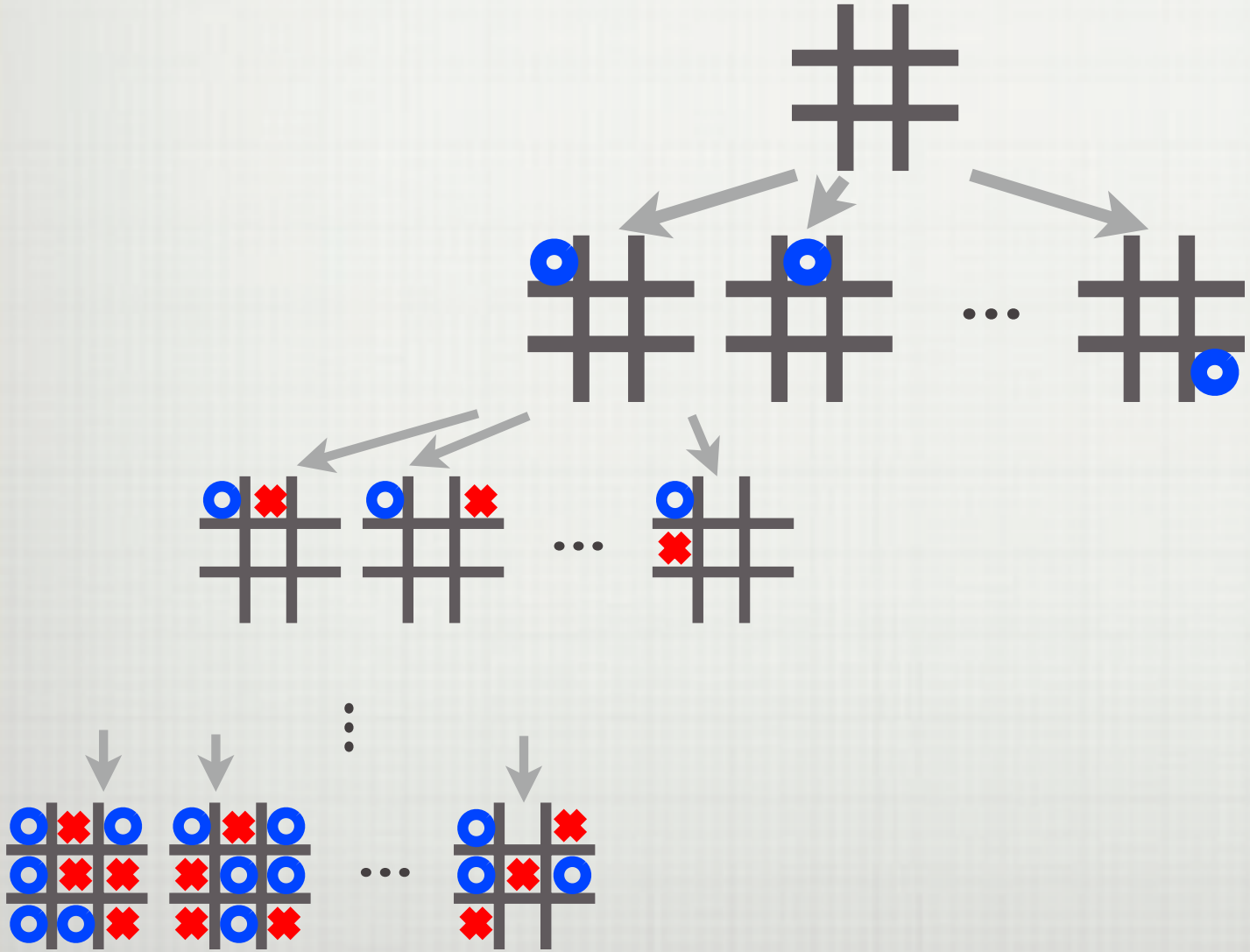
JOHDATUS TEKOÄLYYN

TEEMU ROOS

HELSINGIN YLIOPISTO

PELIPUU



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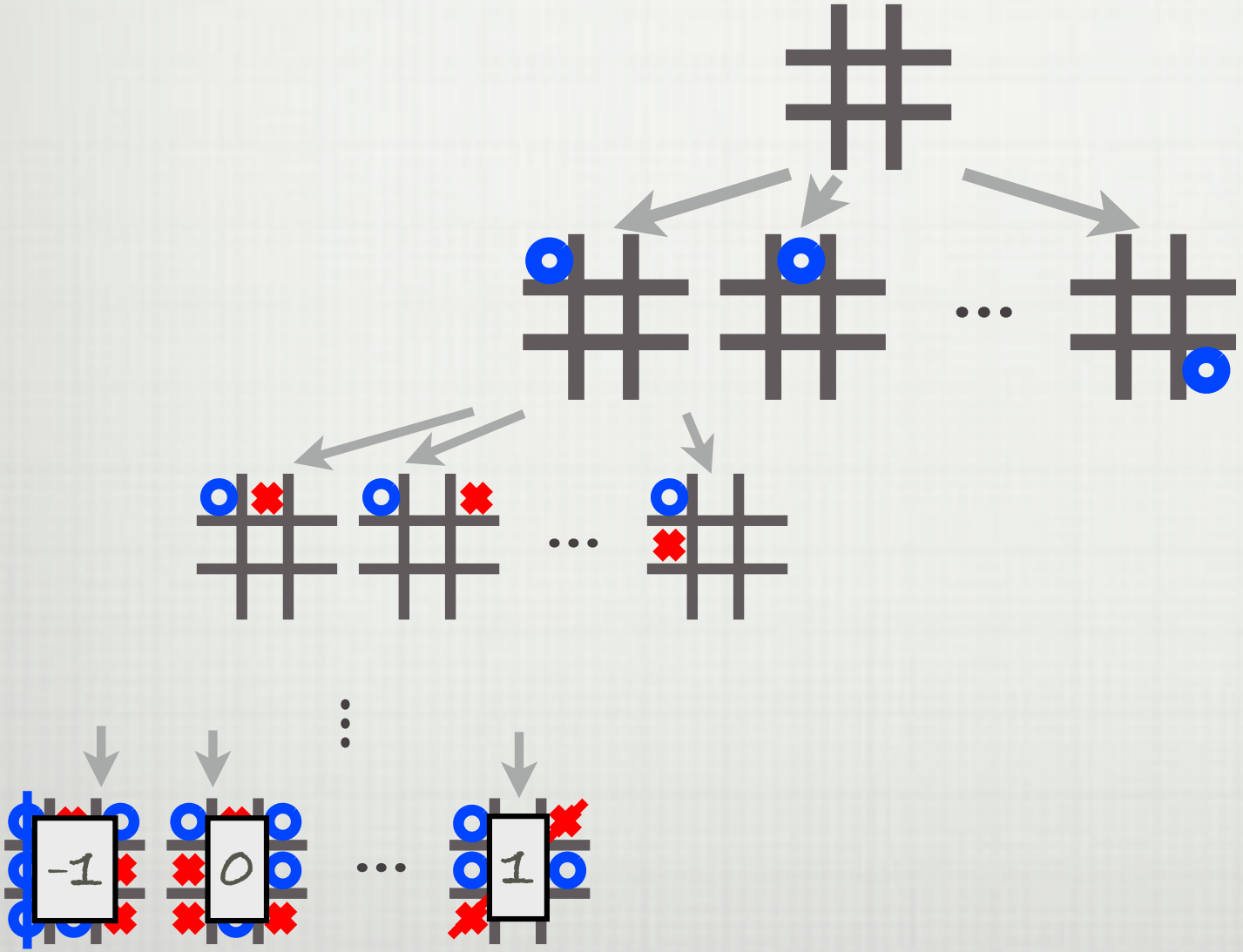

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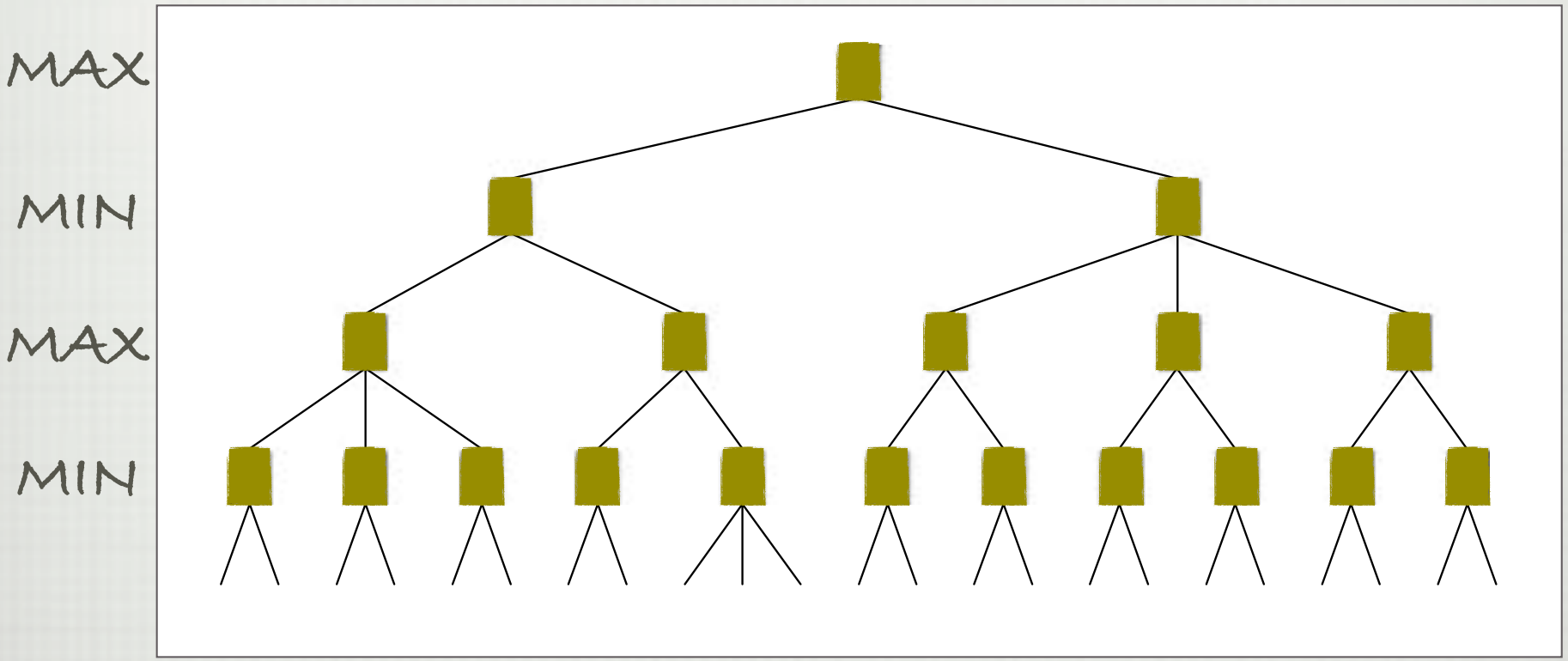

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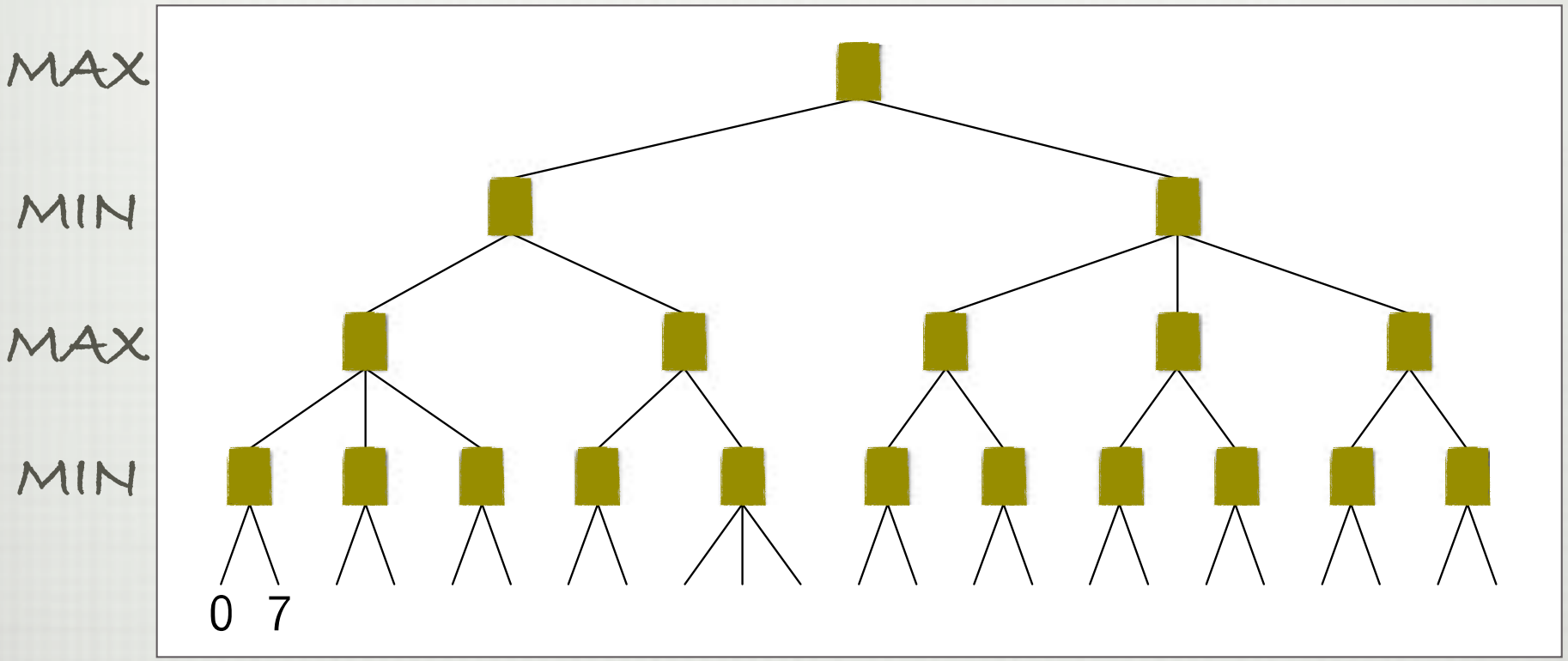

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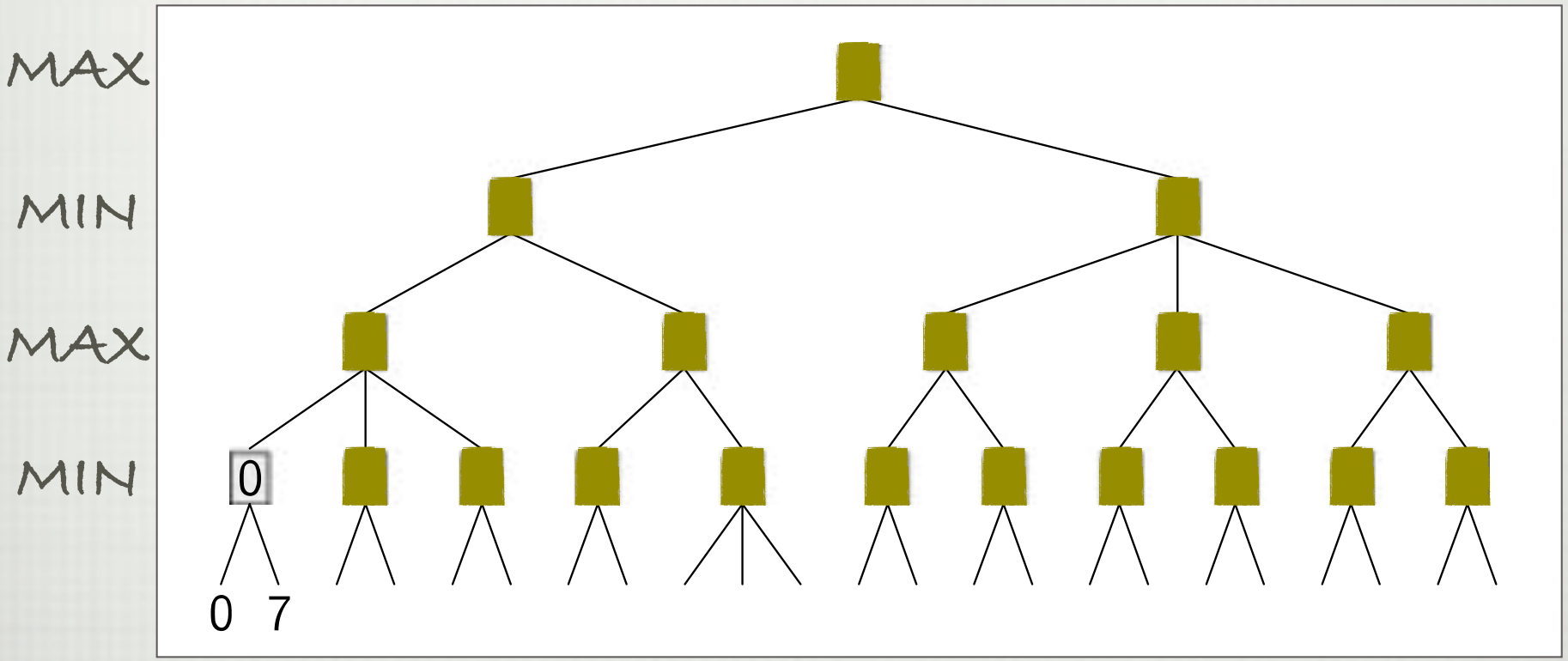

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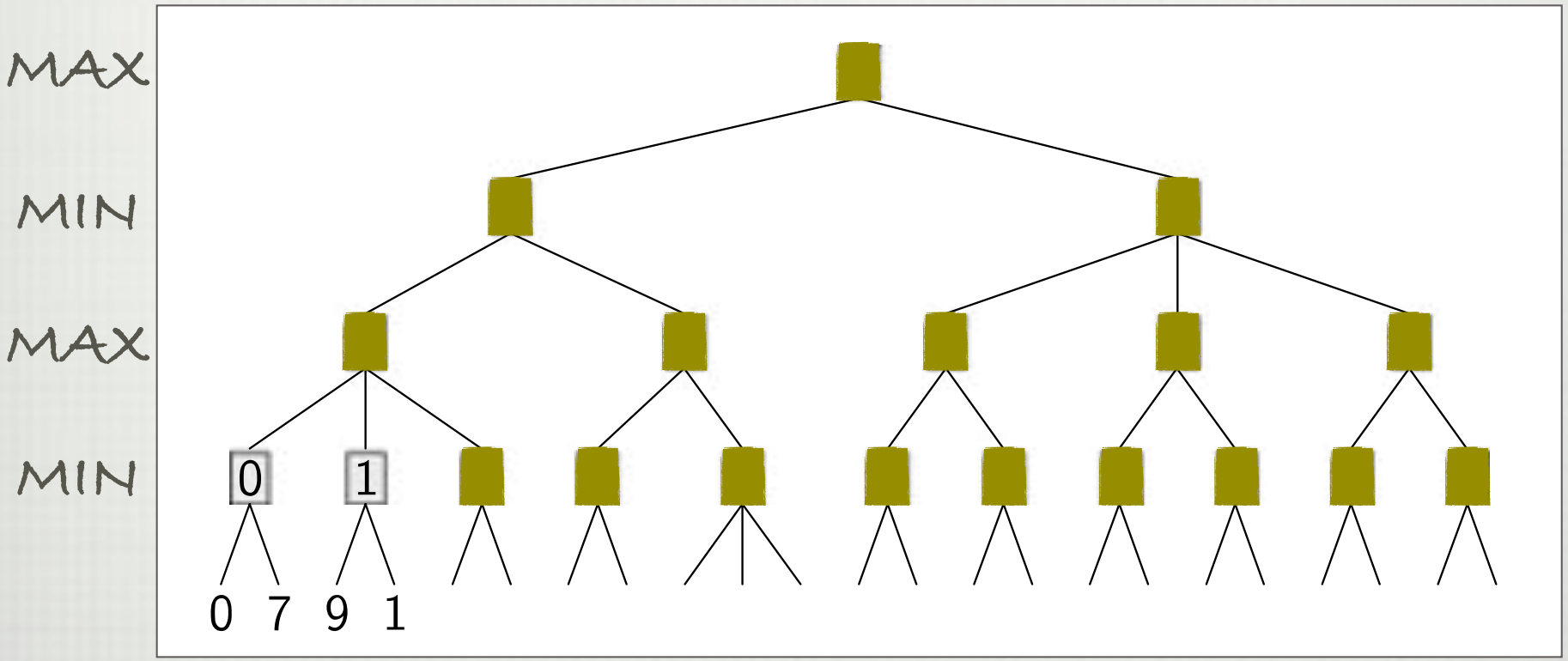

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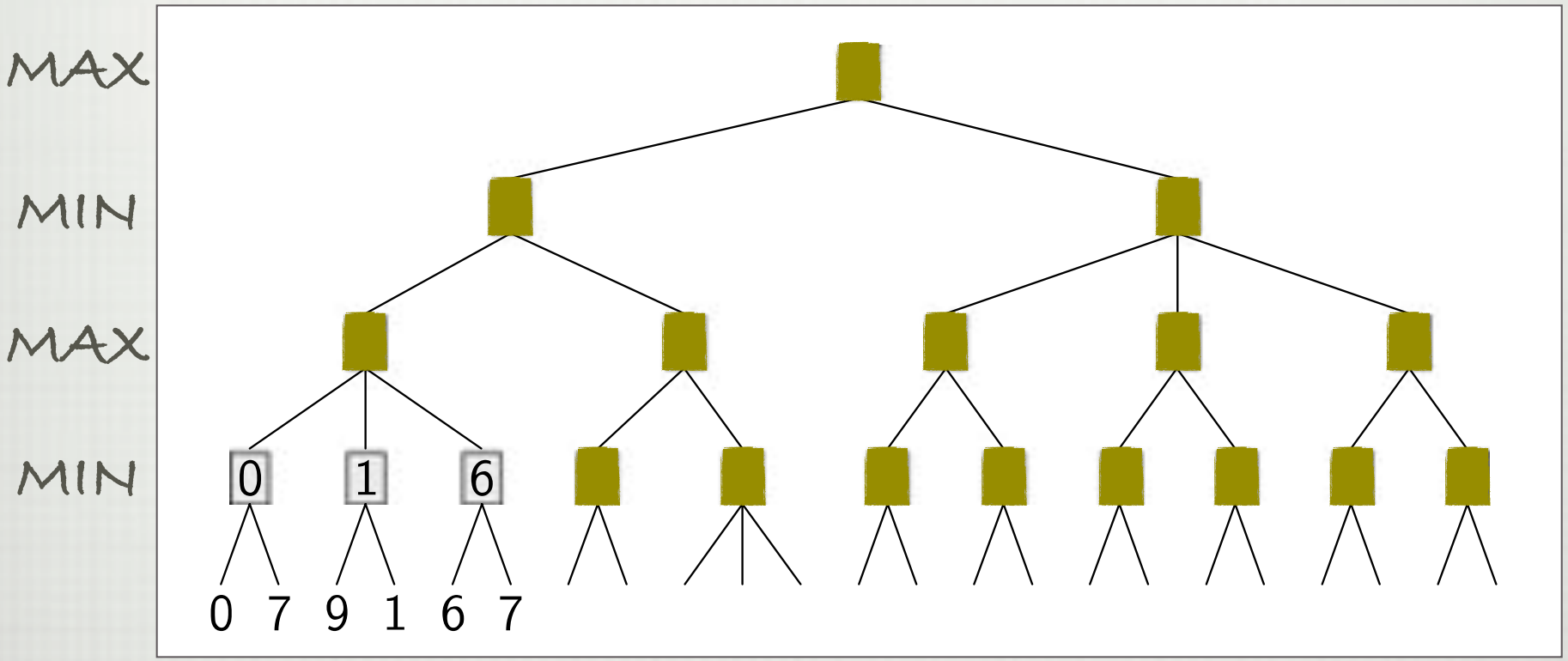

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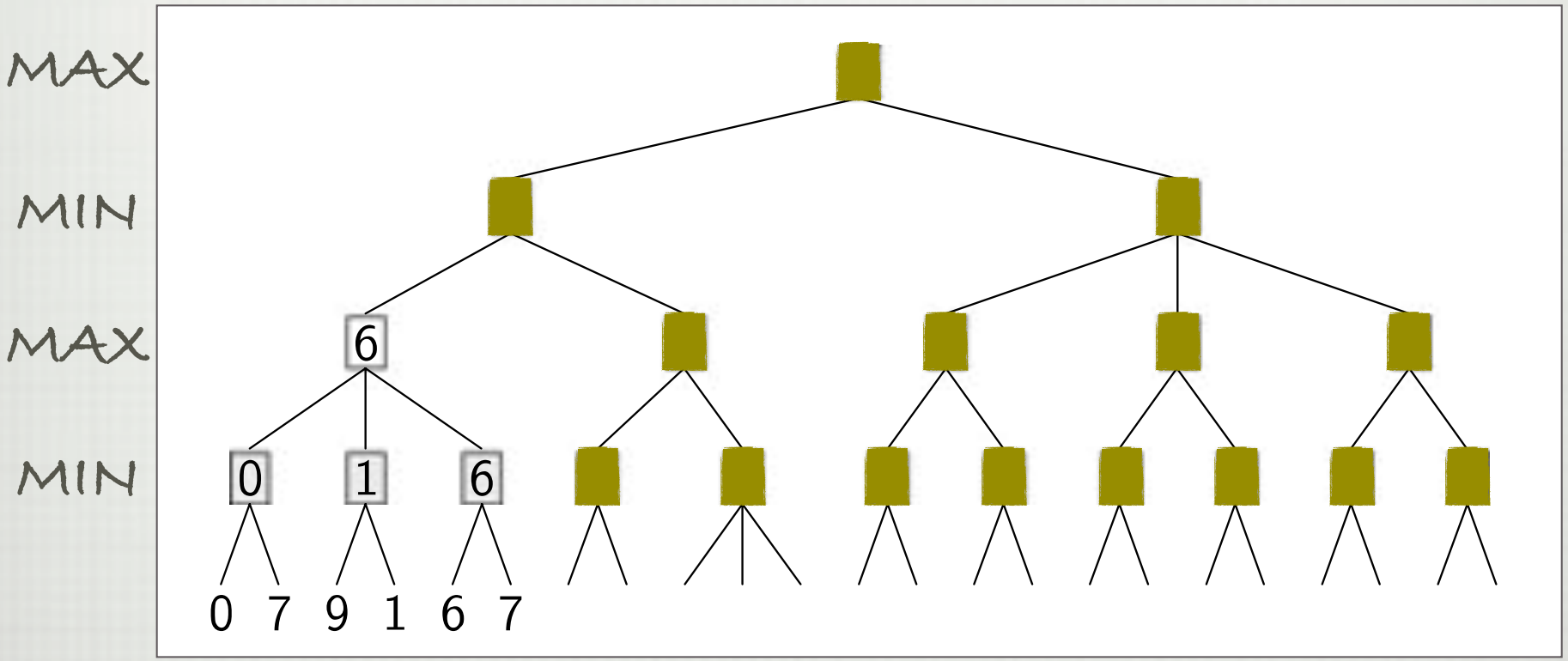

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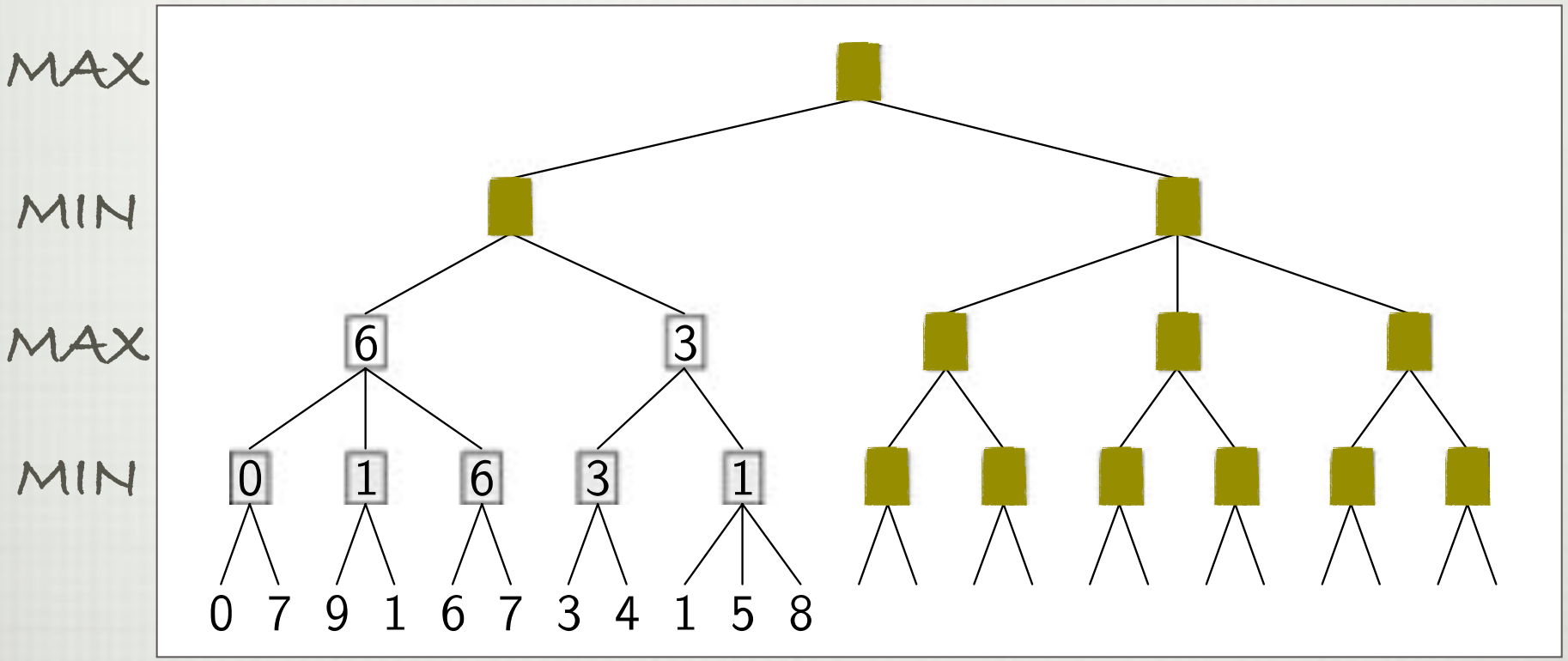

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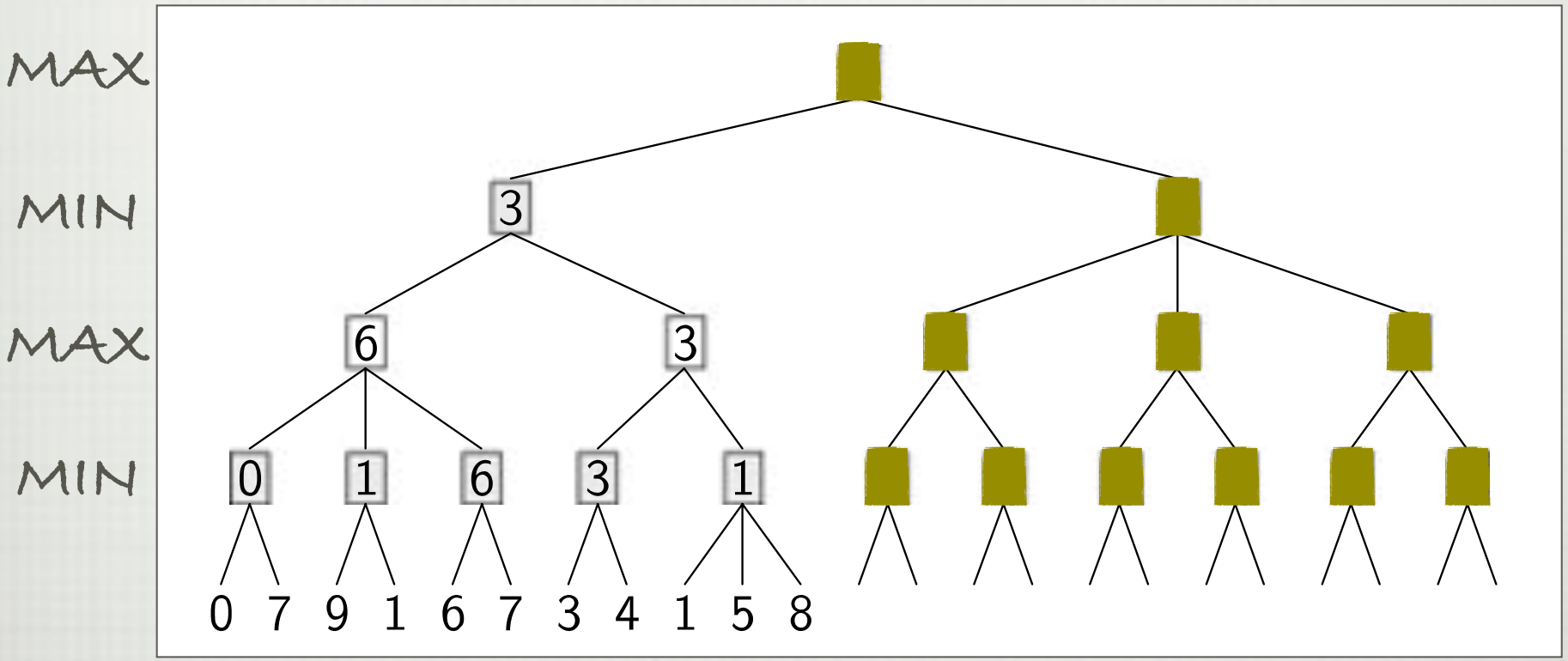

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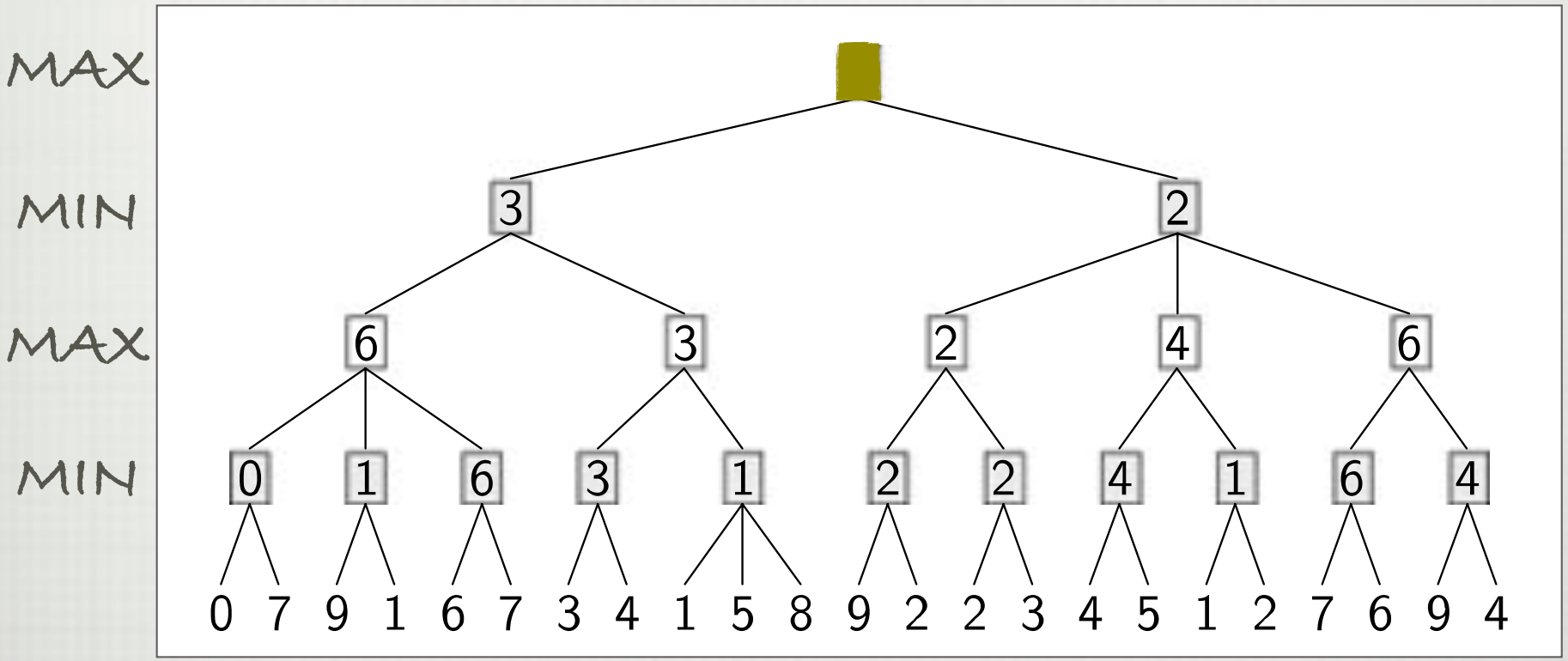
MAX
MIN
MAX
MIN
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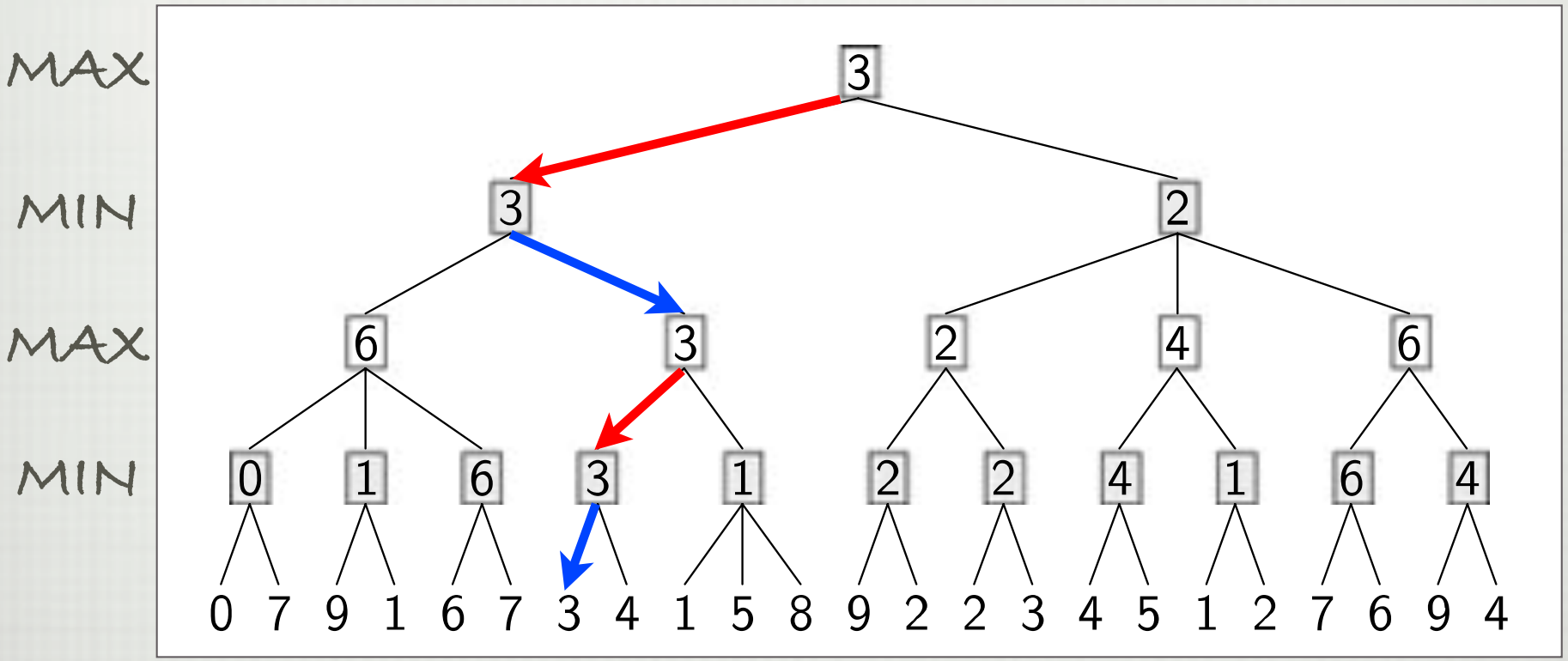
PELIPUU


MAX
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1
6
4
0 7 9 1 6 7 3 4 1 5 8 9 2 2 3 4 5 1 2 7 6 9 4

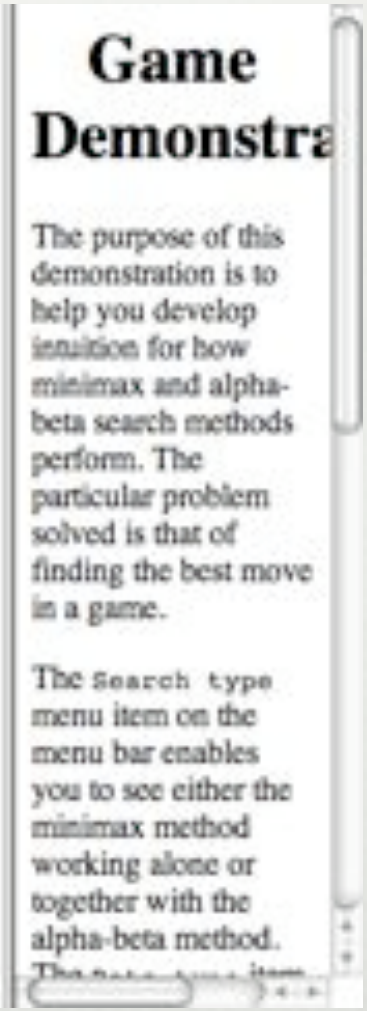
MINIMAX

```
MAX-ARVO(Solmu)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = −∞
    for each Lapsi in LAPSET(Solmu)
        v = MAX(v, MIN-ARVO(Lapsi))
    return(v)

MIN-ARVO(Solmu)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = +∞
    for each Lapsi in LAPSET(Solmu)
        v = MIN(v, MAX-ARVO(Lapsi))
    return(v)
```

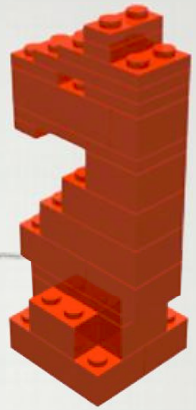
MINIMAX

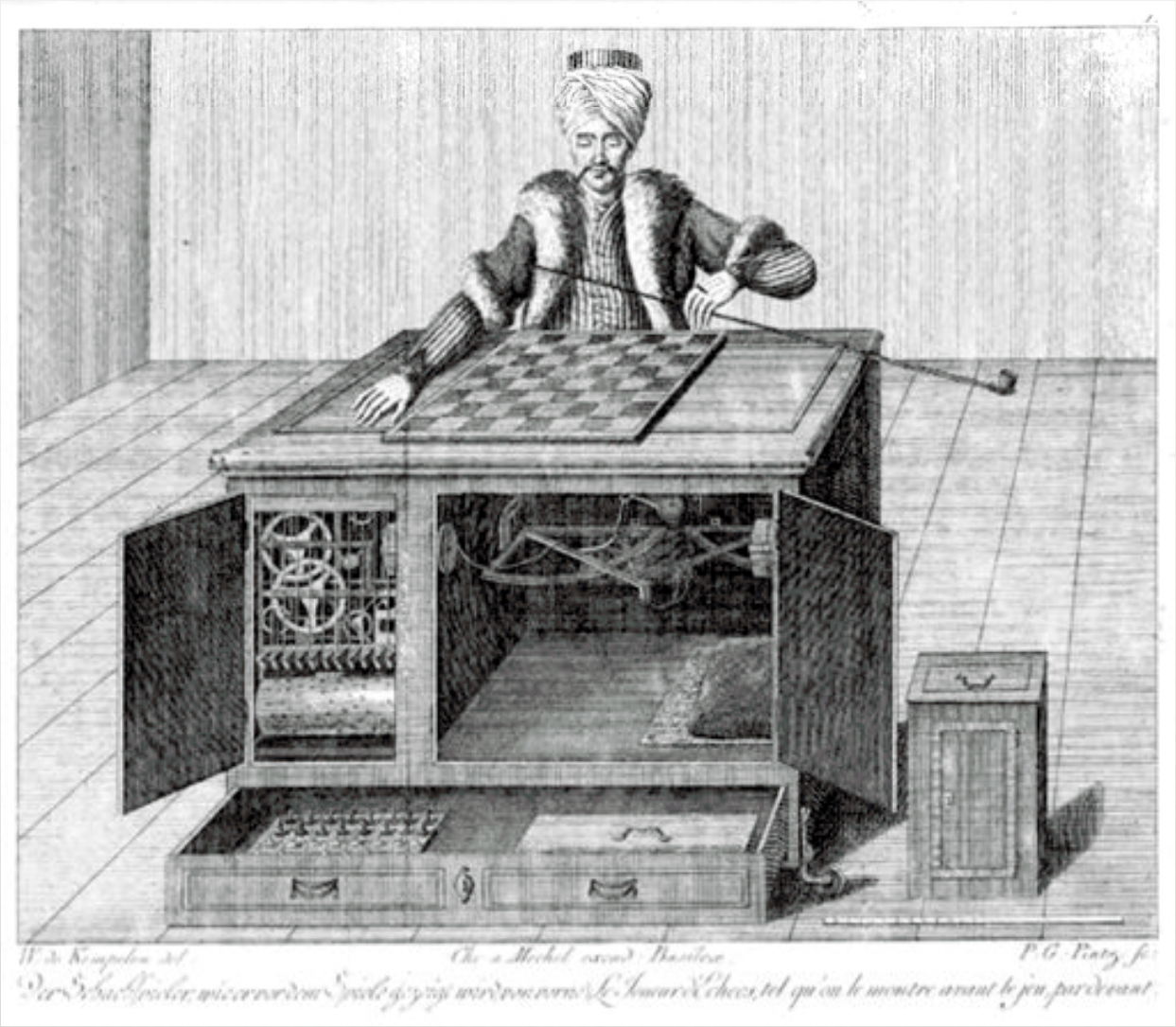
```
MAX-ARVO(Solmu)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = −∞
    for each Lapsi in LAPSET(Solmu)
        v = MAX(v, MIN-ARVO(Lapsi))
    return(v)

MIN-ARVO(Solmu)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = +∞
    for each Lapsi in LAPSET(Solmu)
        v = MIN(v, MAX-ARVO(Lapsi))
    return(v)
```

MINIMAX


Game
Demonstra
The purpose of this demonstration is to help you develop intuition for how minimax and alpha-beta search methods perform. The particular problem solved is that of finding the best move in a game.
The Search type menu item on the menu bar enables you to see either the minimax method working alone or together with the alpha-beta method.

SHAKKI





SHAKKI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Deep Blue beat G. Kasparov in 1997
Eustake
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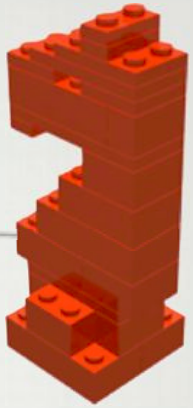
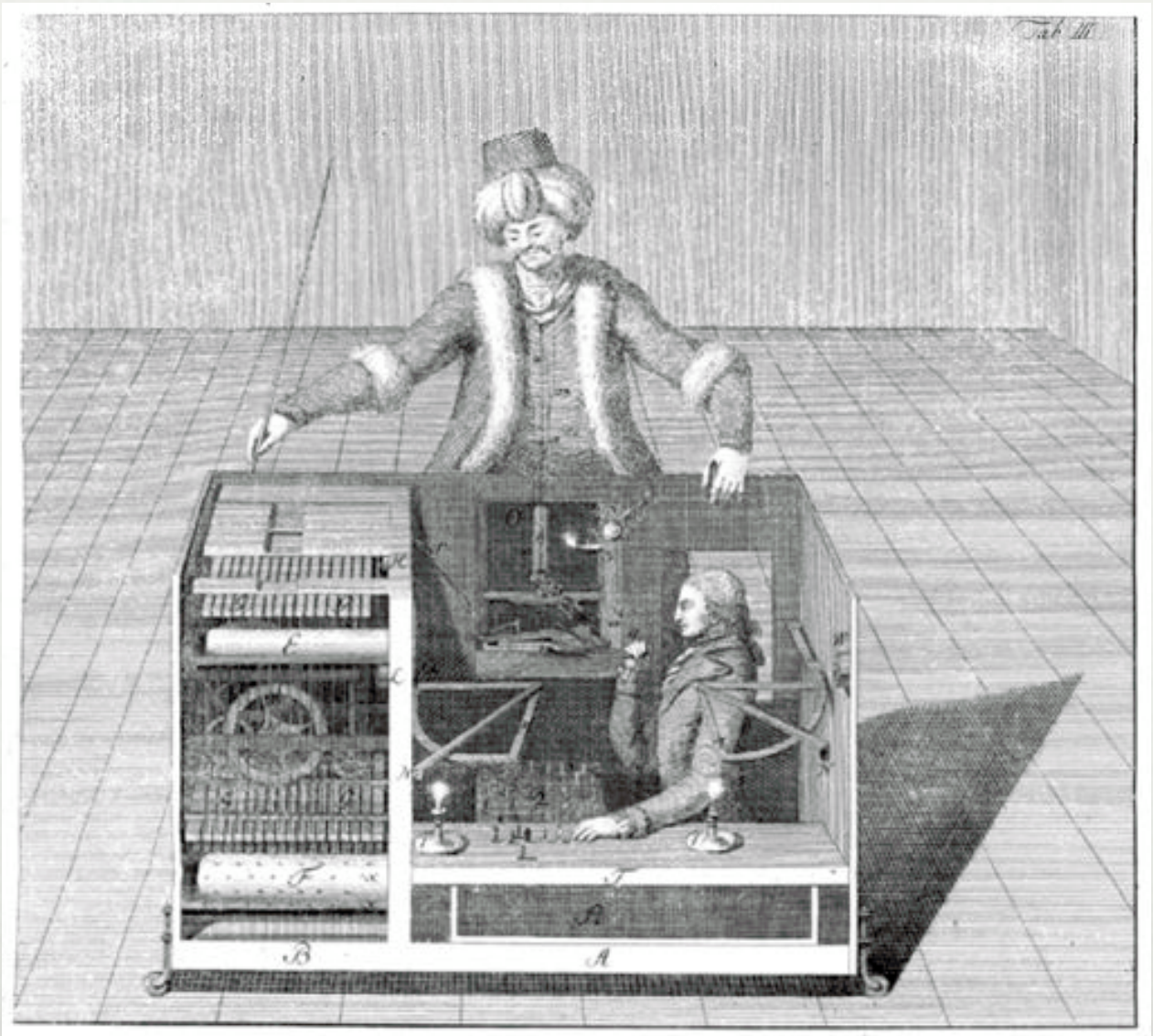
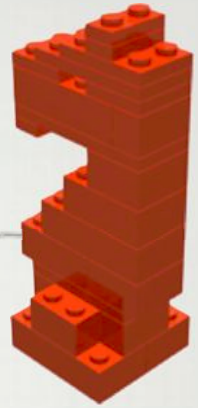
SHAKKI





SHAKKI

(NICE TO KNOW: EI TARVITSE OPETELLA)



1769 **Wolfgang von Kempelen** rakentaa "Turkin"

1912 **L. Torres y Quevedo** rakentaa koneen kuningas&torni vs kuningas -loppupeleihin

1948 **Norbert Wiener** esittää syvyysrajoitetun minimax-algoritmin heuristisella arviontifunktiolla

1950 **Claude Shannon** julkaisee artikkelin "Programming a Computer for Playing Chess"

1951 **Alan Turing** kehittää ensimmäisen algoritmin, joka pystyy pelaamaan kokonaisen shakkiottelun

1956 Los Alamos chess: ensimmäinen tietokoneohjelma, joka pelaa (yksinkertaistettua) shakkia

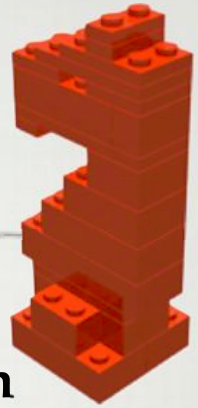
1956 **John McCarthy** keksii alpha-beta-karsinnan

1957 Ensimmäiset oikeaa shakkia pelaavat ohjelmat

1966-67 Ensimmäiset tietokoneohjelmien väliset ottelut (Moskova voittaa.)

SHAKKI

(NICE TO KNOW: EI TARVITSE OPETELLA)



1967 **Ensimmäinen tietokoneohjelman voitto turnauksessa.**

1981 **Cray Blitz voittaa Mississippin osavaltion mestaruuden ja saa ensimmäisenä tietokoneena mestarin statuksen.**

1988 **Deep Thought voittaa ensimmäistä kertaa suurmestarin turnauksessa.**

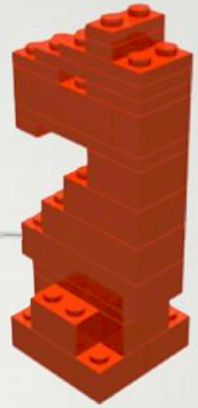
1989 **Garry Kasparov voittaa kaksi näytösottelua Deep Thoughtia vastaan.**

1996 **Garry Kasparov voittaa Deep Bluen kuuden pelin ottelussa.**

1997 **Deep Blue voittaa Garry Kasparovin kuuden pelin ottelussa.**

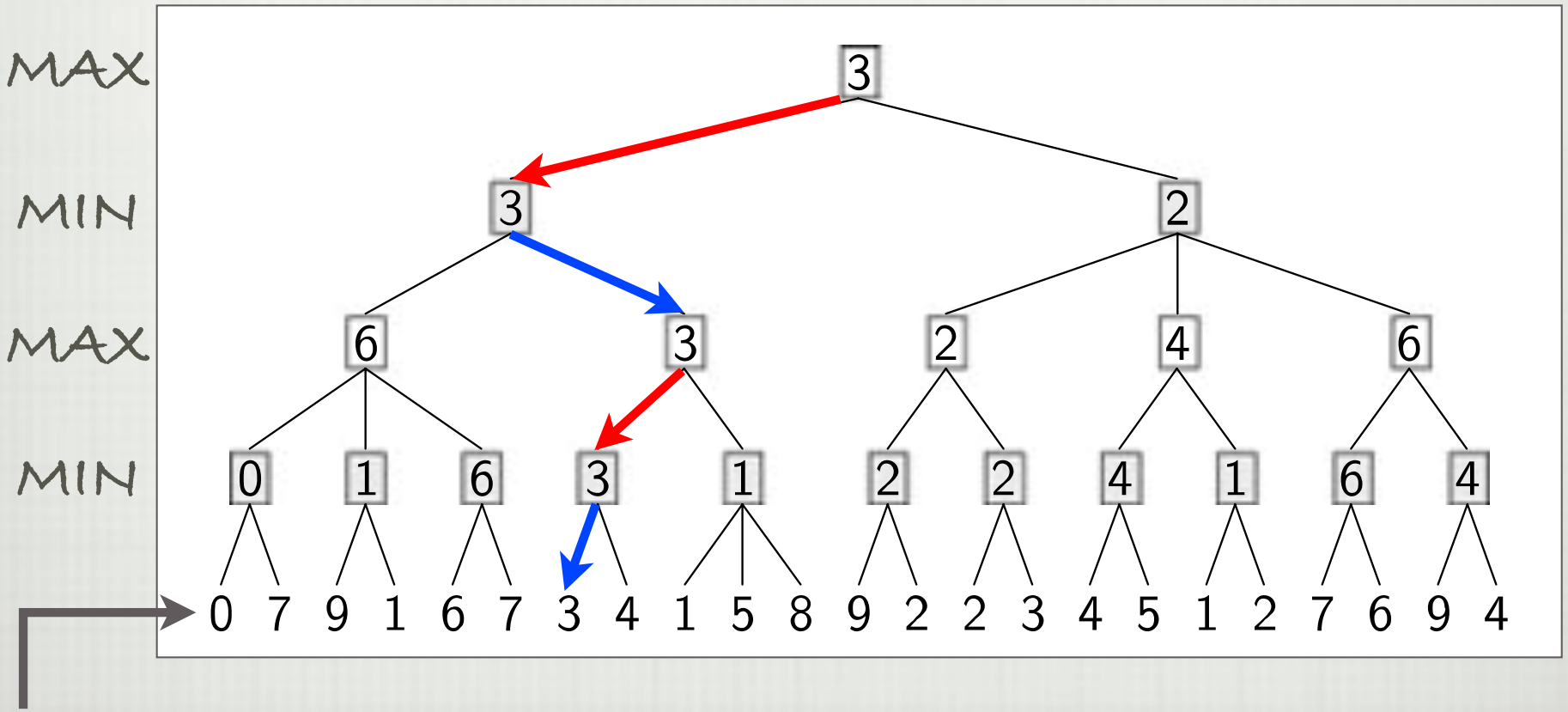
2006 **Deep Fritz voittaa maailmanmestari Vladimir Kramnikin.**

SHAKKI



- TILA: (LAUDAN TILANNE)
- SIIRTYMÄT: (SALLITUT SIIRROT)
- MENETELMÄ: SYVYYSRAJOITETTU ALPHA-BETA-KARSINTA

PELIPUU

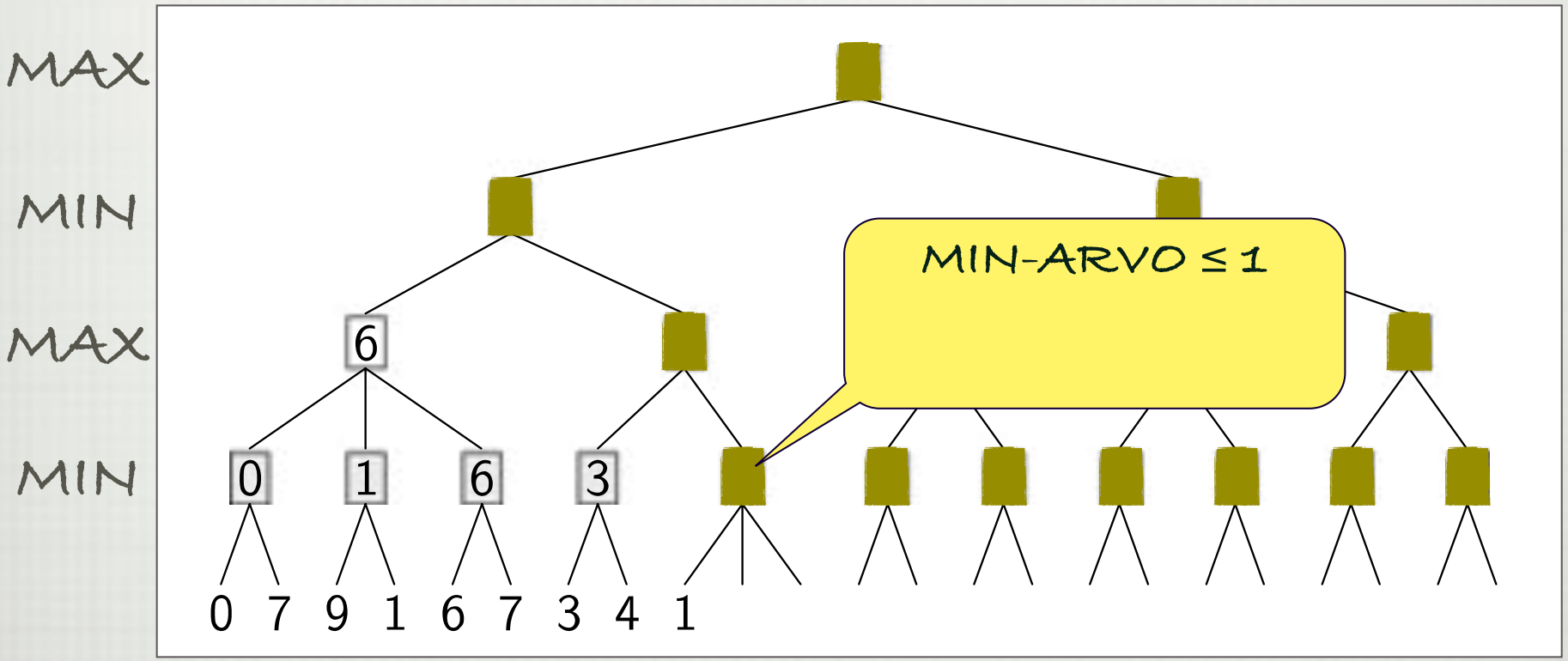


ARVIOITA TILANTEEN HYVYYDESTÄ

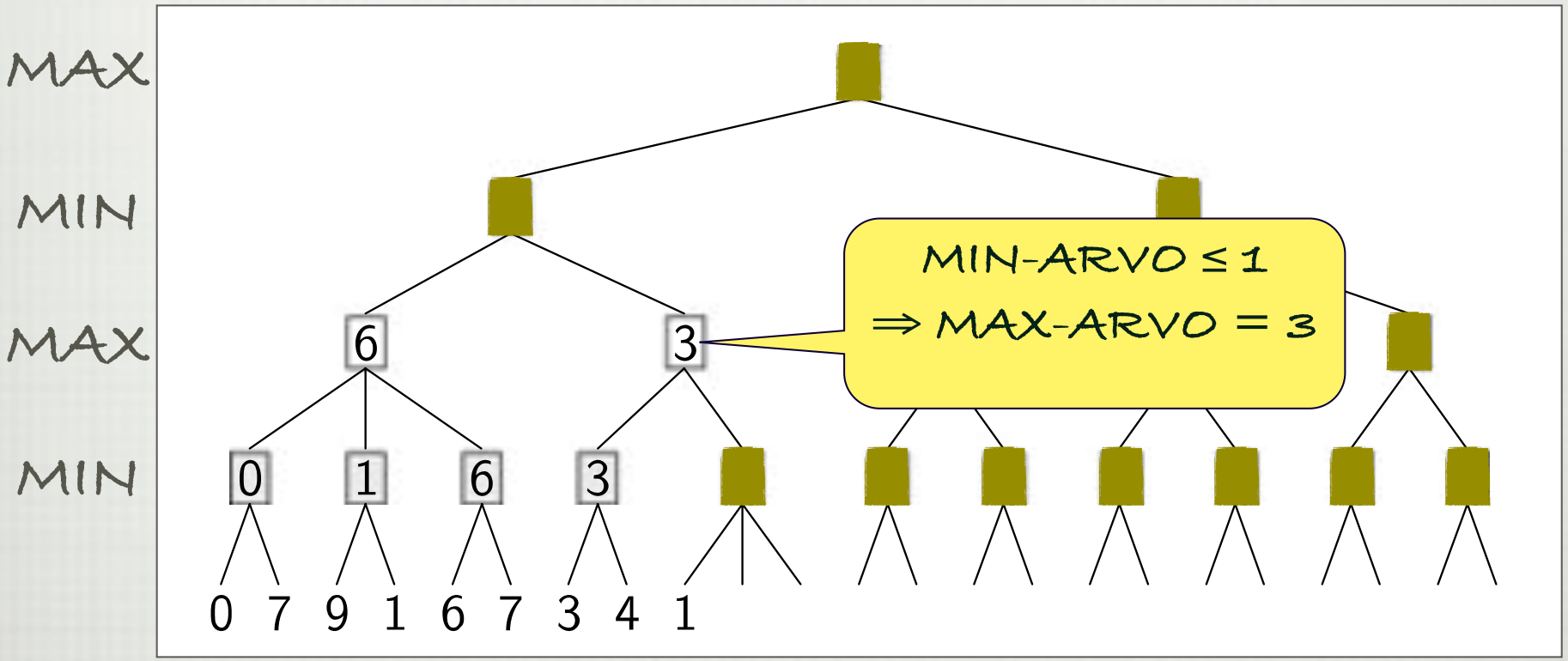
SHAKKI

- TILA: (LAUDAN TILANNE)
- SIIRTYMÄT: (SALLITUT SIIRROT)
- MENETELMÄ: SYVYYSRAJOITETTU ALPHA-BETA-KARSINTA
- TEHTÄVÄ: SUUNNITTELE HEURISTINEN ARVIOINTIFUNKTIO

ALPHA-BETA-KARSINTA



ALPHA-BETA-KARSINTA



ALPHA-BETA-KARSINTA

```
MAX-ARVO(Solmu, α, β)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = −∞
    for each Lapsi in LAPSET(Solmu)
        v = MAX(v, MIN-ARVO(Lapsi, α, β))
        if v ≥ β return(v)
        α = MAX(α, v)
    return(v)
```

MIN-PELAAJAN TOISTAISEKSI PARAS ARVO

MAX-PELAAJAN TOISTAISEKSI PARAS ARVO

ALPHA-BETA-KARSINTA

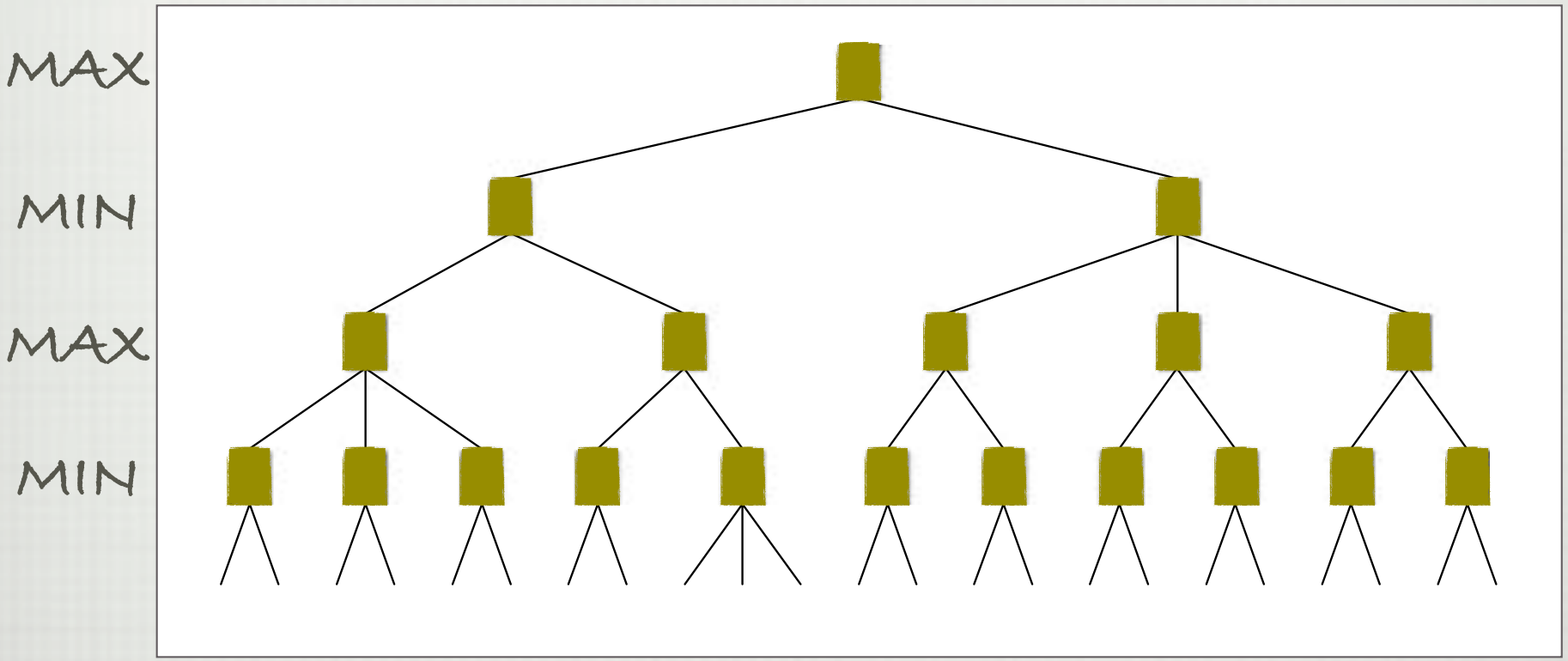
```
MAX-ARVO(Solmu, α, β)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = −∞
    for each Lapsi in LAPSET(Solmu)
        v = MAX(v, MIN-ARVO(Lapsi, α, β))
        if v ≥ β return(v)
        α = MAX(α, v)
    return(v)
```

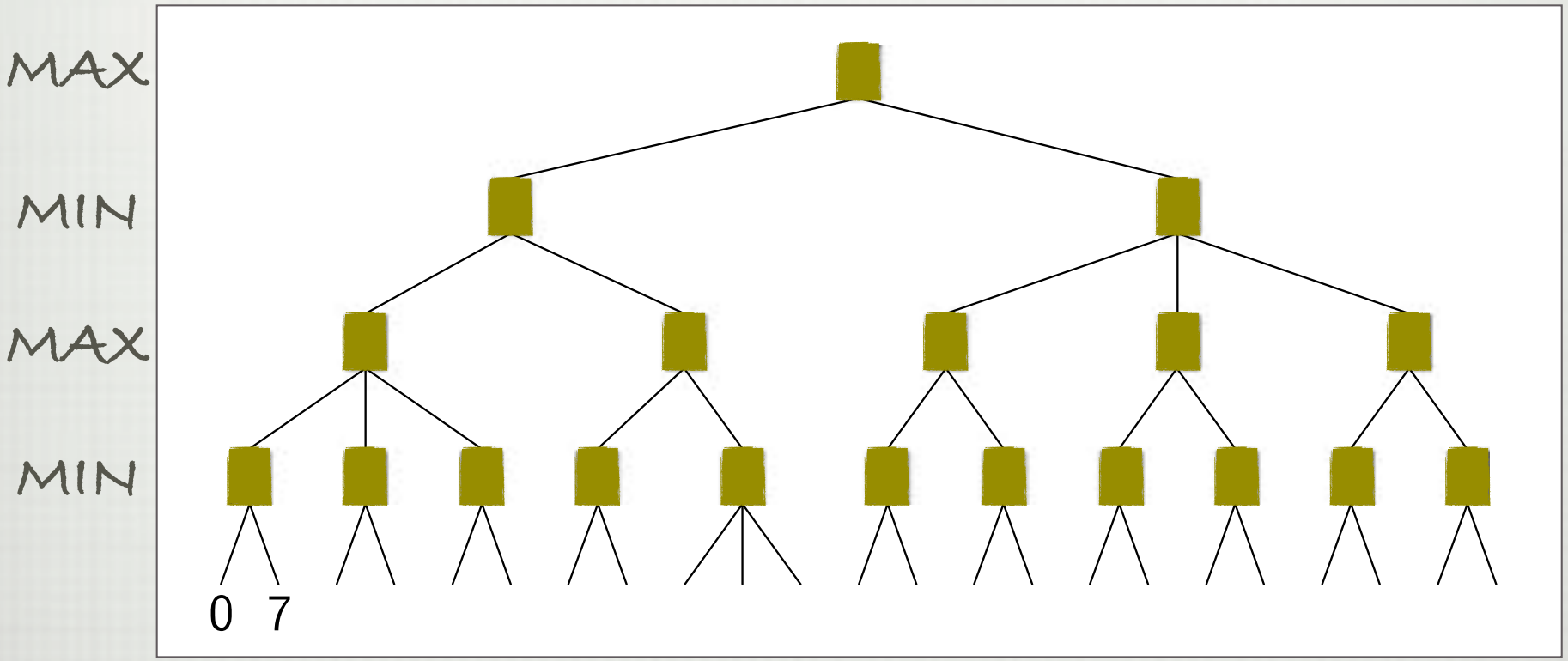
```
MIN-ARVO(Solmu, α, β)

    if LOPPUTILA(Solmu) return(ARVO(Solmu))
    v = +∞
    for each Lapsi in LAPSET(Solmu)
        v = MIN(v, MAX-ARVO(Lapsi, α, β))
        if v ≤ α return(v)
        β = MIN(β, v)
    return(v)
```

ALPHA-BETA-KARSINTA



ALPHA-BETA-KARSINTA



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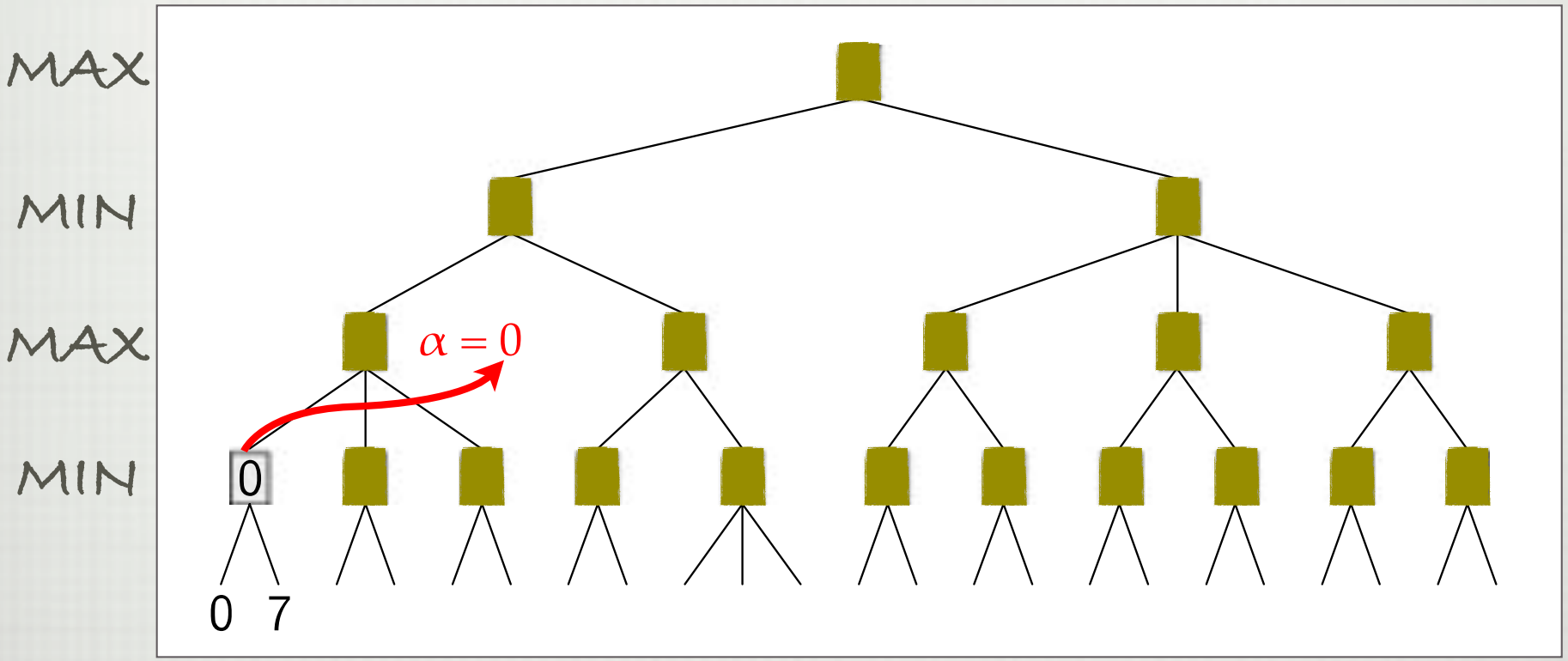

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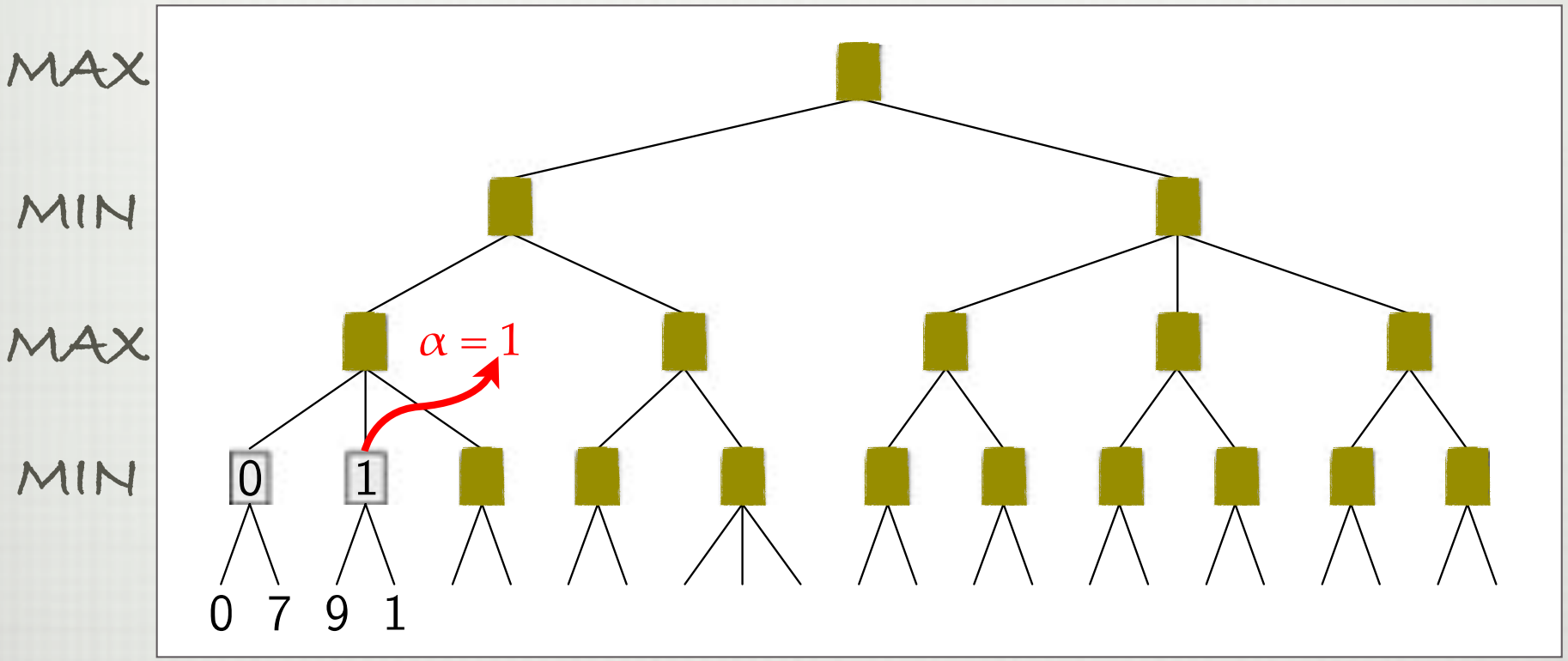

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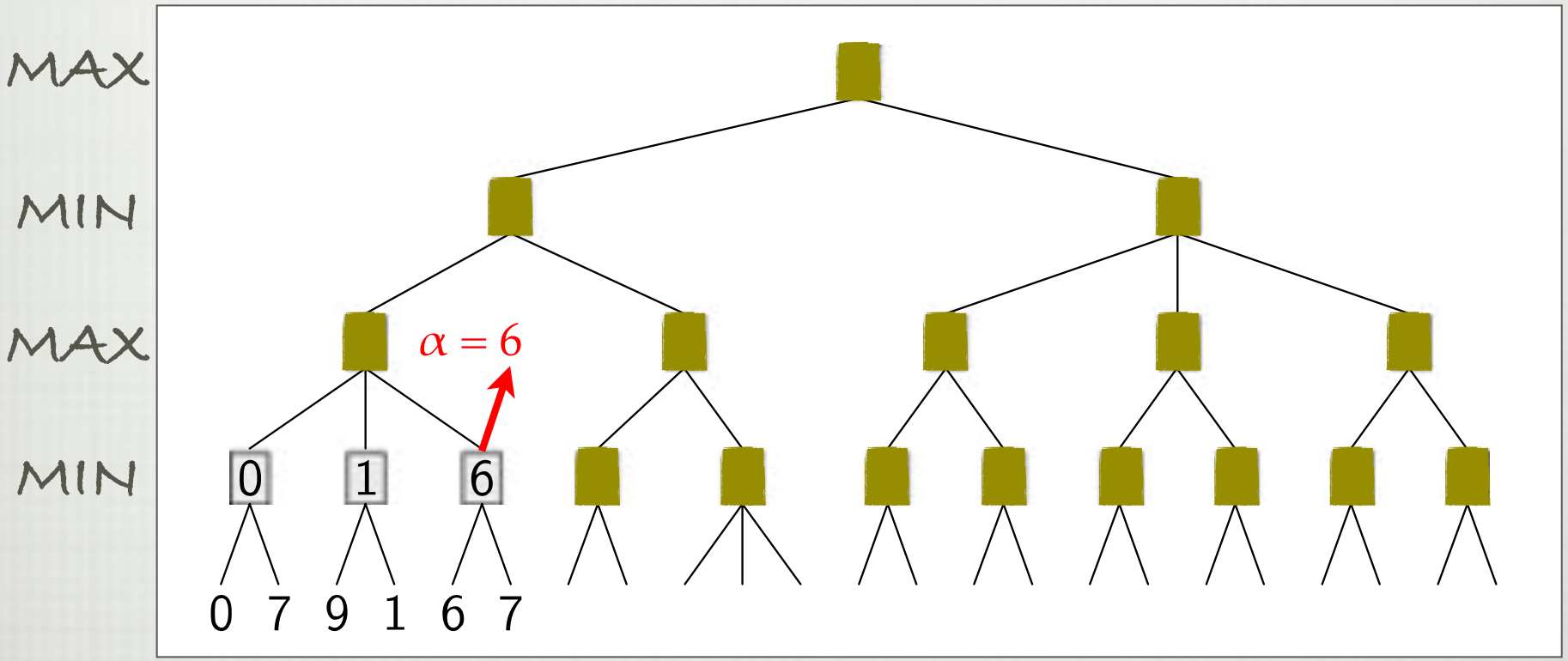

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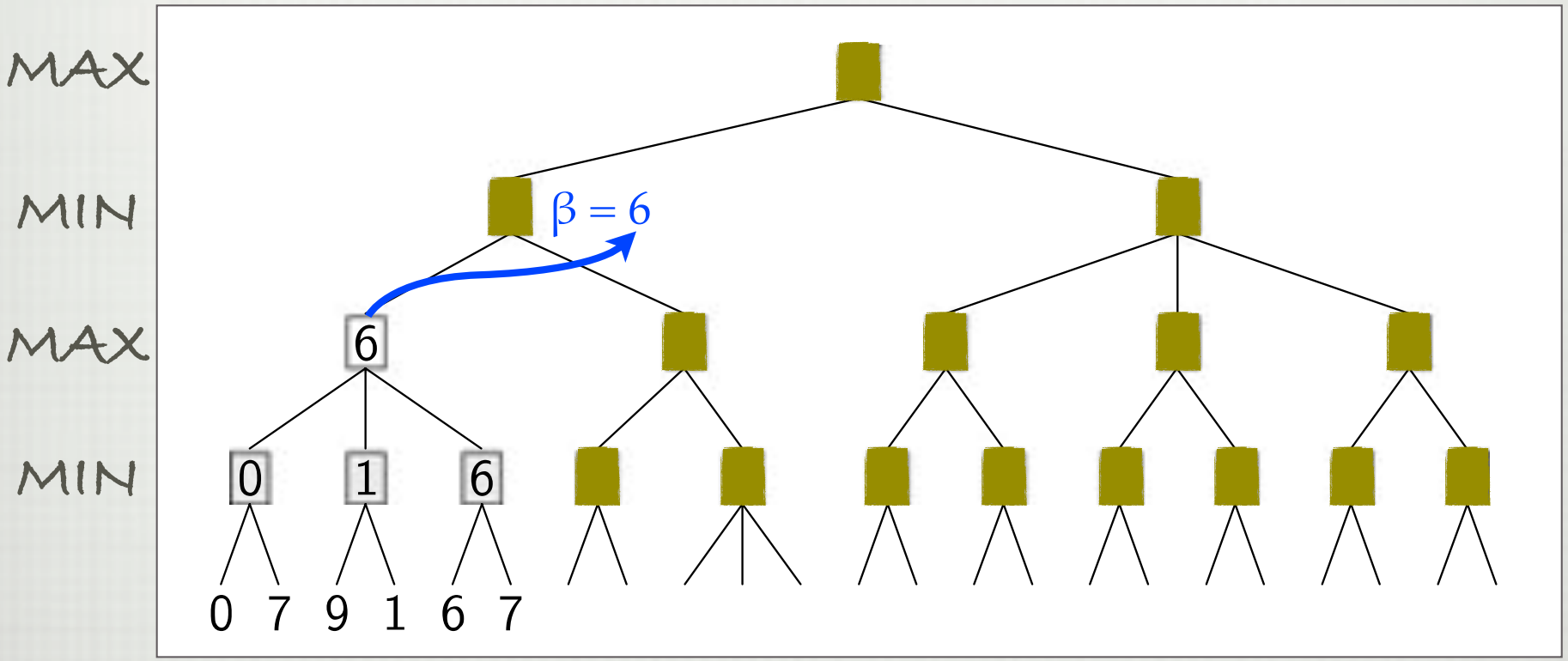

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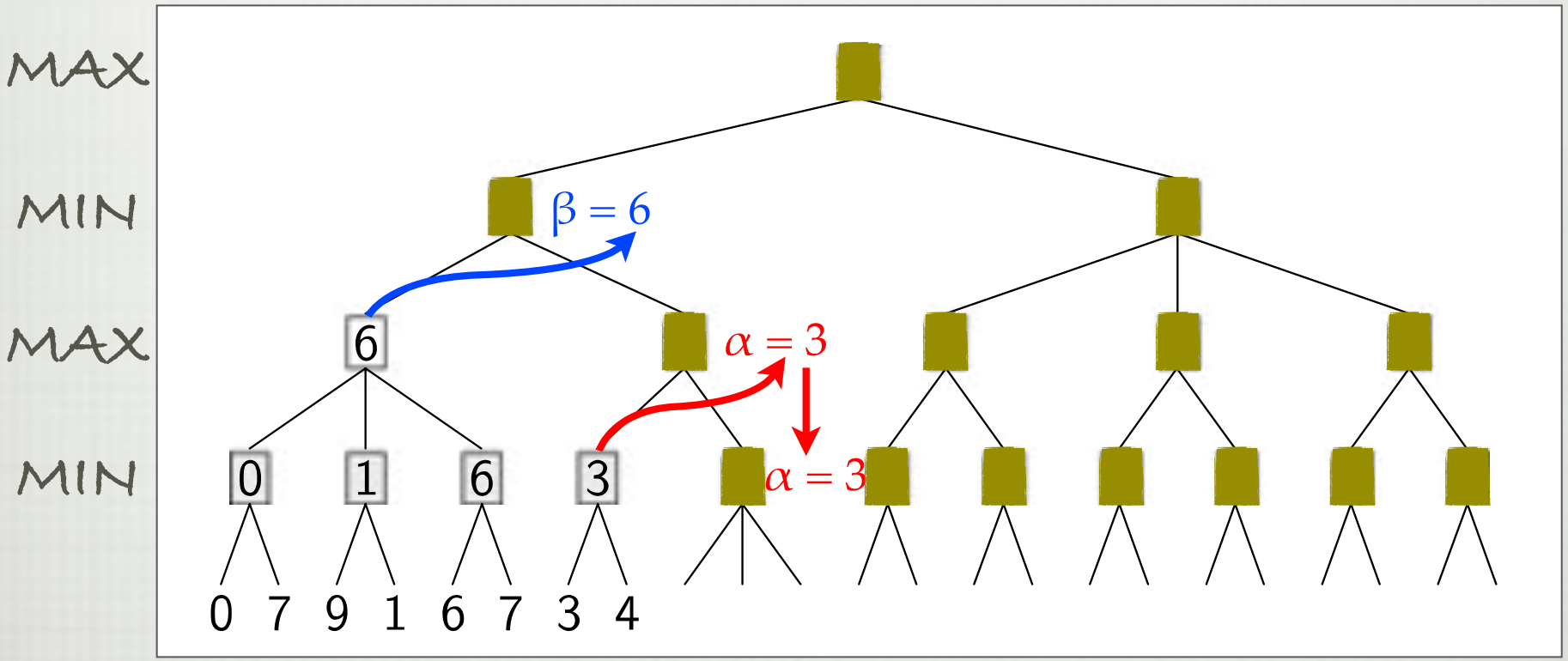
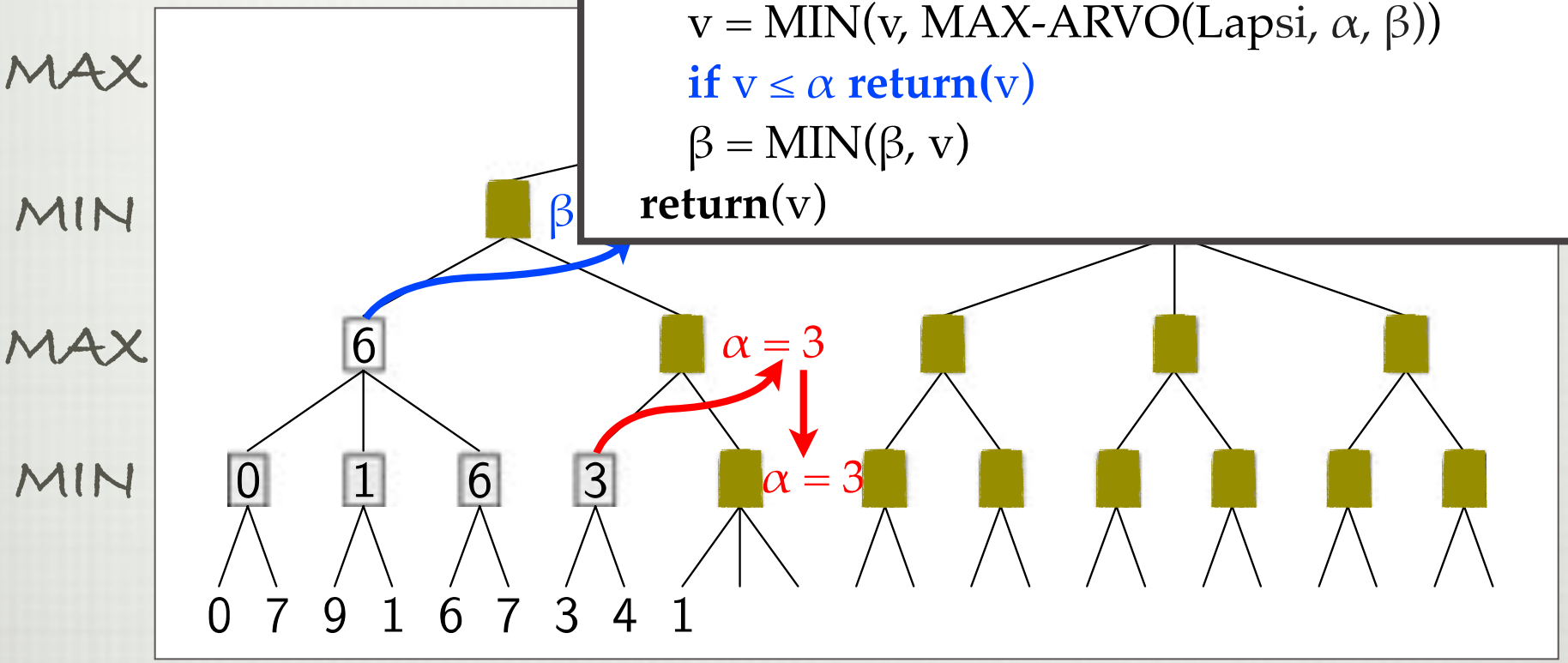


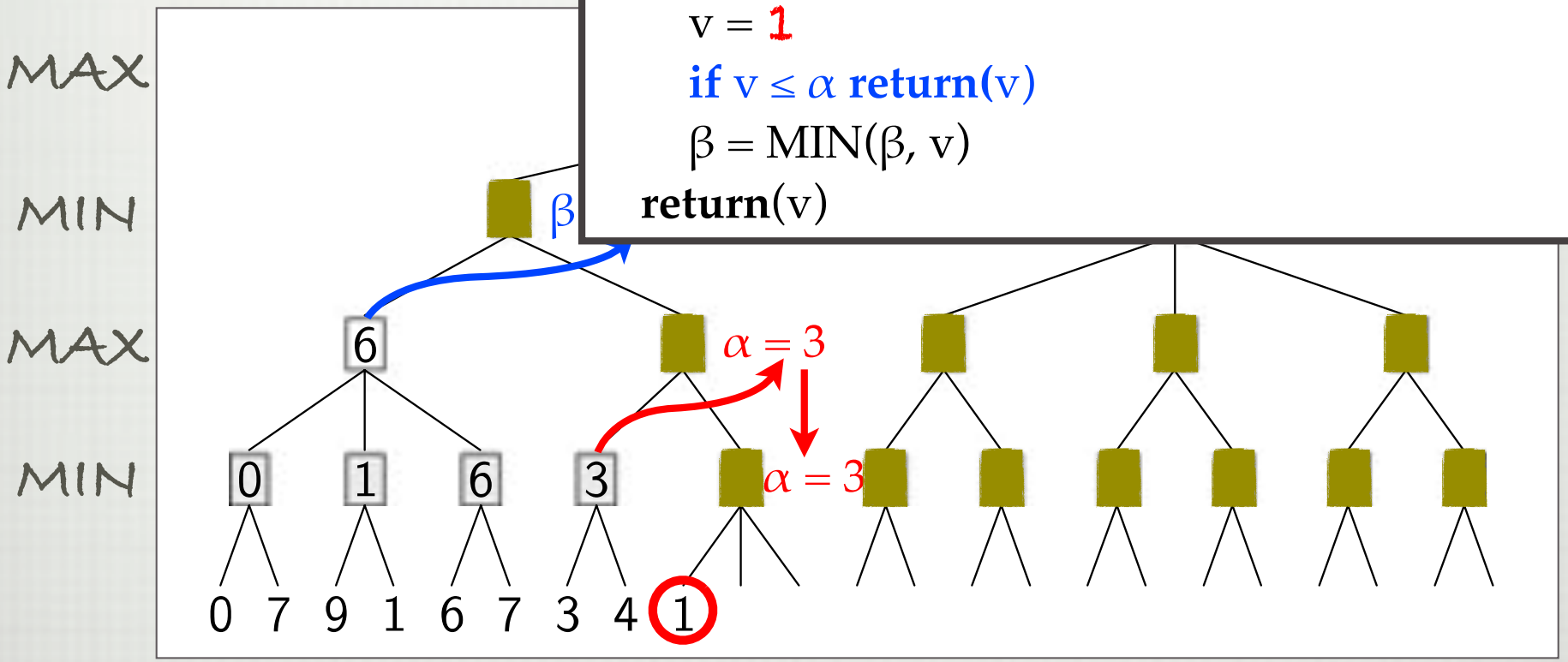
ALPHA

```
MIN-ARVO(Solmu, α, β)

   if LOPPUTILA(Solmu) return(ARVO(Solmu))
   v = +∞
   for each Lapsi in LAPSET(Solmu)
      v = MIN(v, MAX-ARVO(Lapsi, α, β))
      if v ≤ α return(v)
      β = MIN(β, v)
   return(v)
```



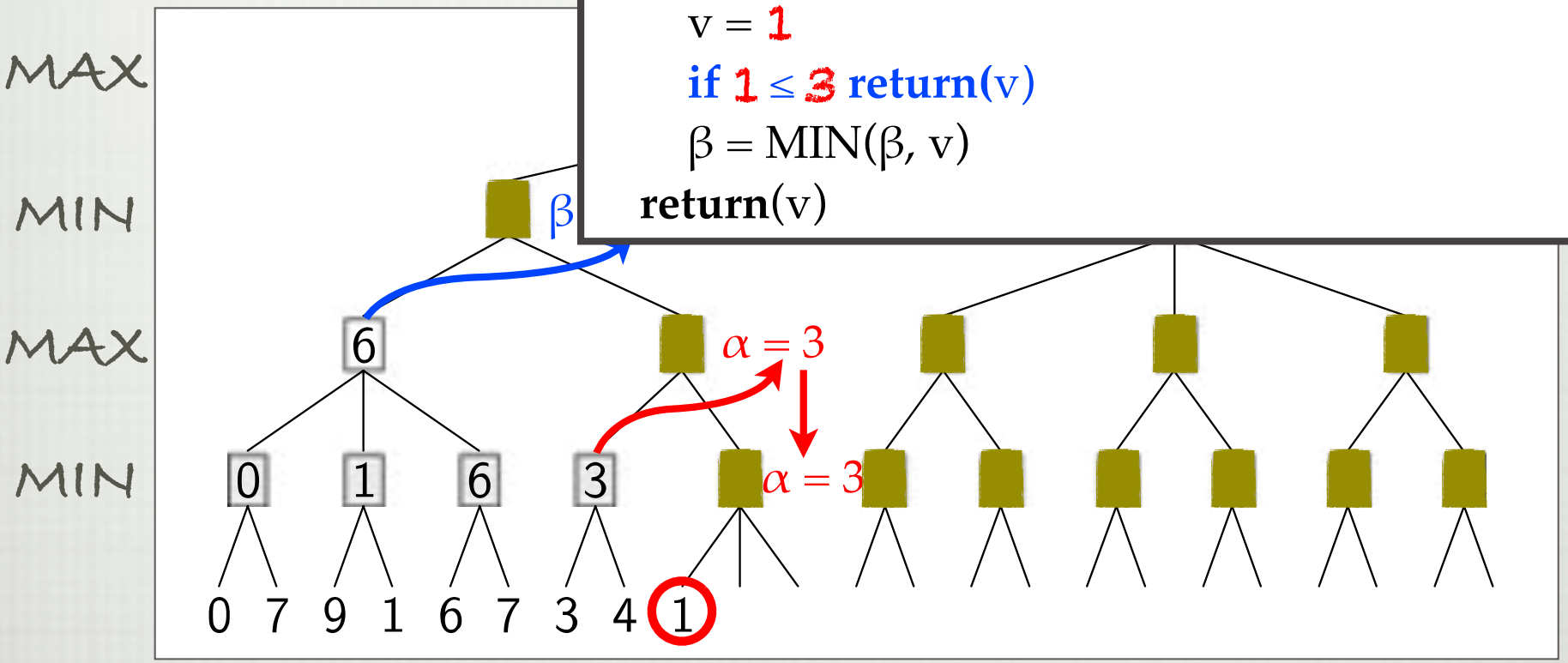
ALPHA

```
MIN-ARVO(Solmu, α, β)

   if LOPPUTILA(Solmu) return(ARVO(Solmu))
   v = +∞
   for each Lapsi in LAPSET(Solmu)
      v = 1
      if v ≤ α return(v)
      β = MIN(β, v)
   return(v)
```



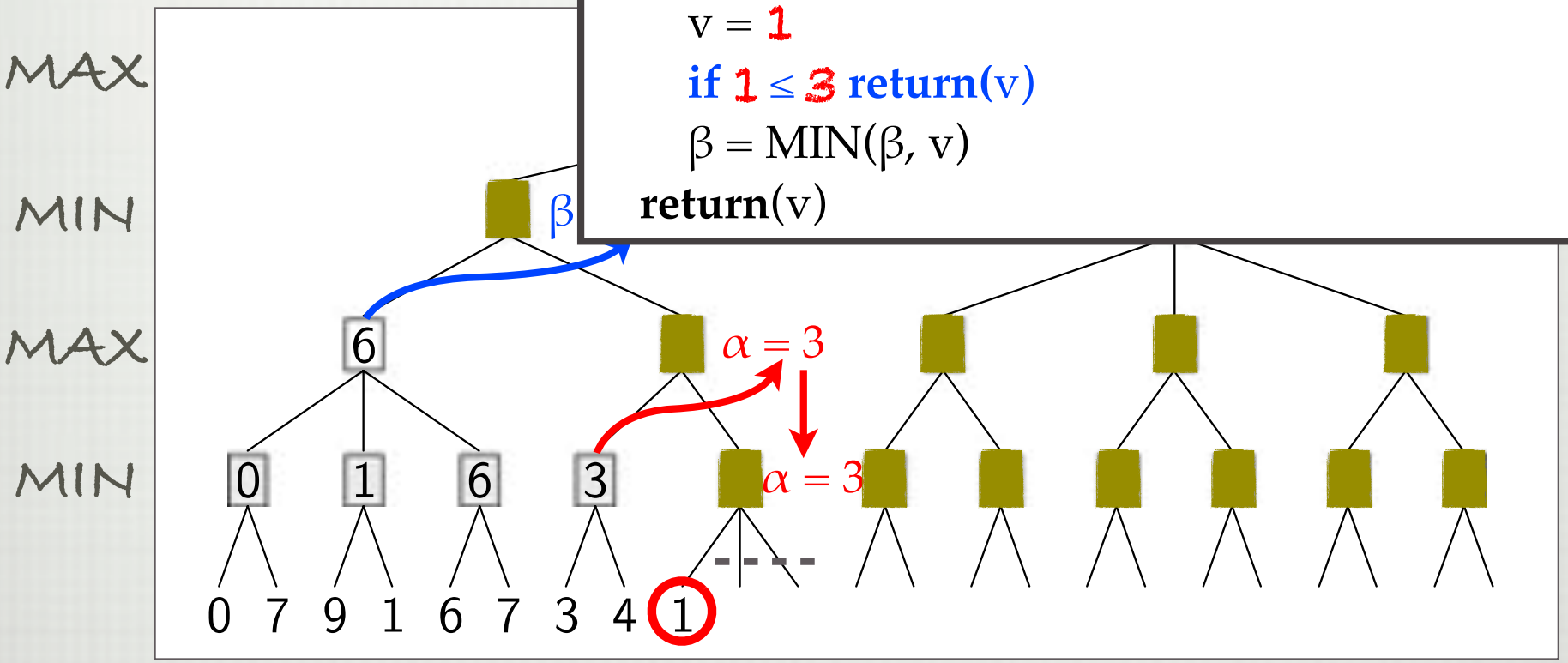
ALPHA

```
MIN-ARVO(Solmu, α, β)

   if LOPPUTILA(Solmu) return(ARVO(Solmu))
   v = +∞
   for each Lapsi in LAPSET(Solmu)
      v = 1
      if 1 ≤ 3 return(v)
      β = MIN(β, v)
   return(v)
```



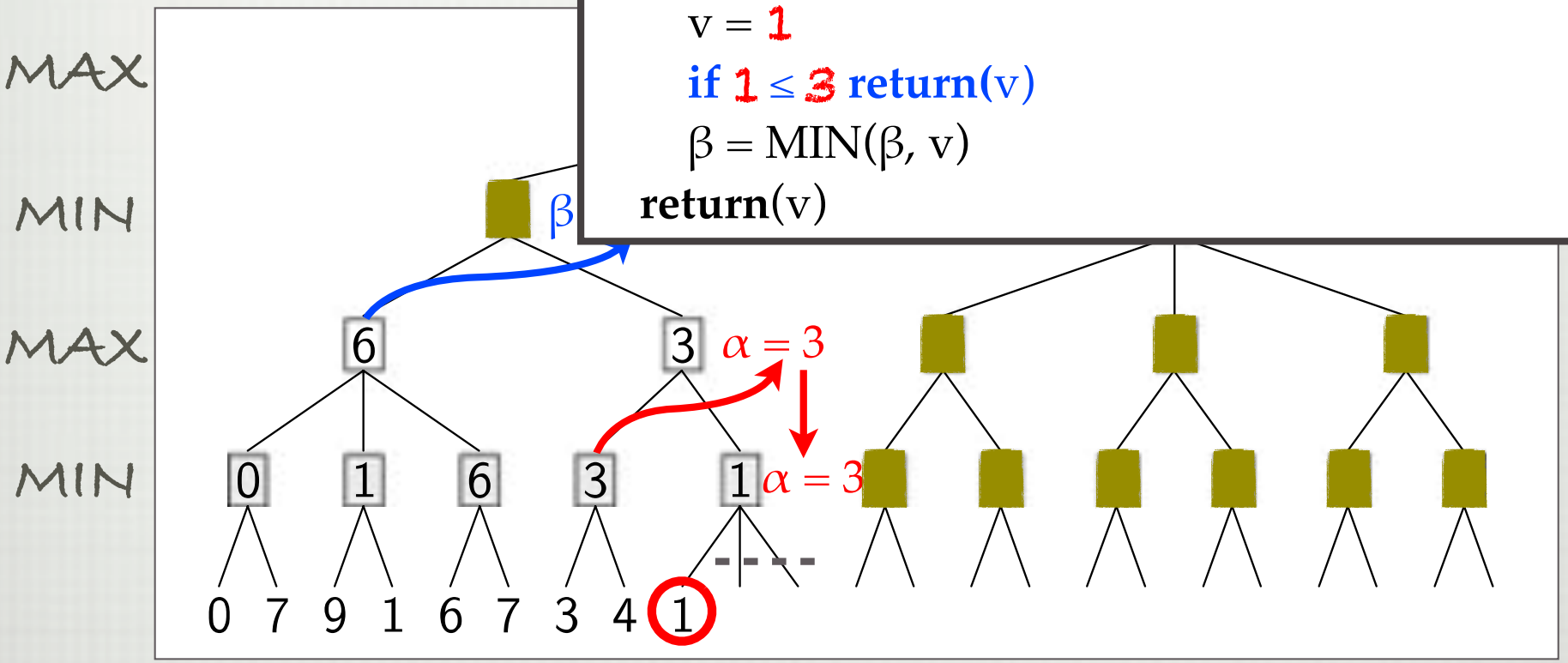
ALPHA

```
MIN-ARVO(Solmu, α, β)

   if LOPPUTILA(Solmu) return(ARVO(Solmu))
   v = +∞
   for each Lapsi in LAPSET(Solmu)
      v = 1
      if 1 ≤ 3 return(v)
      β = MIN(β, v)
   return(v)
```

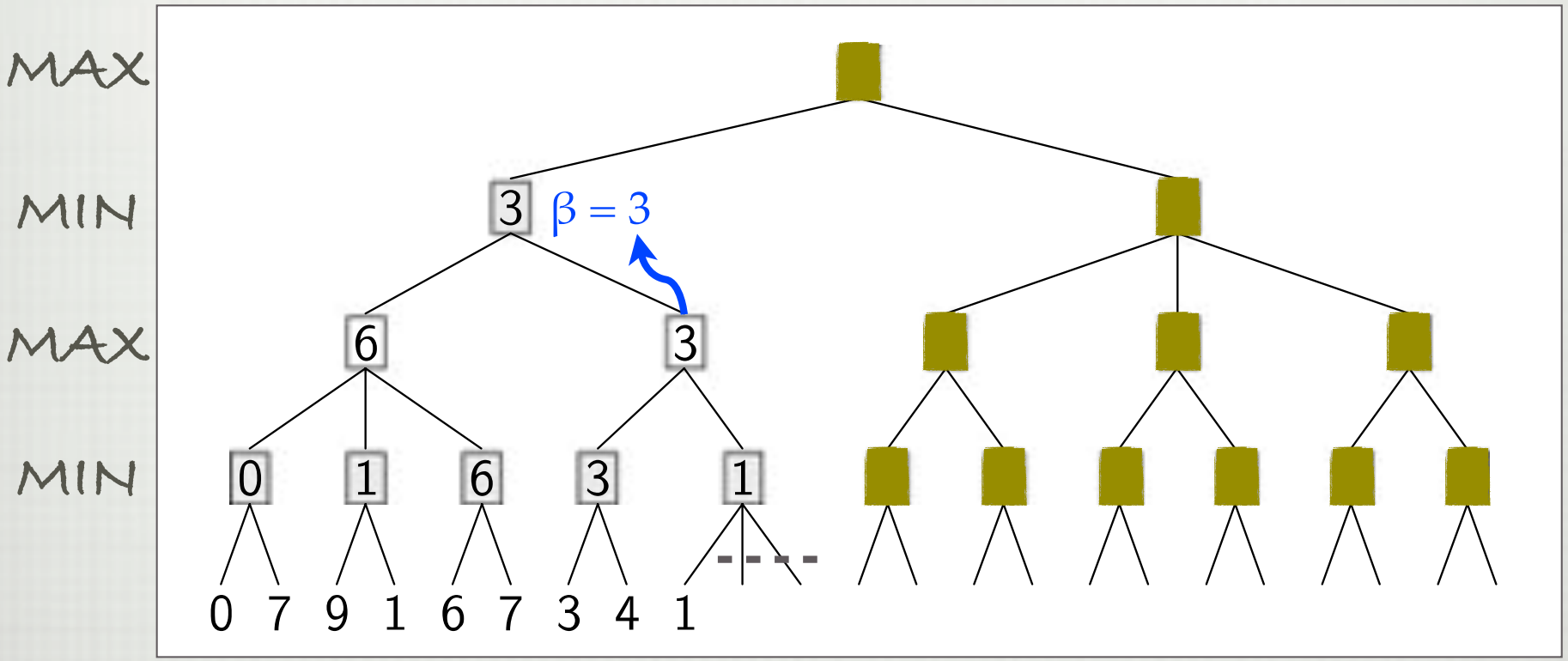


ALPHA

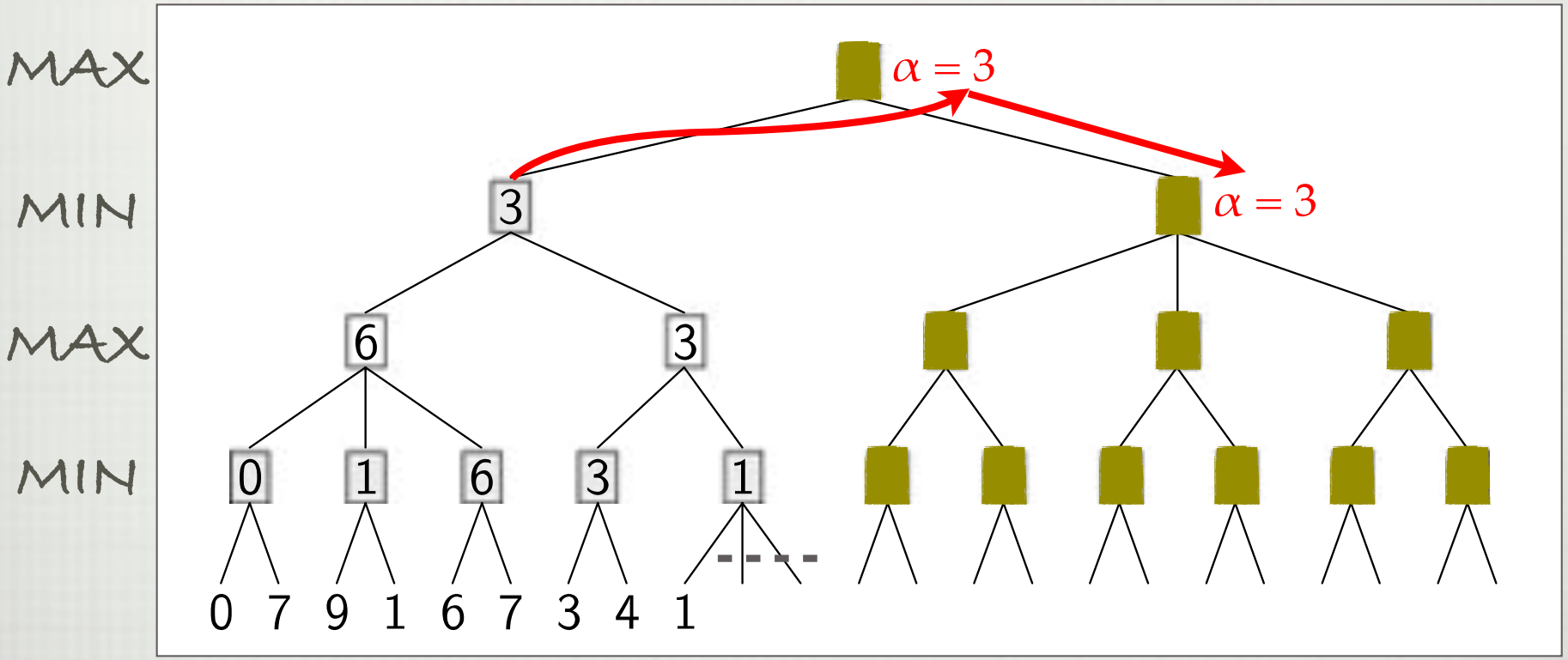
```
MIN-ARVO(Solmu, α, β)

   if LOPPUTILA(Solmu) return(ARVO(Solmu))
   v = +∞
   for each Lapsi in LAPSET(Solmu)
      v = 1
      if 1 ≤ 3 return(v)
      β = MIN(β, v)
   return(v)
```



ALPHA-BETA-KARSINTA



ALPHA-BETA-KARSINTA



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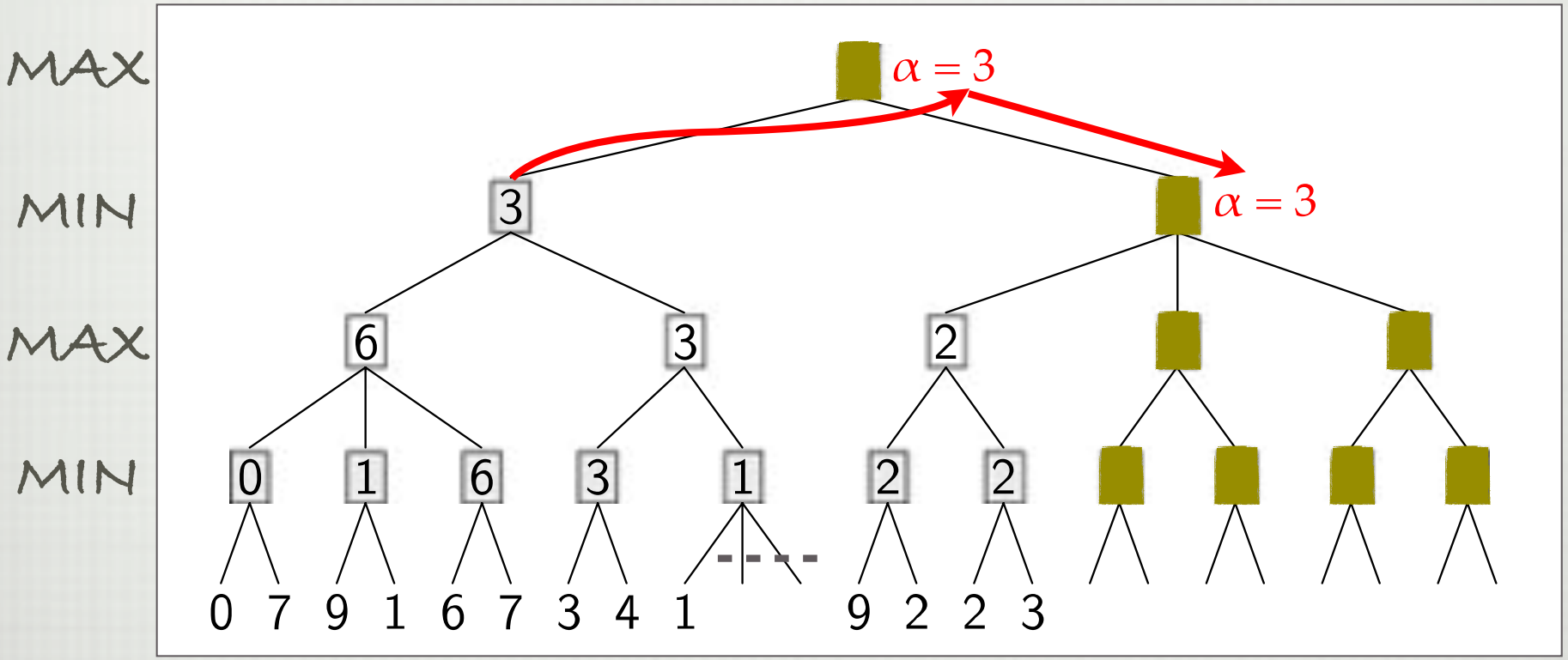
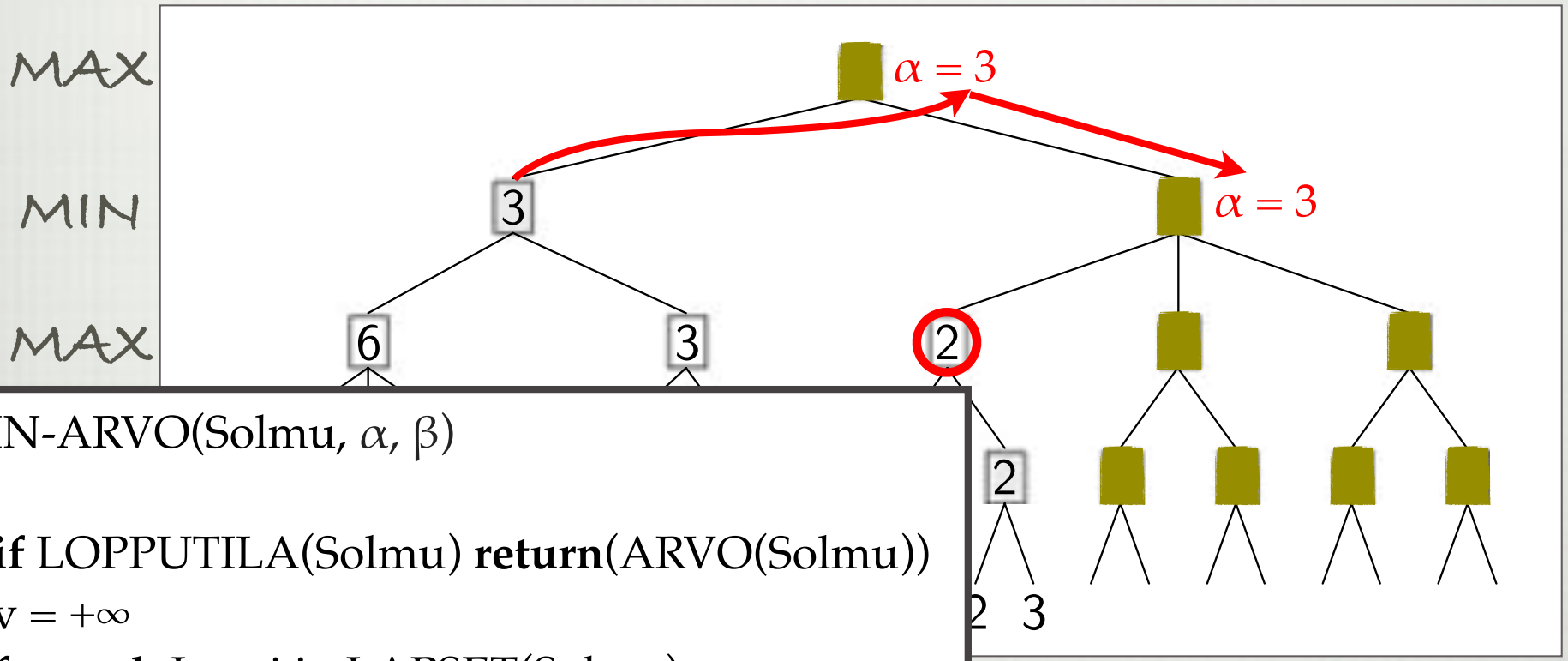


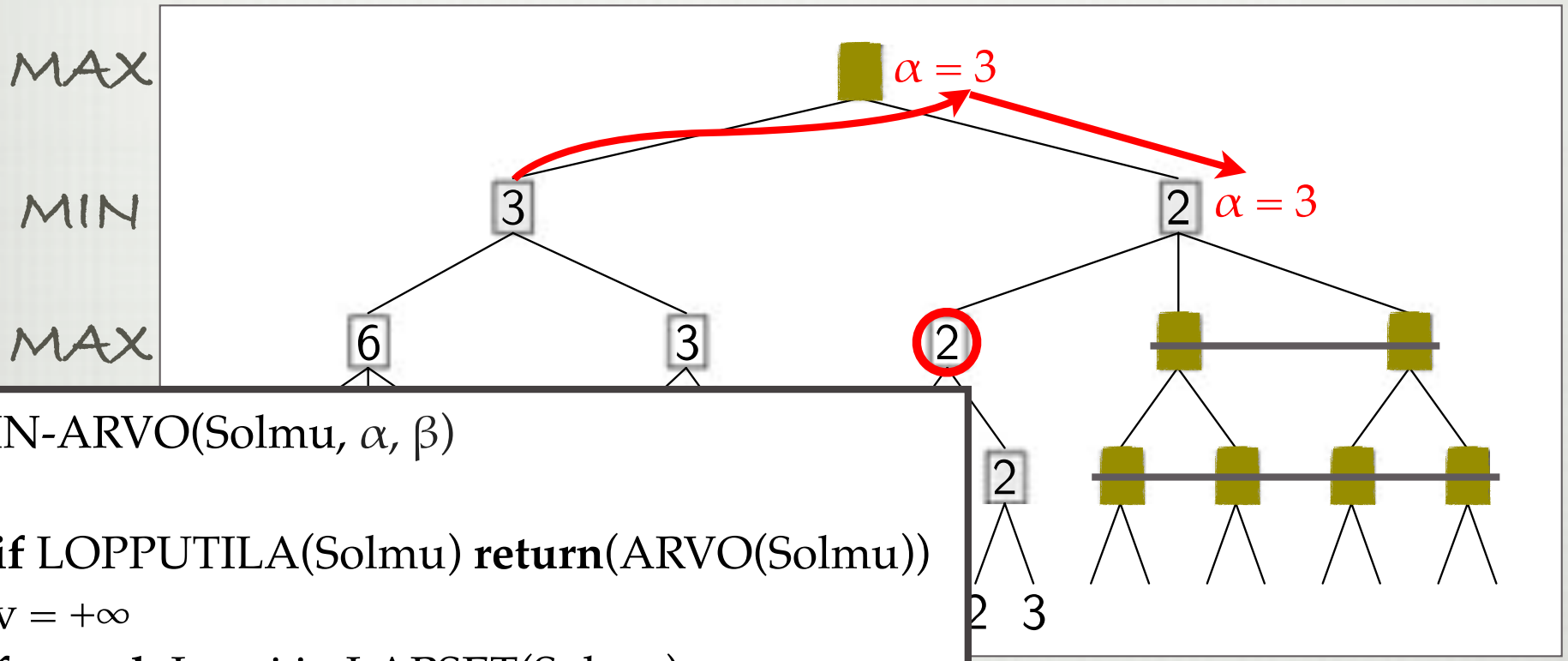
ALPHA-BETA-KARSINTA



MIN-ARVO(Solmu, α, β)

if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = $+\infty$
for each Lapsi in LAPSET(Solmu)
  v = 2
  if v $\leq \alpha$ **return**(v)
  β = MIN(β, v)
return(v)

ALPHA-BETA-KARSINTA



MIN-ARVO(Solmu, α, β)

if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = $+\infty$
for each Lapsi in LAPSET(Solmu)
    v = 2
    if 2 $\leq$ 3 **return**(v)
    β = MIN(β, v)
return(v)

ALPHA-BETA-KARSINTA