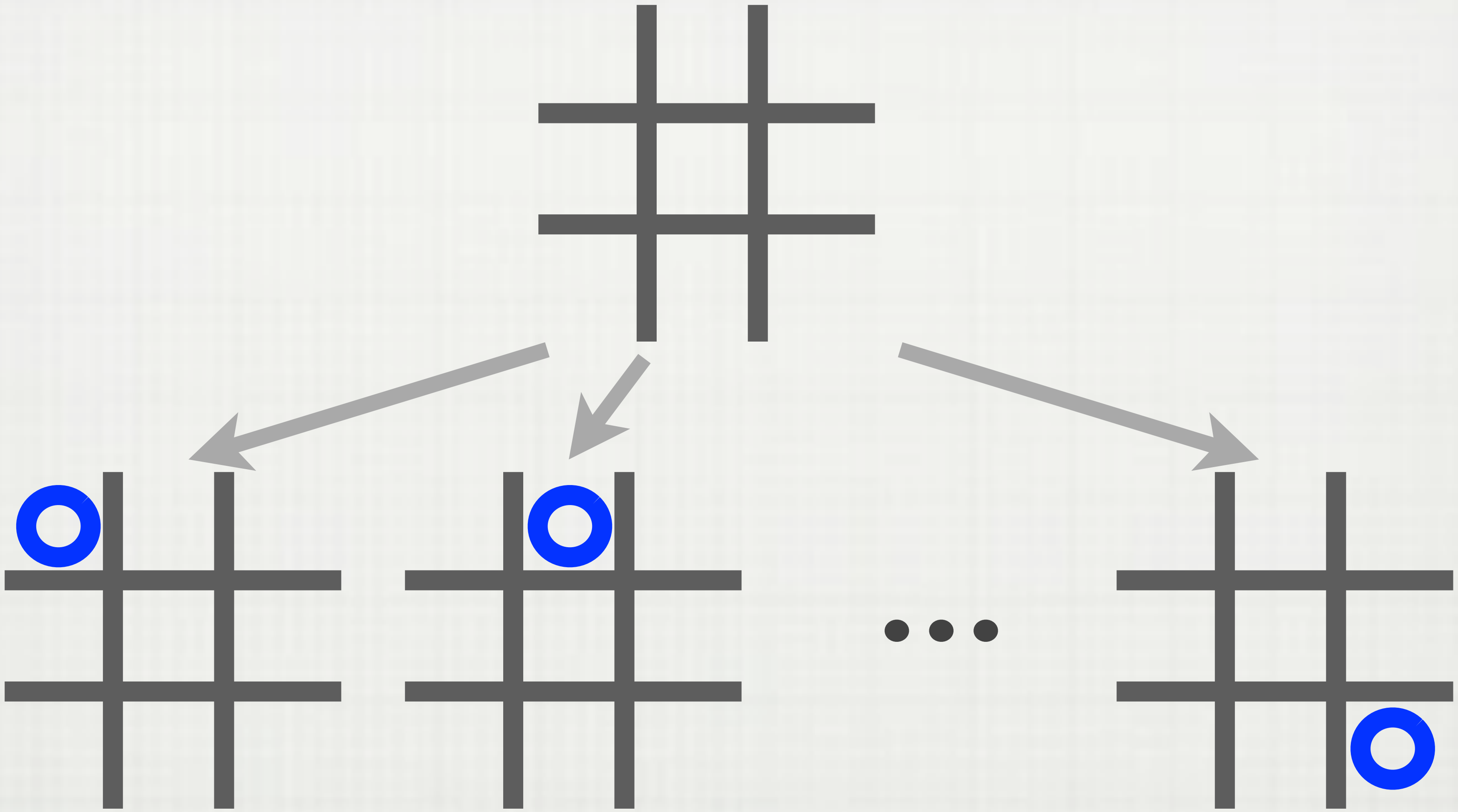
JOHDATUS TEKOÄLYYN

TEEMU ROOS

HELSINGIN YLIOPISTO

PELIPUU



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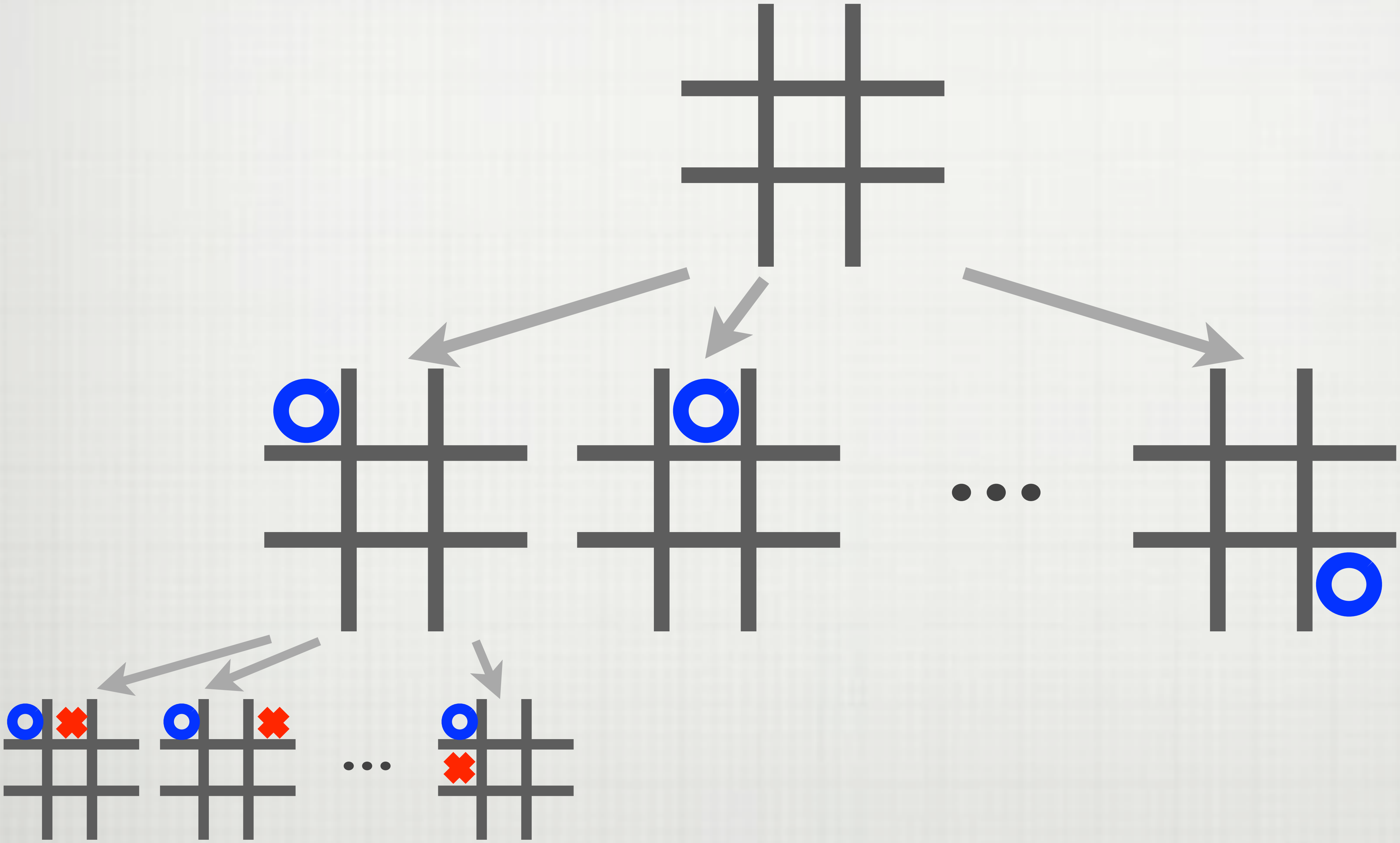

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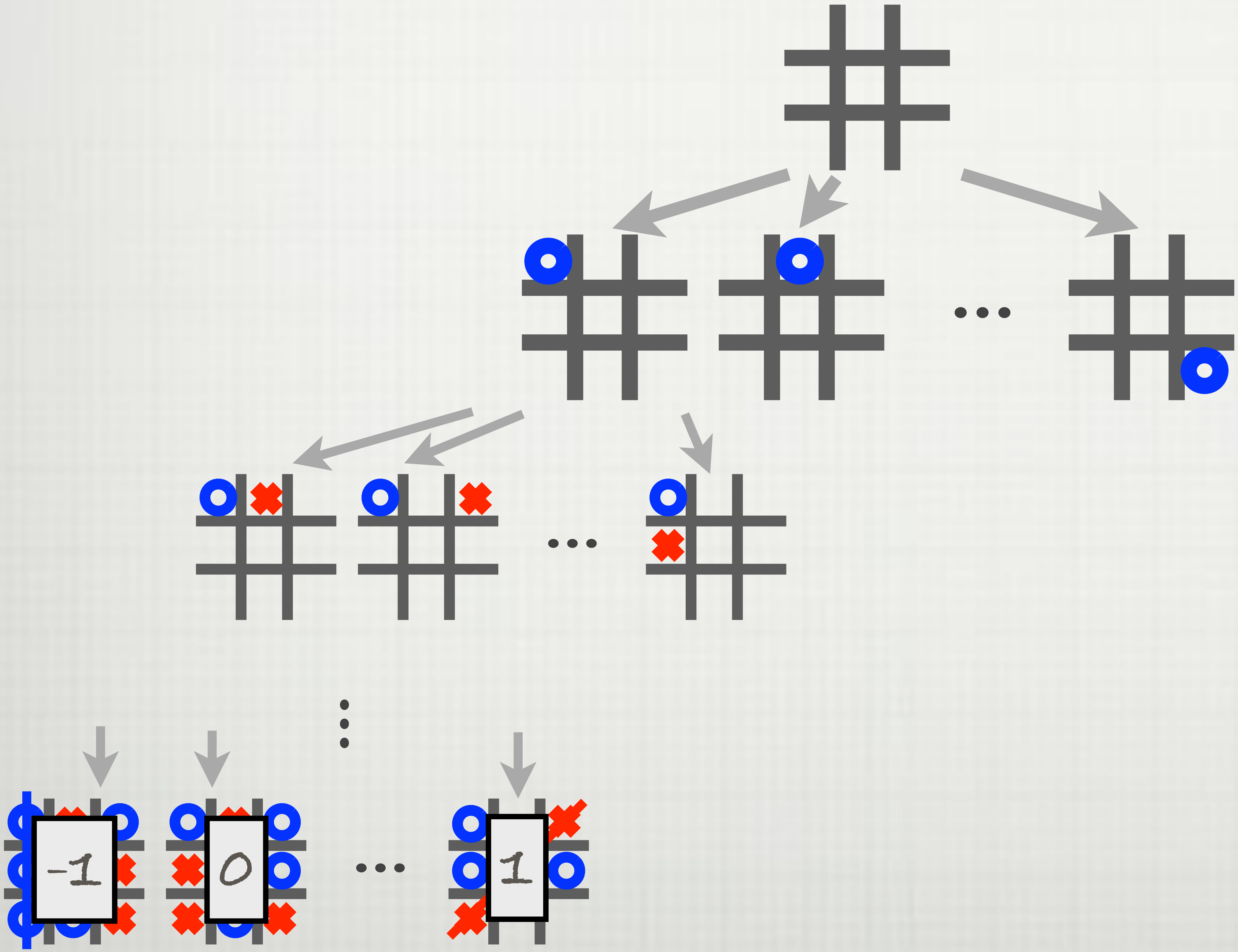

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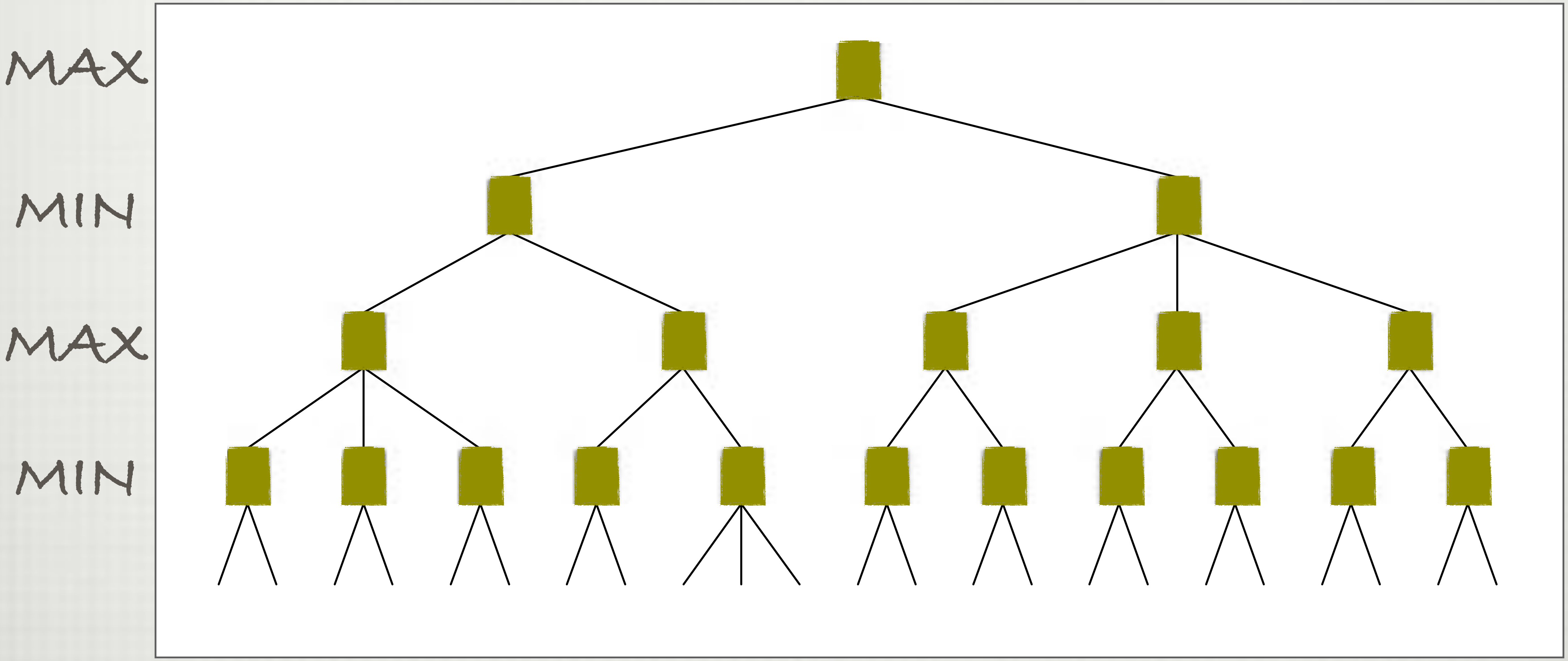

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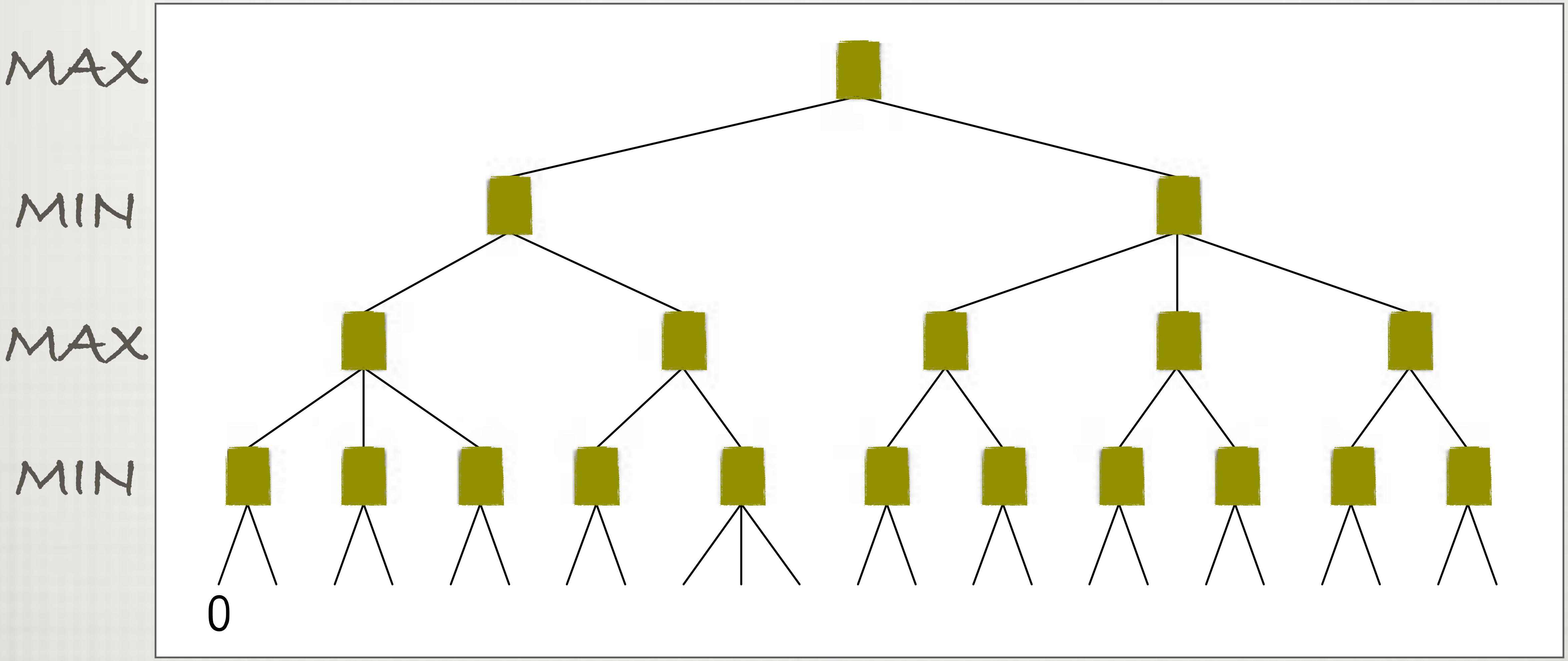

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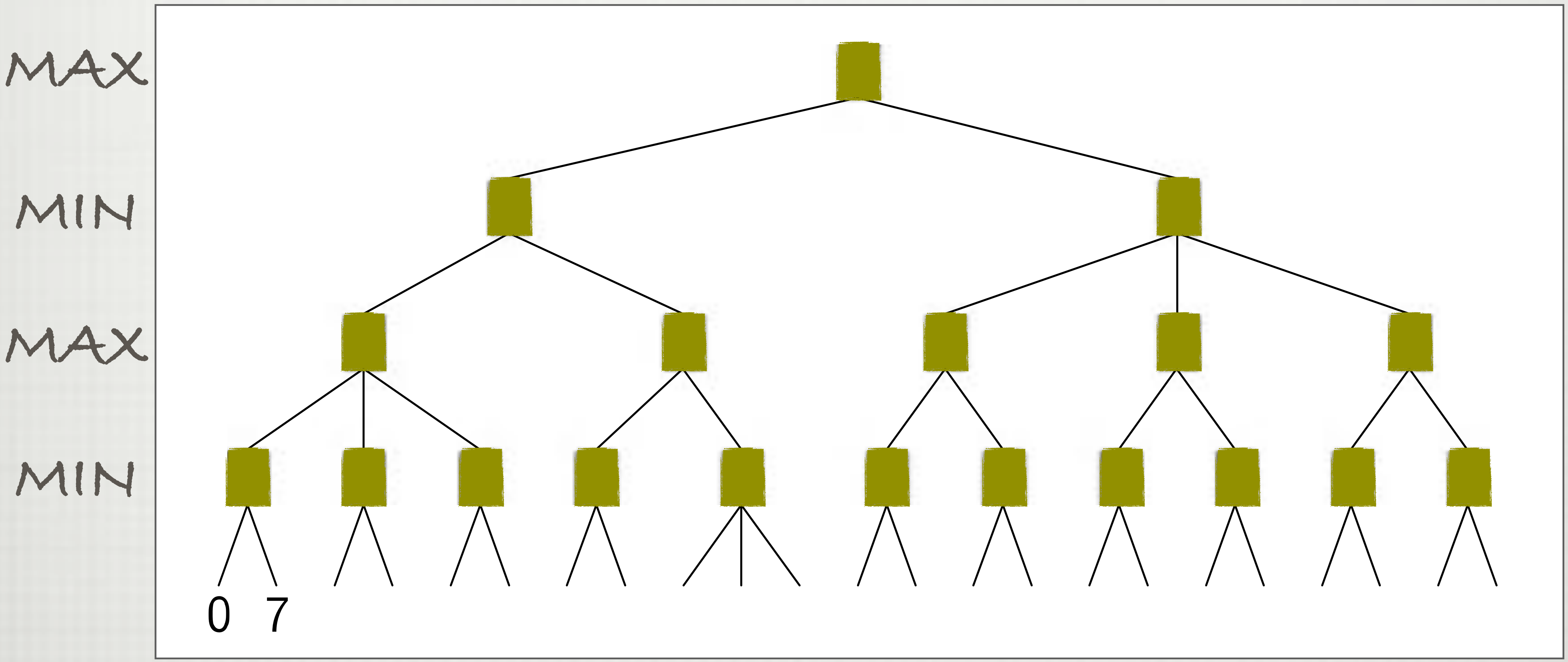

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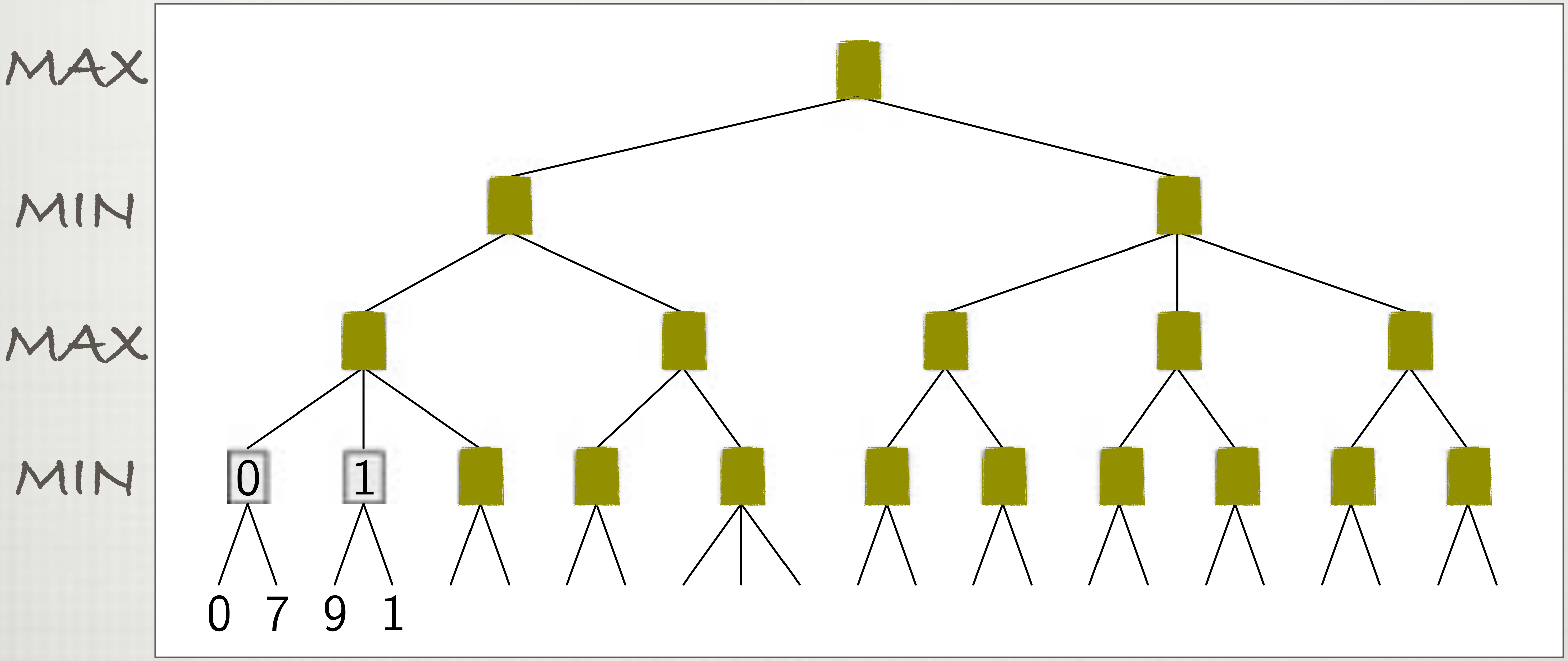

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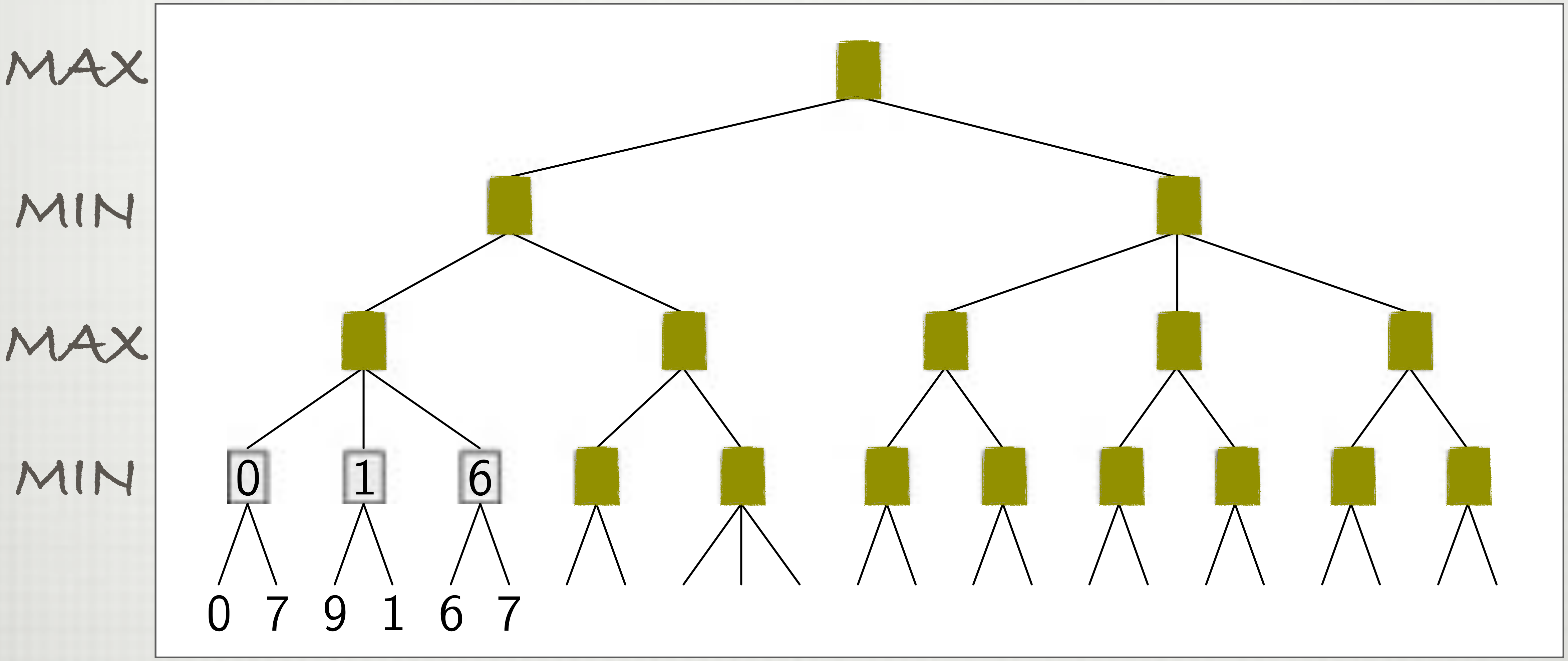

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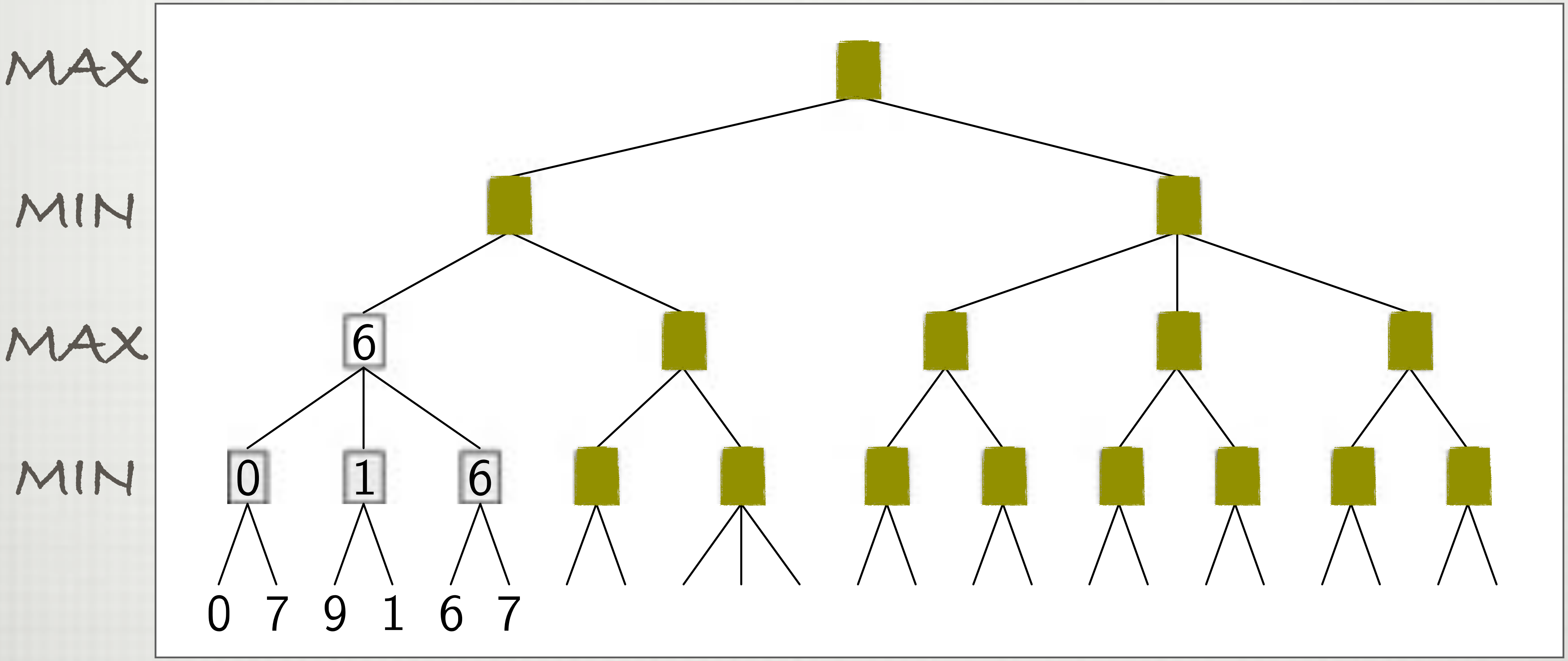

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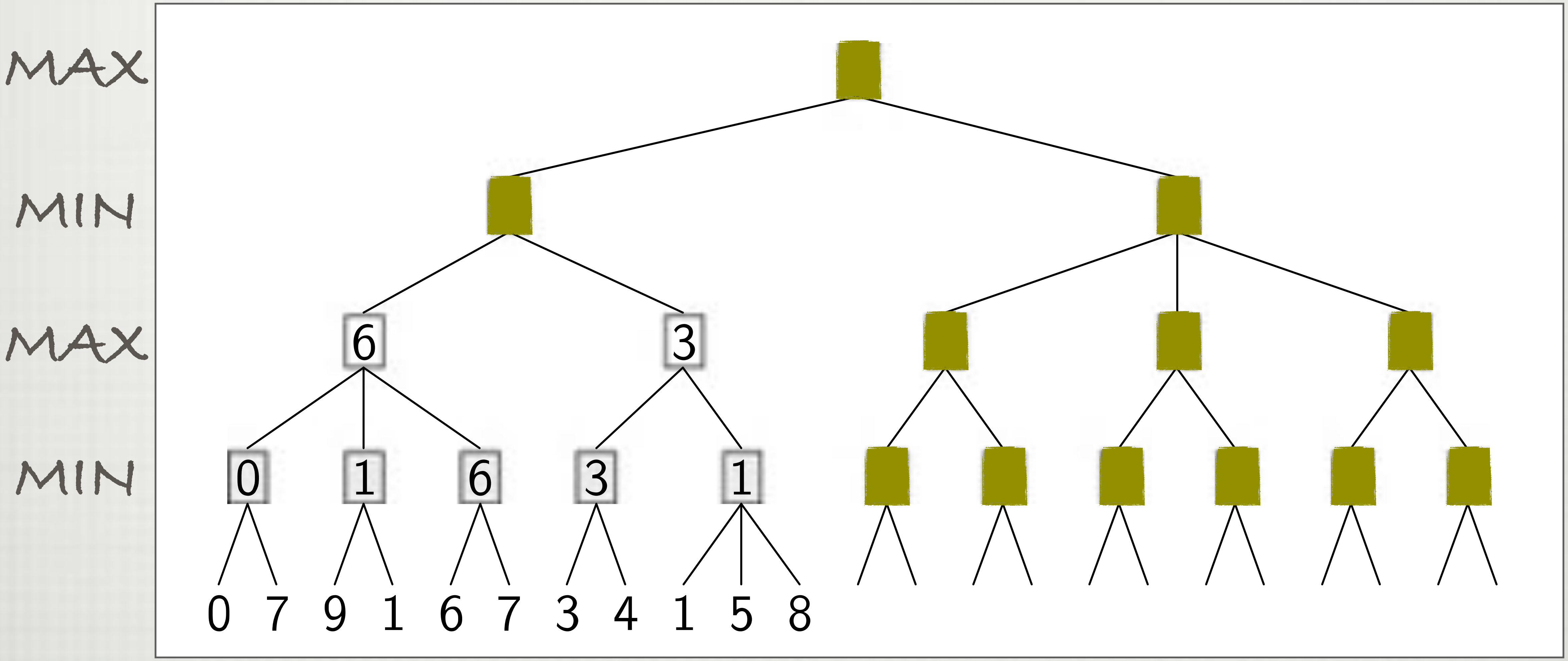

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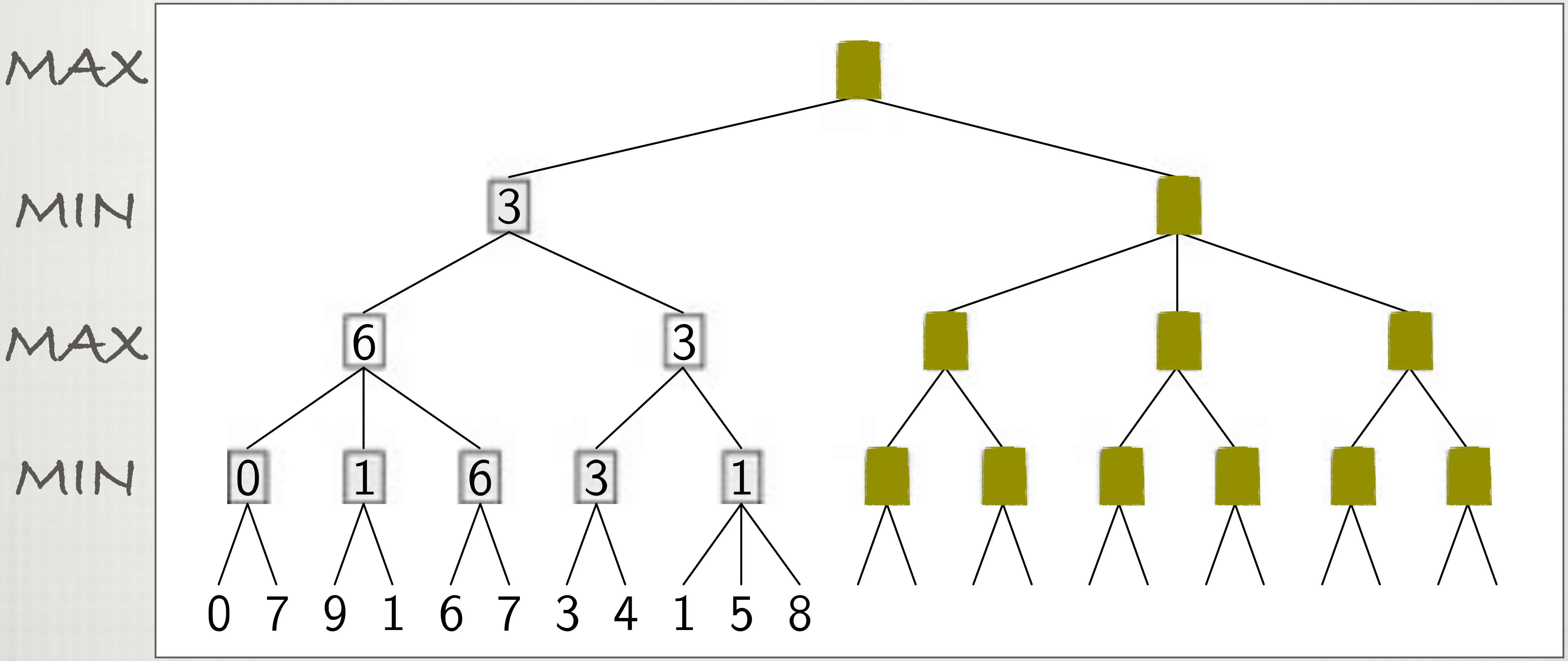

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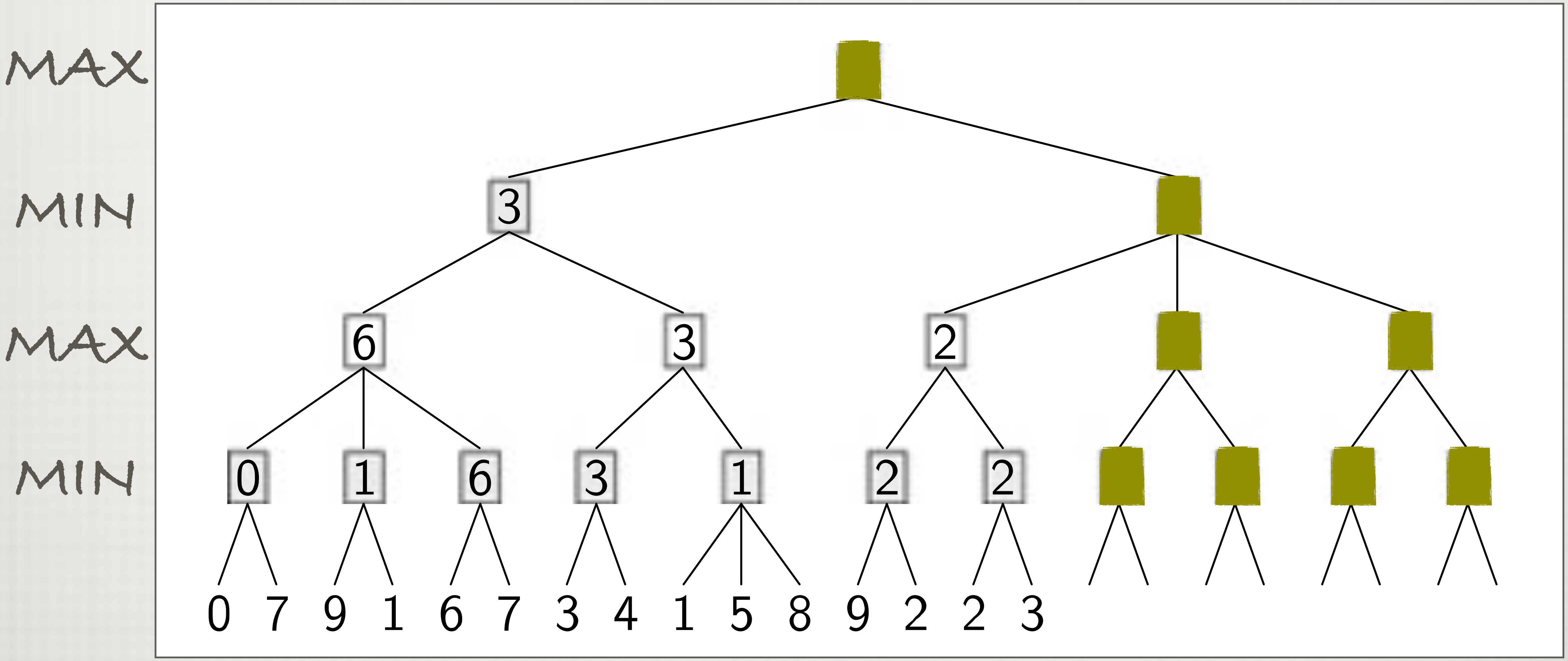

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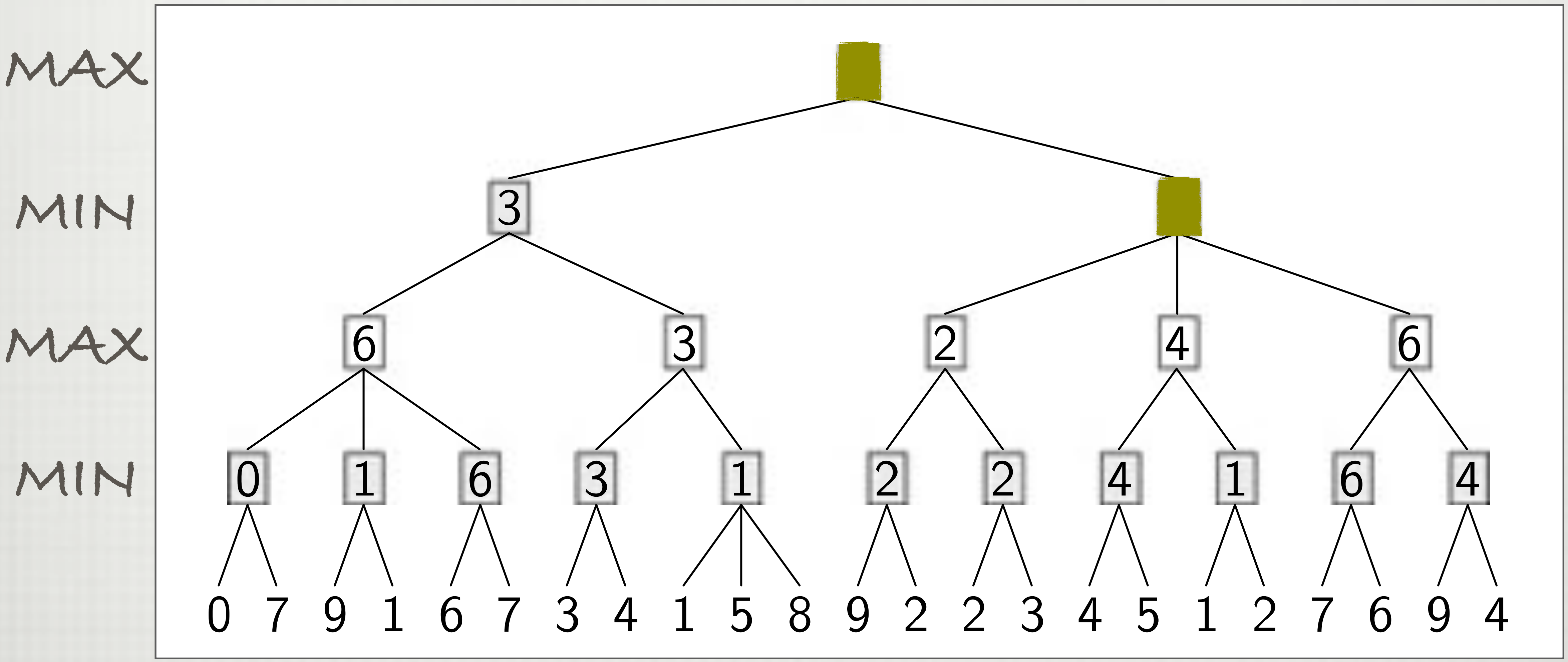
MAX
MIN
MAX
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3
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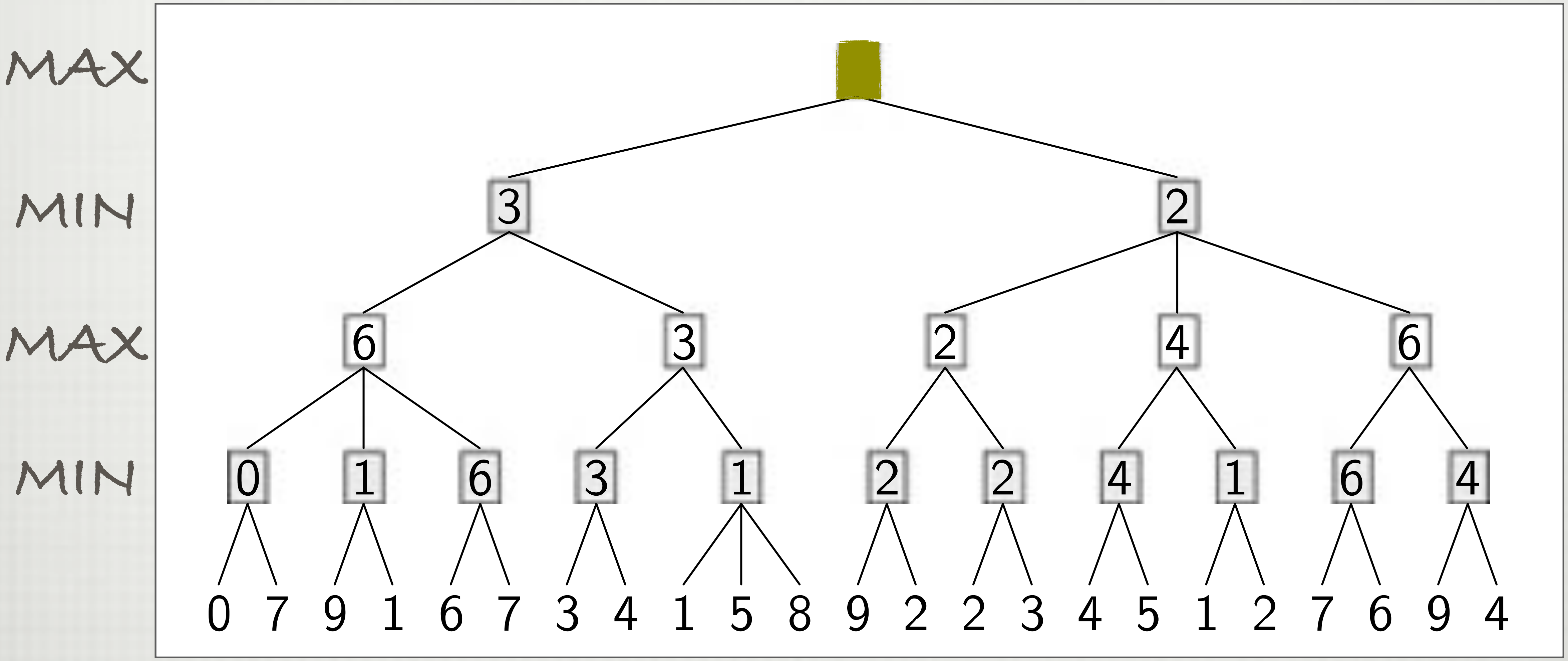
0 7 9 1 6 7 3 4 1 5 8 9 2 2 3 4 5 1 2 7 6 9 4

PELIPUU



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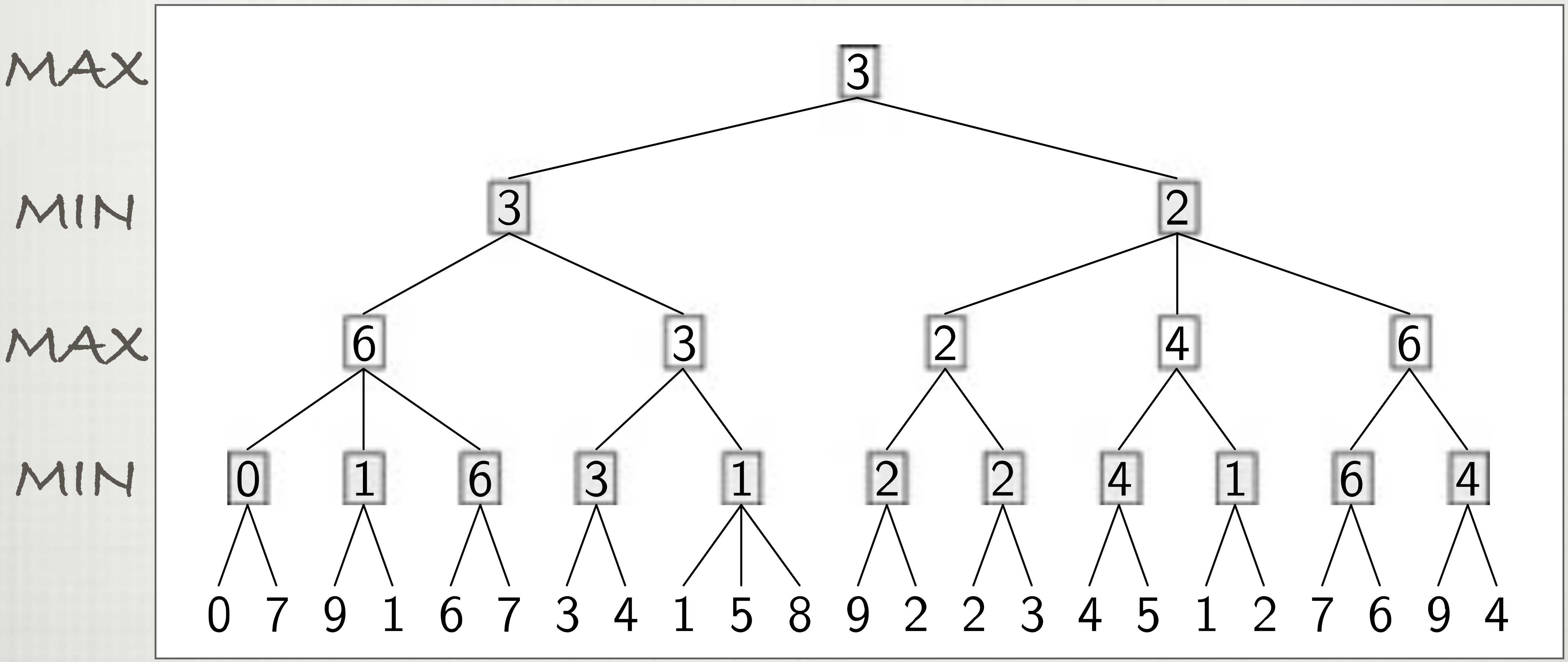
0 1 6 3 1 2 2 4 1 6 4
0 7 9 1 6 7 3 4 1 5 8 9 2 2 3 4 5 1 2 7 6 9 4

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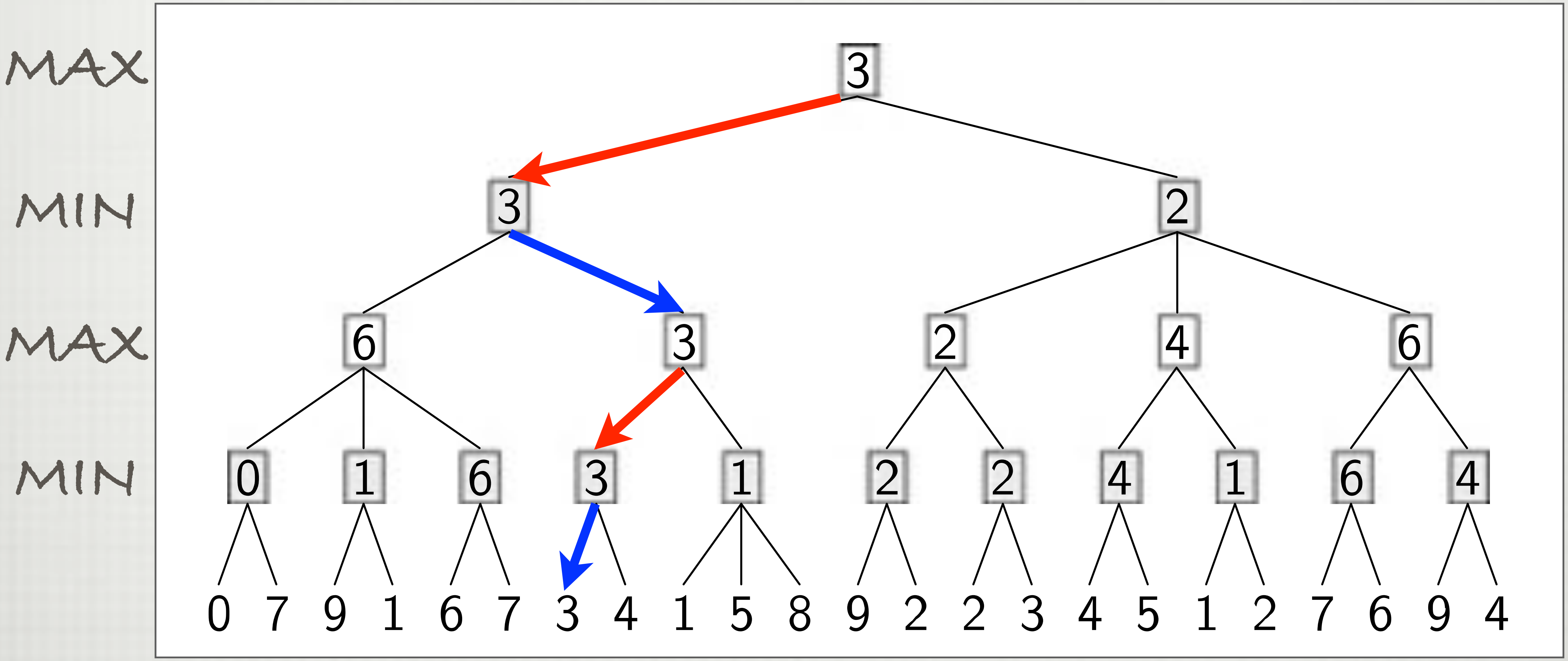
PELIPUU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0 1 6 3 1 2 2 4 1 6 4
0 7 9 1 6 7 3 4 1 5 8 9 2 2 3 4 5 1 2 7 6 9 4

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

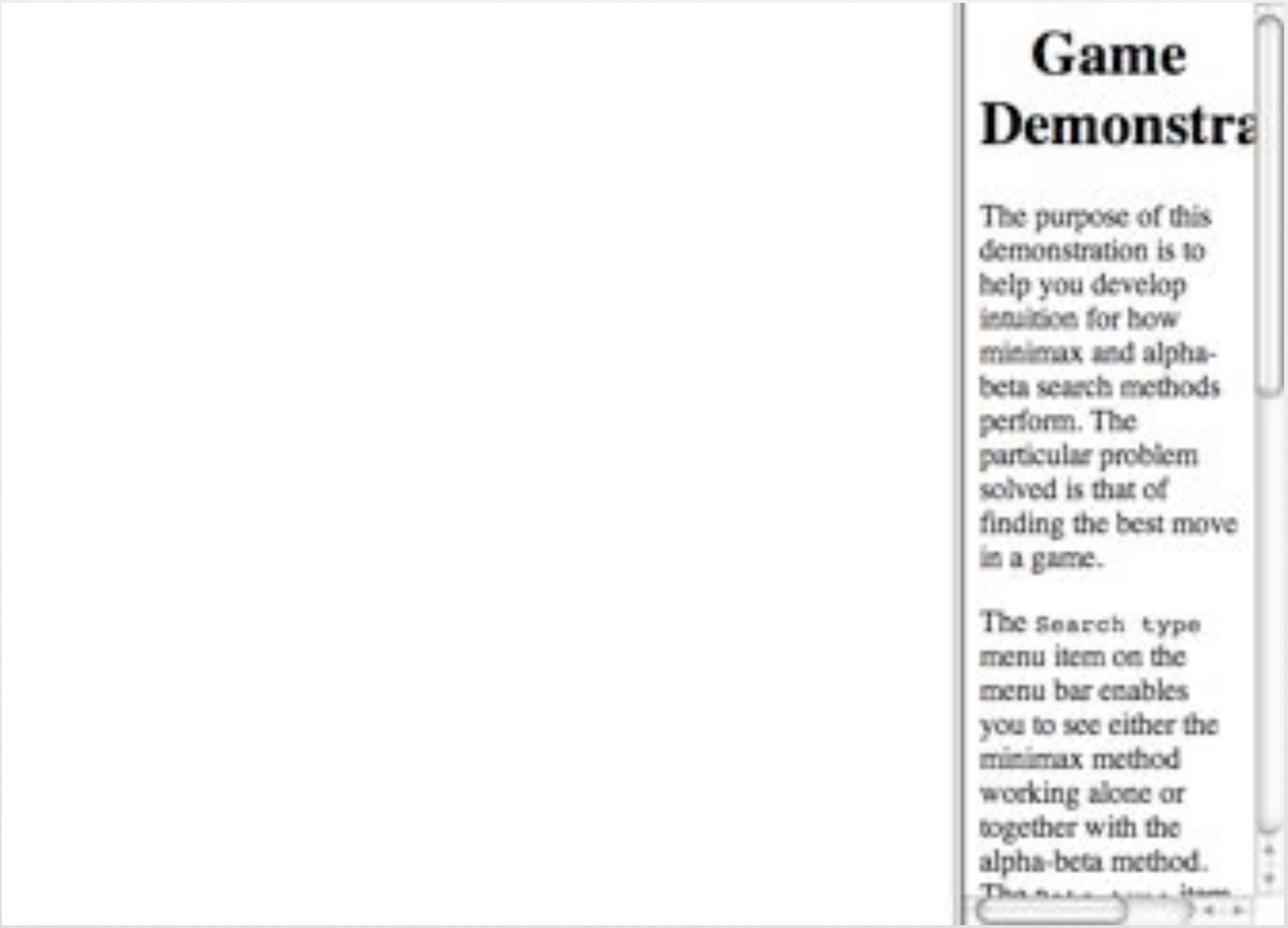
MAX-ARVO(Solmu)

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

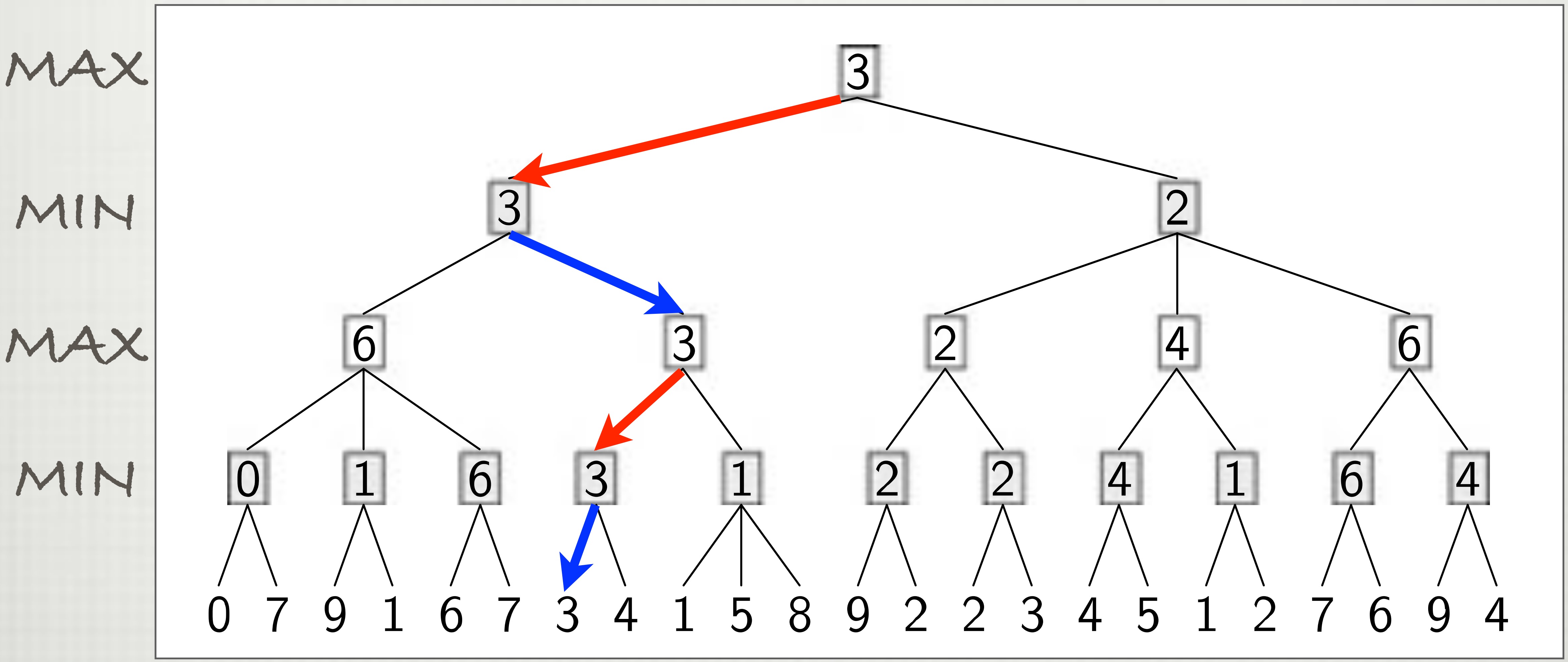
MIN-ARVO(Solmu)

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

MINIMAX

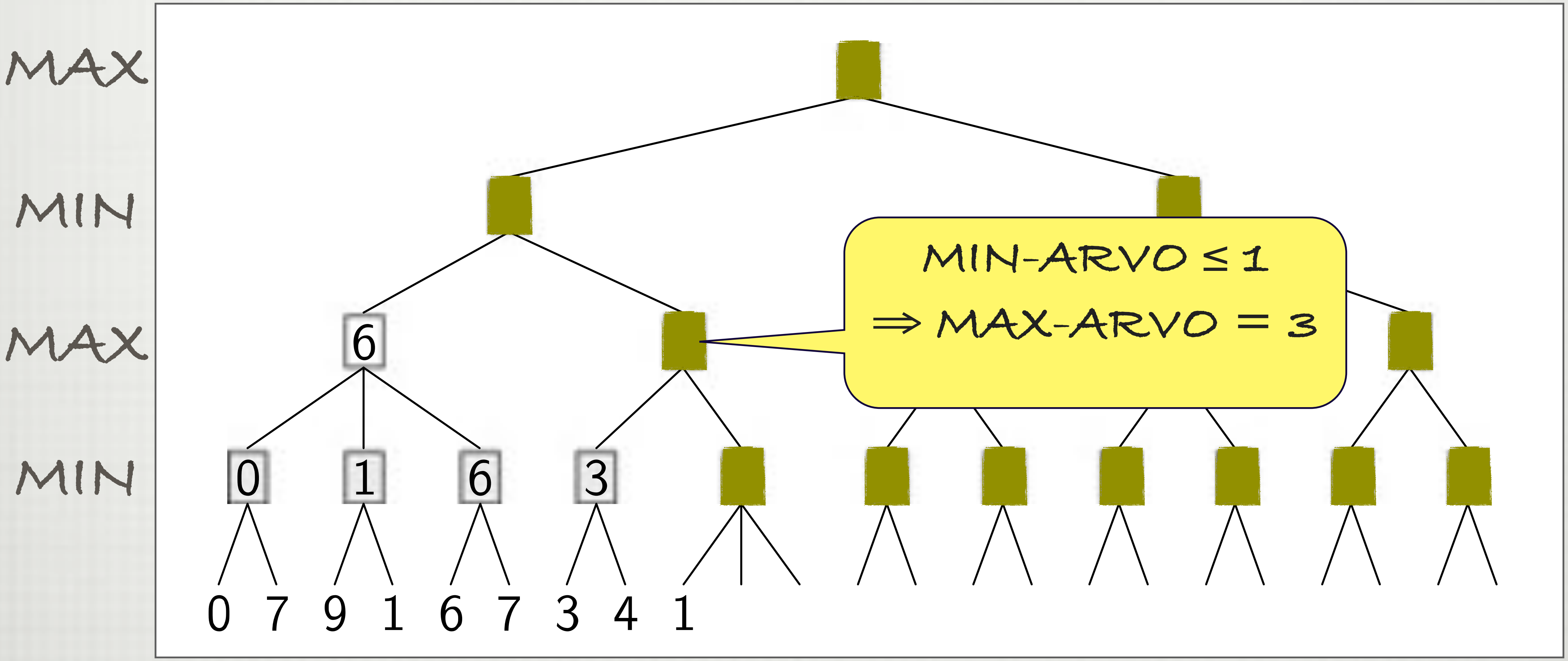

Game
Demonstra
The purpose of this demonstration is to help you develop intuition for how minimax and alpha-beta search methods perform. The particular problem solved is that of finding the best move in a game.
The Search type menu item on the menu bar enables you to see either the minimax method working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

PELIPUU



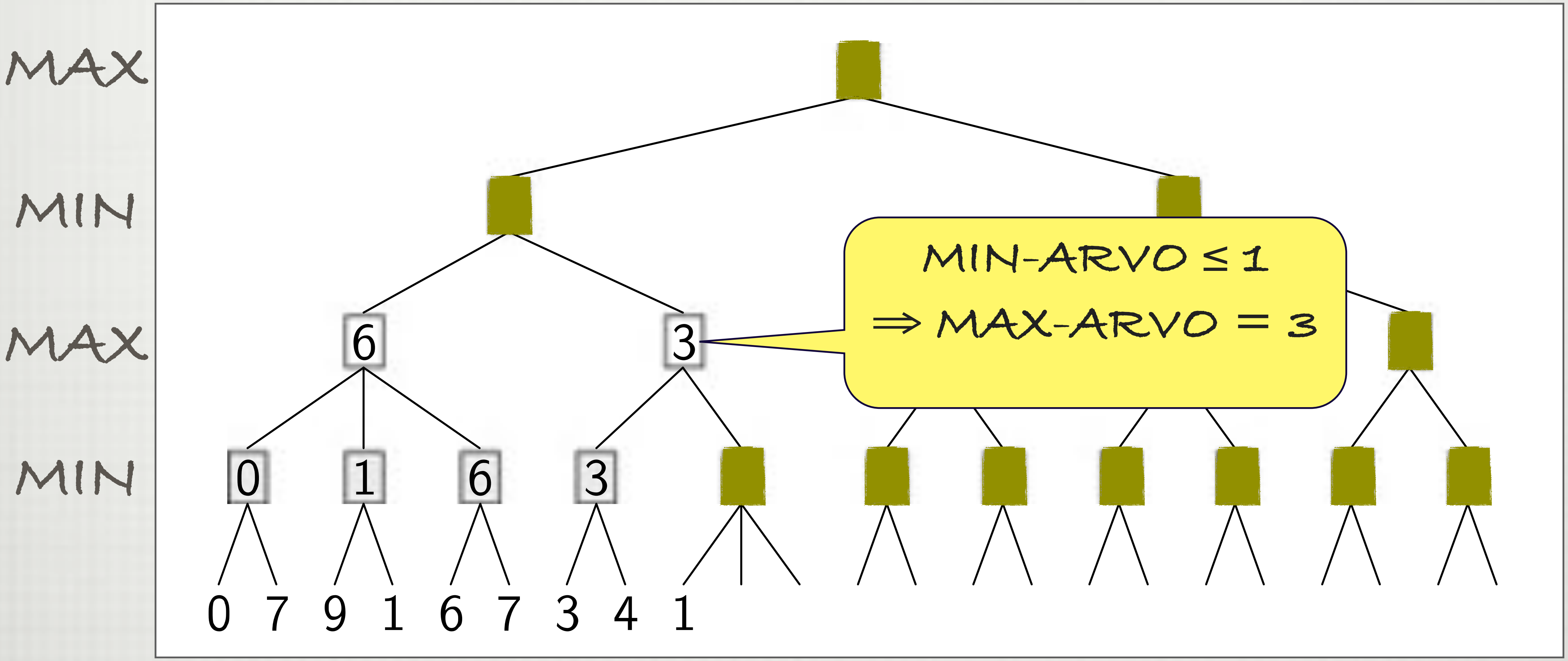
ALPHA-BETA-KARSINTA

PELIPUU



ALPHA-BETA-KARSINTA

PELIPUU



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

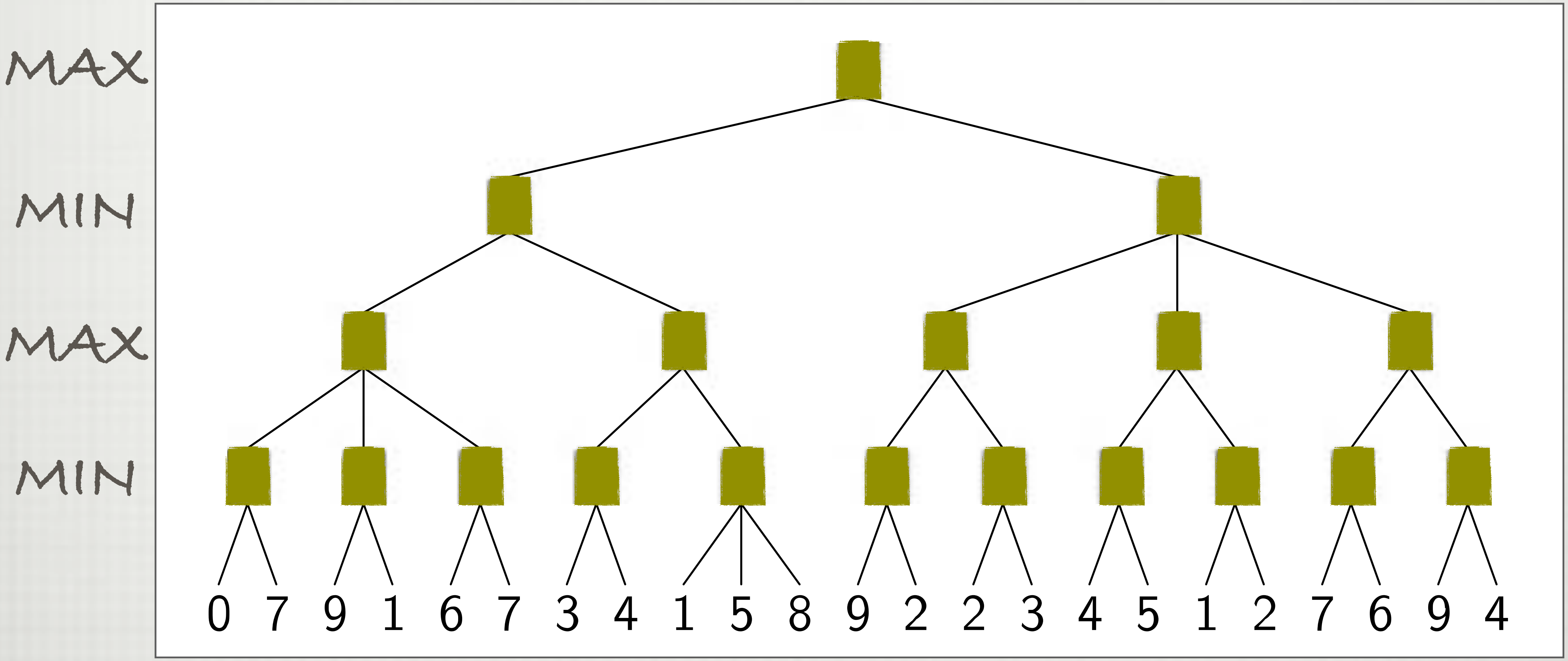
MAX-ARVO(Solmu, α, β)

```
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)
```

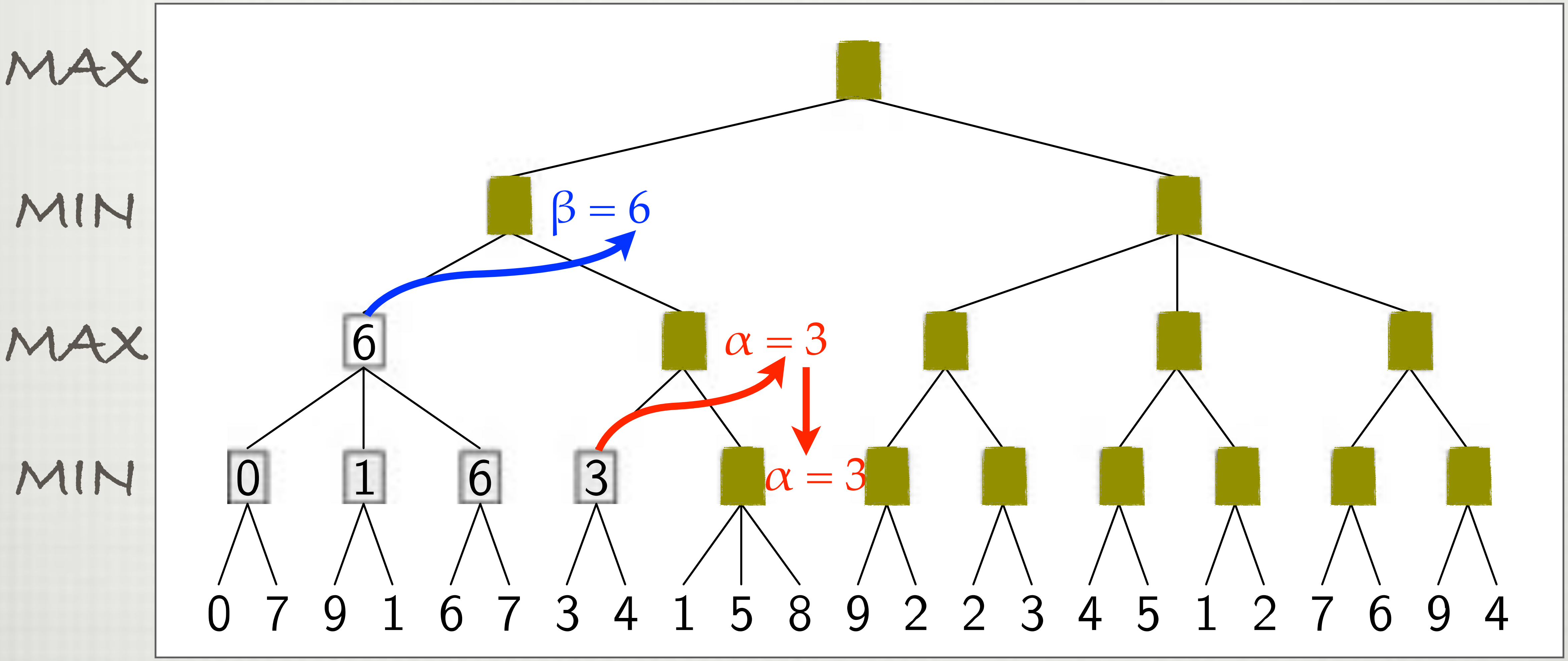
MIN-ARVO(Solmu, α, β)

```
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

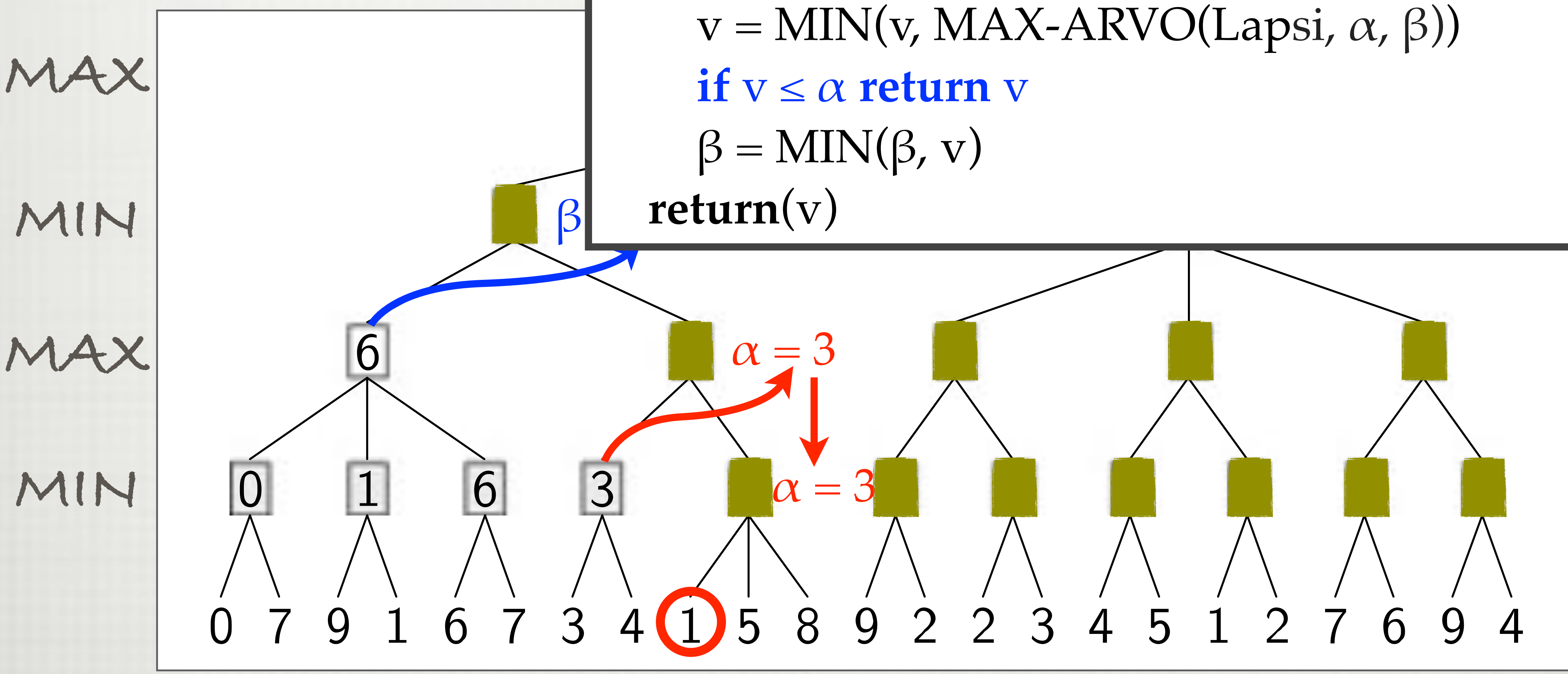


ALPHA-BETA-KARSINTA



ALPHA

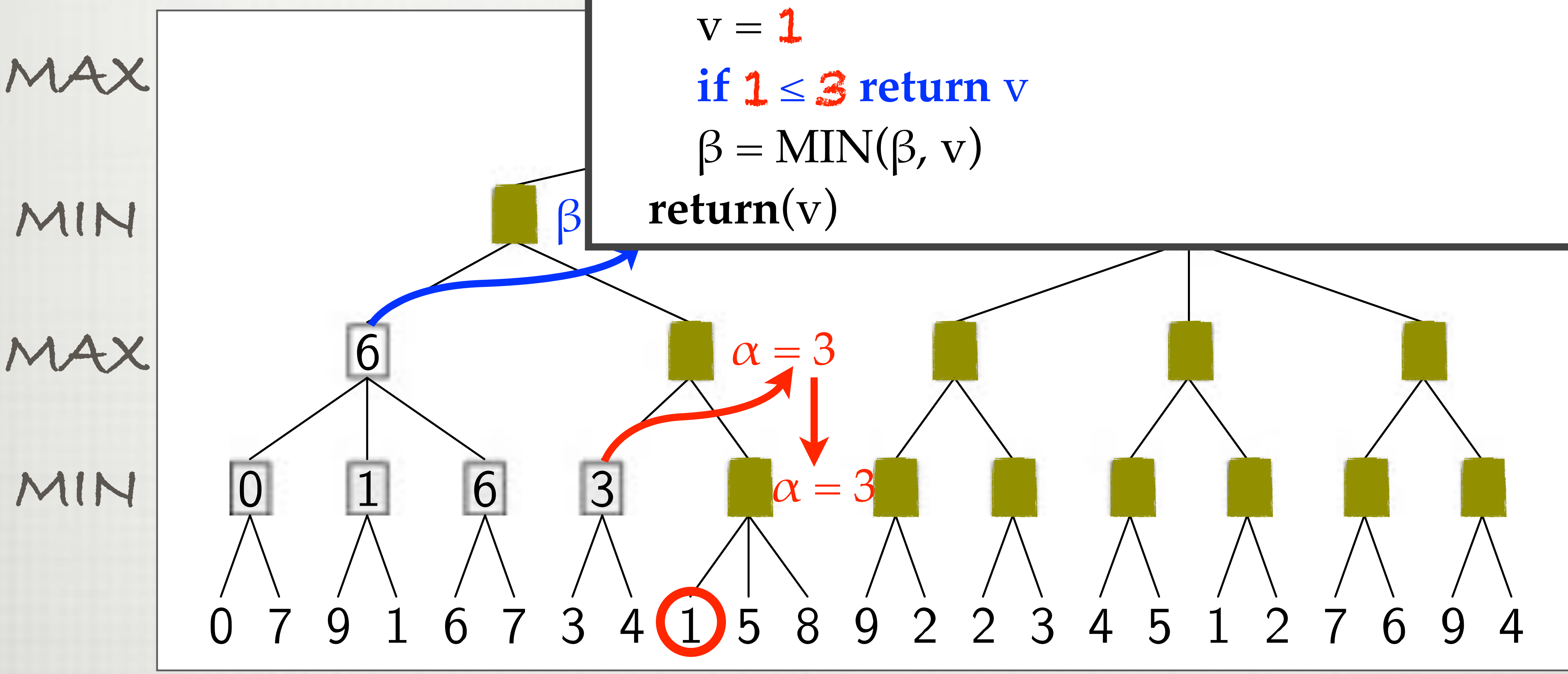
```
MIN-ARVO(Solmu, α, β)

    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)

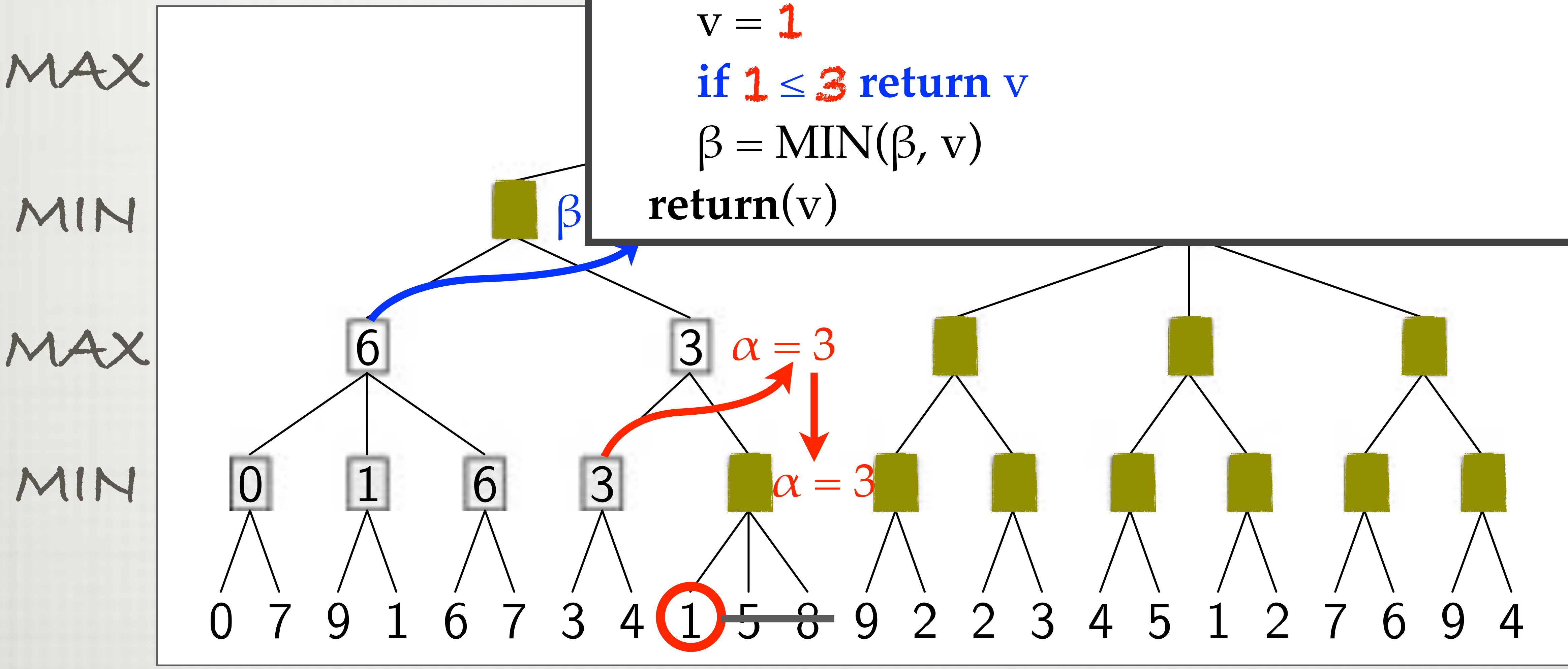
if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = +∞
for each Lapsi in LAPSET(Solmu)
 v = 1
 if 1 ≤ 3 **return** v
 β = MIN(β, v)
return(v)



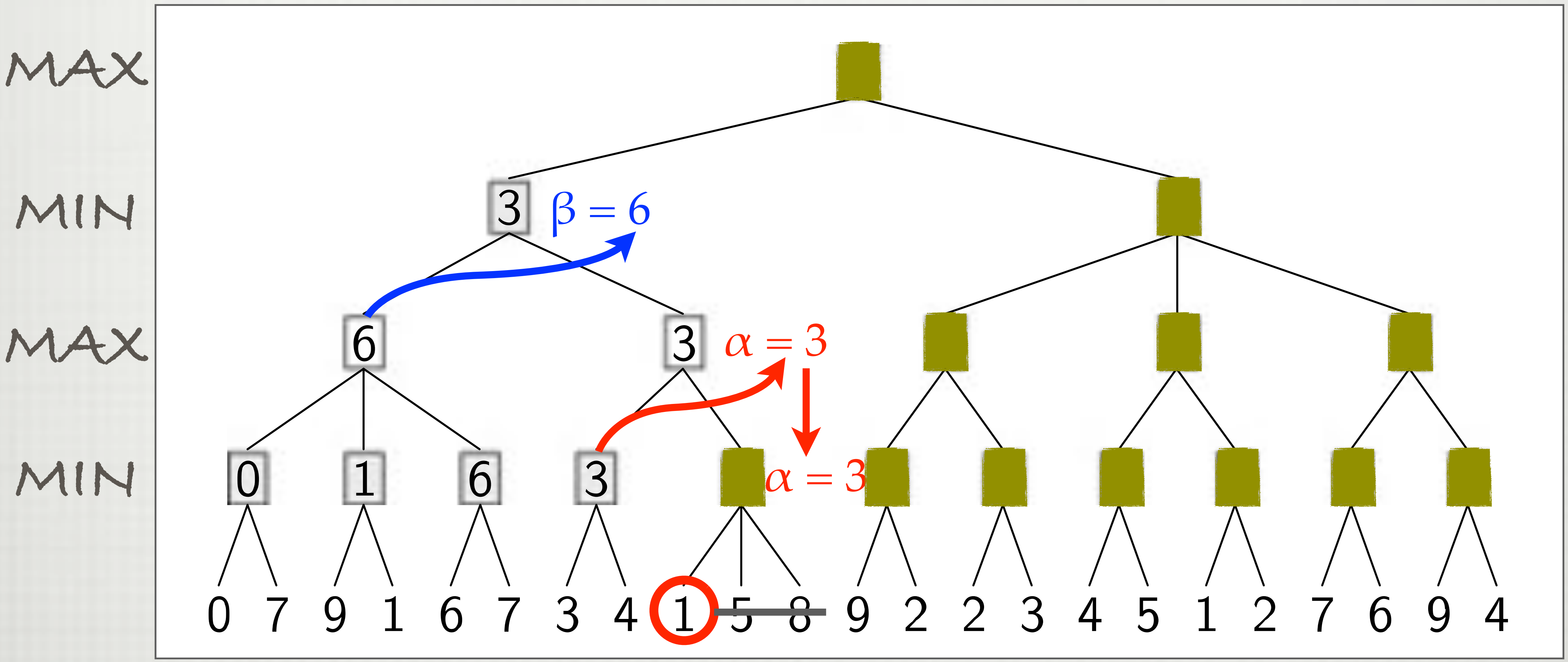
ALPHA

MIN-ARVO(Solmu, α, β)

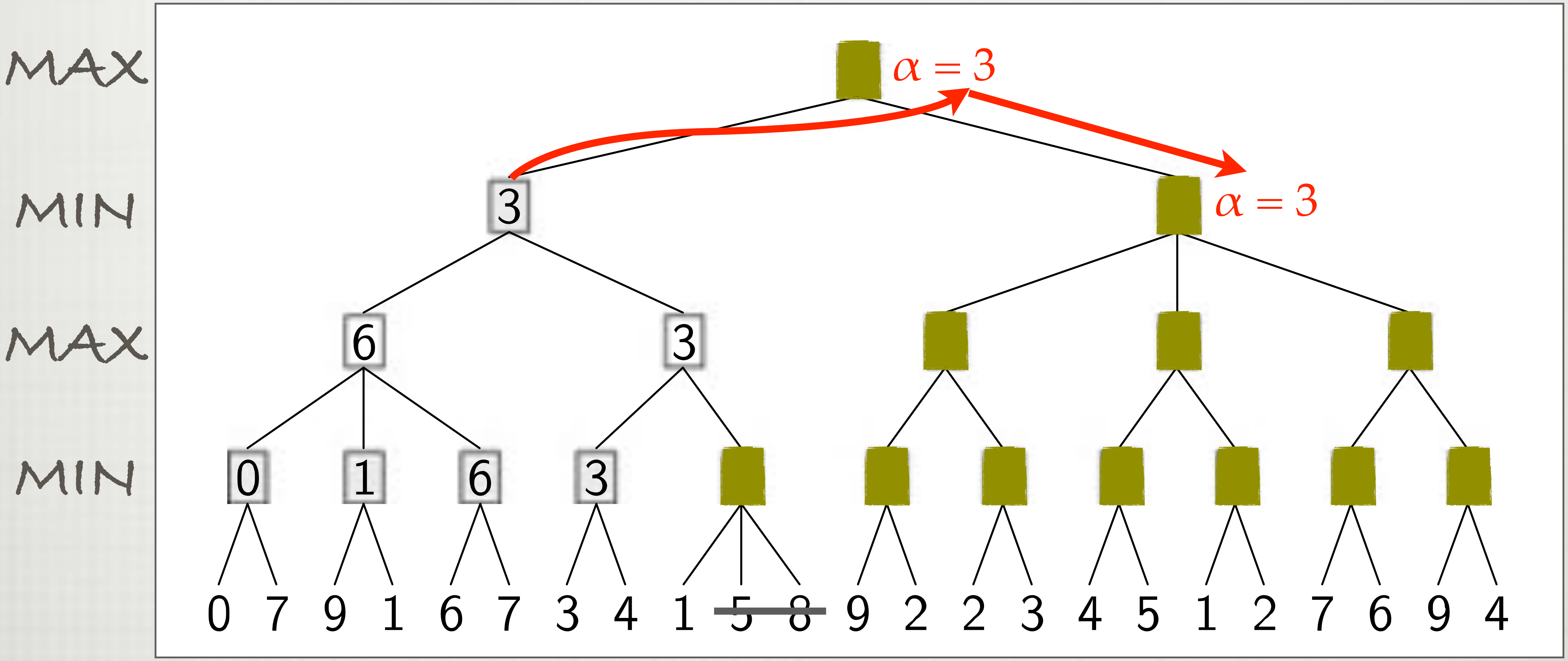
if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = $+\infty$
for each Lapsi in LAPSET(Solmu)
    v = 1
    if 1 ≤ 3 **return** v
    β = MIN(β, v)
return(v)



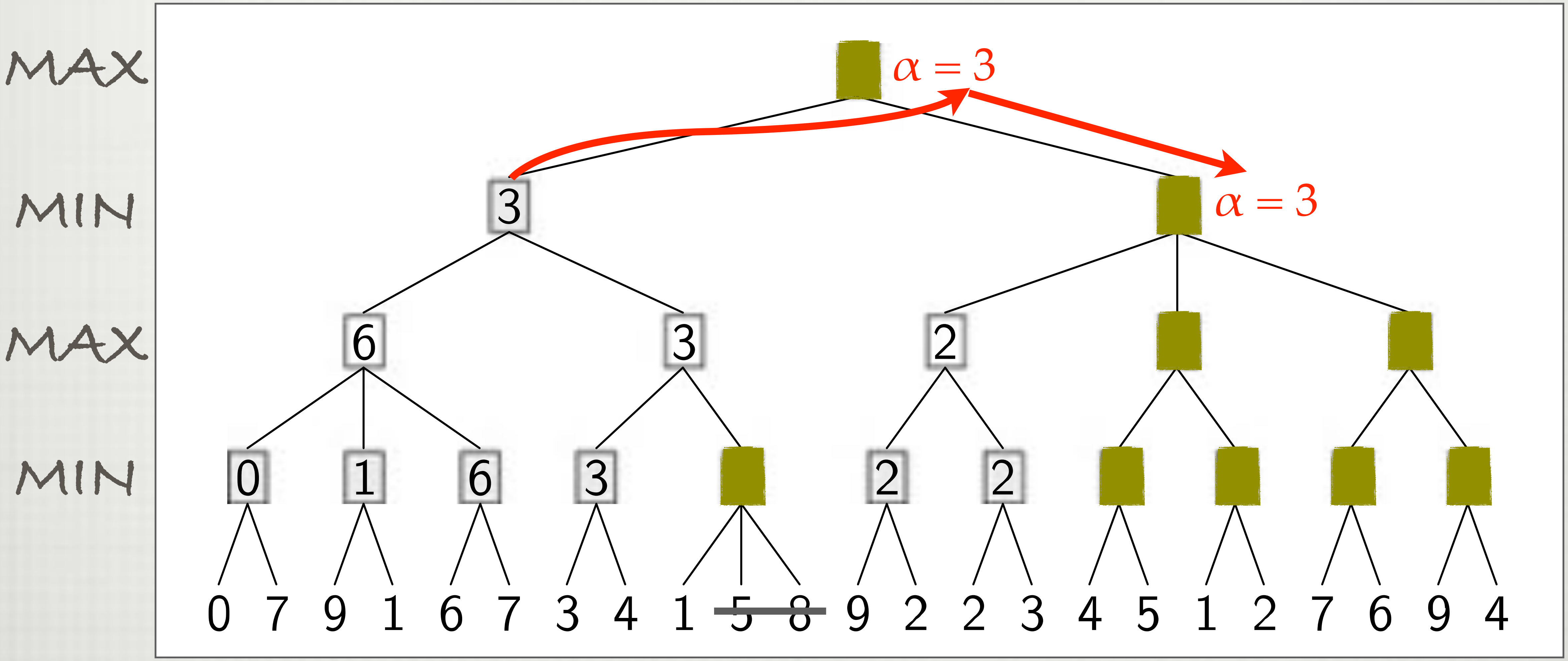
ALPHA-BETA-KARSINTA



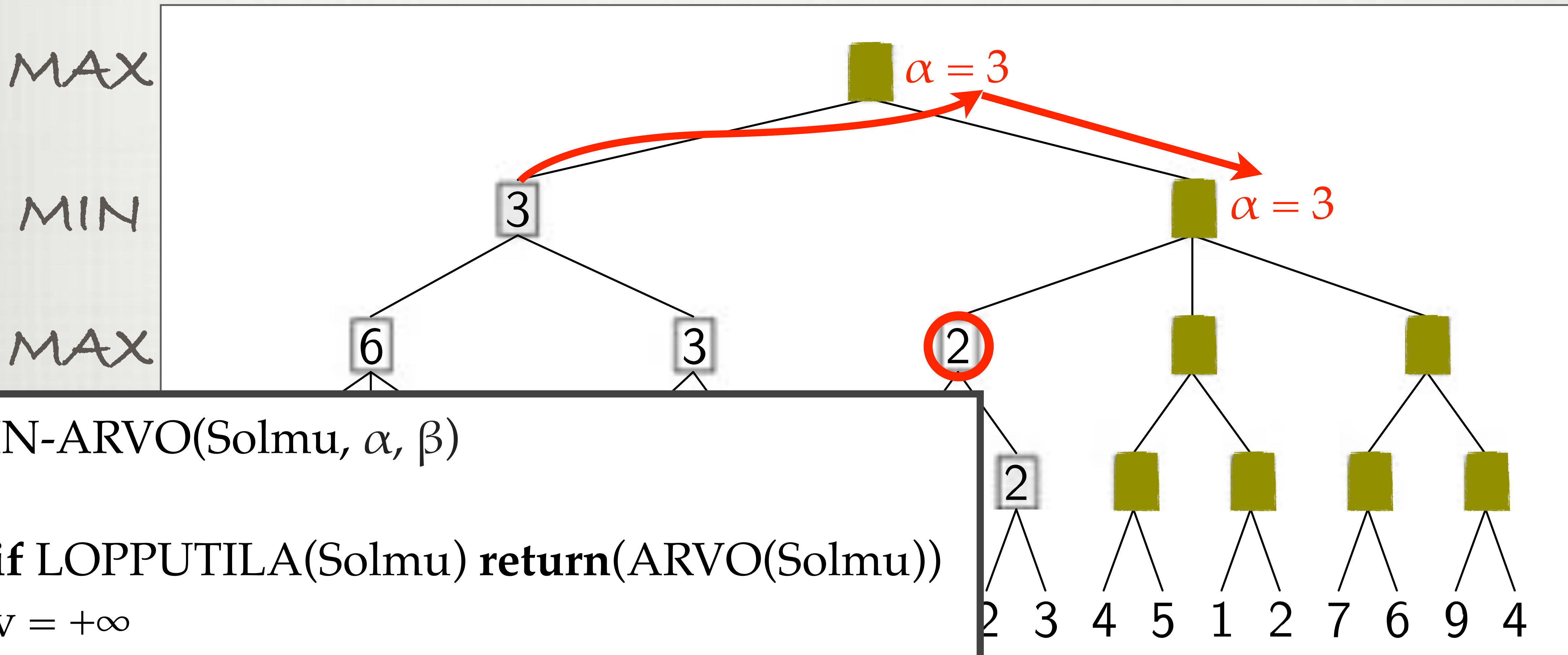
ALPHA-BETA-KARSINTA



ALPHA-BETA-KARSINTA



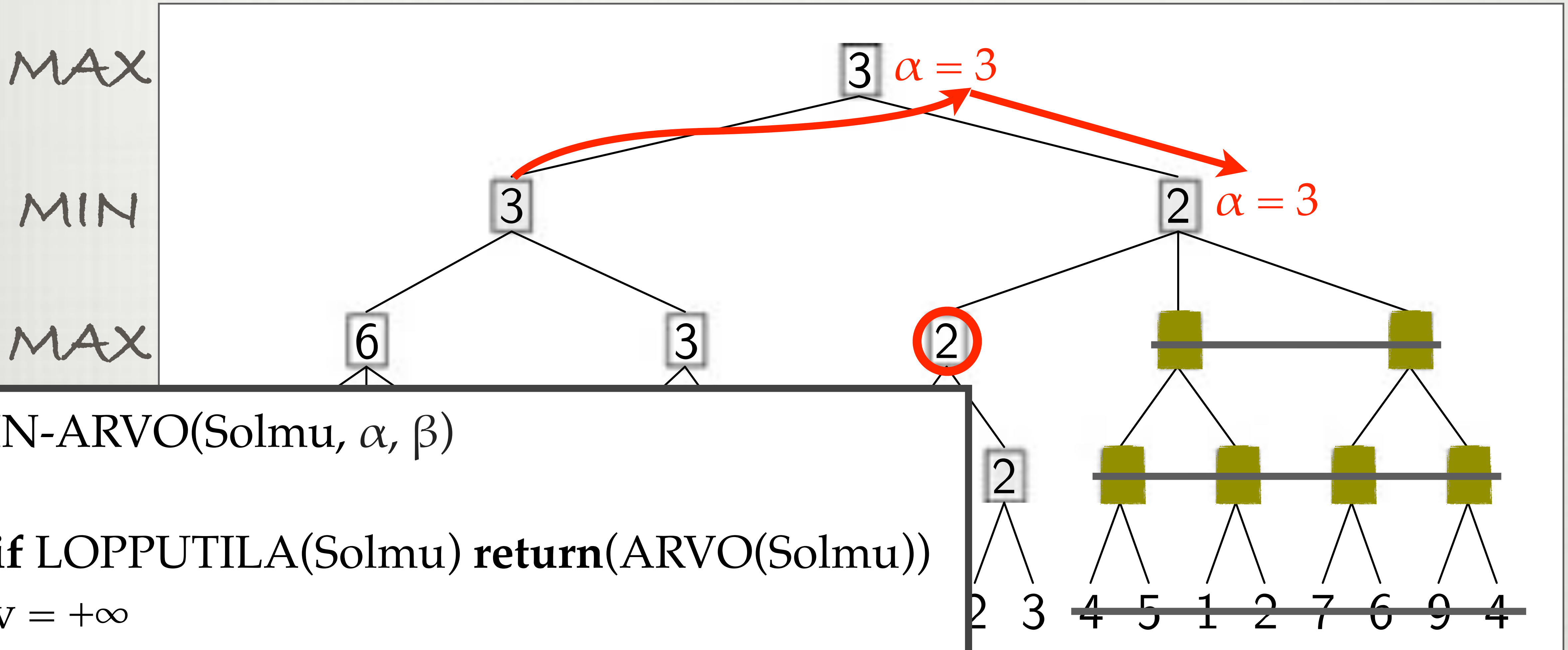
ALPHA-BETA-KARSINTA



MIN-ARVO(Solmu, α, β)

if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = +∞
for each Lapsi in LAPSET(Solmu)
  v = 2
  if 2 ≤ 3 **return** v
  β = MIN(β, v)
return(v)

ALPHA-BETA-KARSINTA



MIN-ARVO(Solmu, α, β)

if LOPPUTILA(Solmu) **return**(ARVO(Solmu))
v = +∞
for each Lapsi in LAPSET(Solmu)
  v = 2
  if 2 ≤ 3 **return** v
  β = MIN(β, v)
return(v)

SHAKKI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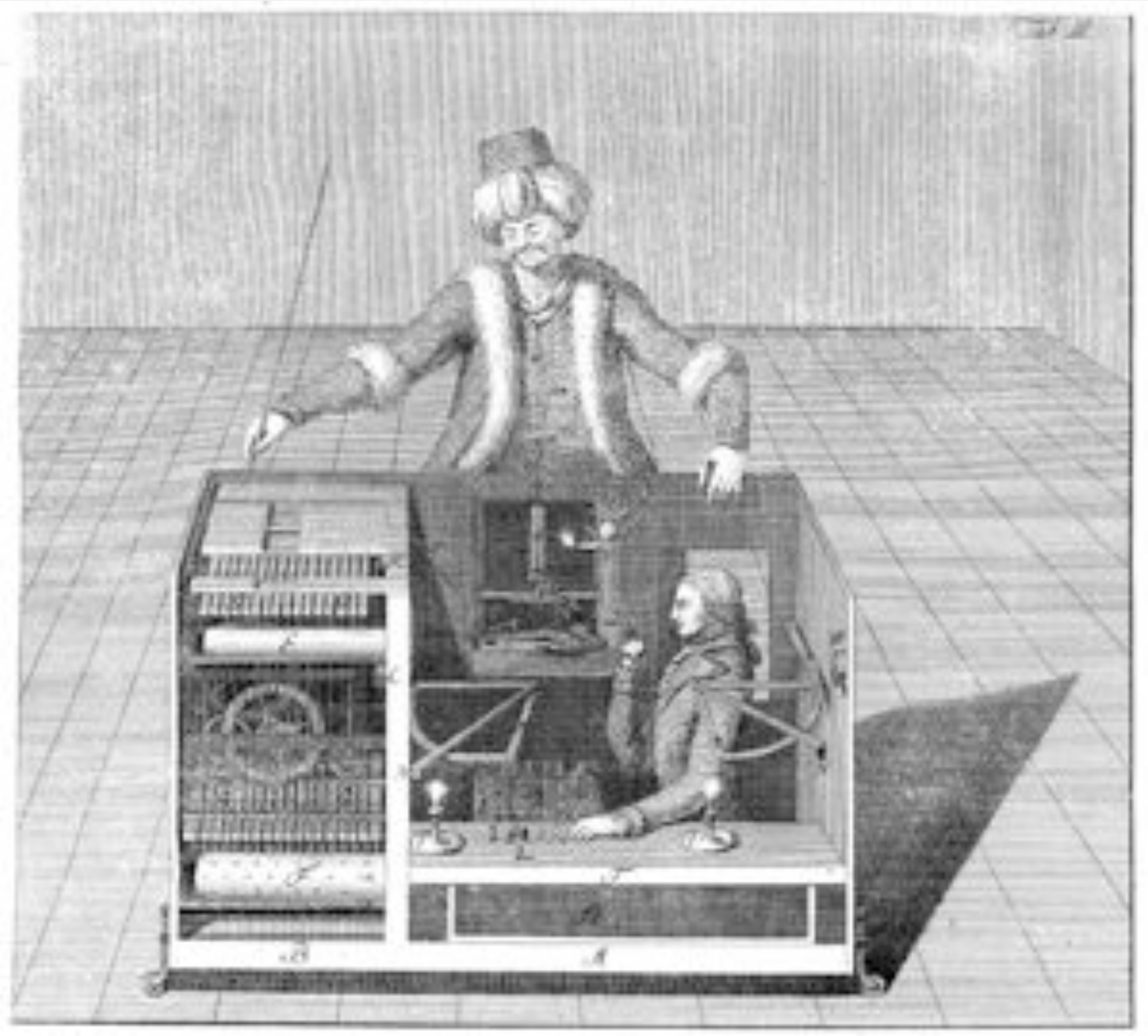
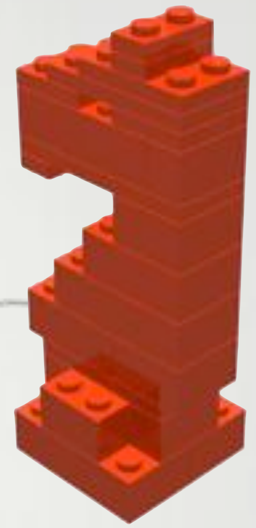
SHAKKI





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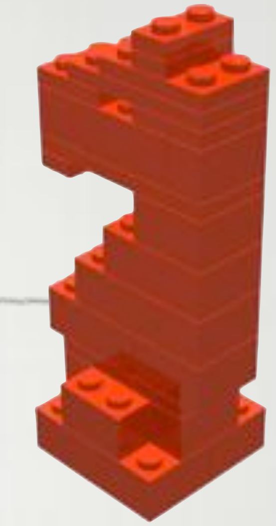


1769 **Wolfgang von Kempelen** rakentaa "Turkin"

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

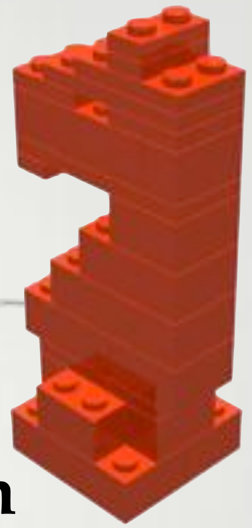
1956 Los Alamos chess: ensimmäinen tietokoneohjelma, joka pelaa (yksinkertaistettua) shakkia

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

1957 Ensimmäiset oikeaa shakkia pelaavat ohjelmat

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

SHAKKI



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.

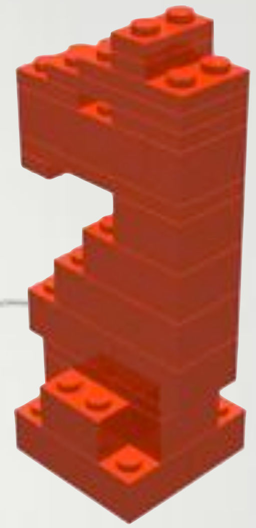
1989 Garry Kasparov voittaa kaksi näytösottelua Deep Thoughtia vastaan.

1996 Garry Kasparov voittaa Deep Bluen kuuden pelin ottelussa.

1997 Deep Blue voittaa Garry Kasparovin kuuden pelin ottelussa.

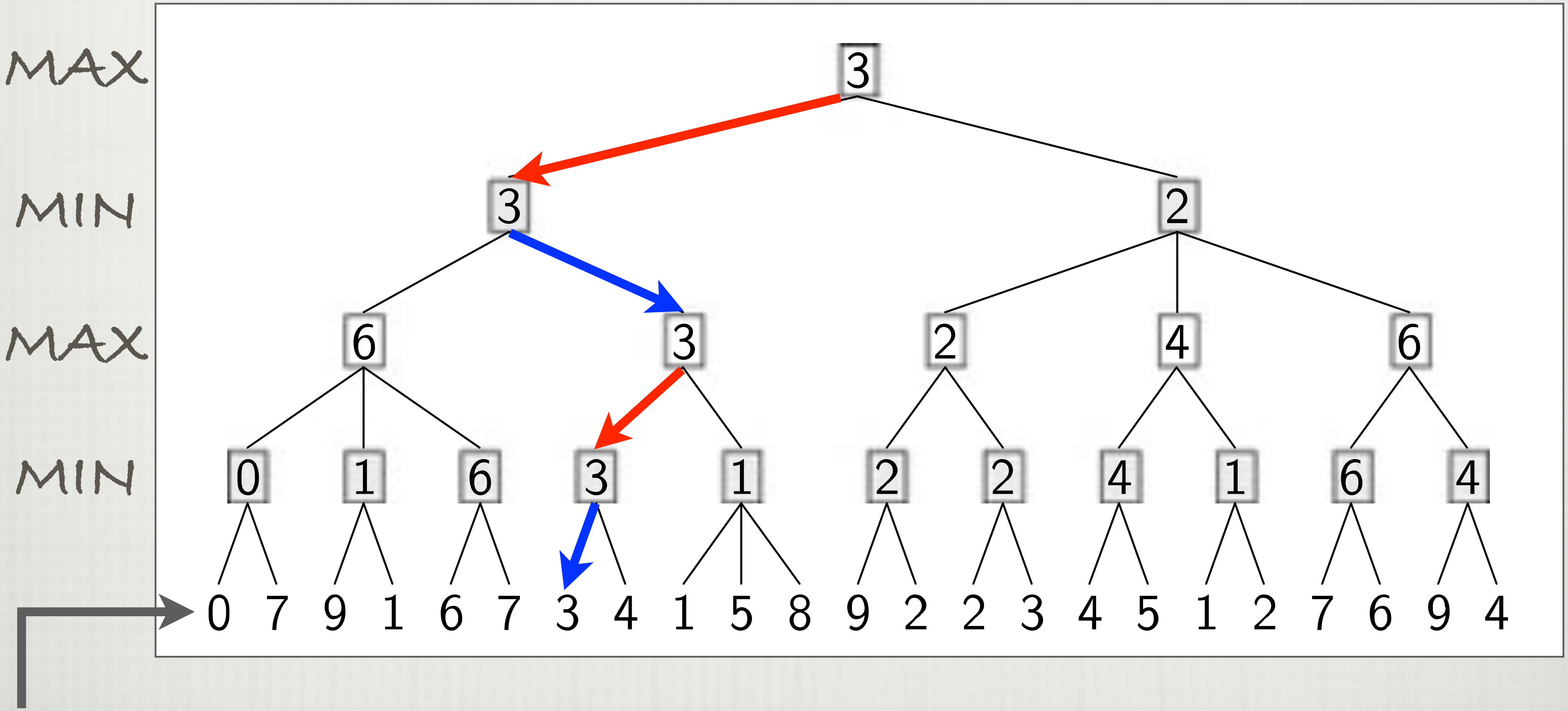
2006 Deep Fritz voittaa maailmanmestari Vladimir Kramnikin.

SHAKKI



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

PELIPUU



ARVIOITA TILANTEEN HYVYYDESTÄ

ARPAPELIT