Analista Programador Universitario

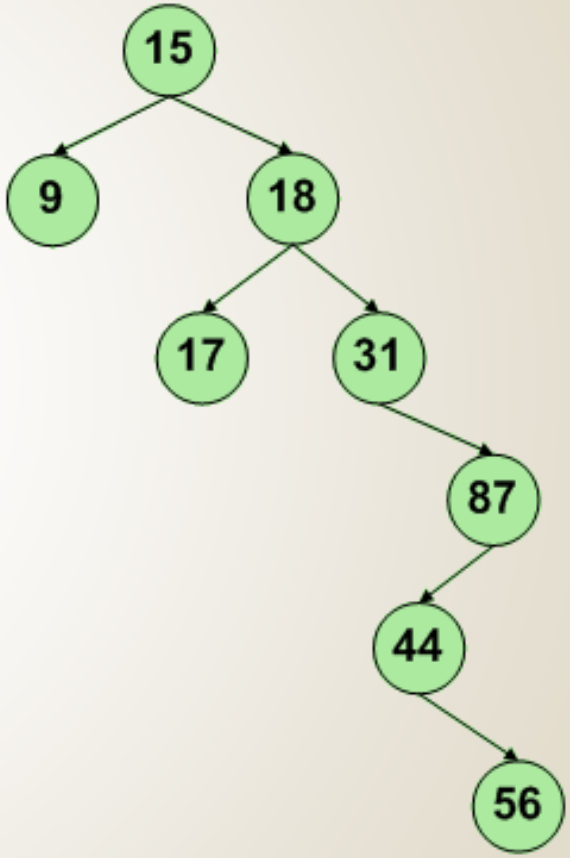
Estructura de Datos

Unidad VI: Árboles AVL

Facultad de Ingeniería
Universidad Nacional de Jujuy

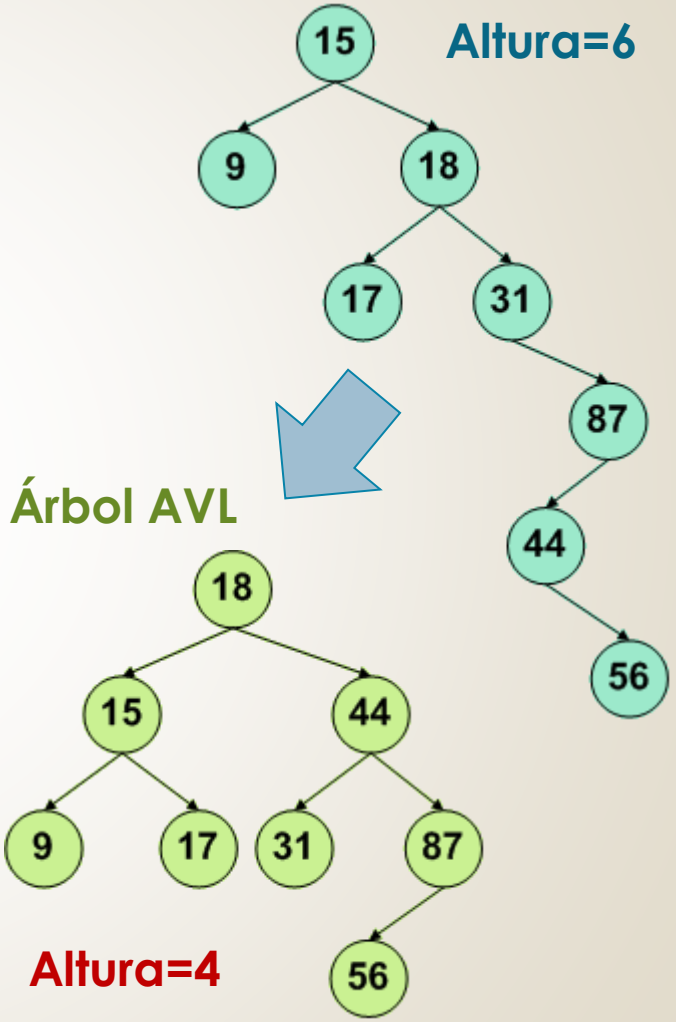
Árboles Binarios

- Los árboles binarios de búsqueda permiten organizar los datos de forma tal que las operaciones de inserción y búsqueda resultan relativamente sencillas.
- Cuando las ramas de un árbol crecen de forma desproporcionada, las operaciones sobre éste implican mayores recorridos de la estructura.



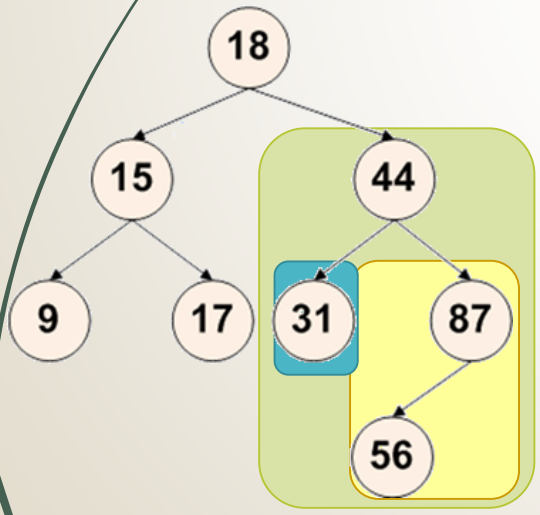
Árboles AVL (1)

- Adelson-Velski y Landis propusieron resolver el problema de crecimiento de los árboles binarios a través de los denominados árboles balanceados o AVL.



Árboles AVL (2)

- Un árbol binario se dice que está balanceado si y sólo si, en cada nodo, las alturas de sus 2 subárboles difieren como máximo en 1 (h_d-h_i pertenece al intervalo [-1,1]).
- La expresión h_d-h_i se denomina balance del nodo.




```
Balance nodo 44
Altura subárbol der (hd): 2
Altura subárbol izq (hi): 1
hd - hi = 2 - 1 = 1

Balance nodo 9: 0      Balance nodo 15: 0
Balance nodo 17: 0     Balance nodo 87: -1
Balance nodo 31: 0     Balance nodo 44: 1
Balance nodo 56: 0     Balance nodo 18: 1
```

Definición

```
typedef struct tnodo *pnodo
typedef struct tnodo
        {
         tipo_dato clave; //clave
         pnodo izq; //puntero a nodo
         pnodo der; //puntero a nodo
         int balance; //dif. hd y hi
         }
```

Inserción AVL (1)

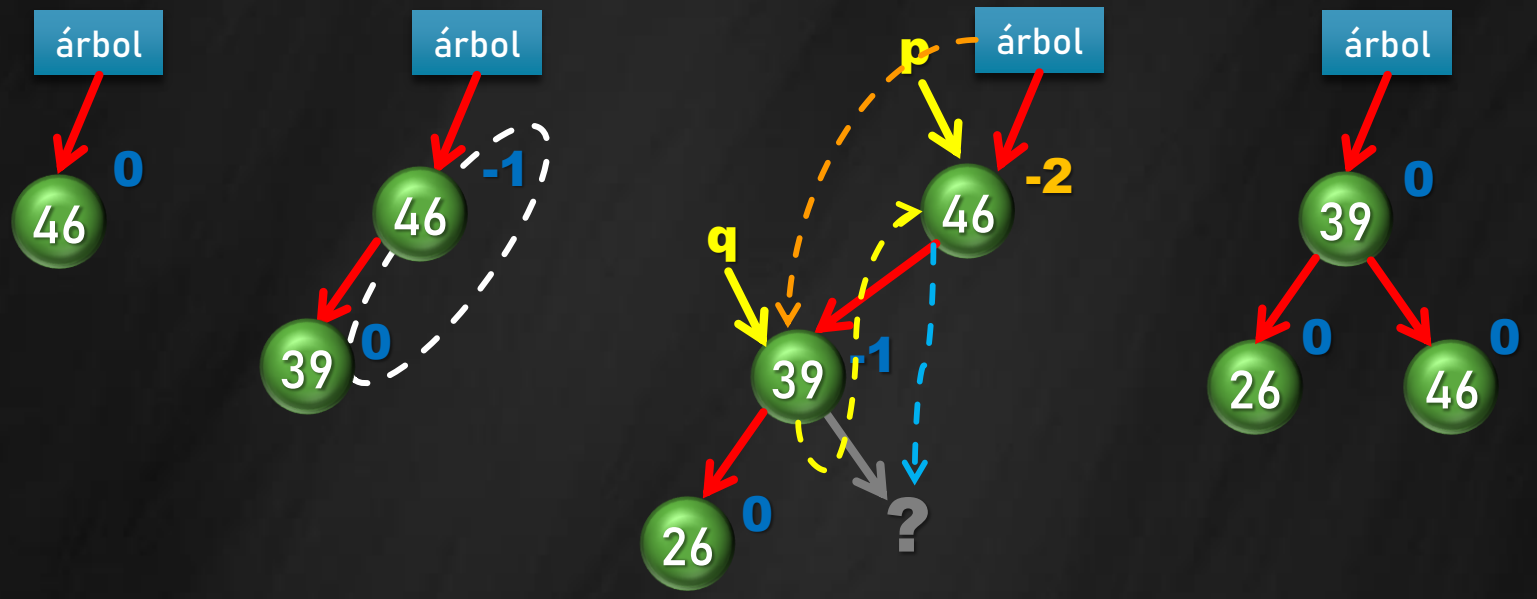
- La inserción en árboles AVL sigue la estrategia vista para árboles binarios de búsqueda, incorporando además un criterio de equilibrio.
- En base a este criterio, tras cada inserción se verifica el balance de los nodos del árbol, que debe ser -1, 0 o 1 para mantener un árbol AVL.
- Si se detecta que el balance no es correcto, el árbol se manipula reubicando nodos.

Inserción AVL (2)

- La inserción puede presentar 4 situaciones en las que es necesario rebalancear el árbol:
  - Left-Left (LL) o Izquierda-Izquierda
  - Left-Right (LR) o Izquierda-Derecha
  - Right-Right (RR) o Derecha-Derecha
  - Right-Left (RL) o Derecha-Izquierda

Caso LL (left-left)

Insertar en AVL: ~~46~~, ~~39~~, ~~26~~, 17, 11, 7




```
p->izq=q->der;
q->der=p;
p=q;
```

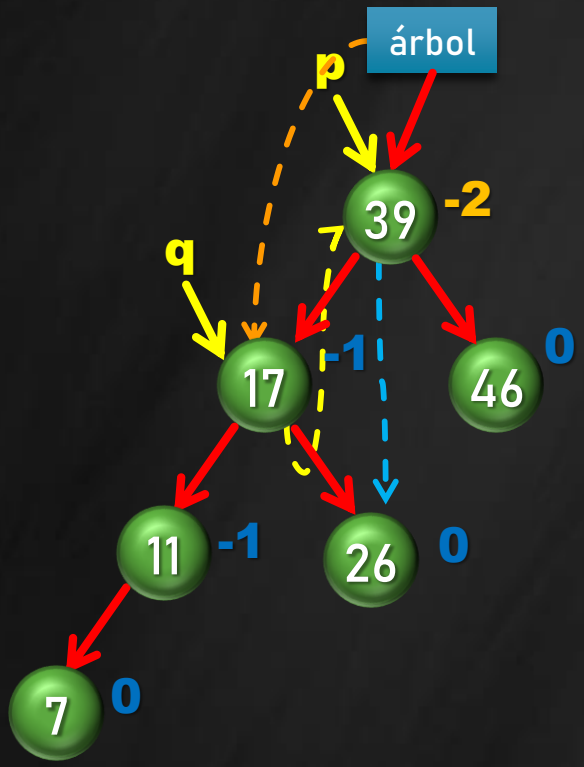
Caso LL (left-left)

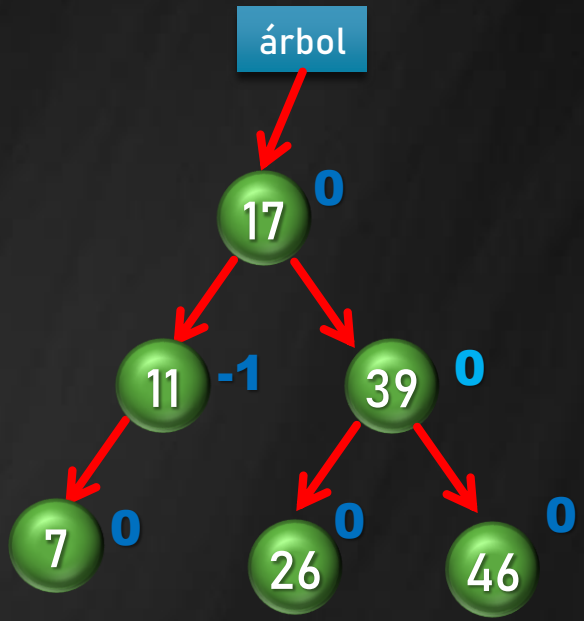
Insertar en AVL: ~~46~~, ~~39~~, ~~26~~, ~~17~~, ~~11~~, 7


```
p->izq=q->der;
q->der=p;
p=q;
```

Caso LL (left-left)

Insertar en AVL: ~~46~~, ~~39~~, ~~26~~, ~~17~~, ~~11~~, ~~7~~

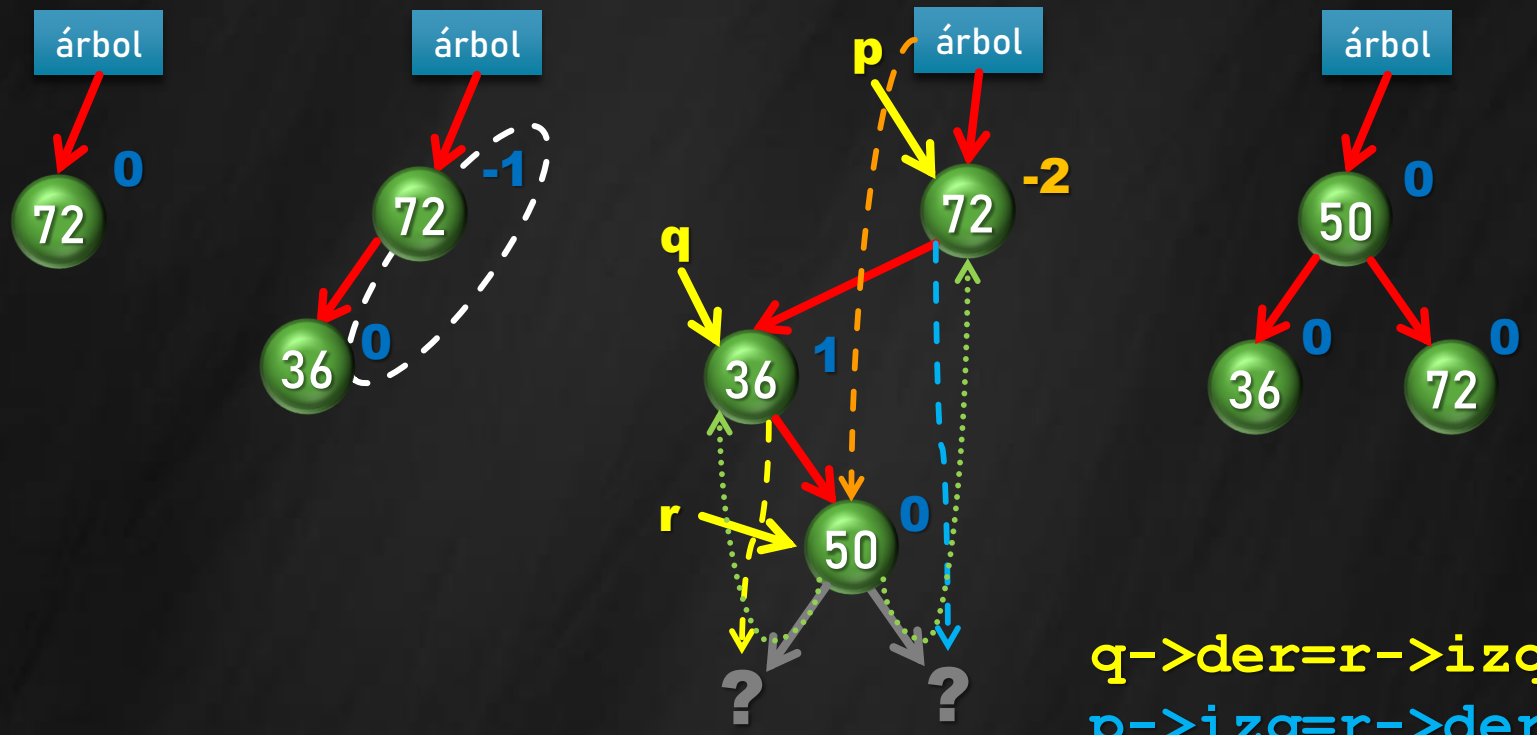





```
p->izq=q->der;
q->der=p;
p=q;
```

Caso LR (left-right)

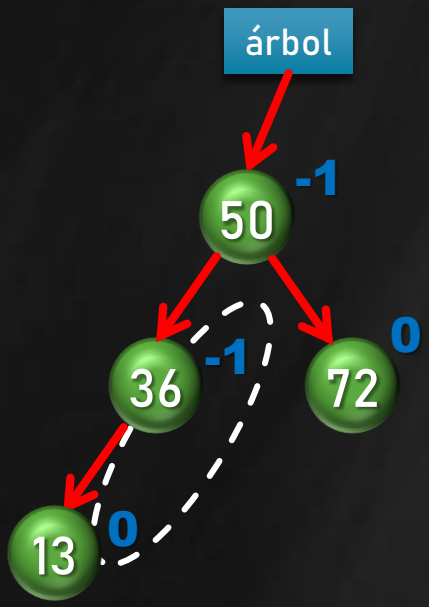
Insertar en AVL: ~~72~~, ~~36~~, ~~50~~, 13, 24, 31

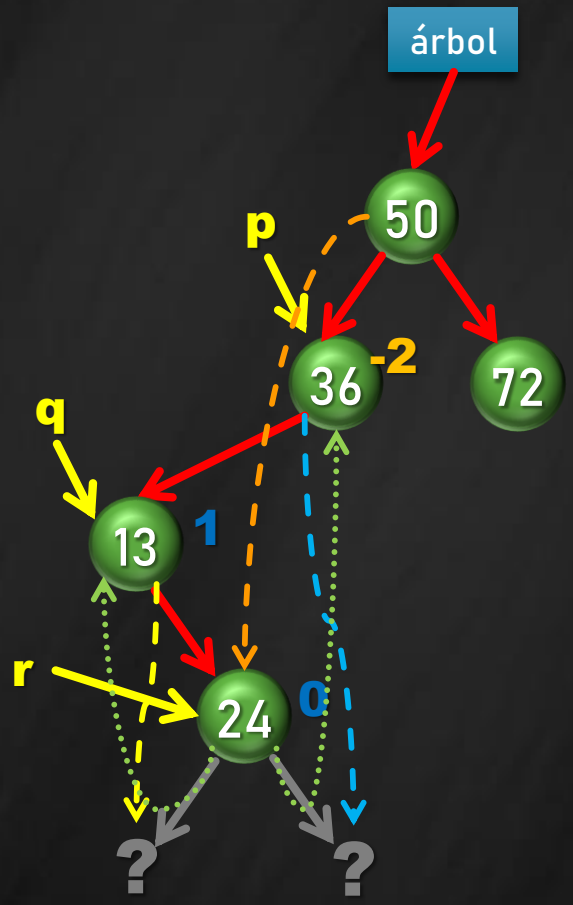


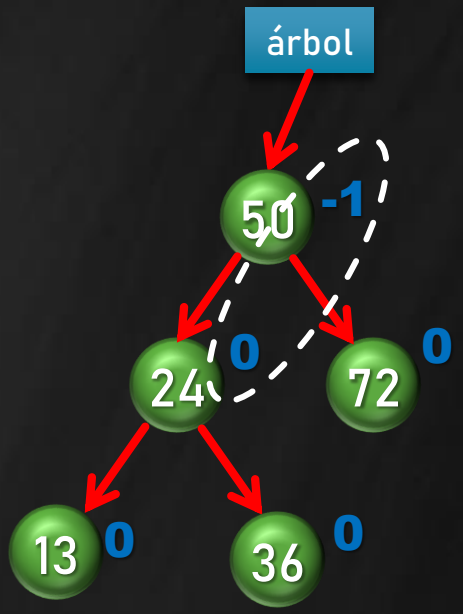

```
q->der=r->izq;
p->izq=r->der;
r->izq=q;
r->der=p
p=r;
```

Caso LR (left-right)

Insertar en AVL: ~~72~~, ~~36~~, ~~50~~, ~~13~~, ~~24~~, 31





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q->der=r->izq;
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r->der=p;
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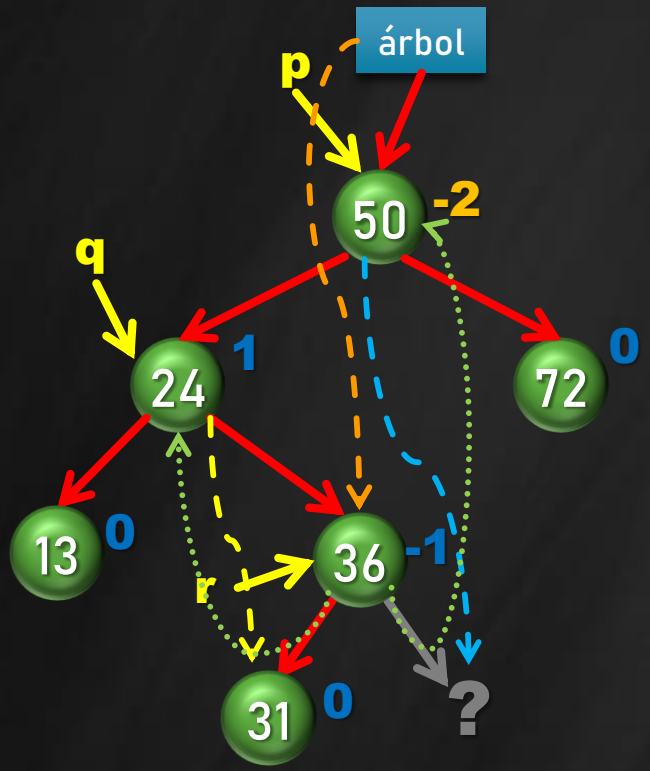
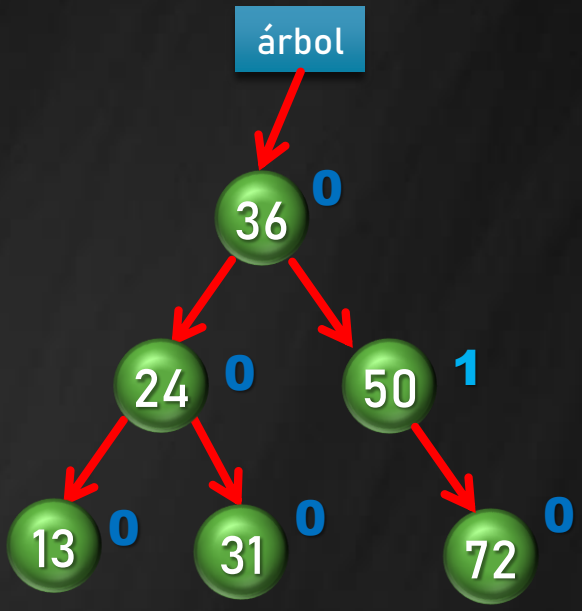
Caso LR (left-right)

Insertar en AVL: ~~72~~, ~~36~~, ~~50~~, ~~13~~, ~~24~~, ~~31~~

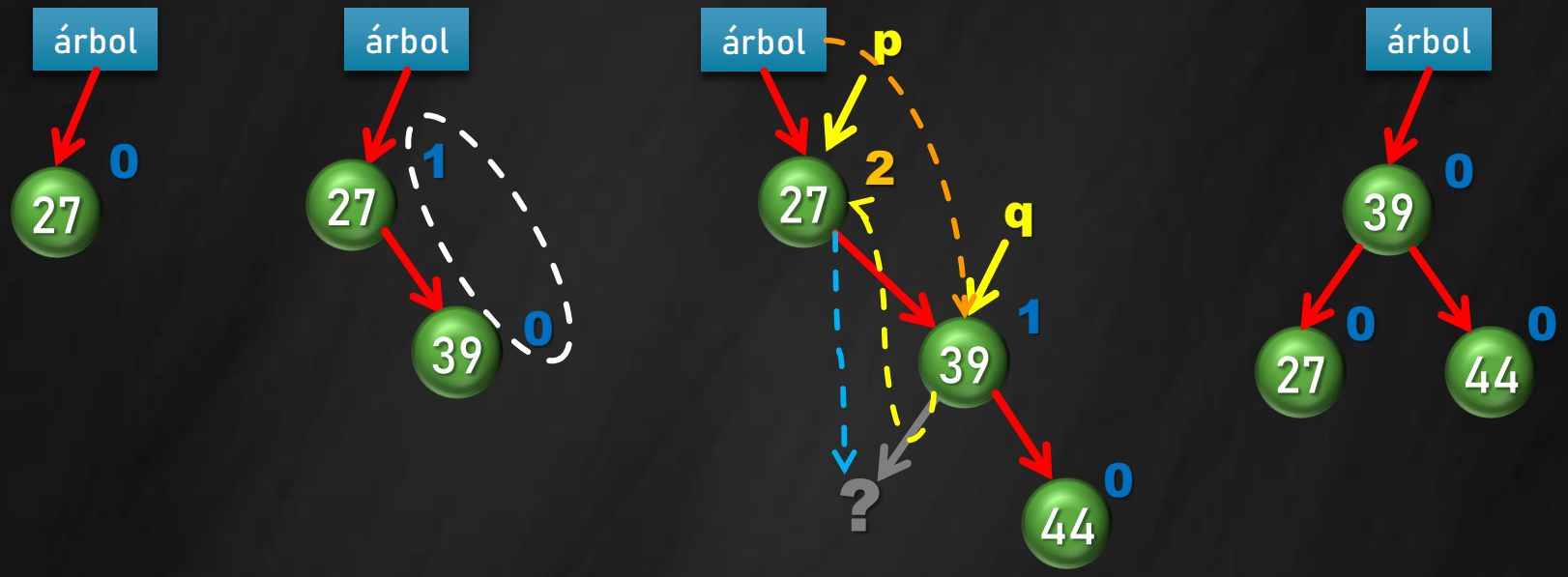





```
q->der=r->izq;
p->izq=r->der;
r->izq=q;
r->der=p
p=r;
```

Caso RR (right-right)

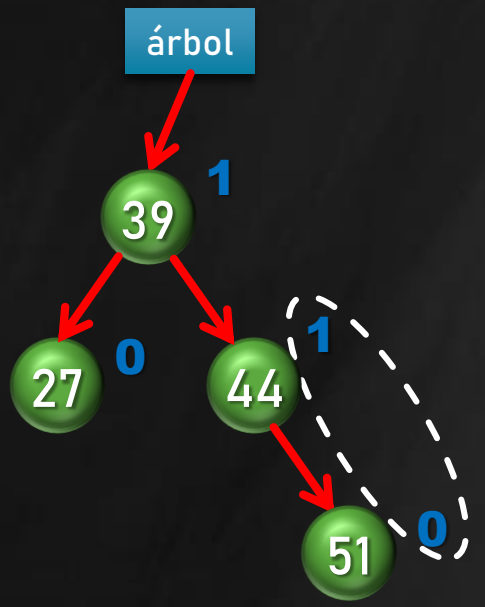
Insertar en AVL: ~~27~~, ~~39~~, ~~44~~, 51, 67, 58

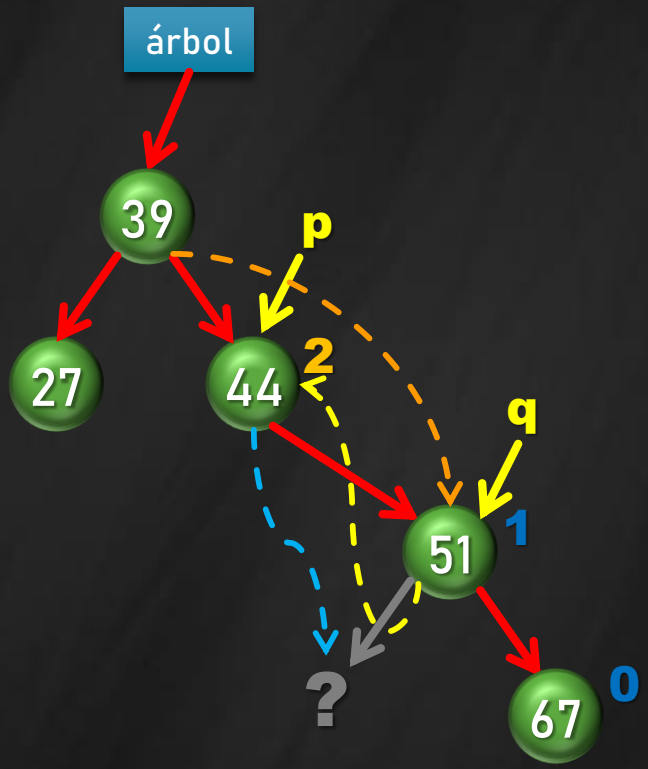


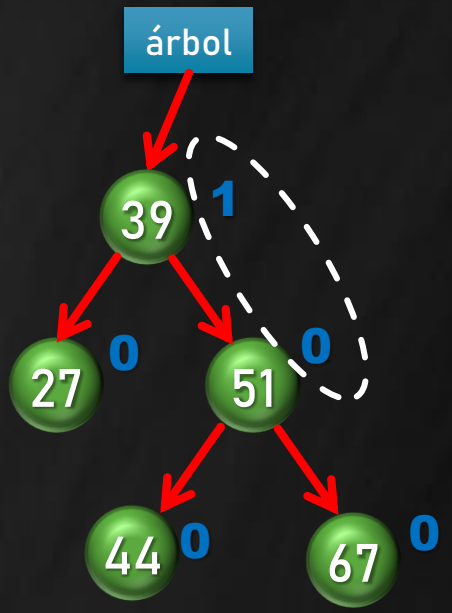

```
p->der=q->izq;
q->izq=p;
p=q;
```

Caso RR (right-right)

Insertar en AVL: ~~27~~, ~~39~~, ~~44~~, ~~51~~, ~~67~~, 58



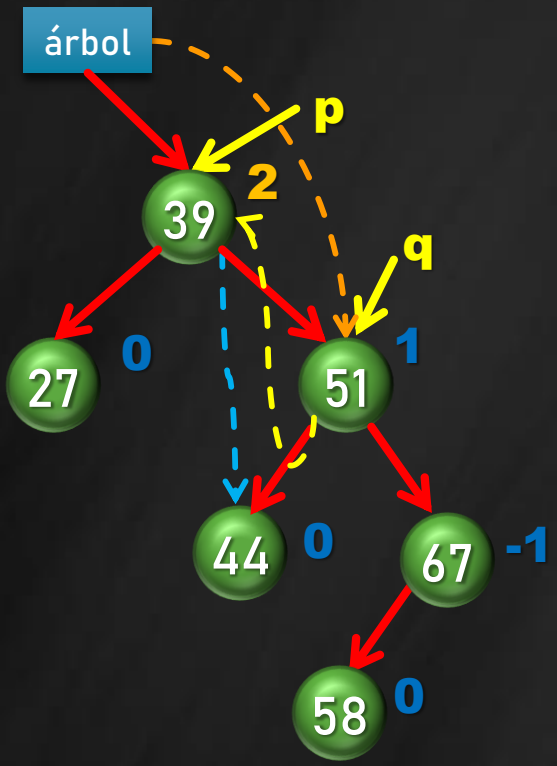


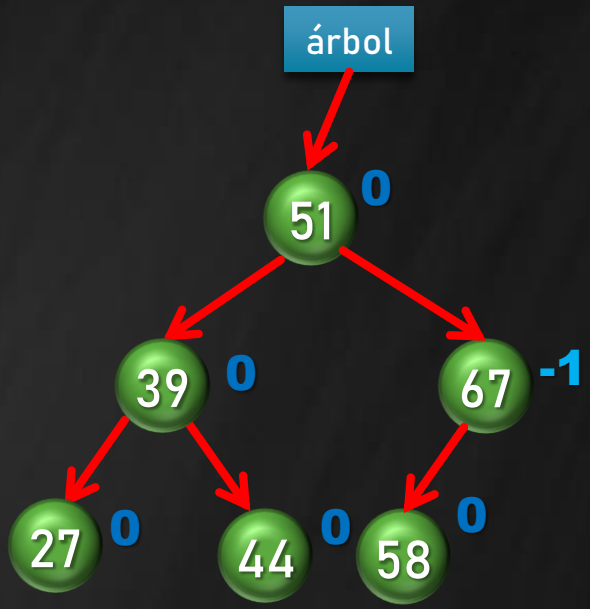



```
p->der=q->izq;
q->izq=p;
p=q;
```

Caso RR (right-right)

Insertar en AVL: ~~27~~, ~~39~~, ~~44~~, ~~51~~, ~~67~~, ~~58~~

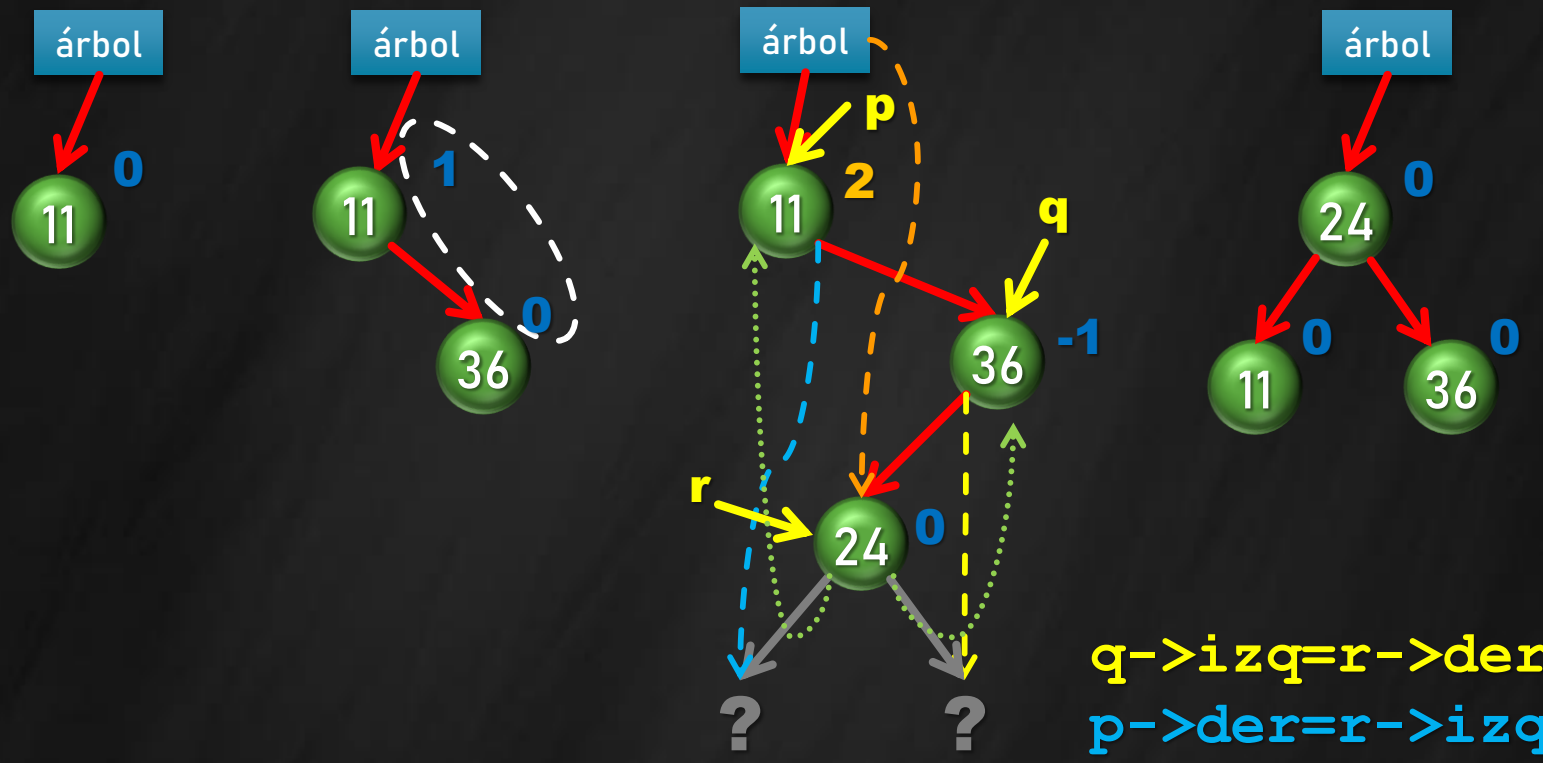





```
p->der=q->izq;
q->der=p;
p=q;
```

Caso RL (right-left)

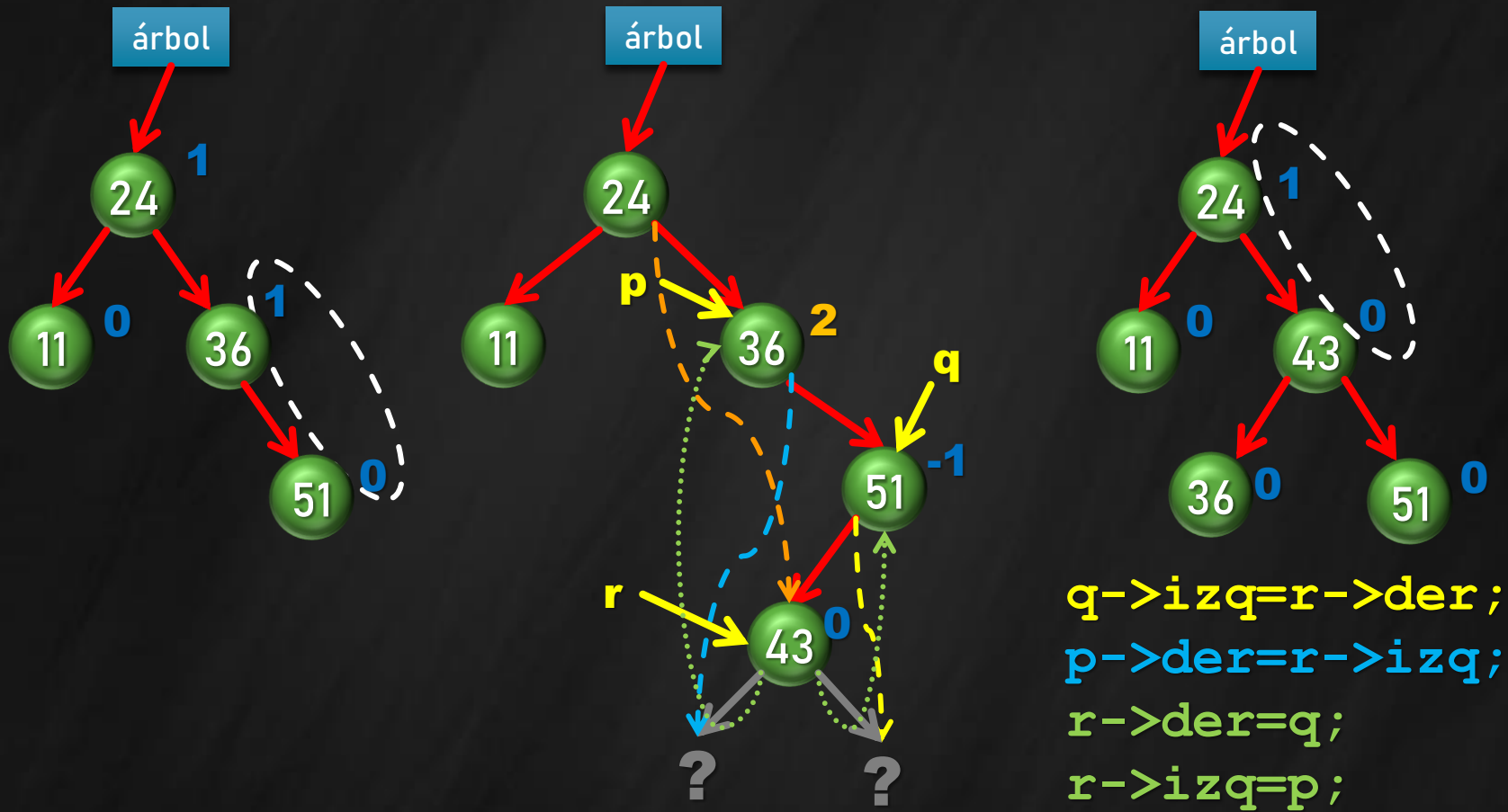
Insertar en AVL: ~~11~~, ~~36~~, ~~24~~, 51, 43, 39




```
q->izq=r->der;
p->der=r->izq;
r->der=q;
r->izq=p;
p=r;
```

Caso RL (right-left)

Insertar en AVL: ~~11, 36, 24, 51, 43~~, 39

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Caso RL (right-left)

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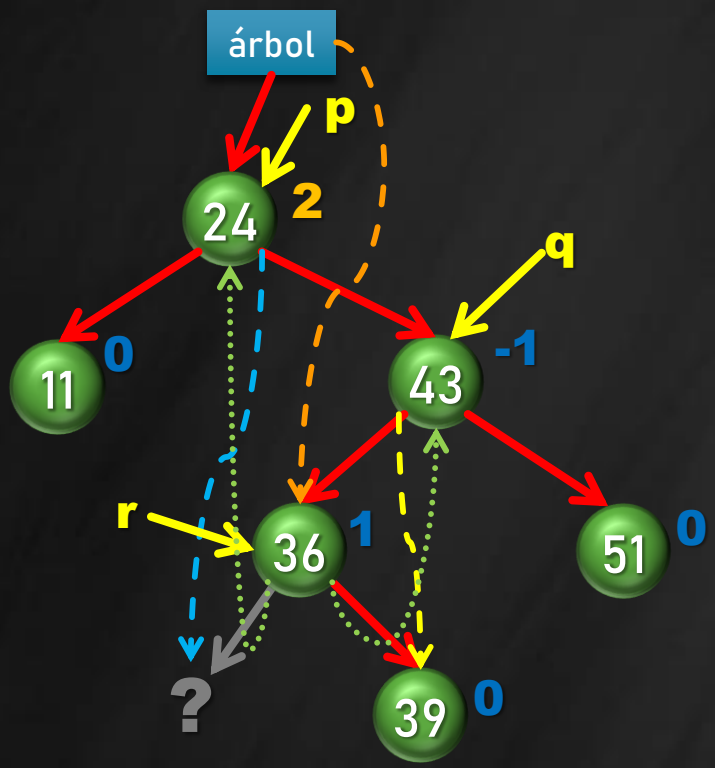

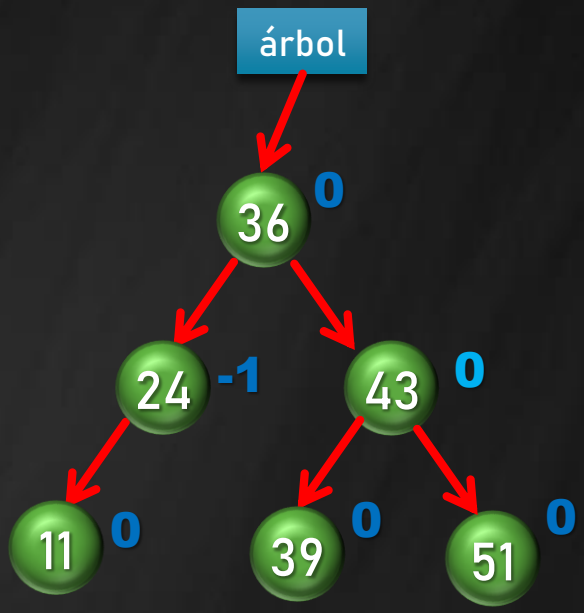


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q->izq=r->der;
p->der=r->izq;
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Bibliografía

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- Joyanes Aguilar *et al*. Estructuras de Datos en C++. Mc Graw Hill. 2007.
- De Giusti, Armando *et al.* Algoritmos, datos y programas, conceptos básicos. Editorial Exacta. 1998.
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