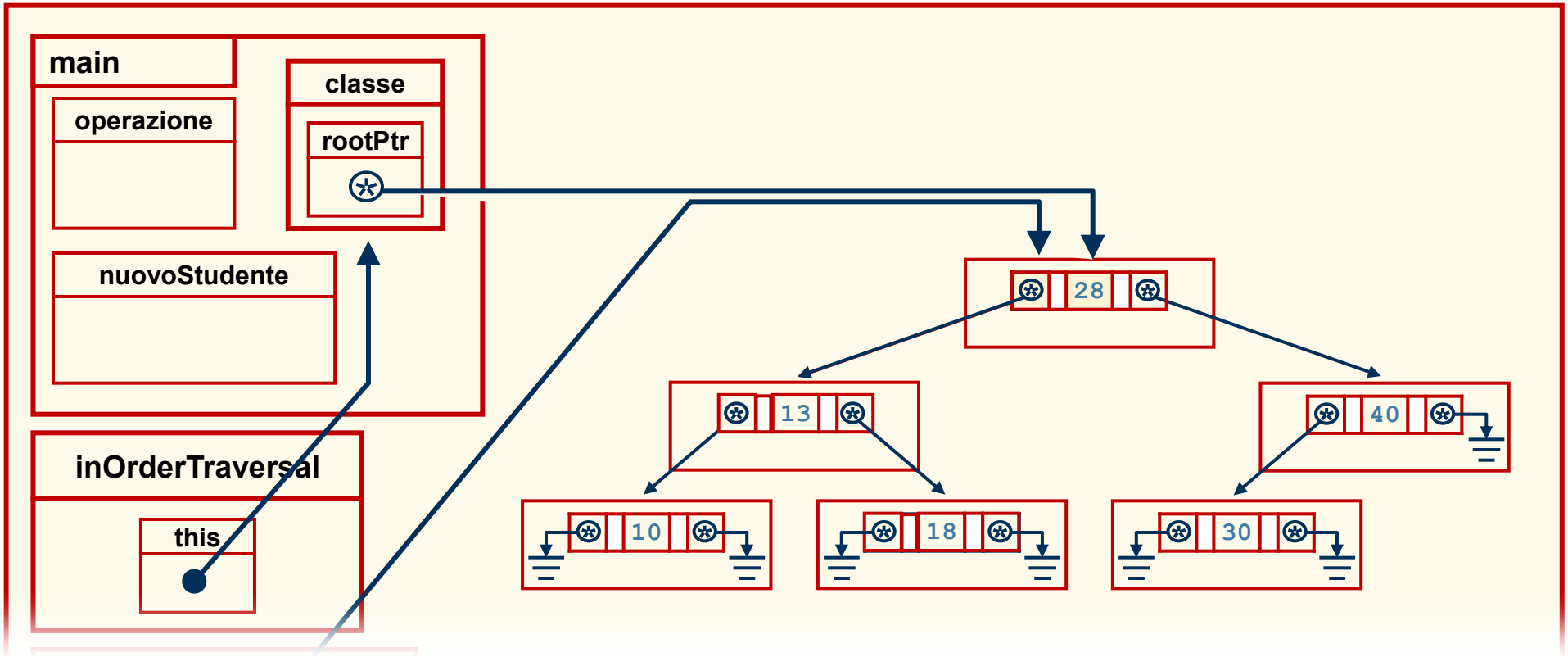
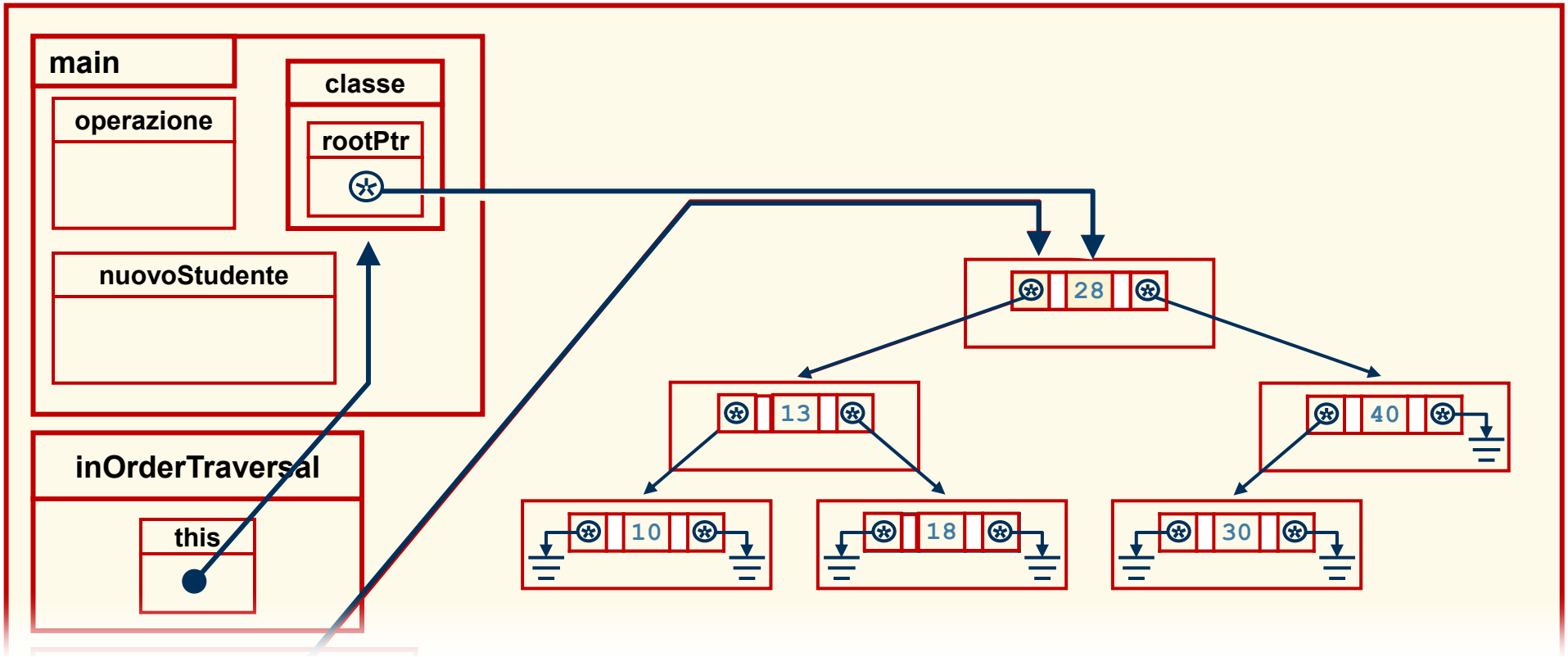
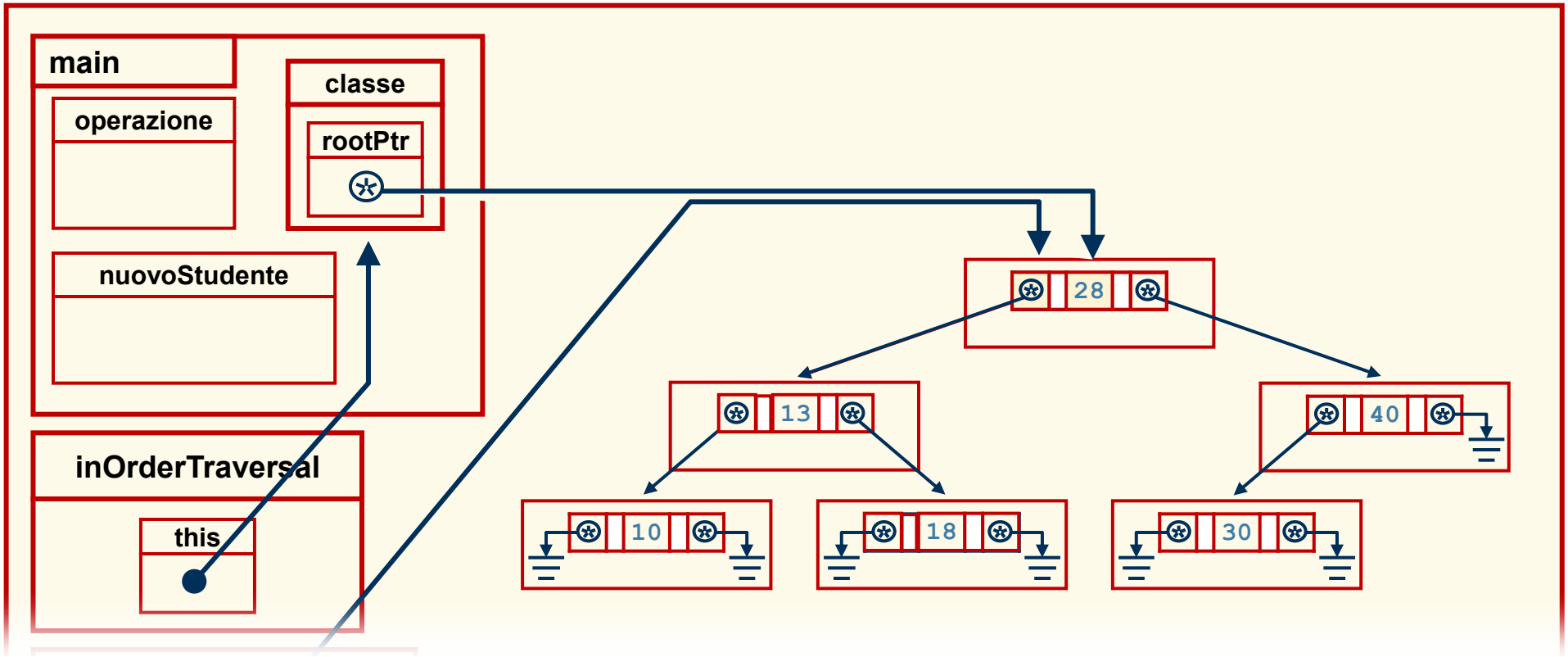



```
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);
      }
}
```

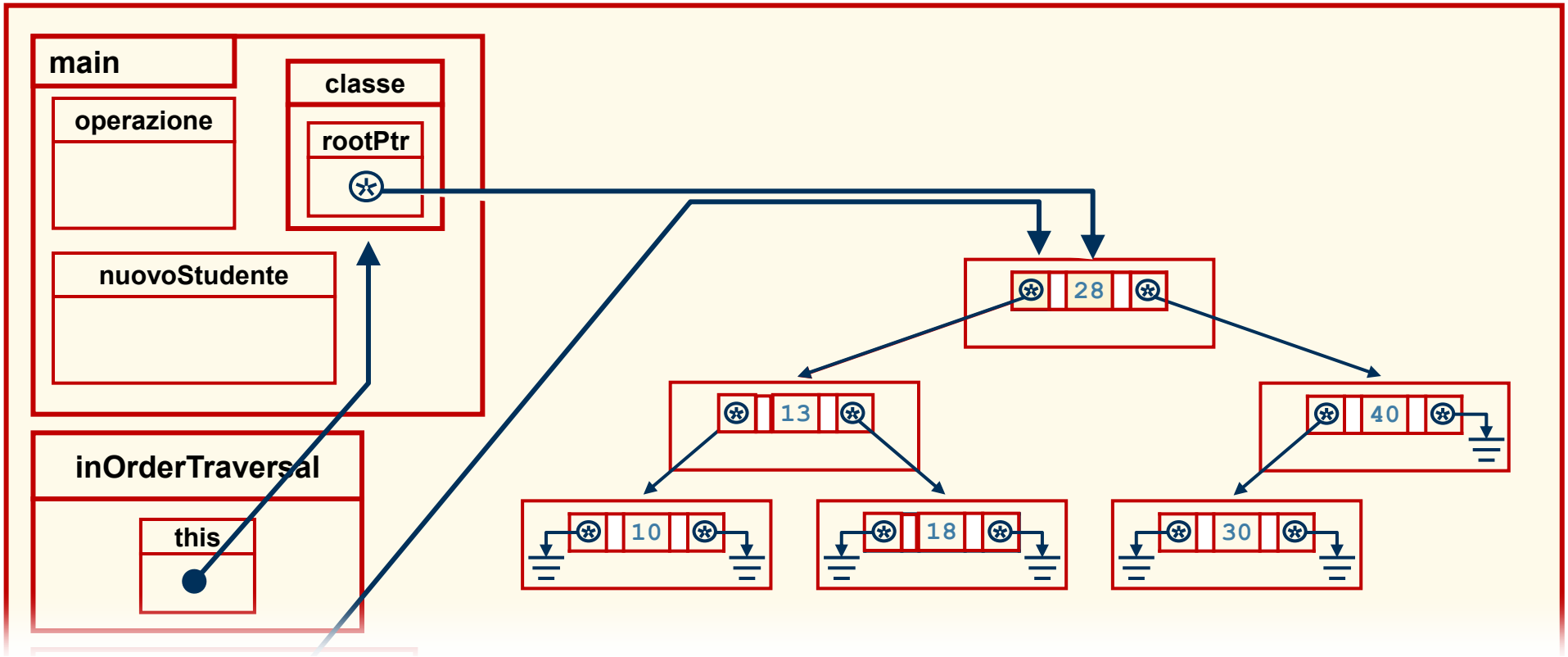
β



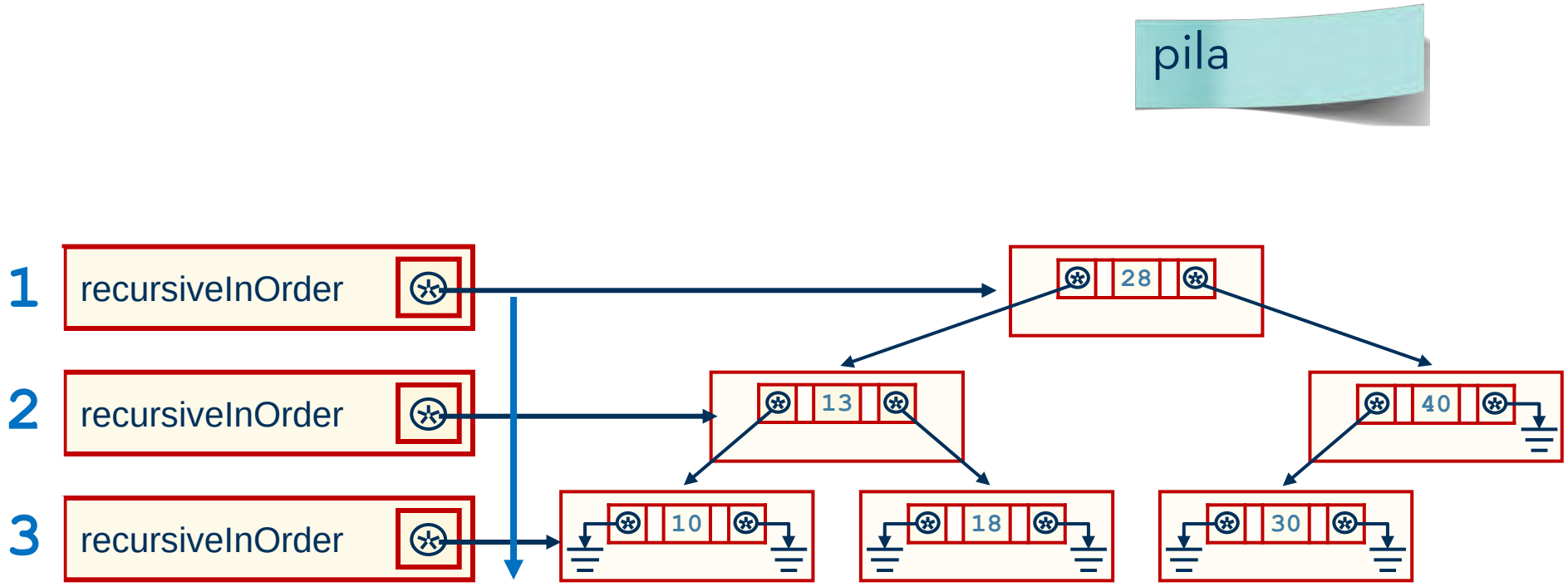

```
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);
      }
}
```



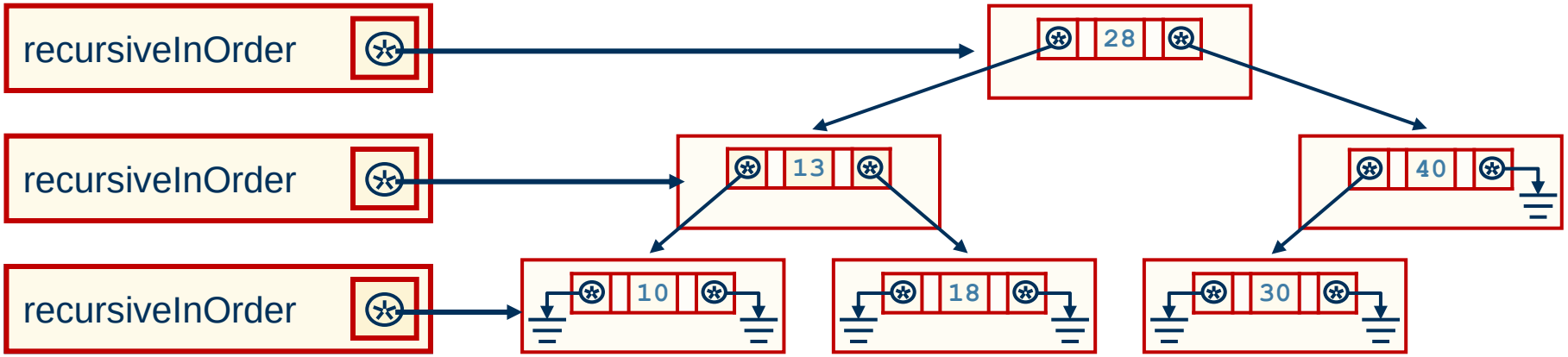

```
void Tree :: inOrderTraversal()
{   recursiveInOrder(rootPtr);
}
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);
      }
}
```



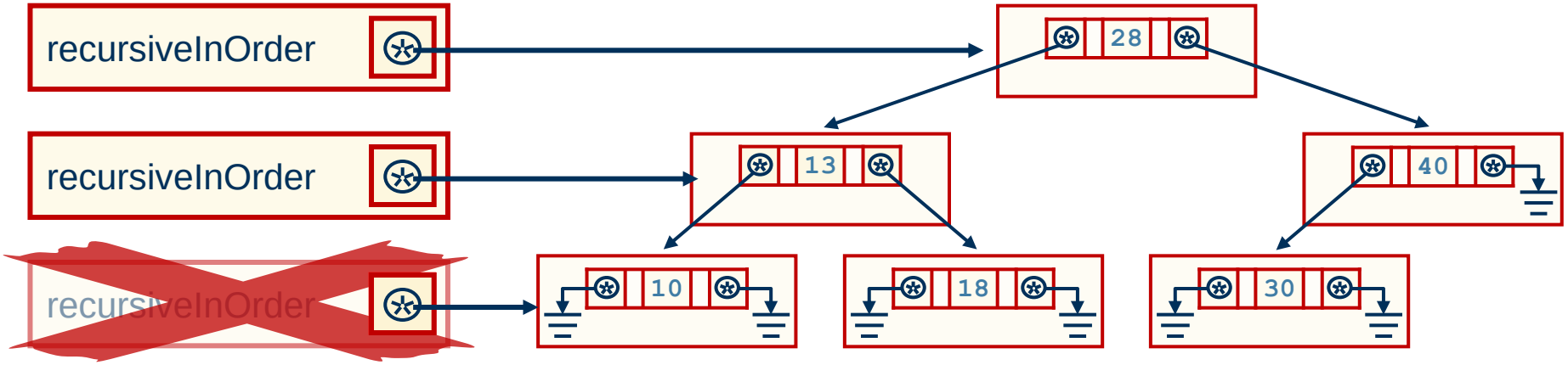
10 13 18 28 30 40



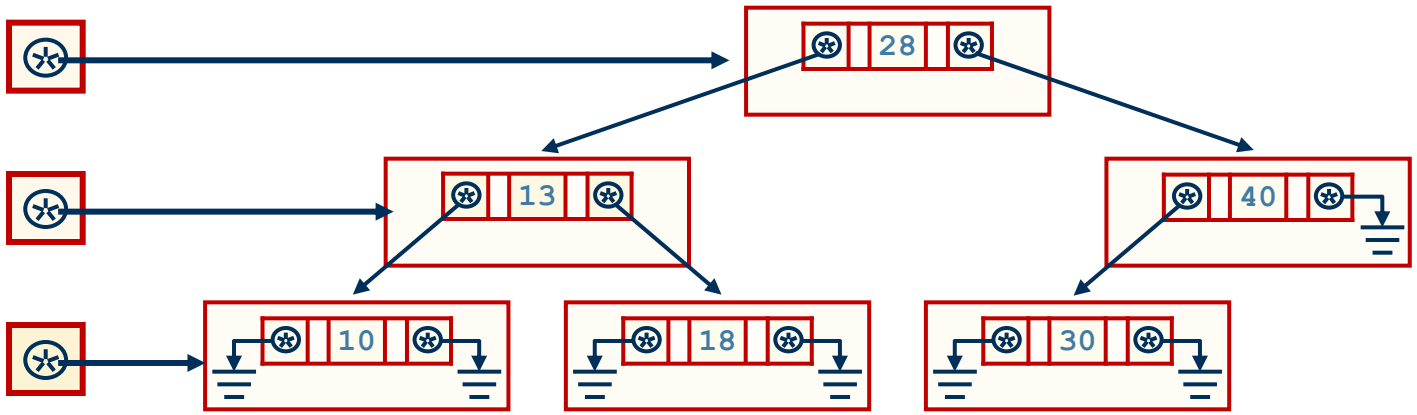

```
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
     { recursiveInOrder(ptr->leftPtr);
       cout << ptr->datiStud.matricola << ' ';
       recursiveInOrder(ptr->rightPtr);
     }
}
```




```
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
     { recursiveInOrder(ptr->leftPtr);
       cout << ptr->datiStud.matricola << ' ';
       recursiveInOrder(ptr->rightPtr);
     }
}
```

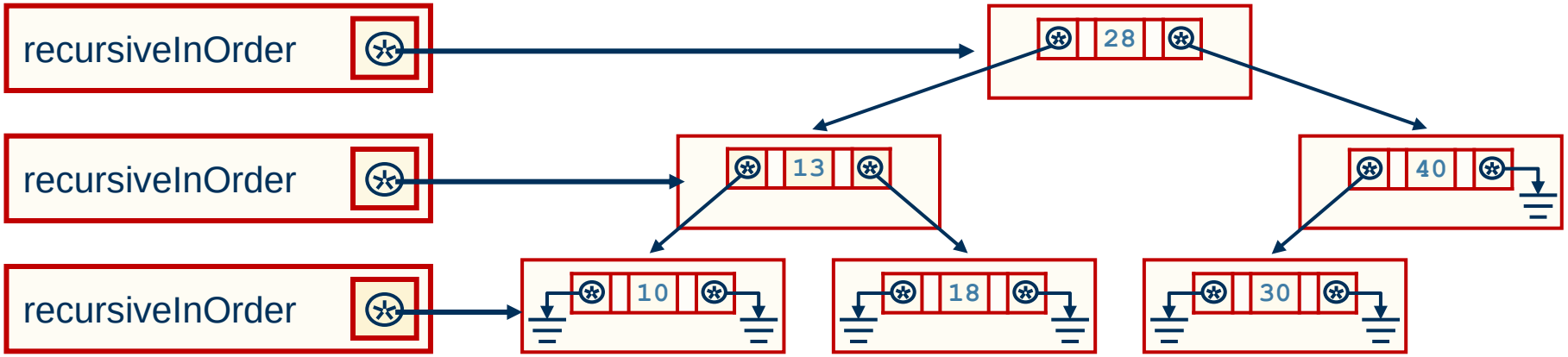



```
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
     { recursiveInOrder(ptr->leftPtr);
       cout << ptr->datiStud.matricola << ' ';
       recursiveInOrder(ptr->rightPtr);
     }
}
```

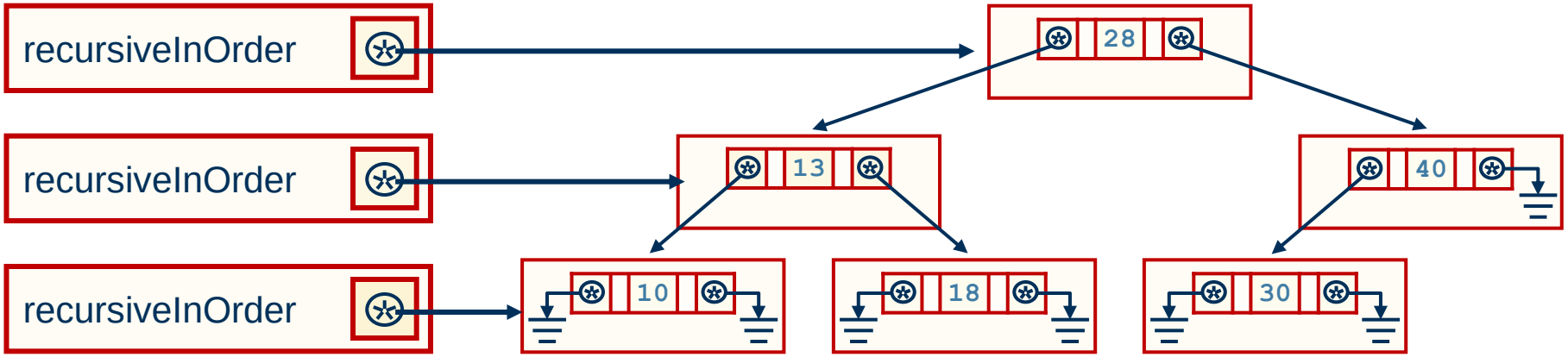


soluzione iterativa

Doppia ricorsione




```
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
     { recursiveInOrder(ptr->leftPtr);
       cout << ptr->datiStud.matricola << ' ';
       recursiveInOrder(ptr->rightPtr);
     }
}
```




```
void Tree :: recursiveInOrder(TreeNode *ptr)
{   if (ptr != 0)
      { recursiveInOrder(ptr->leftPtr);
        cout << ptr->datiStud.matricola << ' ';
        recursiveInOrder(ptr->rightPtr);
      }
}
```

```
void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

void Tree :: recursiveInOrder(TreeNode *ptr)
{  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

```
class Tree
{
  public:
    ...
    void inOrderTraversal();
  private:
    ...
    void recursiveInOrder(TreeNode *);
};

void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

void Tree :: recursiveInOrder(TreeNode *ptr)
{  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

```
class Tree
{
  public:
    ...
    void inOrderTraversal();
  private:
    ...
    void recursiveInOrder(TreeNode *);
};

void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

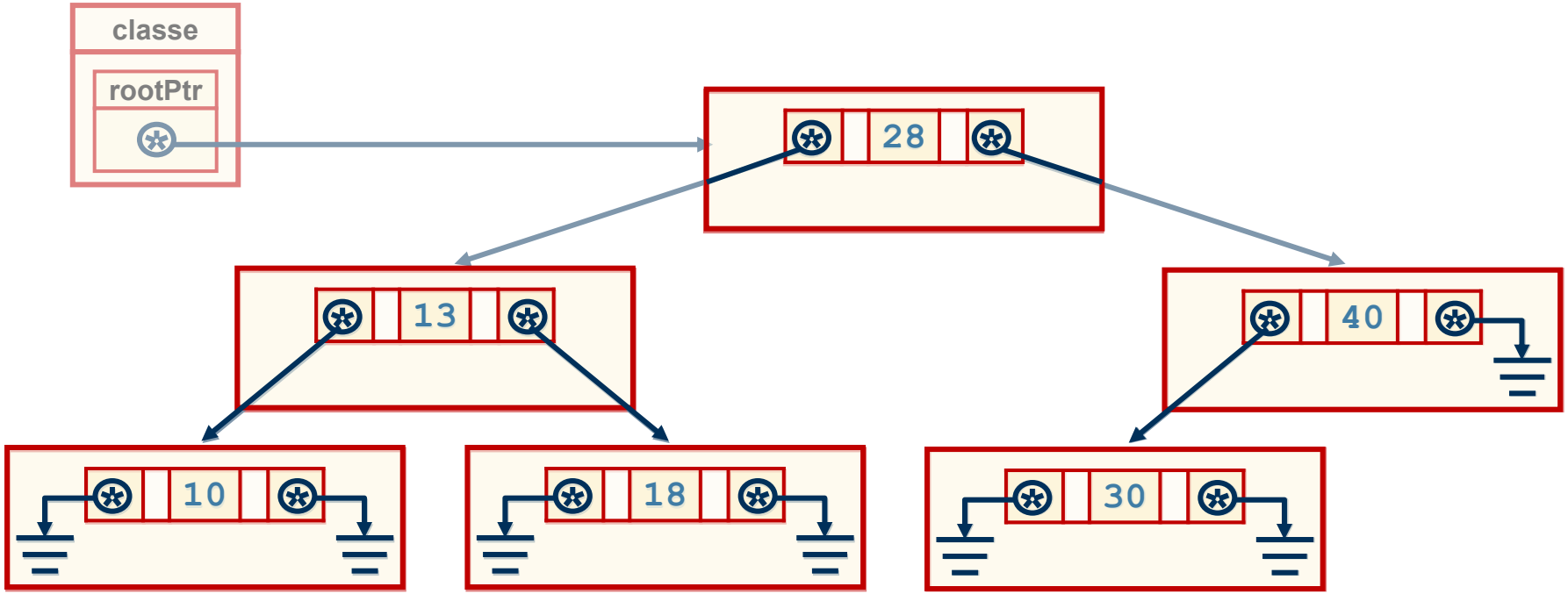
void Tree :: recursiveInOrder(TreeNode *ptr)
{  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

```
class Tree
{
  public:
    ...
    void inOrderTraversal();
  private:
    ...
    void recursiveInOrder(TreeNode *);
};

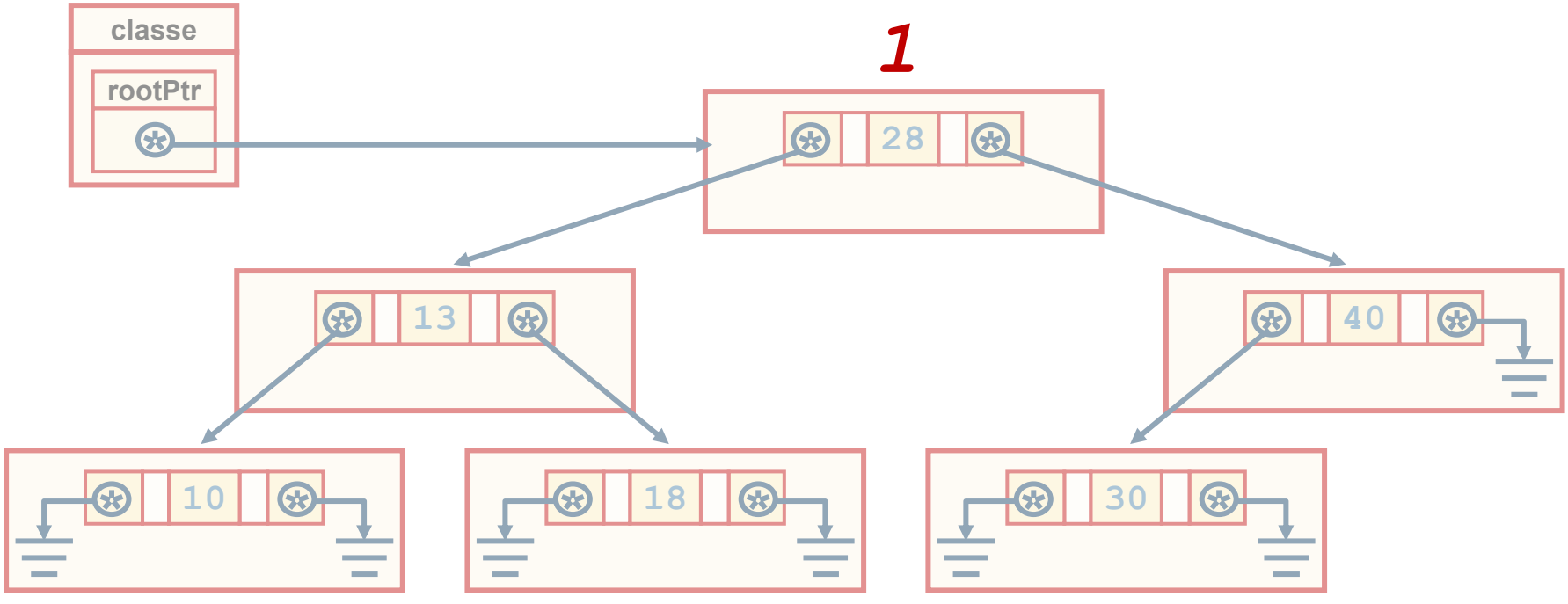
void Tree :: inOrderTraversal()
{
  recursiveInOrder(rootPtr);
}

void Tree :: recursiveInOrder(TreeNode *ptr)
{  if (ptr != 0)
    { recursiveInOrder(ptr->leftPtr);
      cout << ptr->datiStud.matricola << ' ';
      recursiveInOrder(ptr->rightPtr);
    }
}
```

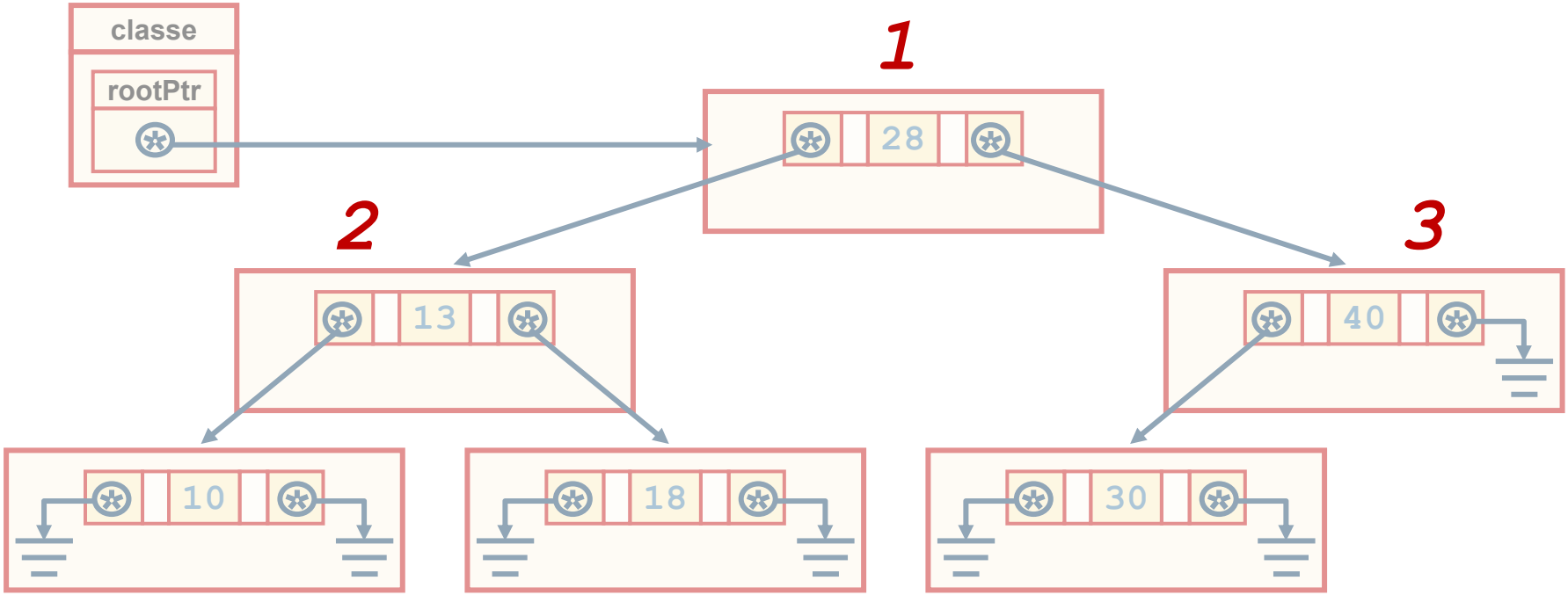
inOrderTraversal

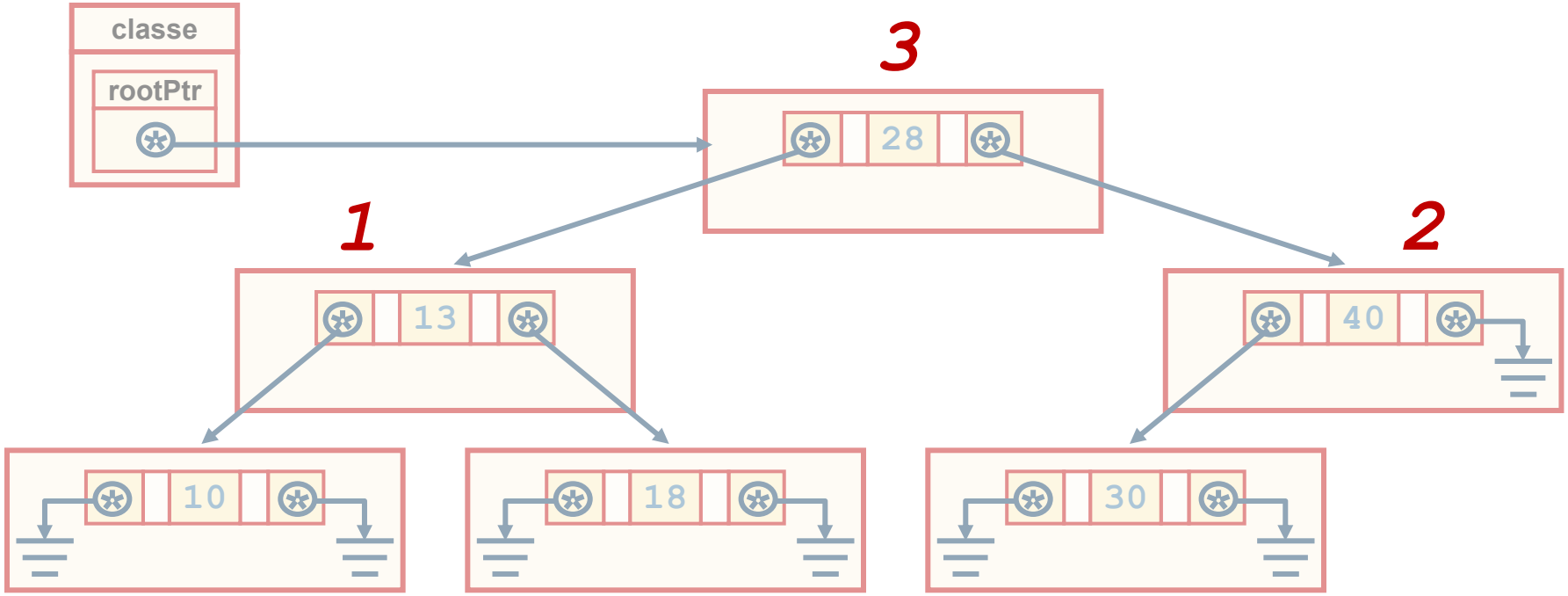


inOrderTraversal



preOrderTraversal




classe
rootPtr
3
28
1
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2
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10
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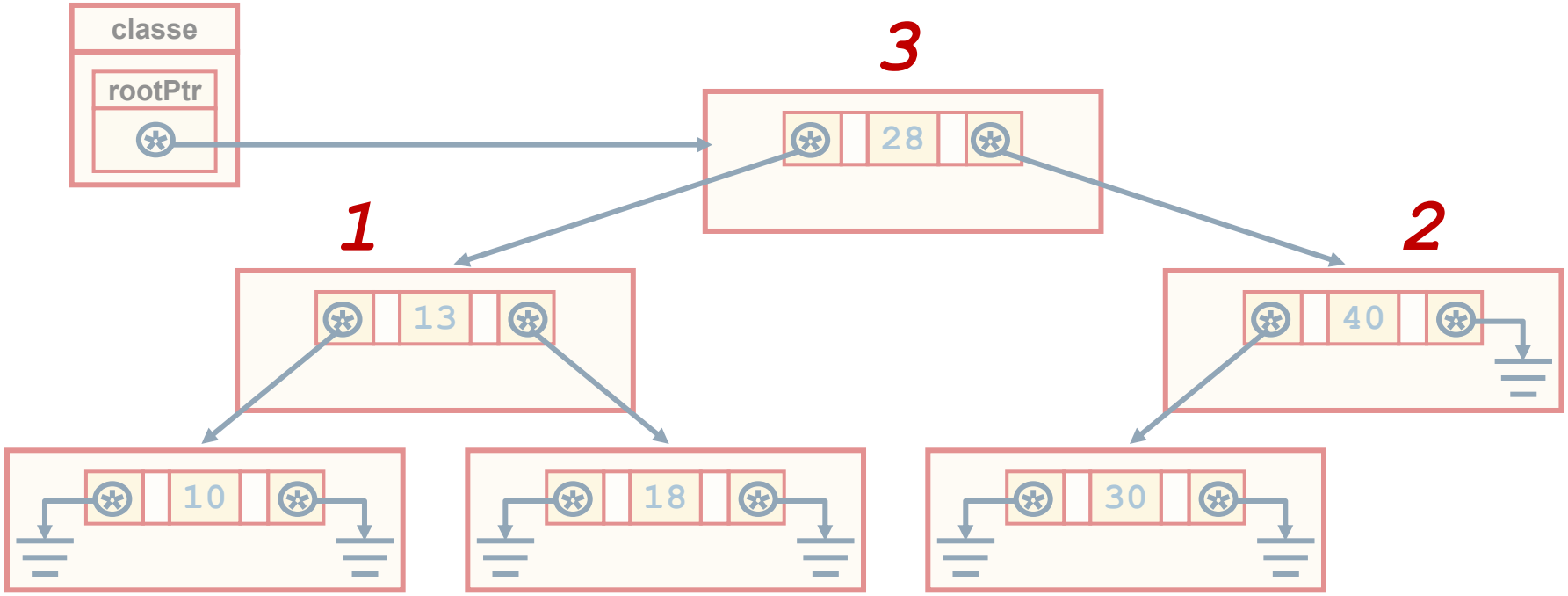
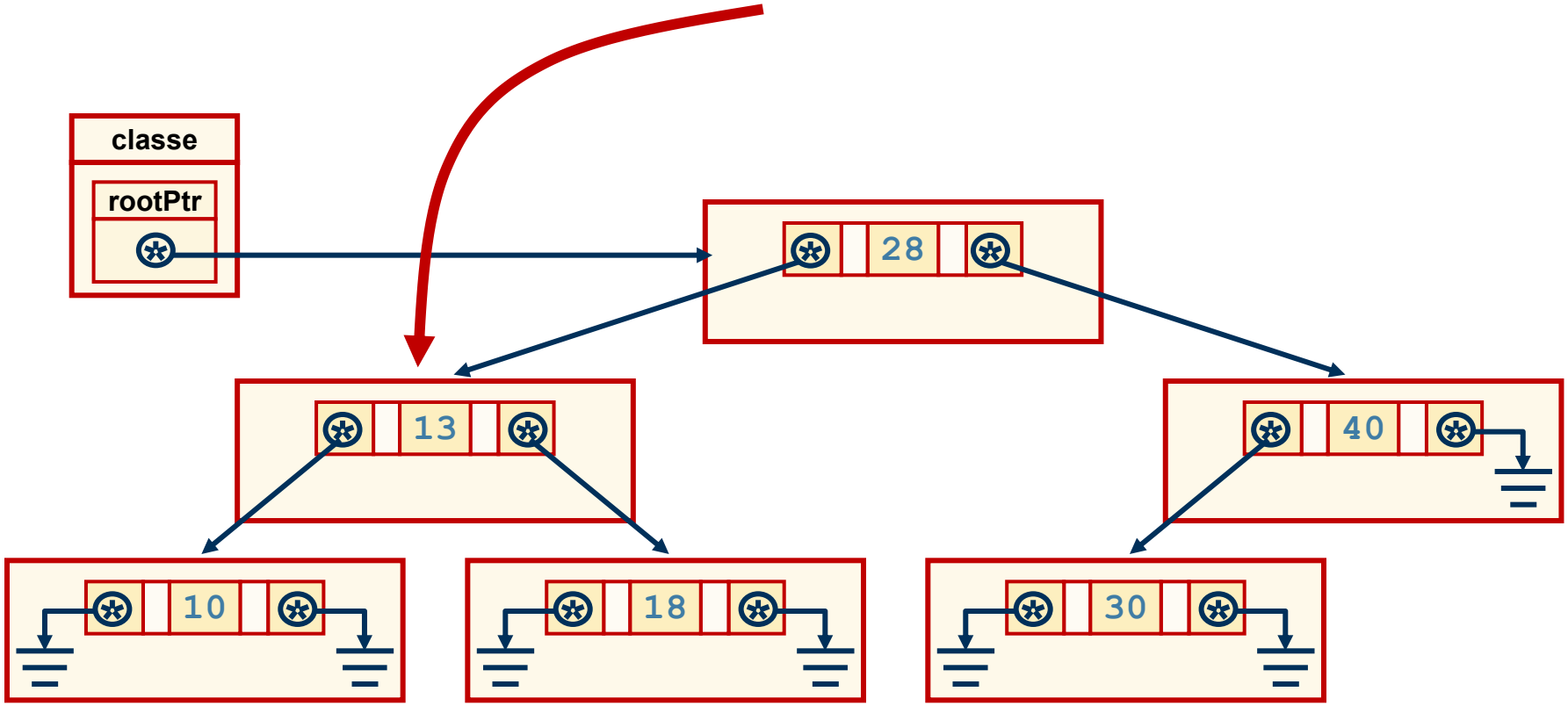
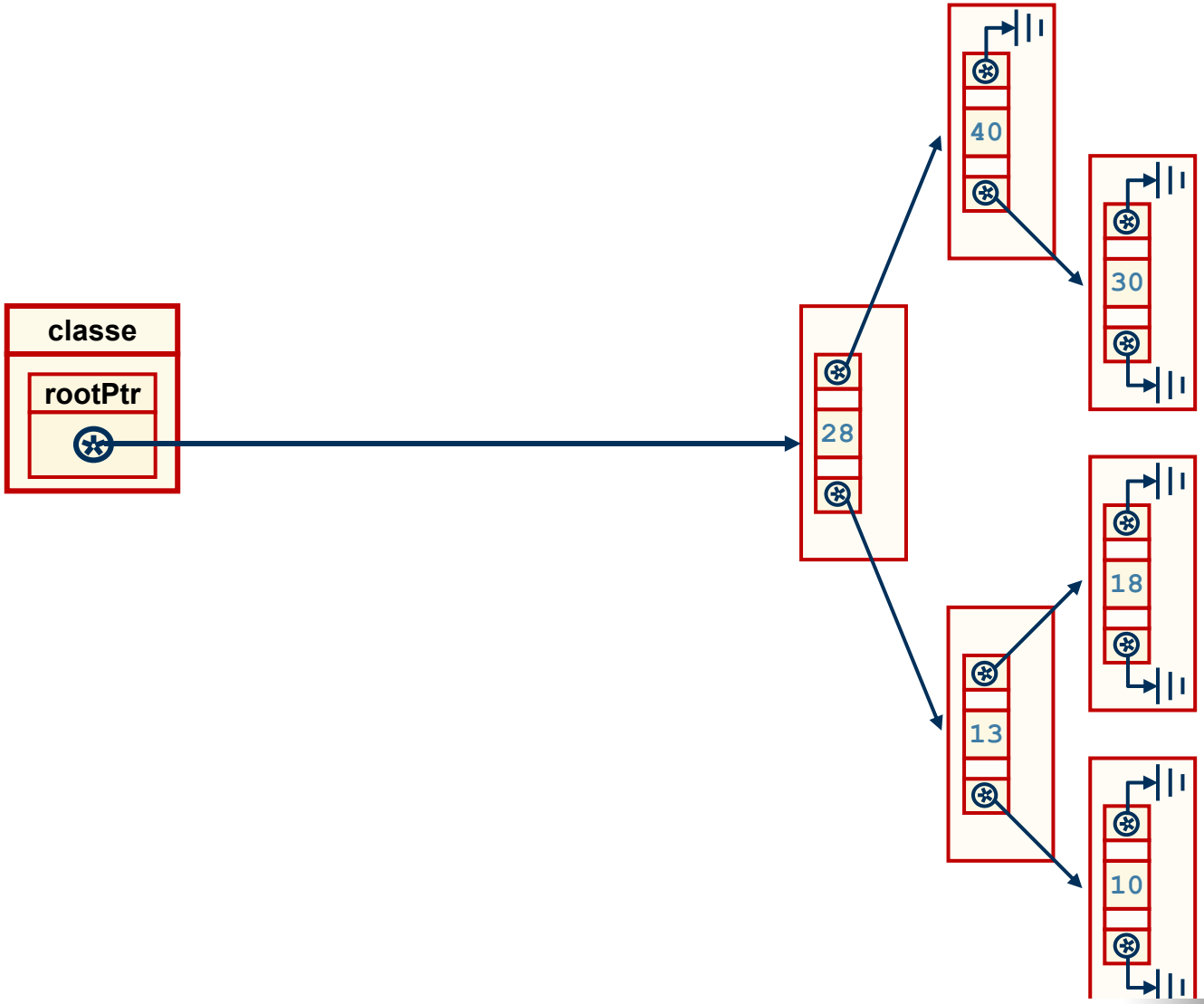
postOrderTraversal



Albero rovesciato




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

```
class Tree
{
  public:
    Tree();
    void inserisciSeNonEsiste(Studente);
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```

```
class Tree
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  public:
    Tree();
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    void stampaAlbertoRovesciato();
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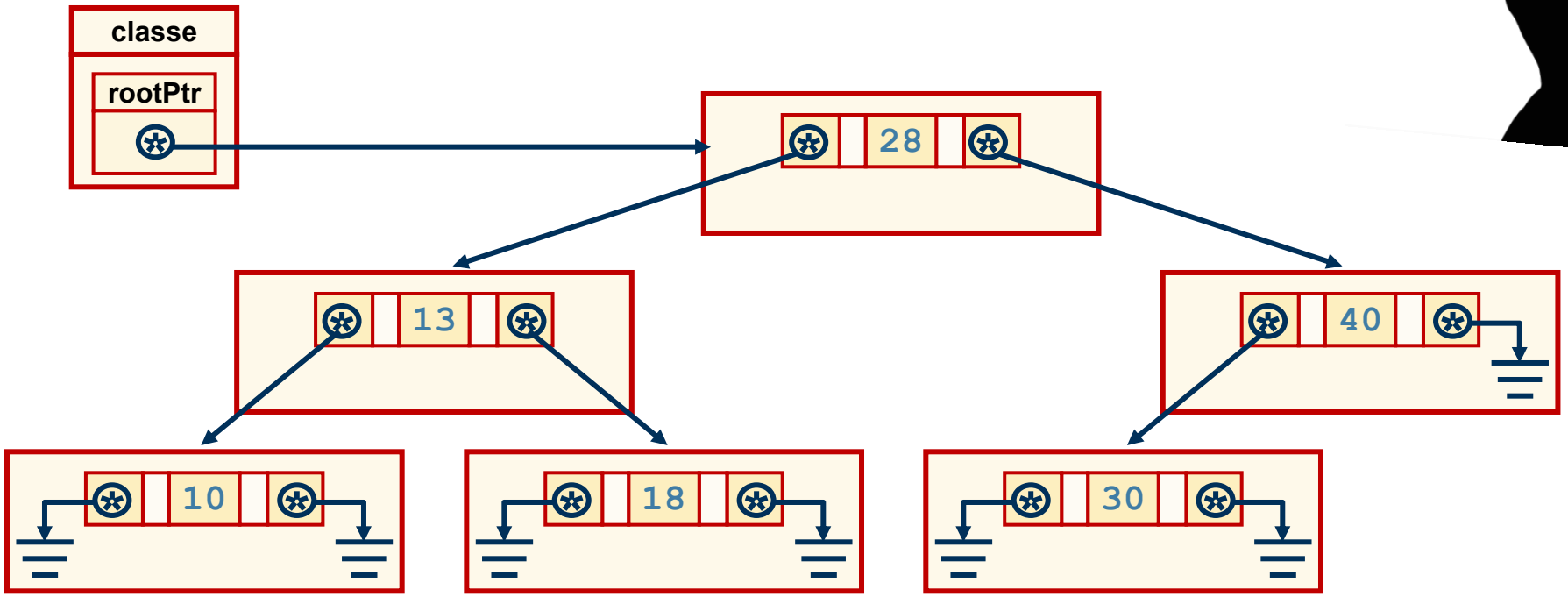
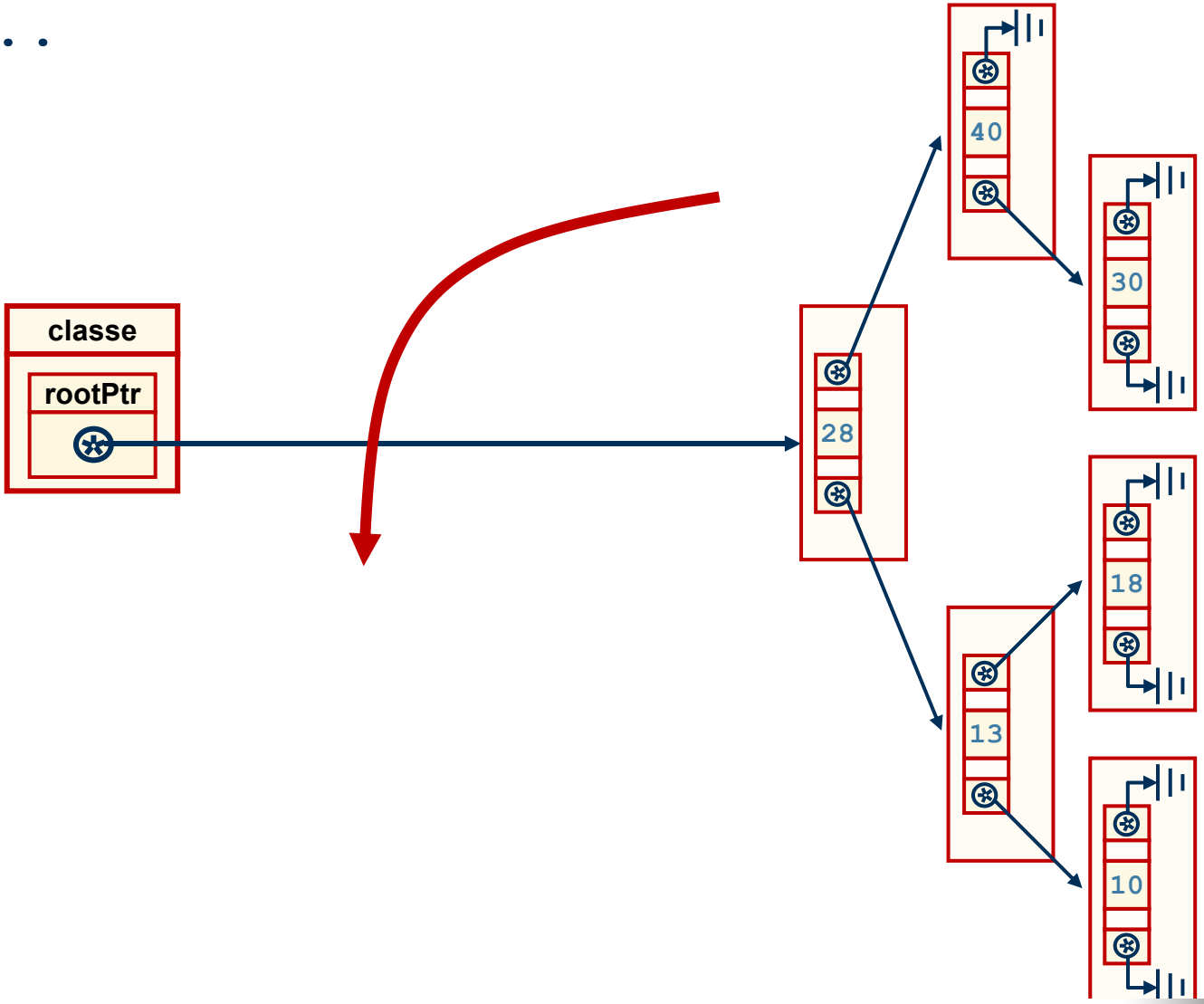
    void recursivePreOrder(TreeNode *);
    void recursivePostOder(TreeNode *);
    void stampaRovesciatoRicorsiva(TreeNode *, int);
};
```

Tree :: stampaAlbero(…)



```
Tree :: stampaAlberoRovesciato(…)
{...
}
```



```
void Tree:: stampaAlberoRovesciato()
{

  cout << "stato dell'albero ruotato di 90° in senso "
       << "antiorario" << endl;
  stampaRovesciatoRicorsiva(rootPtr);
}

void Tree:: stampaRovesciatoRicorsiva(TreeNode *ptr)
{

  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr);
      cout << "-"
           << ptr->datiStud.matricola << endl;
      stampaRovesciatoRicorsiva(ptr->leftPtr);
    }
}
```

```
void Tree:: stampaAlberoRovesciato()
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```

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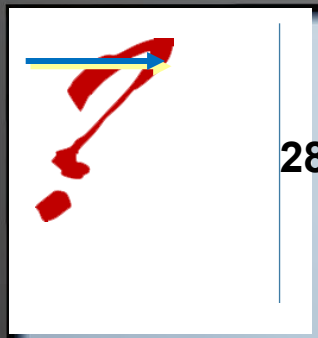

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  cons int initIdent = 10;
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}

void Tree:: stampaRovesciatoRicorsiva(TreeNode *ptr, int indent)
{

  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr,indent+ ...);
      cout << "-"
           << ptr->datiStud.matricola << endl;
      stampaRovesciatoRicorsiva(ptr->leftPtr);
    }
}
```

```
void Tree:: stampaAlberoRovesciato()
{
  cons int initIdent = 10;
  cout << "stato dell'albero ruotato di 90° in senso "
       << "antiorario" << endl;
  stampaRovesciatoRicorsiva(rootPtr, initIdent);
}

void Tree:: stampaRovesciatoRicorsiva(TreeNode *ptr, int indent)
{
  const int incrIndent = 3;
  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr,indent+ ...);
      cout << "-"
           << ptr->datiStud.matricola << endl;
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    }
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```

```
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void Tree:: stampaRovesciatoRicorsiva(TreeNode *ptr, int indent)
{
  const int incrIndent = 3;
  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr,indent+incrIndent);
      cout << "-"
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{
  const int incrIndent = 3;
  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr,indent+incrIndent);
      cout << setw(indent) << "-" << setw(dataDim)
           << ptr->datiStud.matricola << endl;
      stampaRovesciatoRicorsiva(ptr->leftPtr);
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  if (ptr != 0)
    { stampaRovesciatoRicorsiva(ptr->rightPtr,indent+incrIndent);
      cout << setw(indent) << "-" << setw(dataDim)
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              - 18
        - 13
              - 10
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