

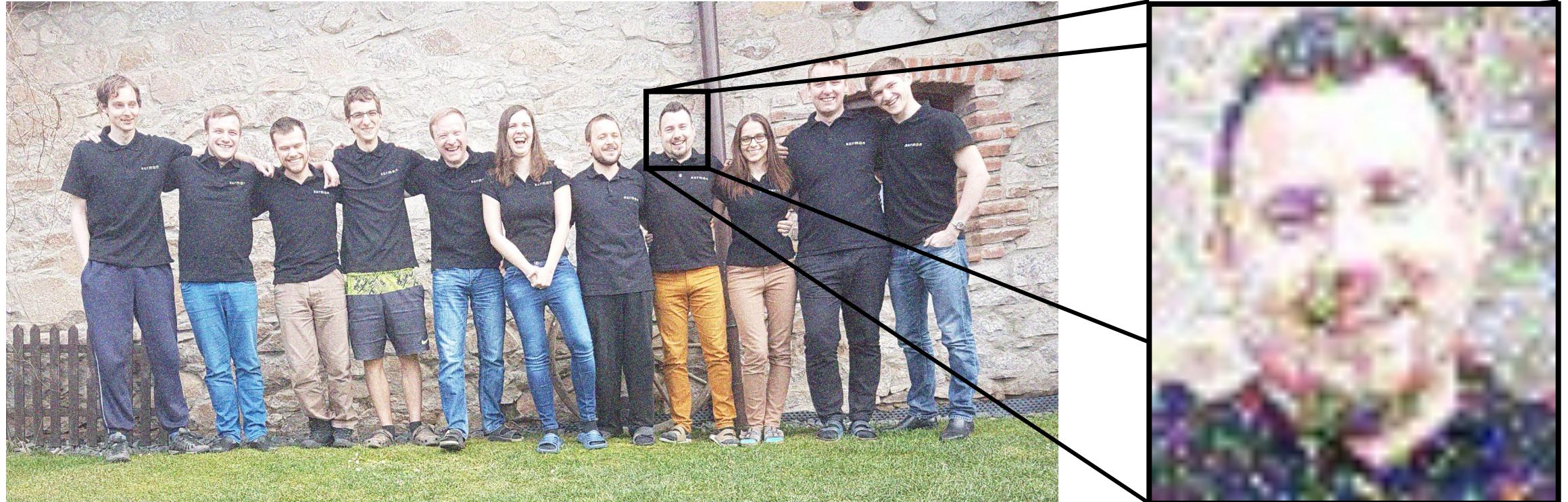
# Morfologie a tvarové charakteristiky

Strojové vidění a zpracování obrazu (BI-SVZ)

# Šum v obrazu (noise)



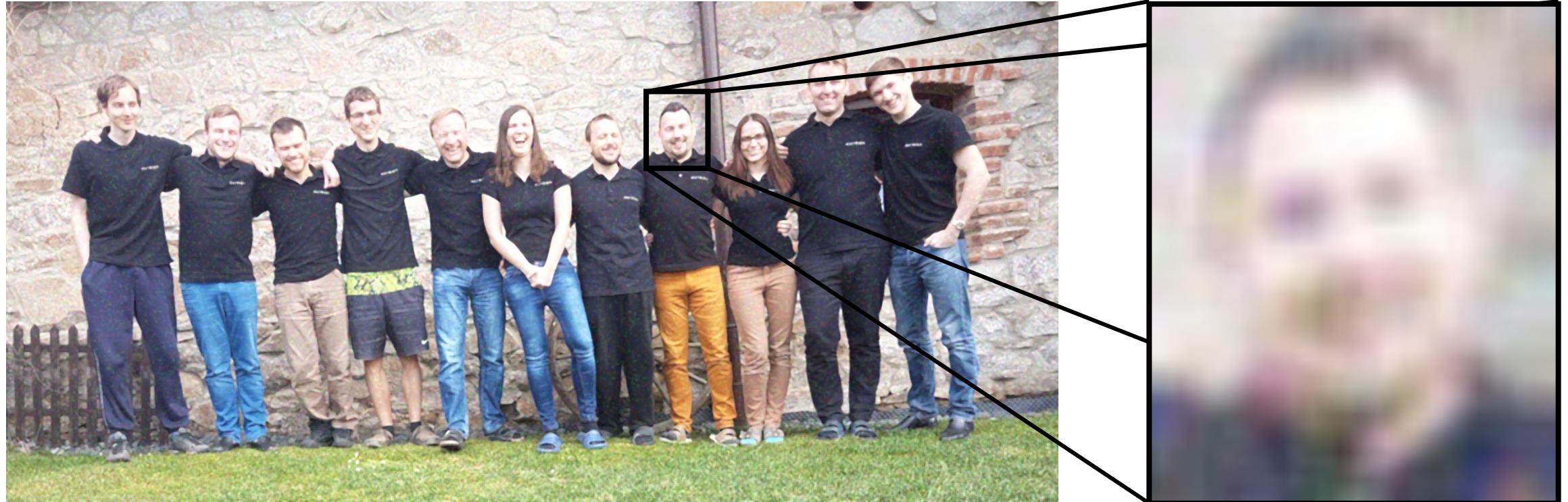
# Šum v obrazu – Gaussian noise



Aditivní šum s Gaussovým rozložením

- Nejčastější typ
- Náhodné přičtení hodnot k hodnotám pixelů

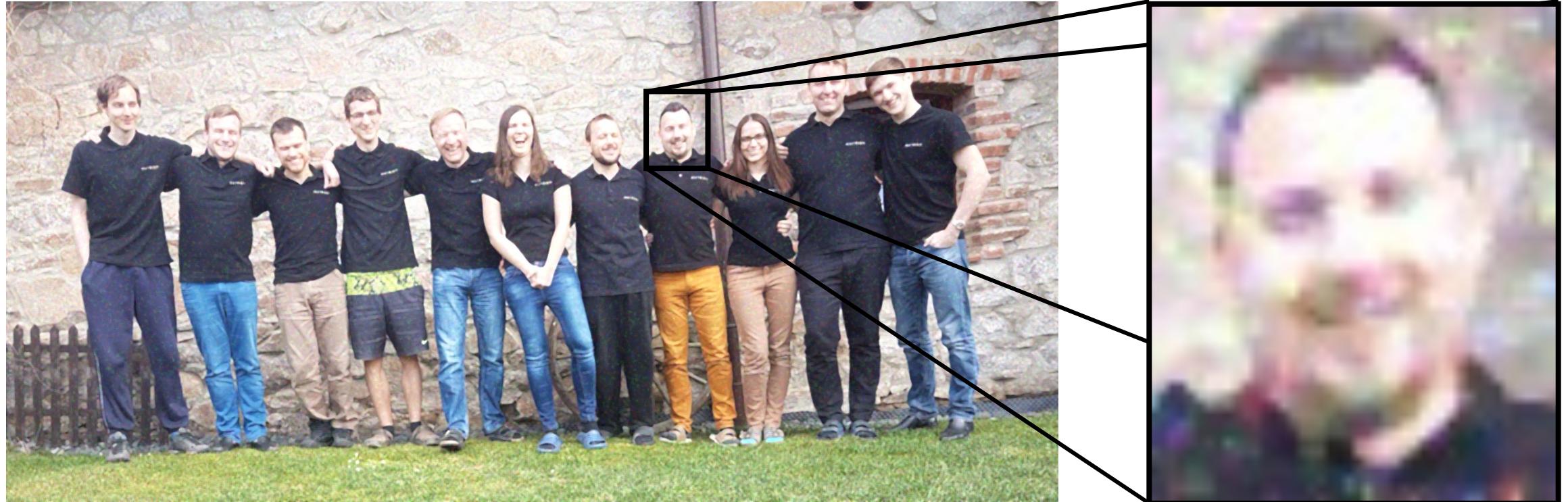
# Šum v obrazu – Gaussian noise



Odstanění

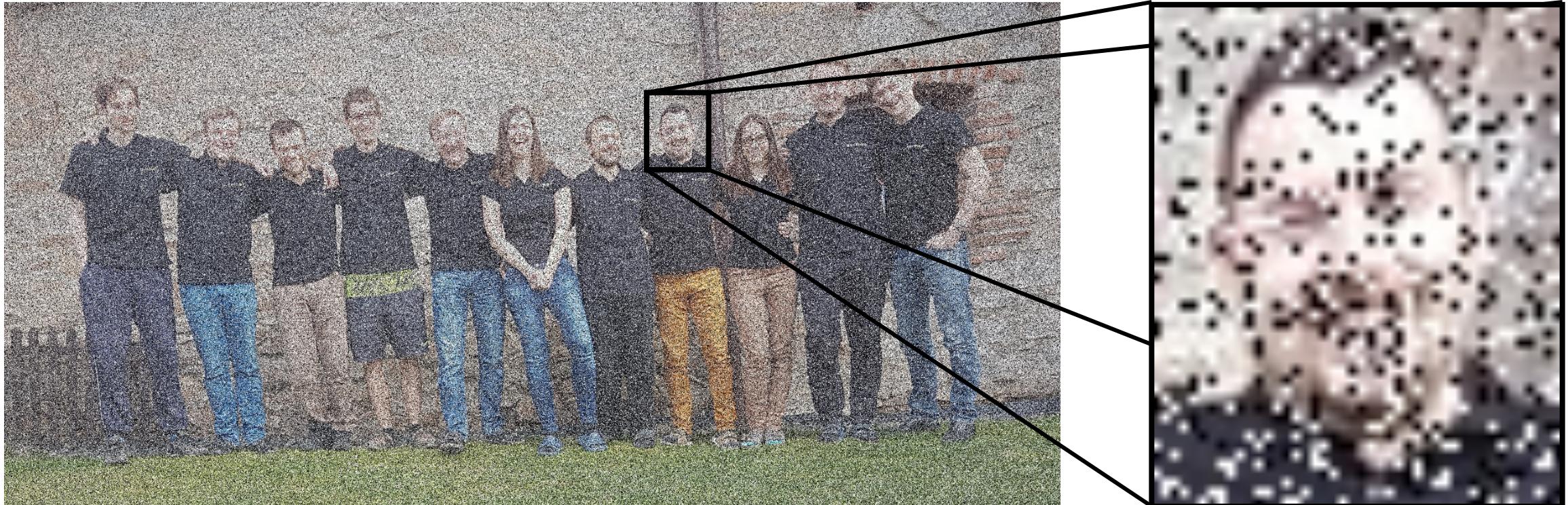
- Rozmazáním
- Průměrováním

# Šum v obrazu – Gaussian noise



Odstanění  
• Mediánem

# Šum v obrazu – Salt&Pepper noise



Náhodný šum 0 nebo 255

- Vadný senzor
- Saturace světločivné buňky

# Šum v obrazu – Salt&Pepper noise



Odstanění

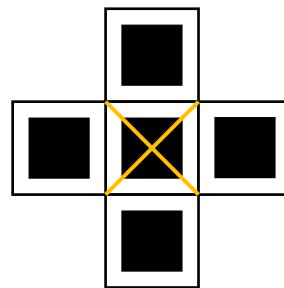
- Mediánem

# Morfologie v biologii

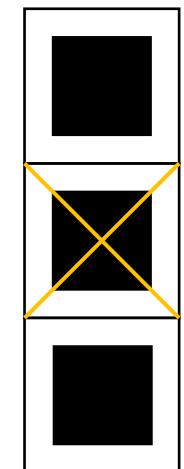
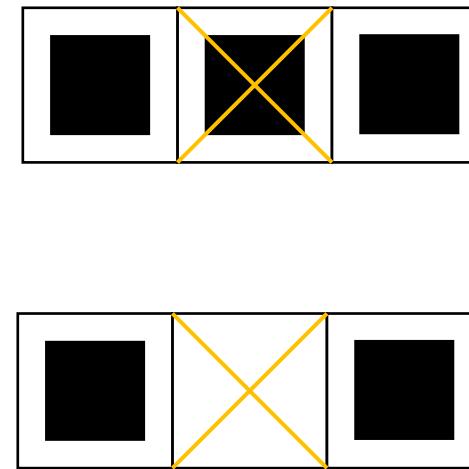
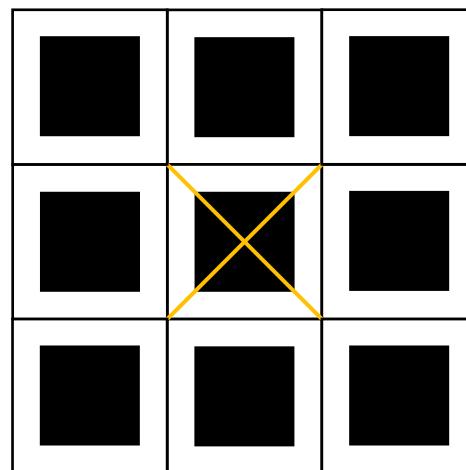
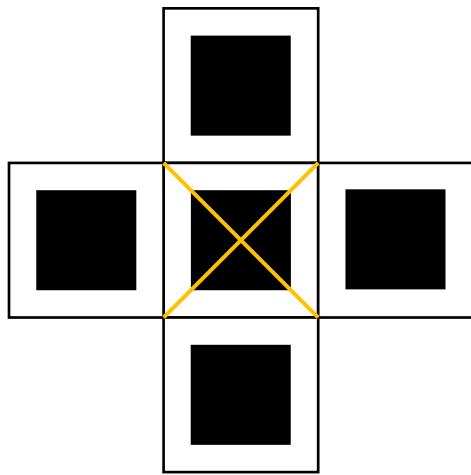
*Studium velikosti, tvaru a vnitřní struktury zvířat, rostlin a mikroorganismů a hledání souvislostí mezi jejich vnitřními částmi.*

# Morfologie ve zpracování obrazu

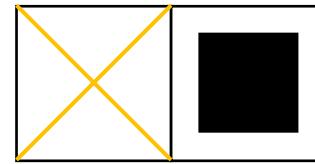
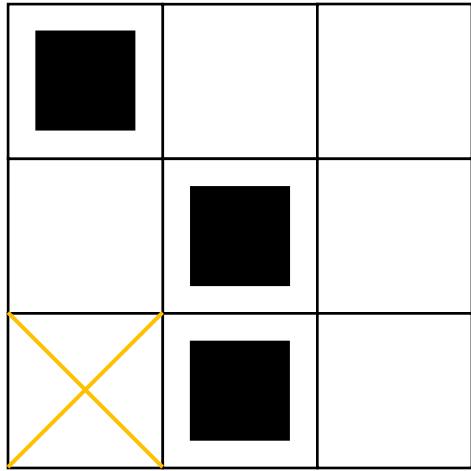
*Způsob, jak odhalit a získat znalosti z diskrétního obrazu pomocí jeho postupné analýzy malou sondou – strukturním elementem.*



# Strukturní element

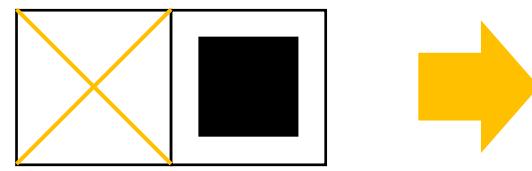
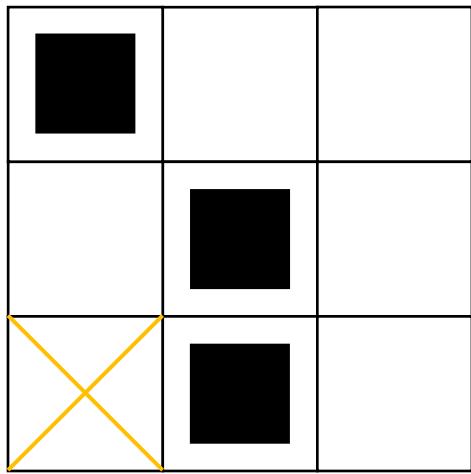


# Strukturní element – porovnávání

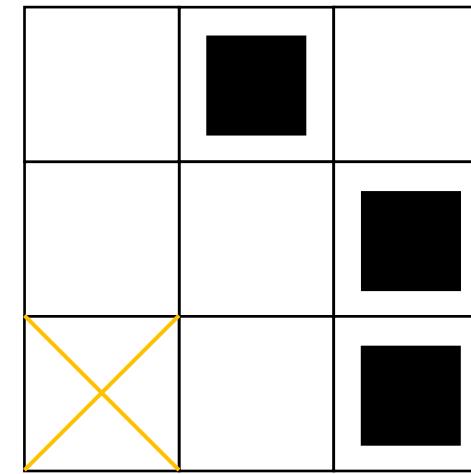


Postupný posun po obrázku a zjišťování,  
zda v počátku SE je objekt (1)

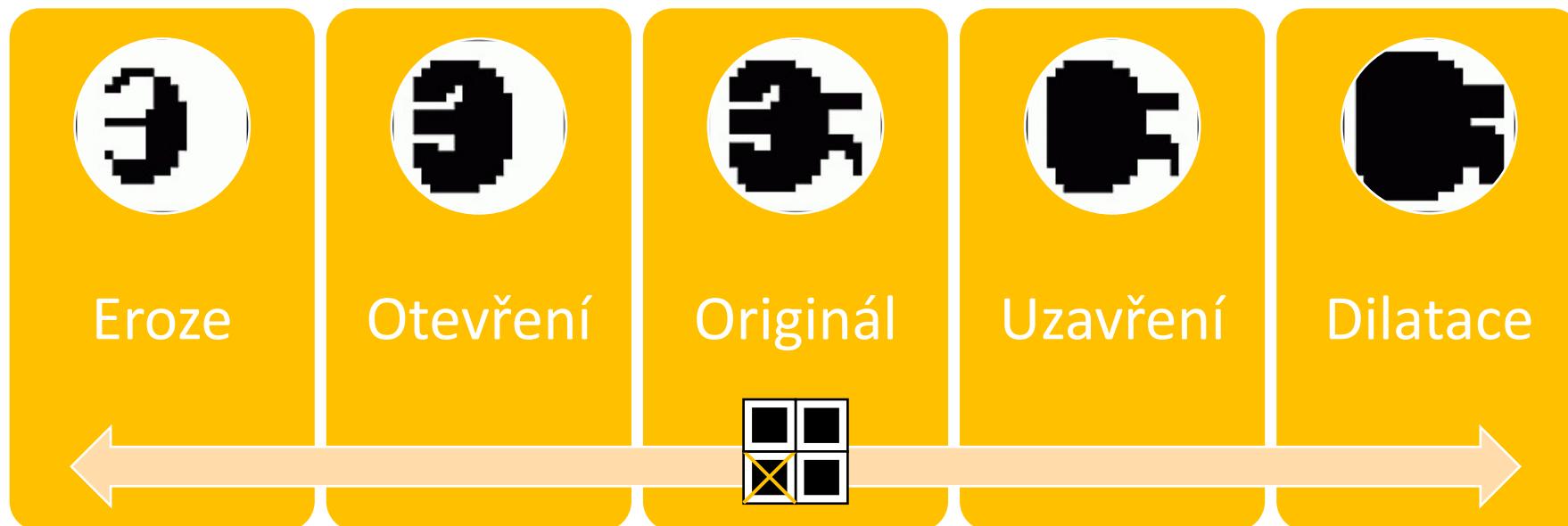
# Strukturní element – porovnání



= SE posun doprava



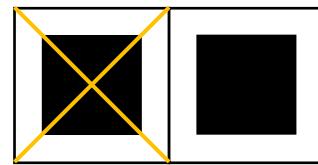
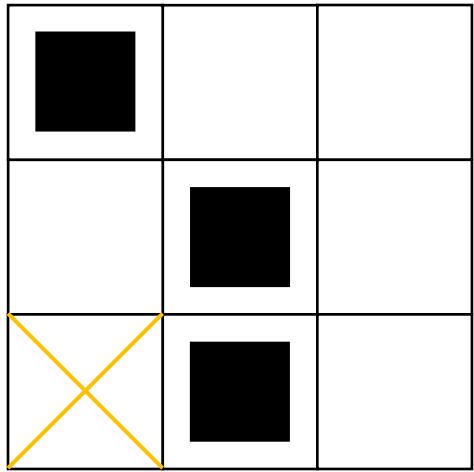
# Metody binární morfologie



SMITH, W. *Digital signal processing: scientist and engineer's guide*. Vyd. 1. California: California Technical Publishing, 1997, 626 s. ISBN 09-660-1763-3.

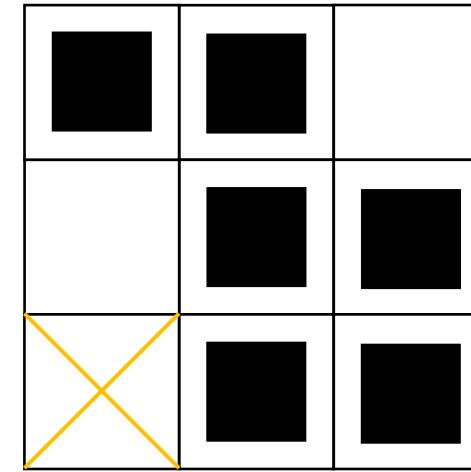
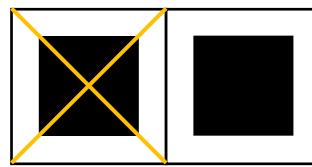
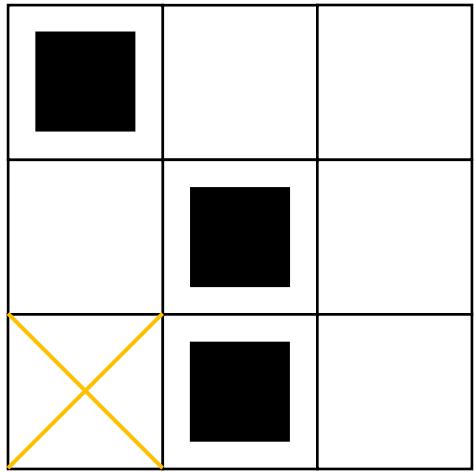
# Dilatace

- Expanze objektu



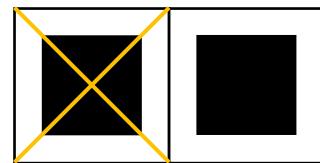
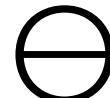
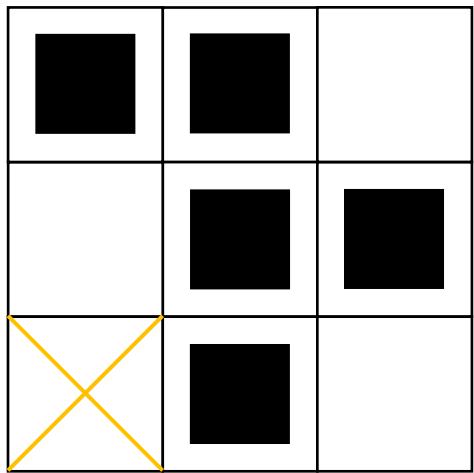
# Dilatace

- Expanze objektu



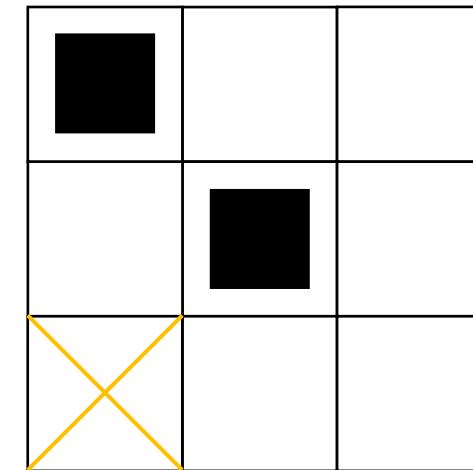
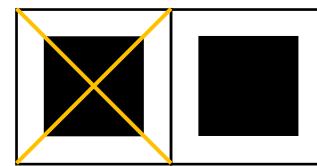
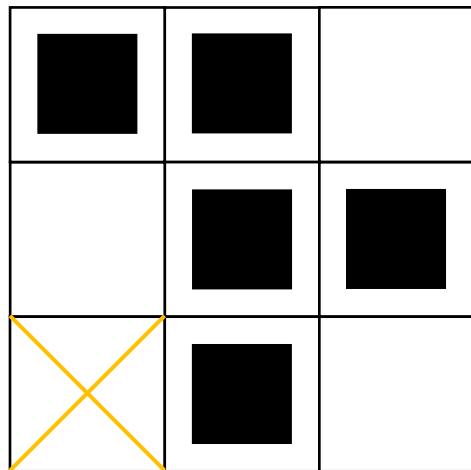
# Eroze

- Kontrakce objektu
- Oddělení objektů

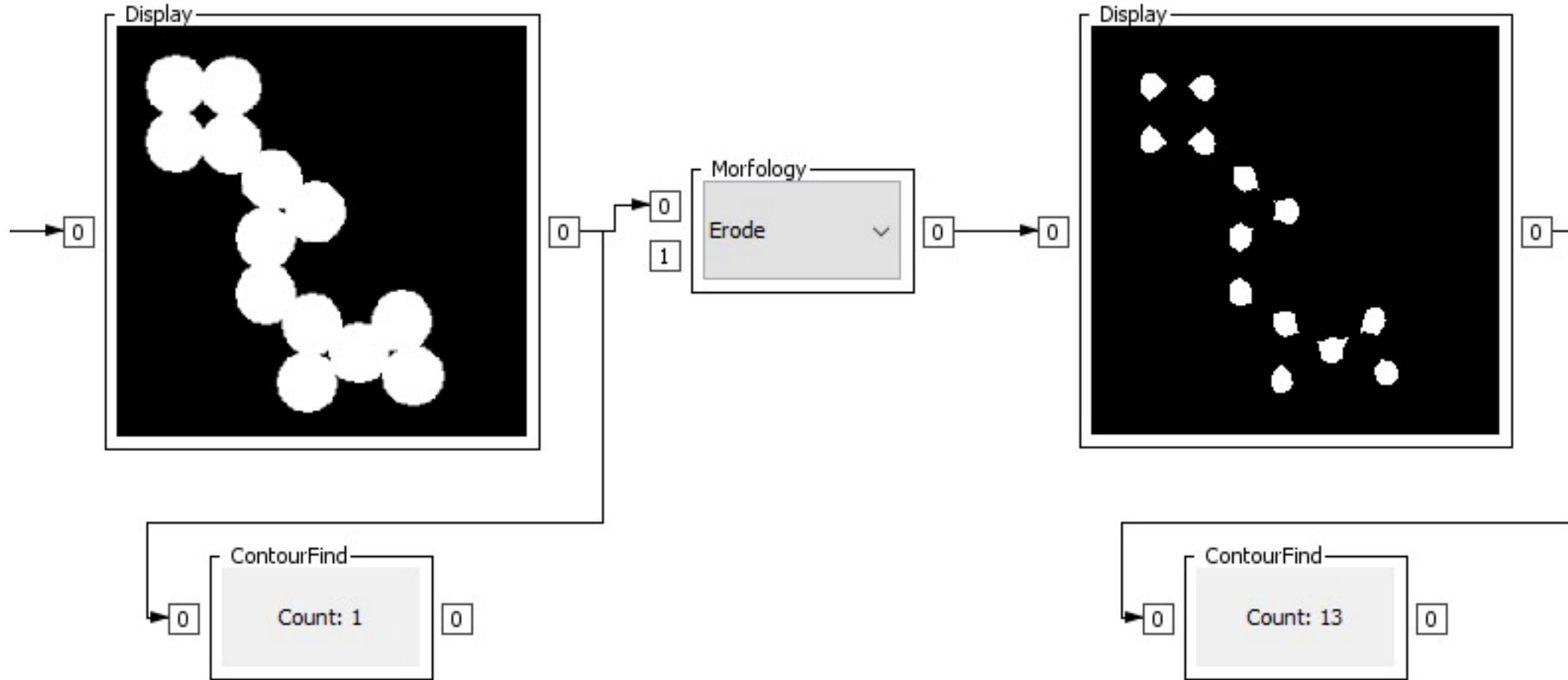


# Eroze

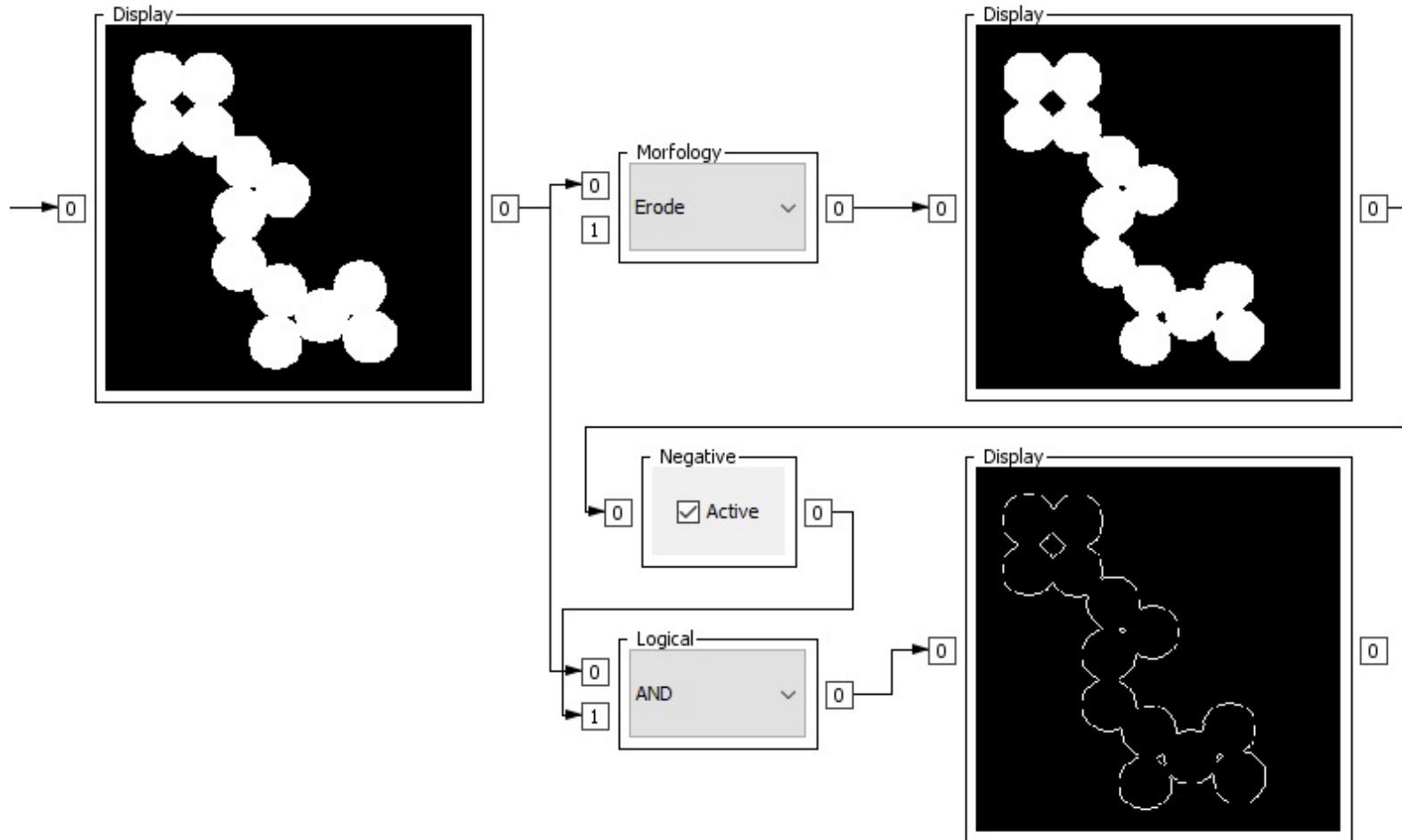
- Kontrakce objektu
- Oddělení objektů



# Eroze

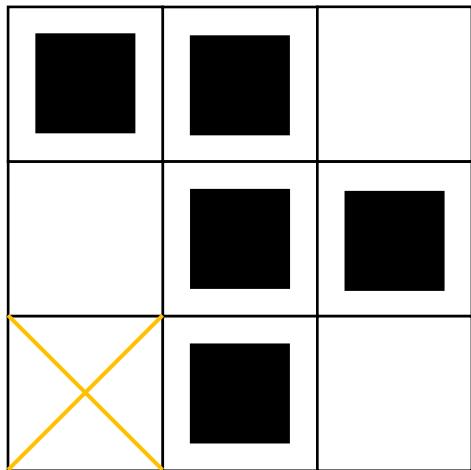


# Eroze – získ kontur

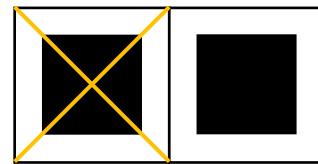


# Otevření

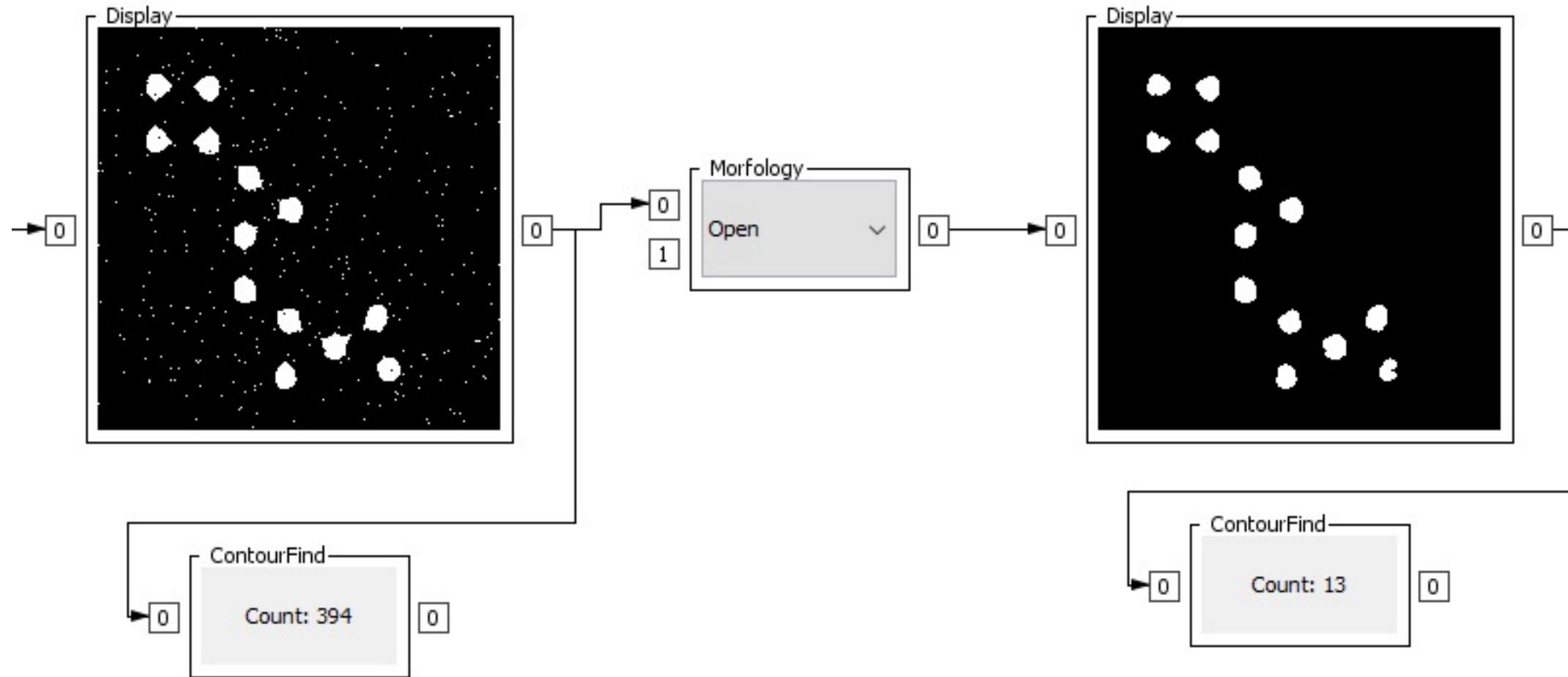
- Zbavení se šumu
- Nejdřív eroze, potom dilatace



o

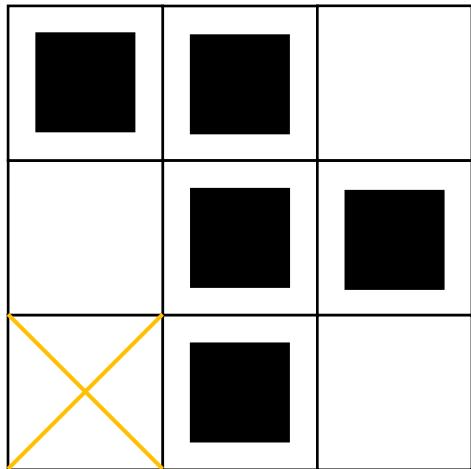


# Otevření

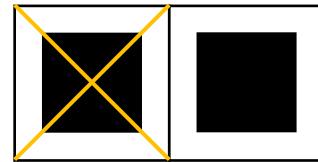


# Uzavření

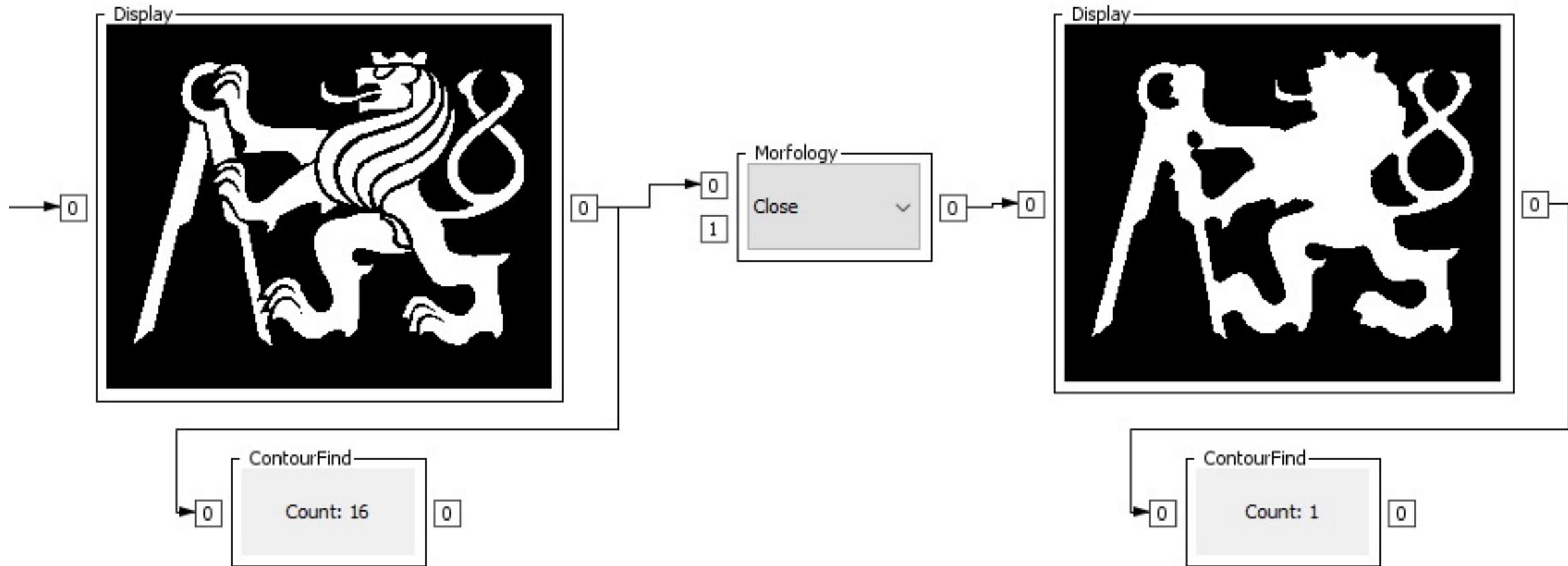
- Spojení objektů, zaplnění děr,
- Nejdřív dilatace, potom eroze



•



# Uzavření



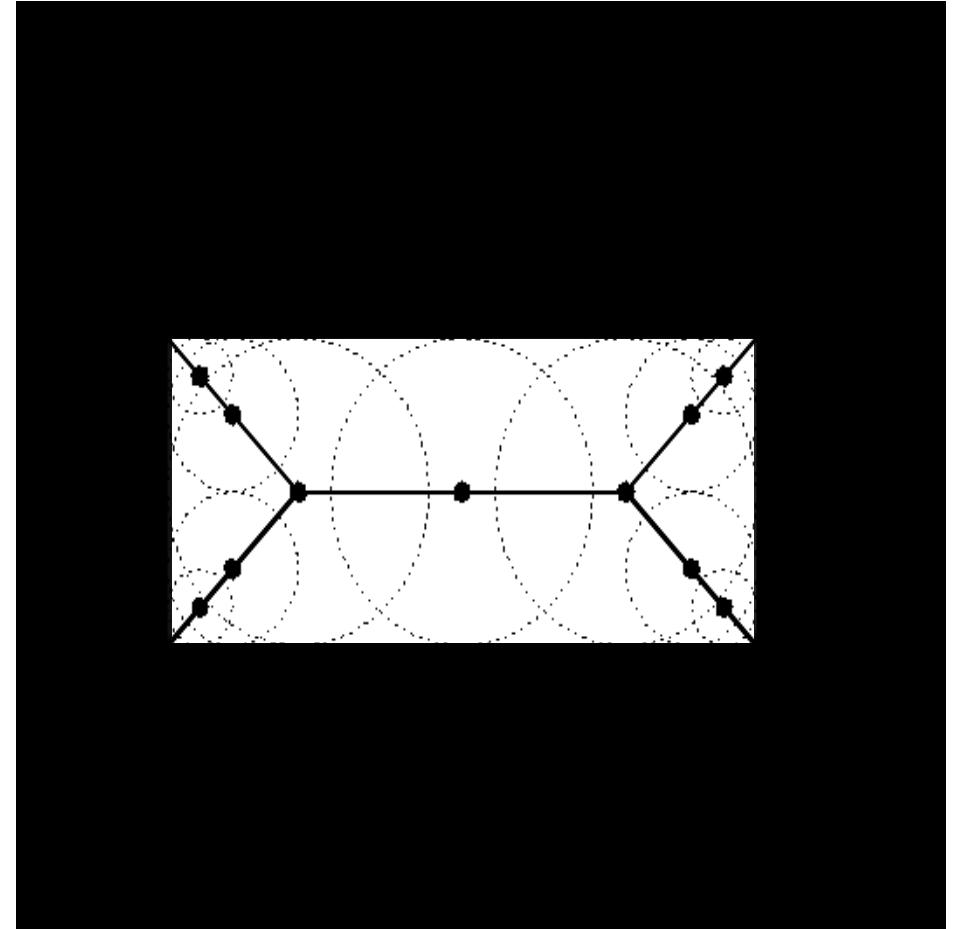
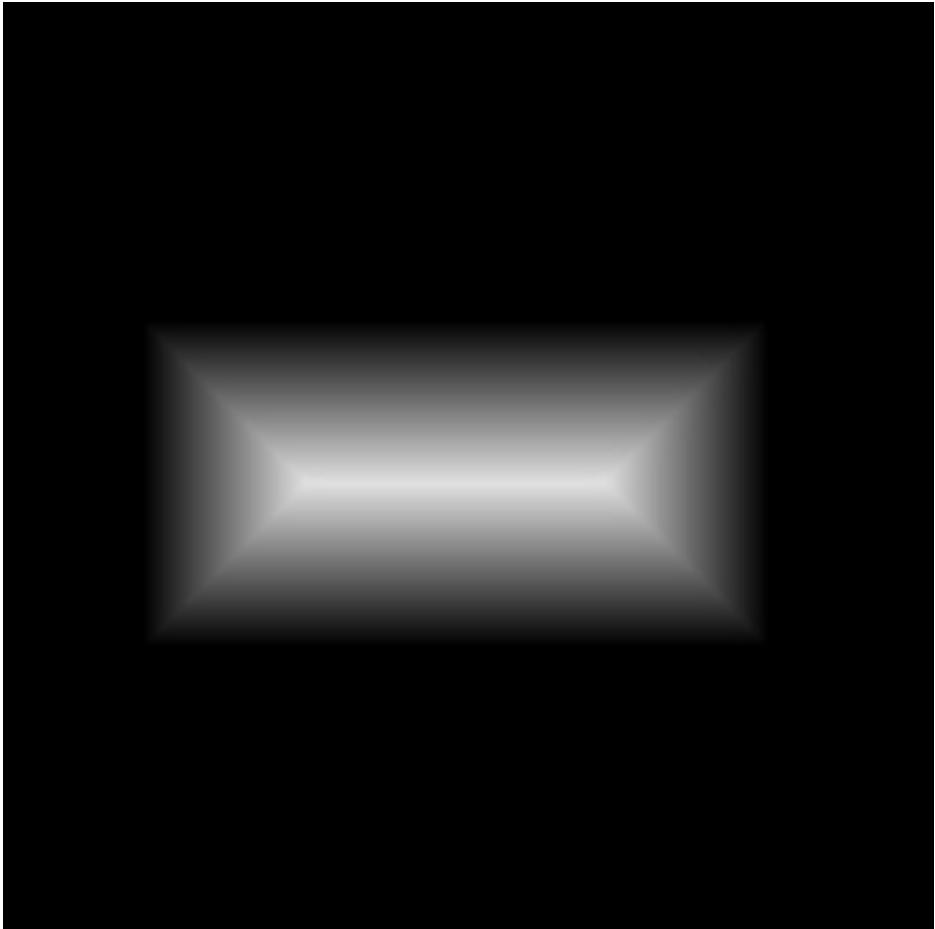
# Skeletonizace

- Vytvoření binárního skeletonu
- Spojení středů největších vepsaných kruhů
- Vzdálenostní transformace      ×      Tenčení
- Aproximace přímkami
  - Geometrie objektu
- Detekce konců

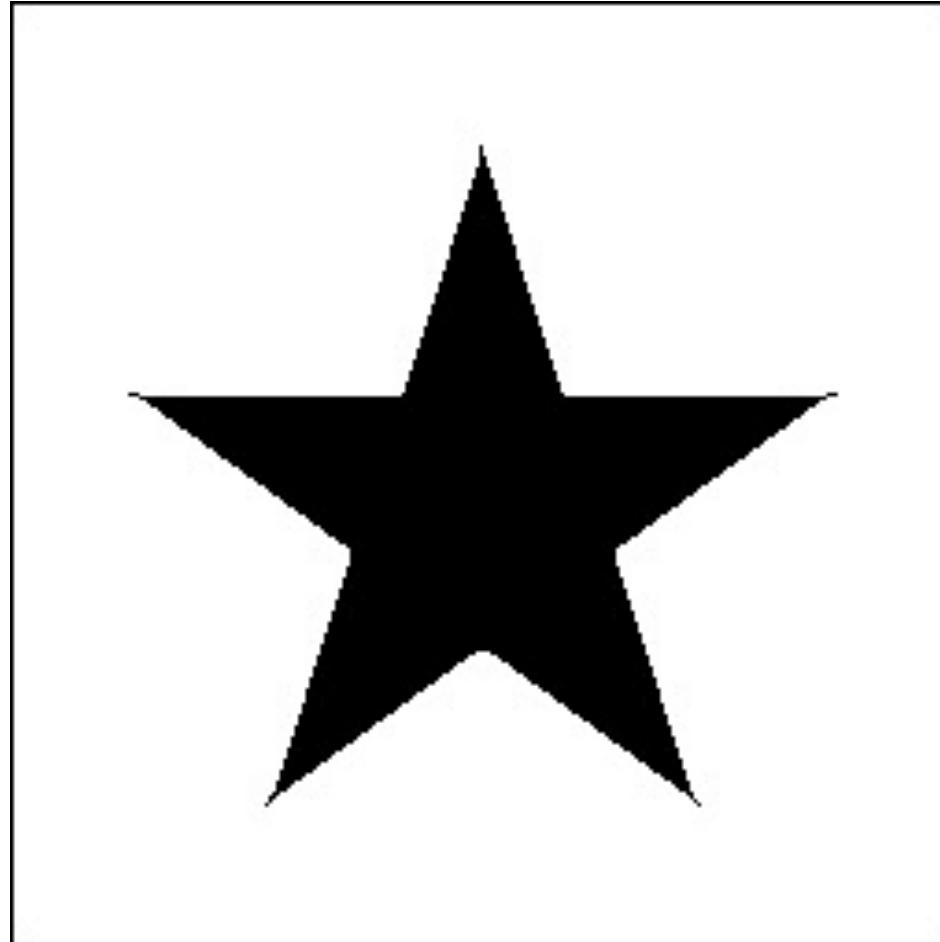


<https://stock.adobe.com/cz/images/cartoon-illustration-of-human-skeleton-of-dead-businessman-sitting-in-front-of-computer/166967190>

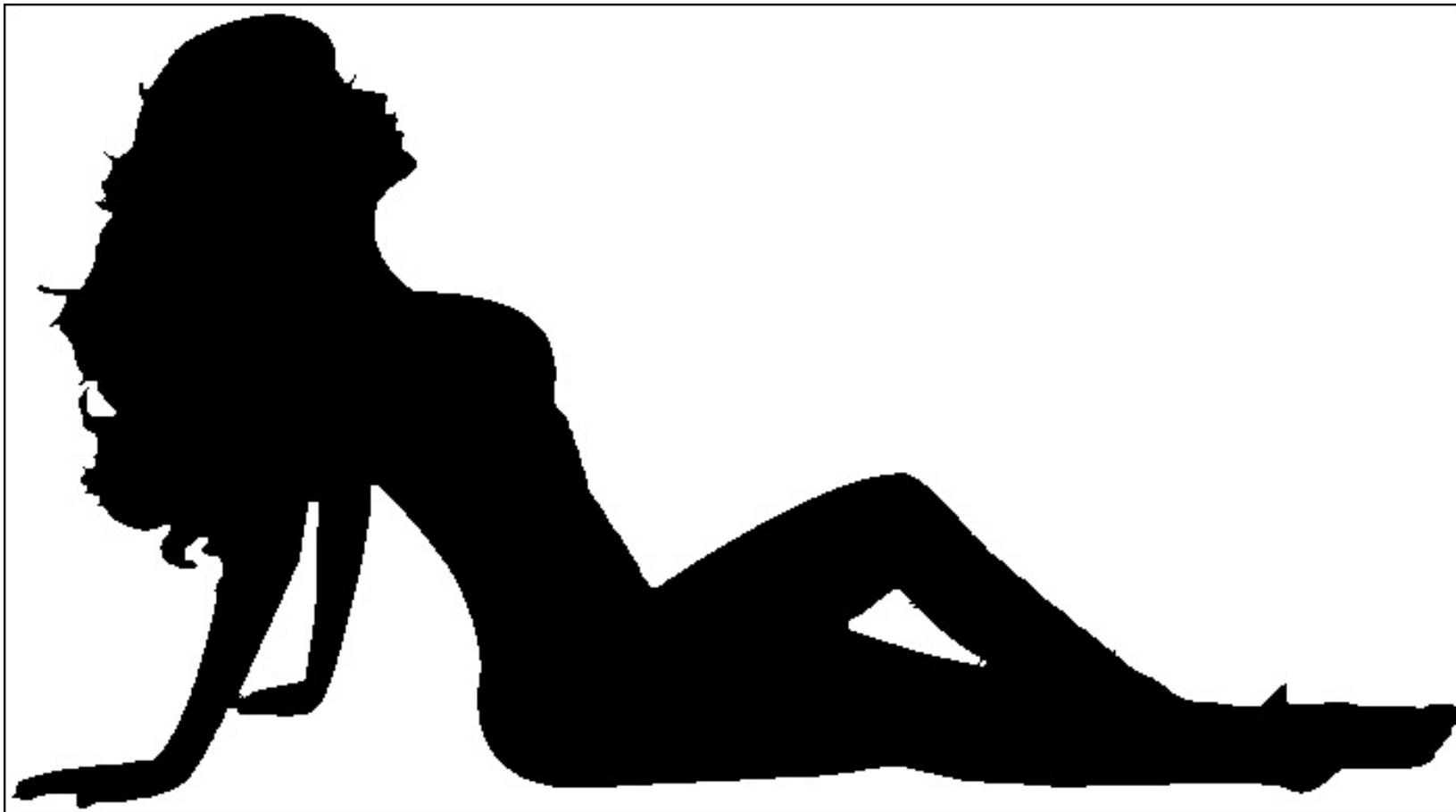
# Vzdálenostní transformace



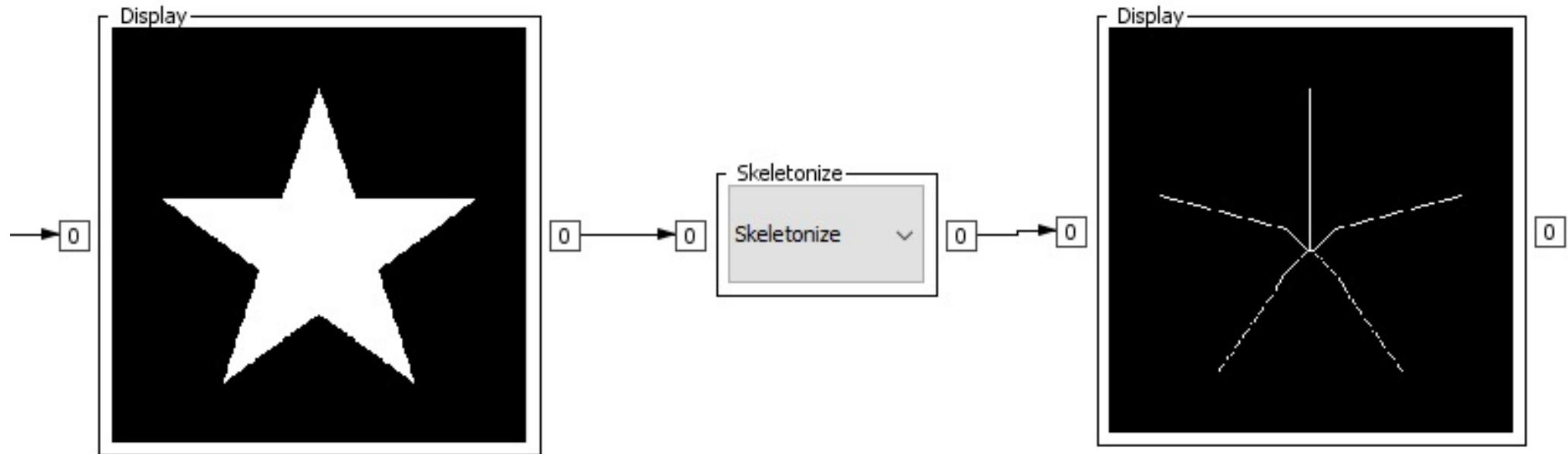
# Tenčení (thinning)



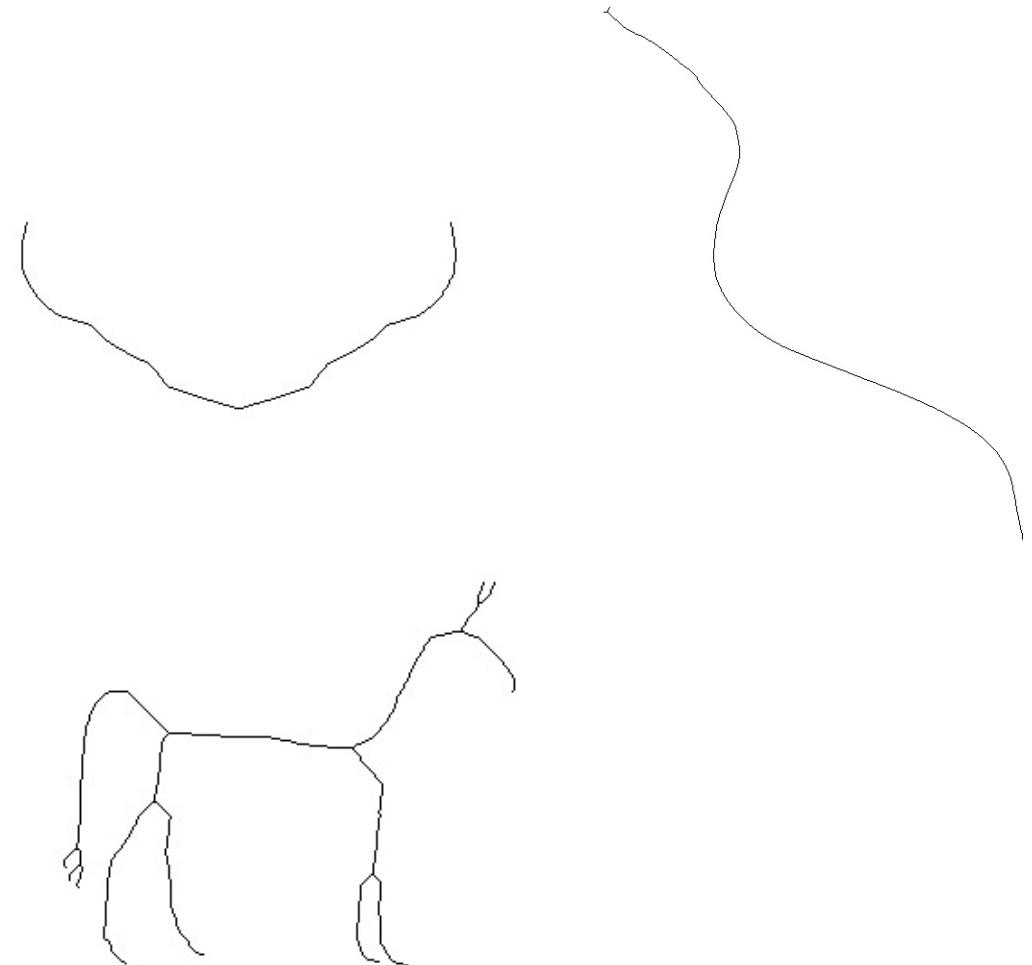
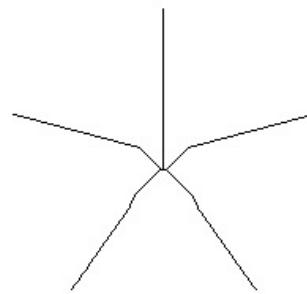
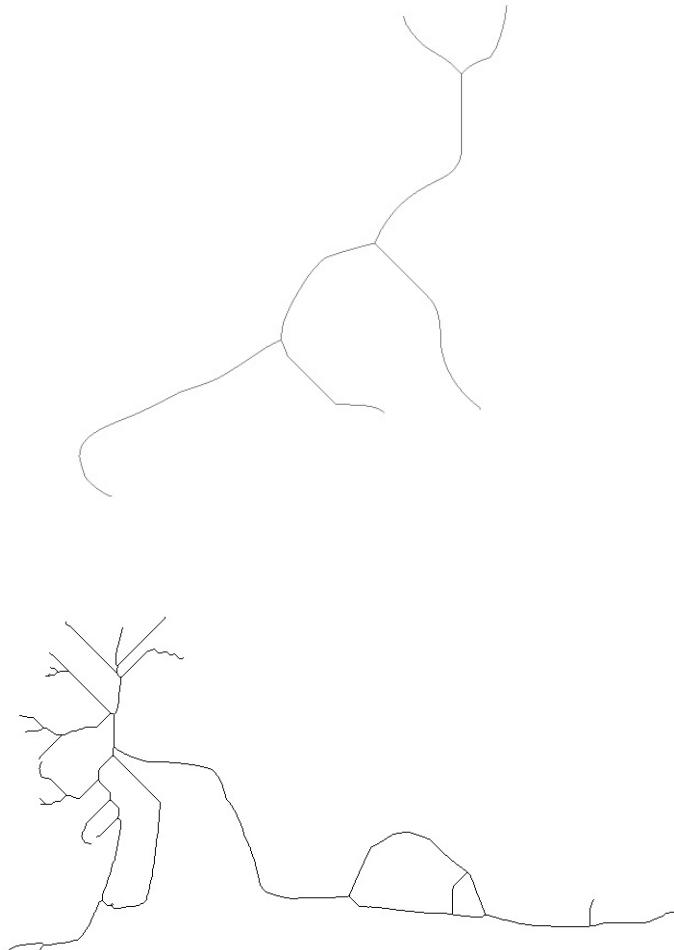
# Tenčení (thinning)



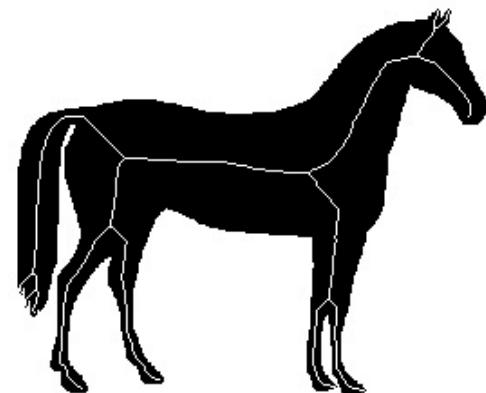
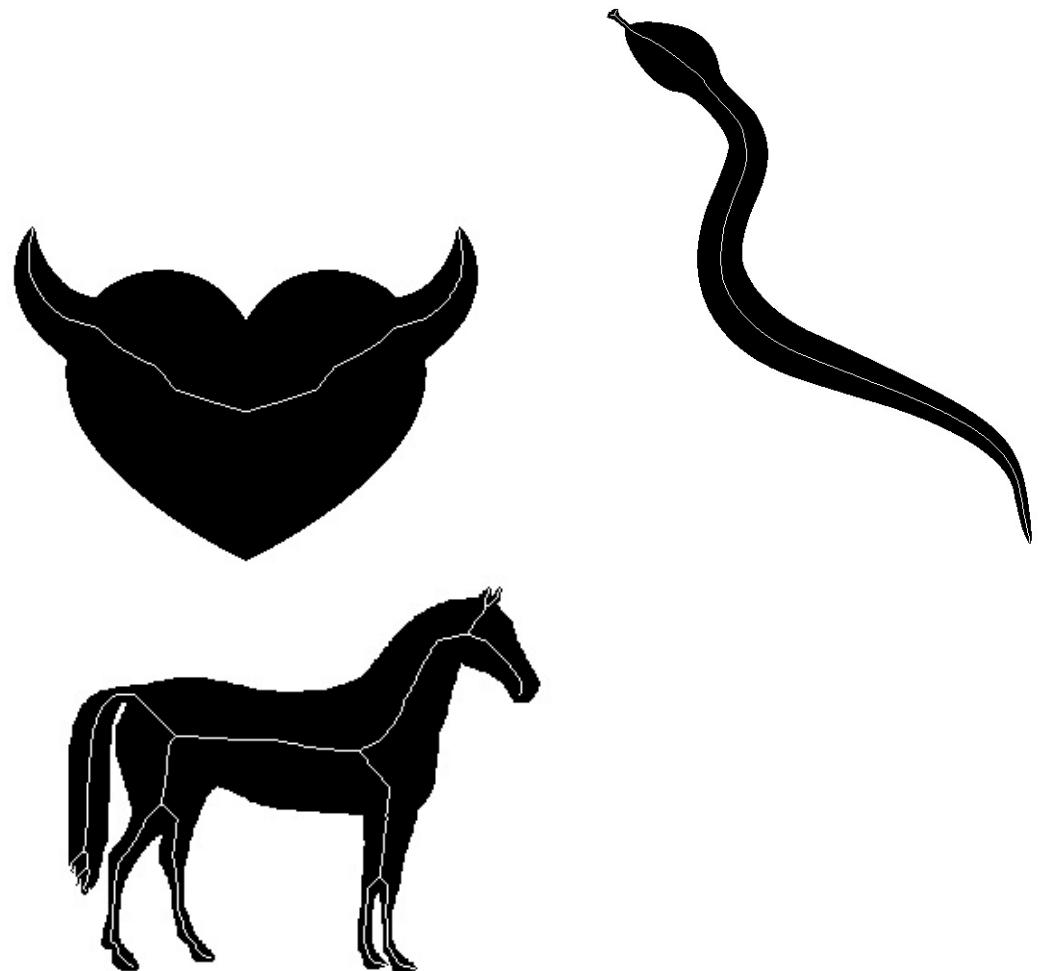
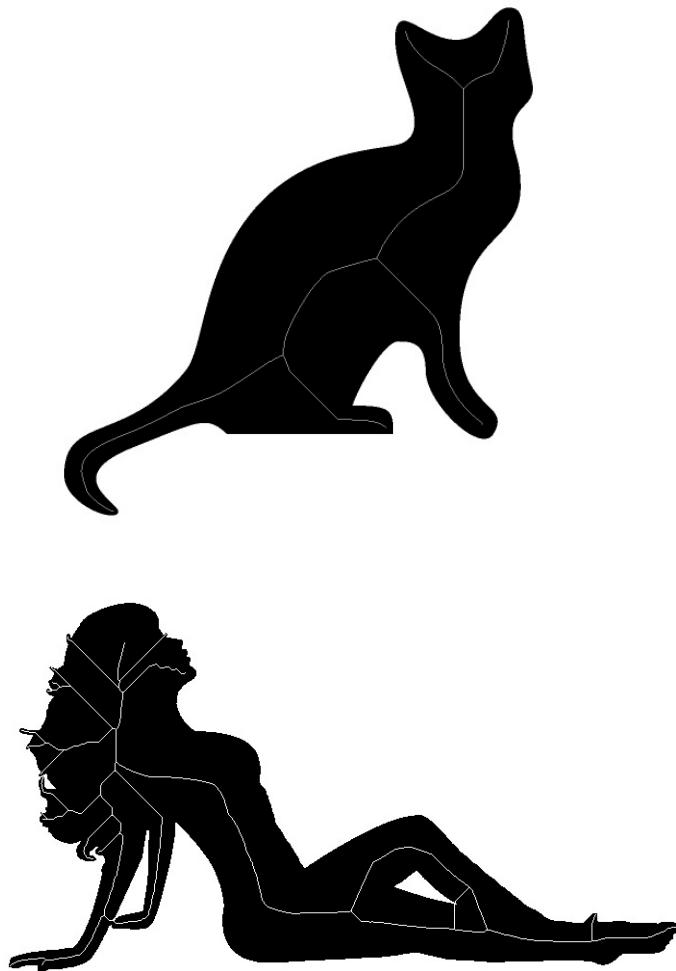
# Skeletonizace (medial-axis transform)



# Skeletonizace

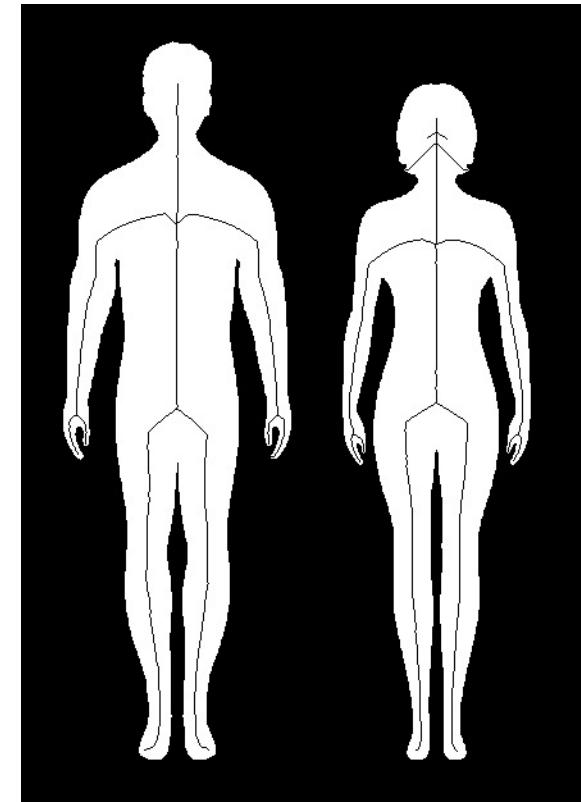
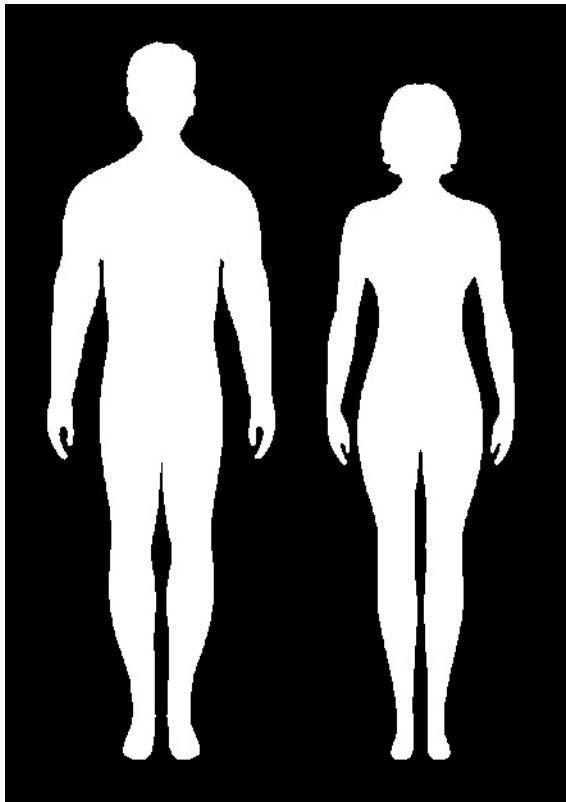


# Skeletonizace



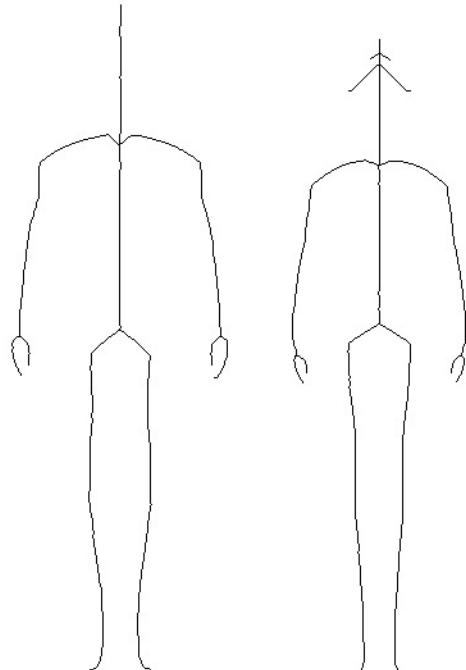
# Pruning

- Ořezání volných konců



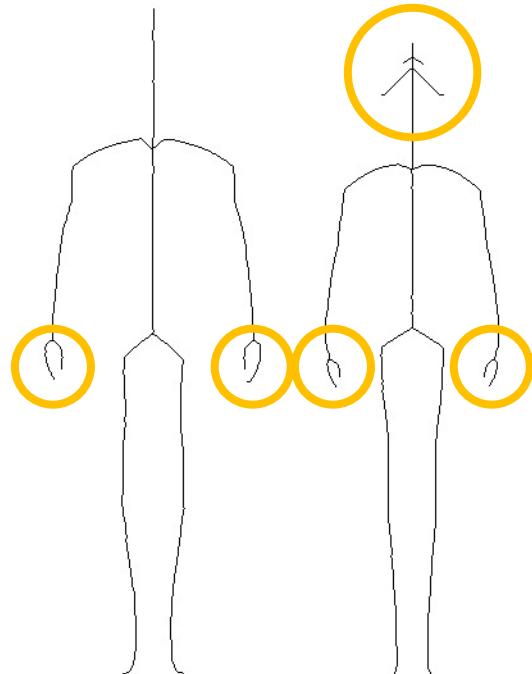
# Pruning

- Ořezání volných konců



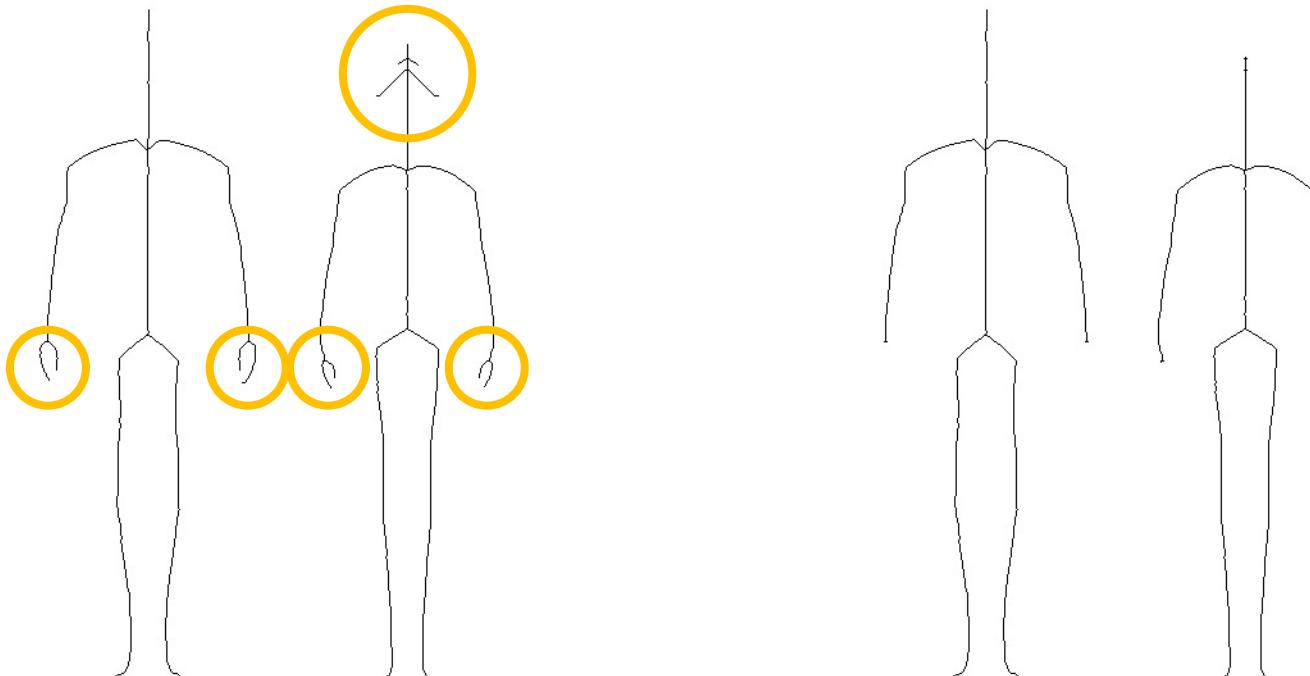
# Pruning

- Ořezání volných konců



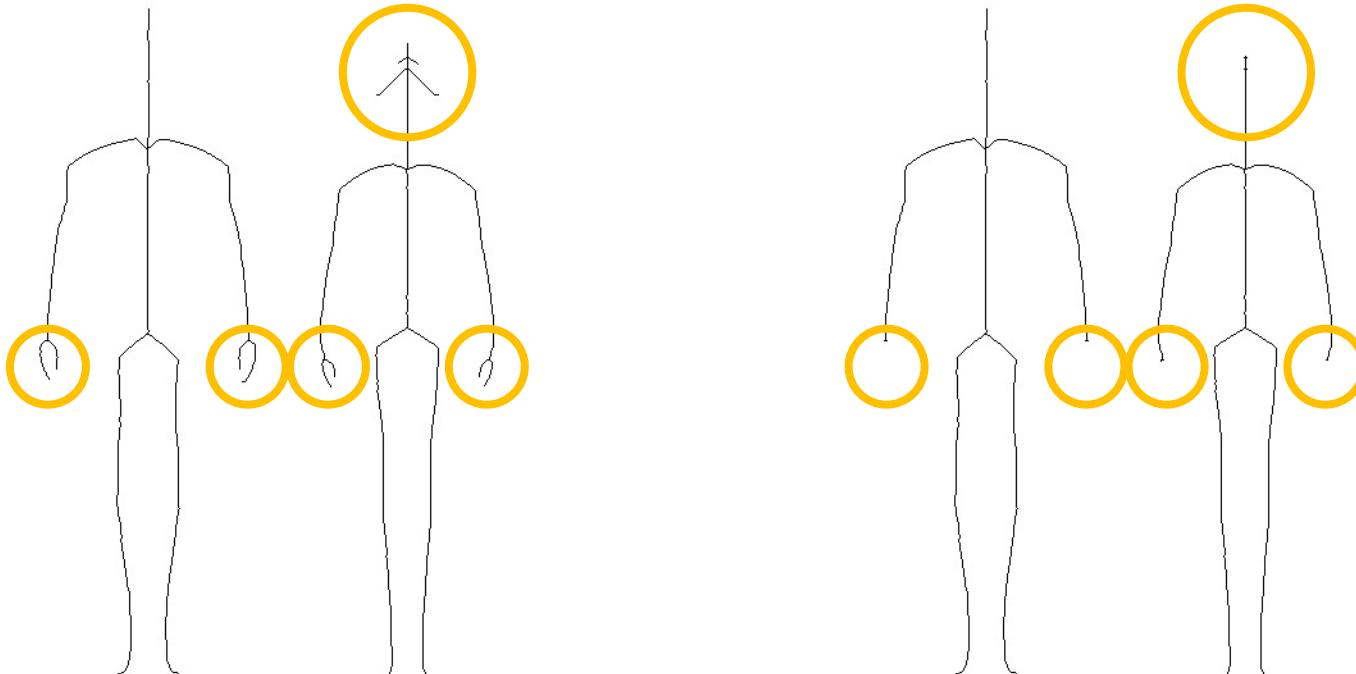
# Pruning

- Ořezání volných konců



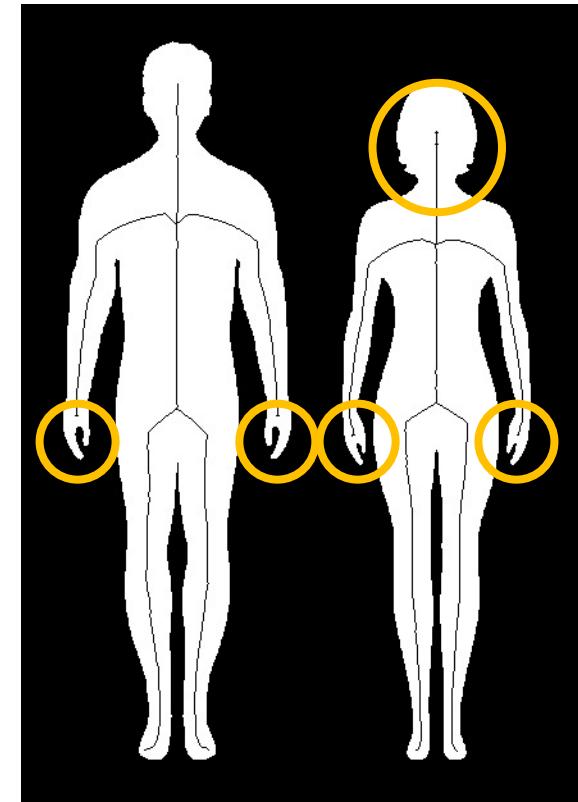
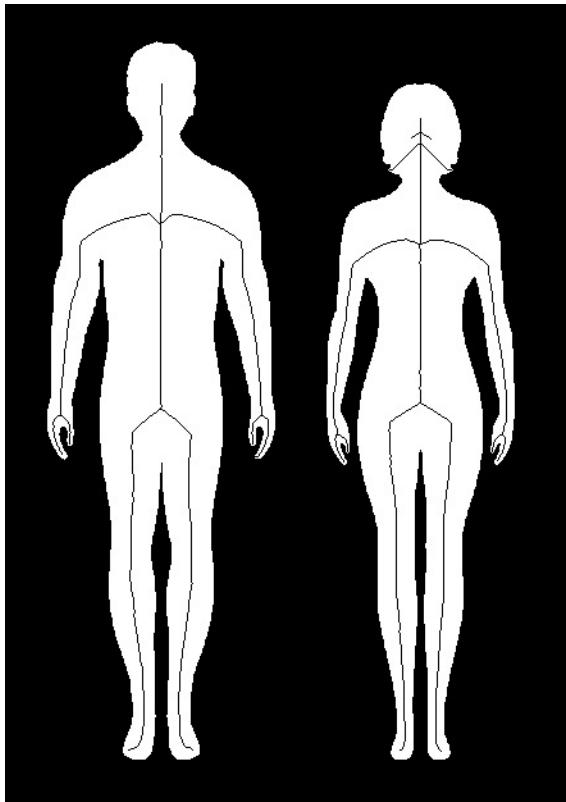
# Pruning

- Ořezání volných konců

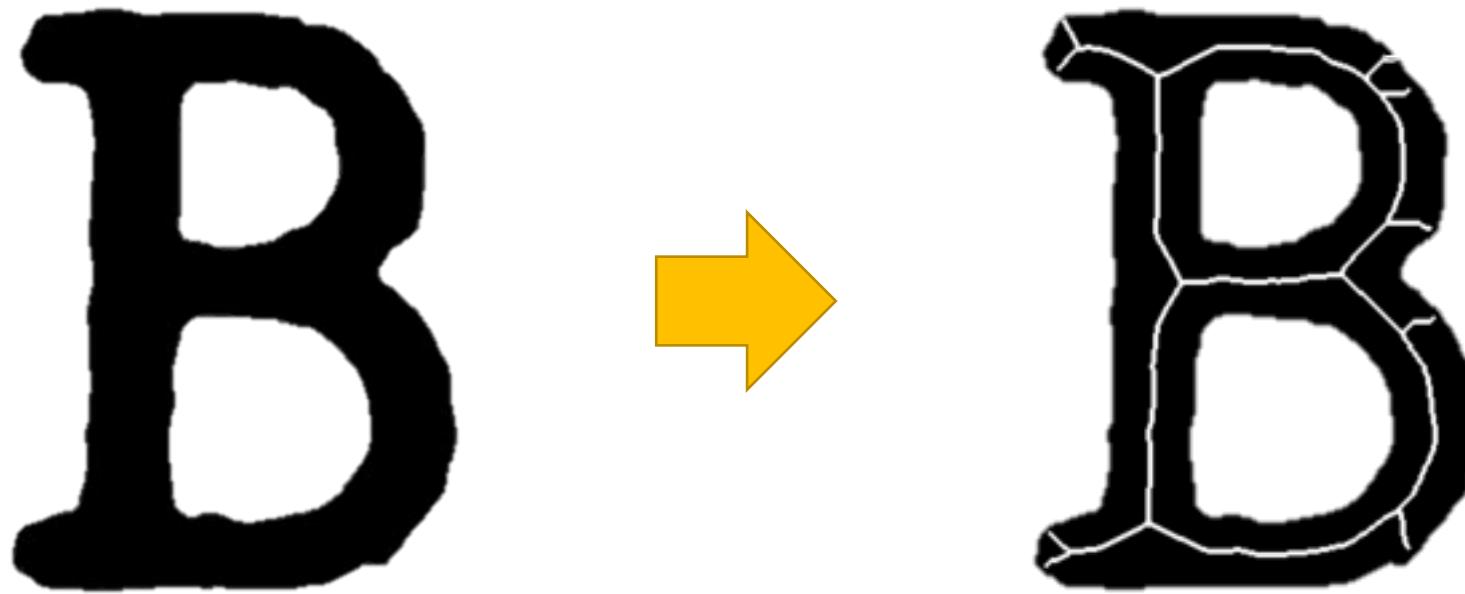


# Pruning

- Ořezání volných konců

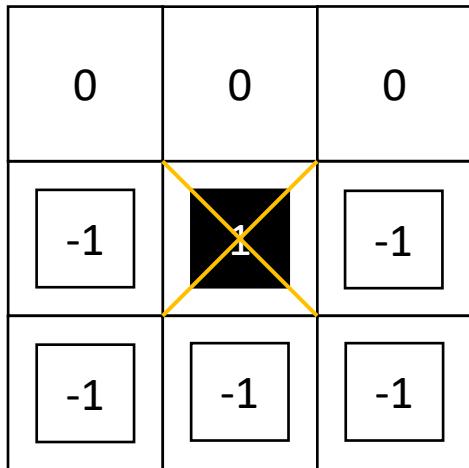


# Zpracování textu (typický příklad)



# Hit-or-miss transformace

- Detekce koncových bodů skeletonu



Speciální případ pro opencv

- 0 : nezájem
- 1 : popředí
- -1 : pozadí

# Hit-or-miss transformace

- Detekce koncových bodů skeletonu

0	0	0
-1	1	-1
-1	-1	-1

0	-1	-1
0	1	-1
0	-1	-1

-1	-1	-1
-1	1	-1
0	0	0

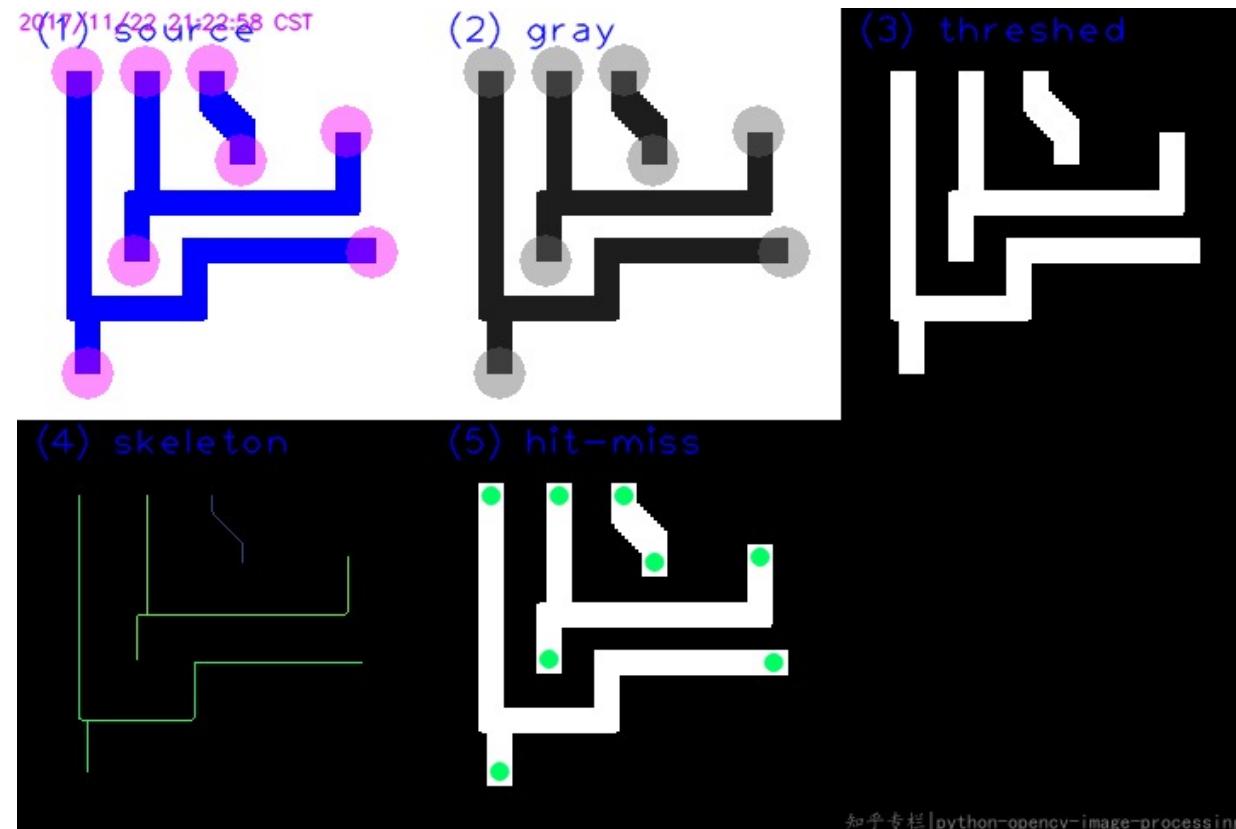
-1	-1	0
-1	1	0
-1	-1	0

Speciální případ pro opencv

- 0 : nezájem
- 1 : popředí
- -1 : pozadí

4x

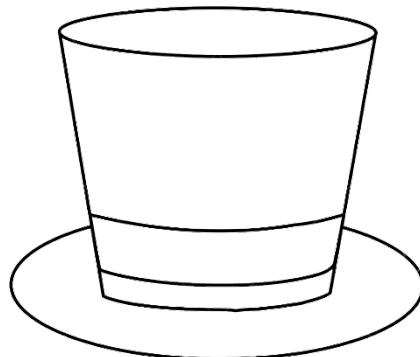
# Hit-or-miss transformace



<https://stackoverflow.com/a/47430038/1398955>

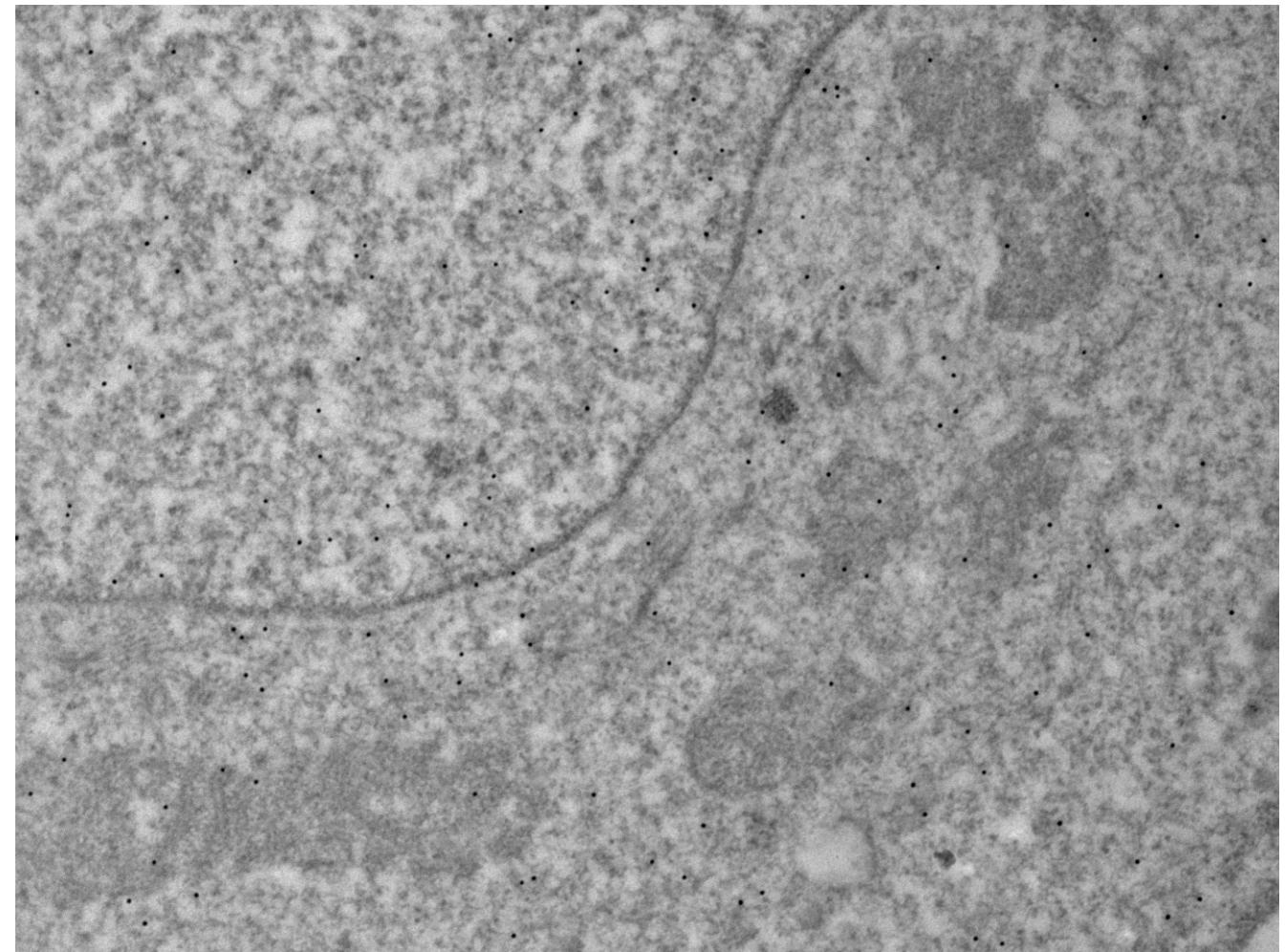
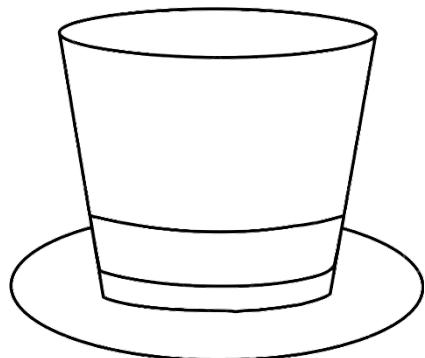
# Metody šedotónové morfologie

- Lze použít již zmíněné metody
- Nově
  - Top-hat transformace
  - Black-hat transformace

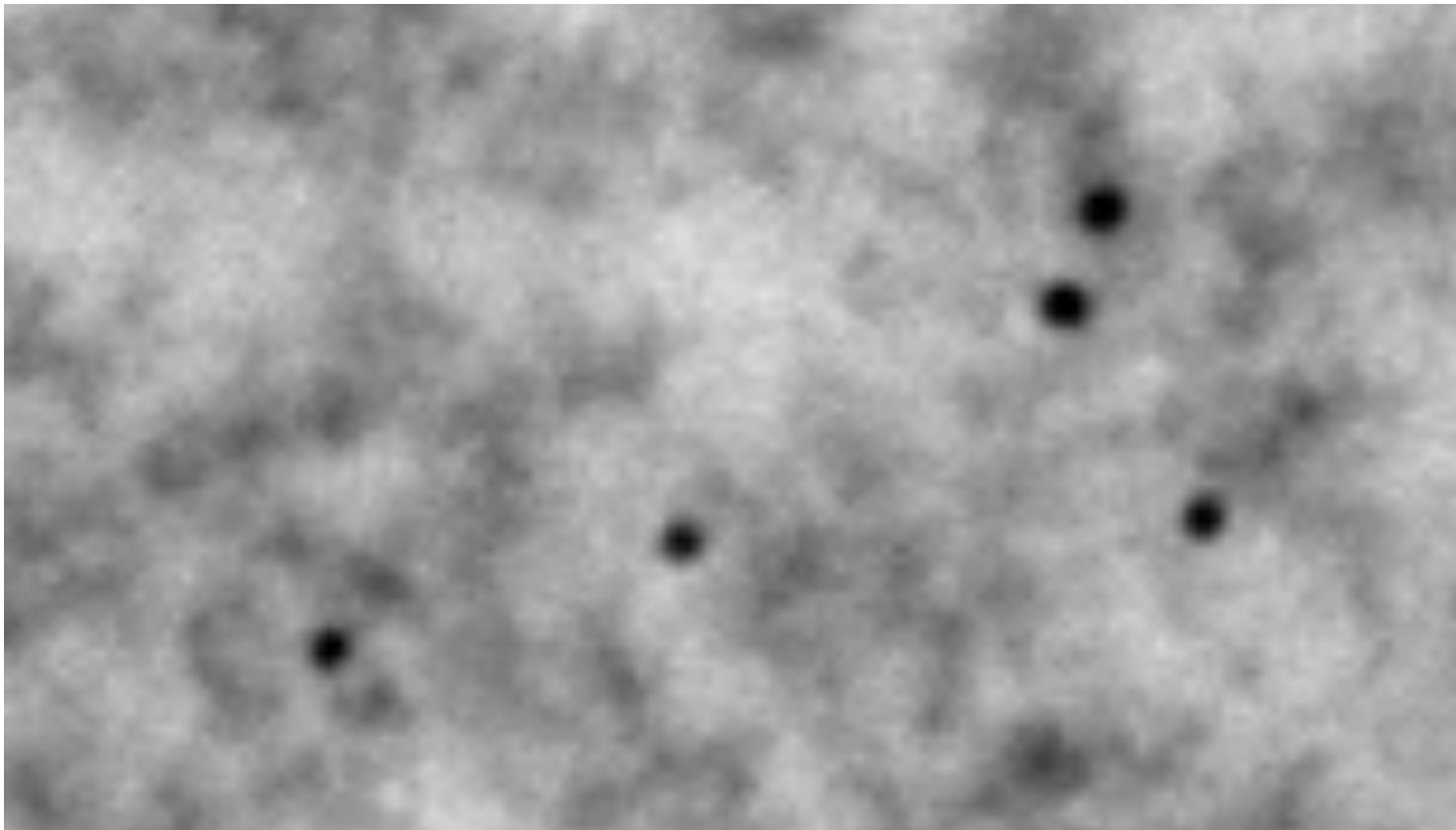


# Metody šedotónové morfologie

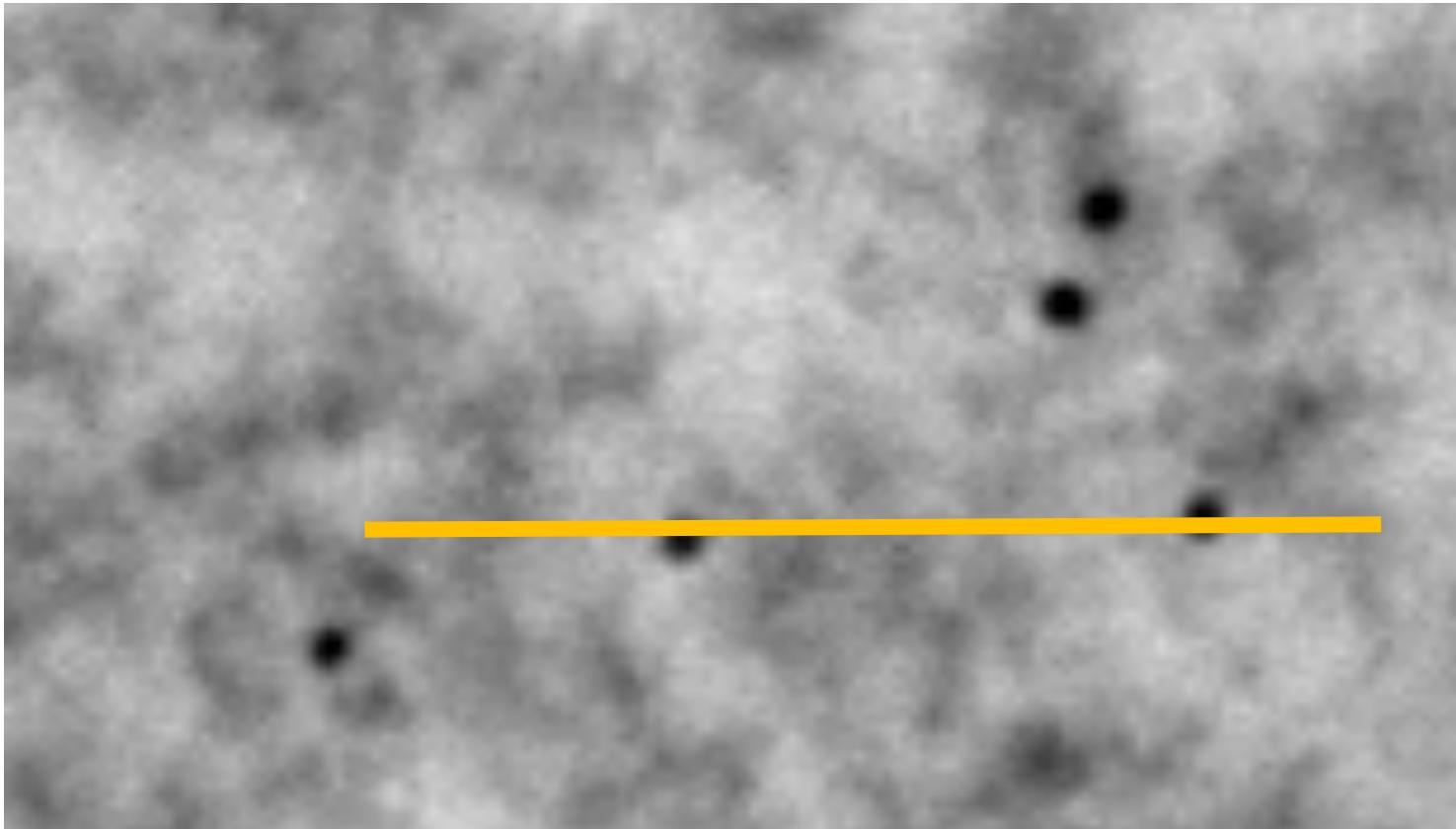
- Lze použít již zmíněné metody
- Nově
  - Top-hat transformace
  - Black-hat transformace



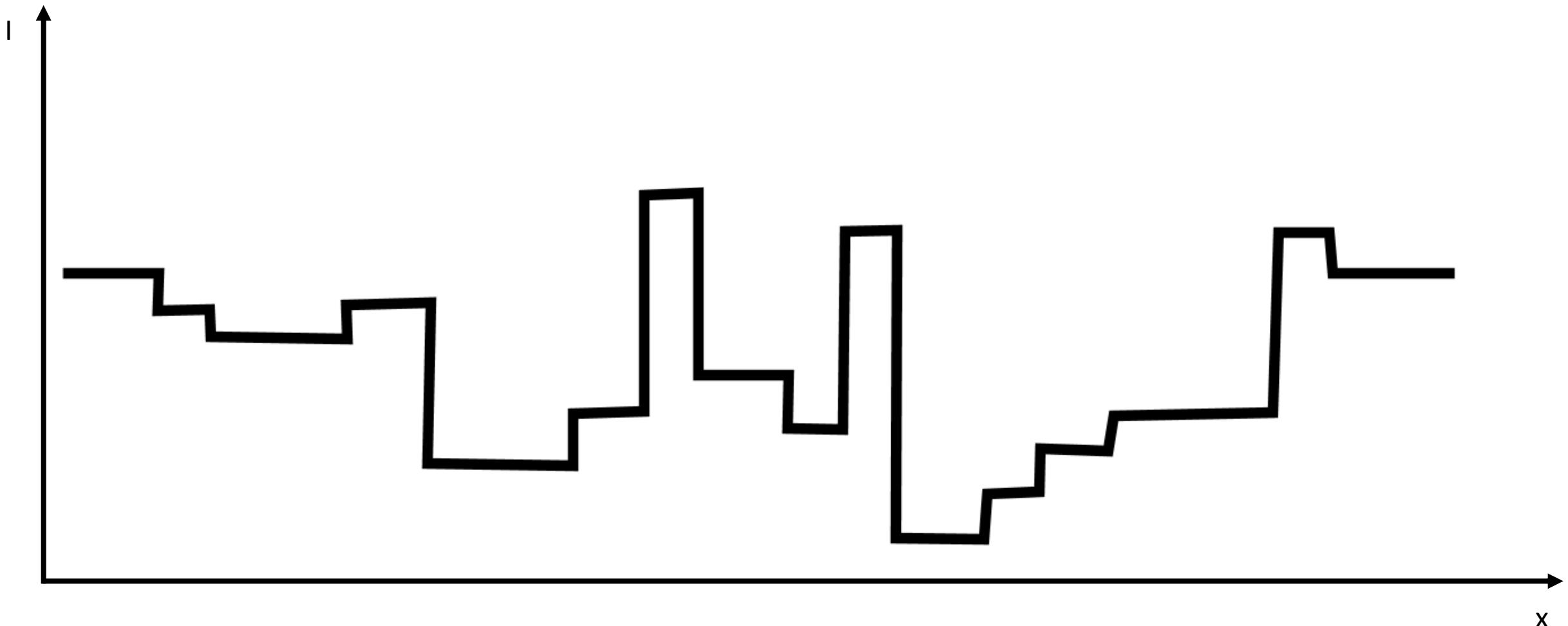
# Top-hat transformace



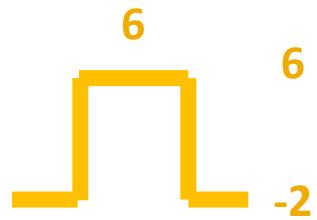
# Top-hat transformace



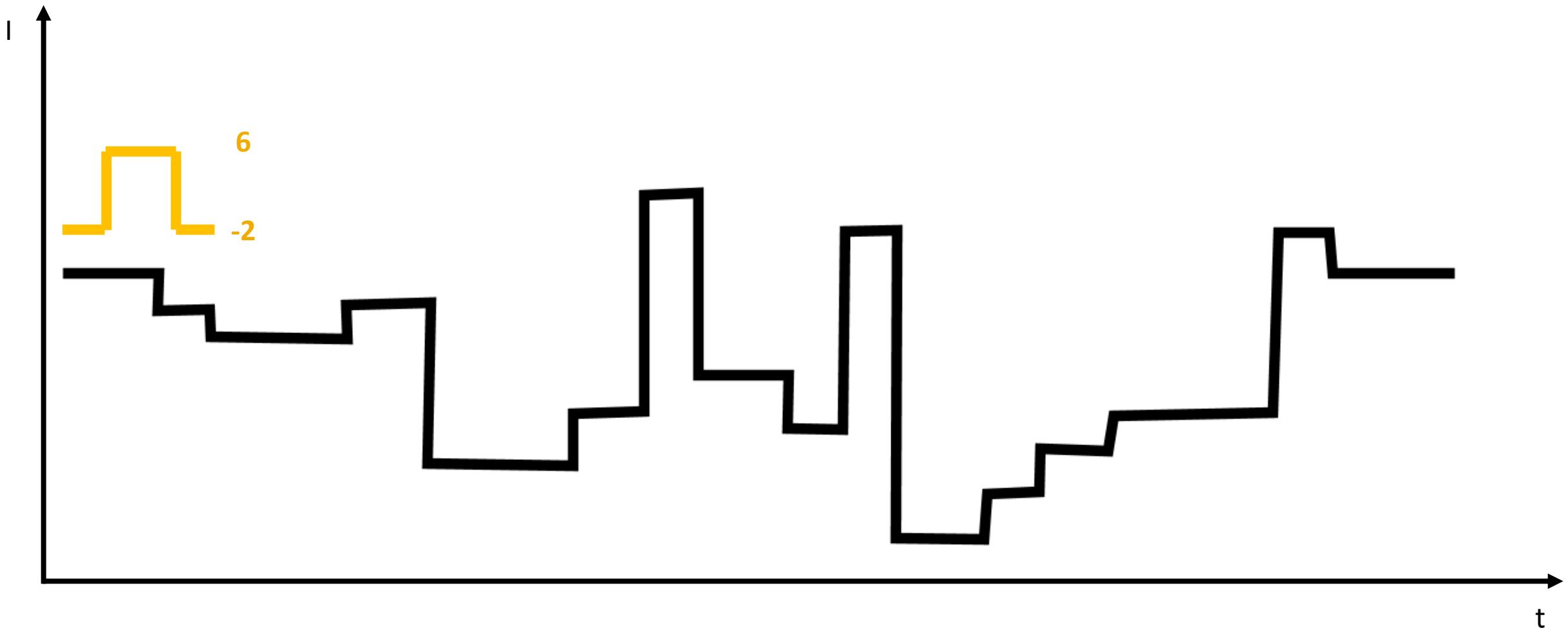
# Top-hat transformace



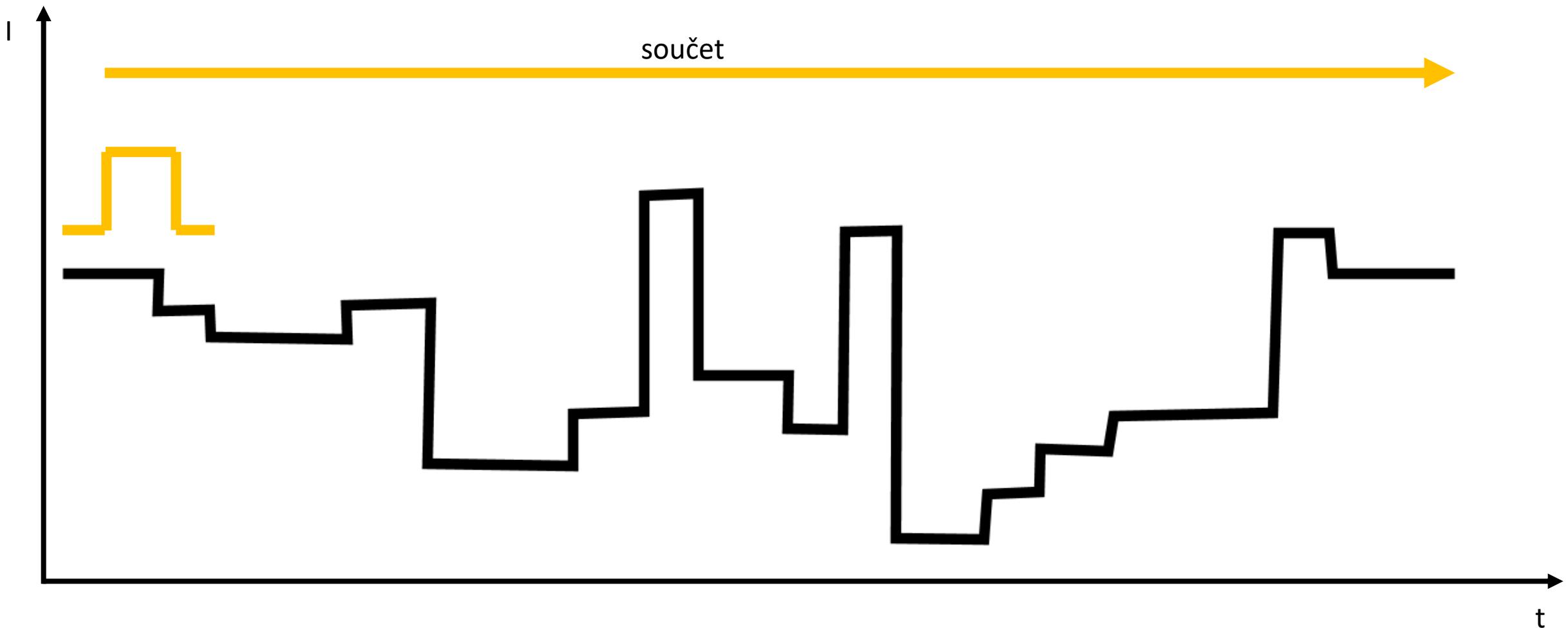
# Top-hat transformace



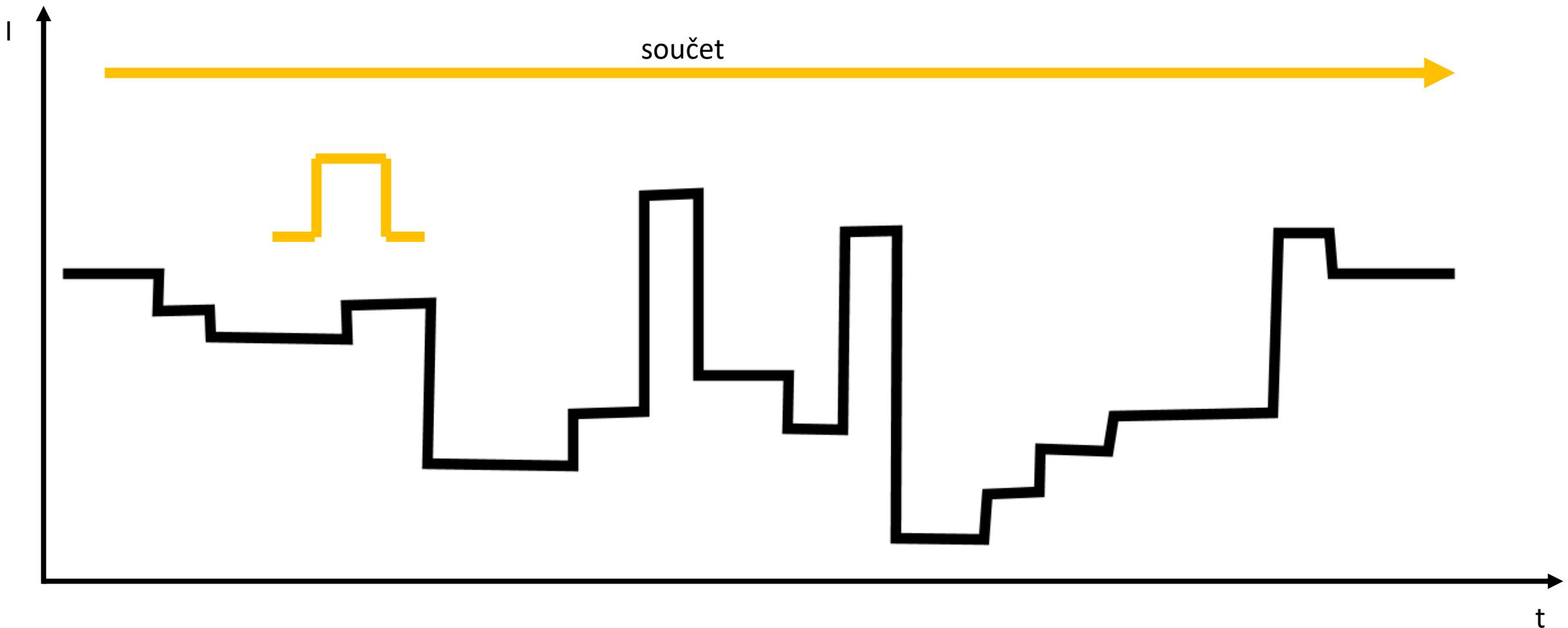
# Top-hat transformace



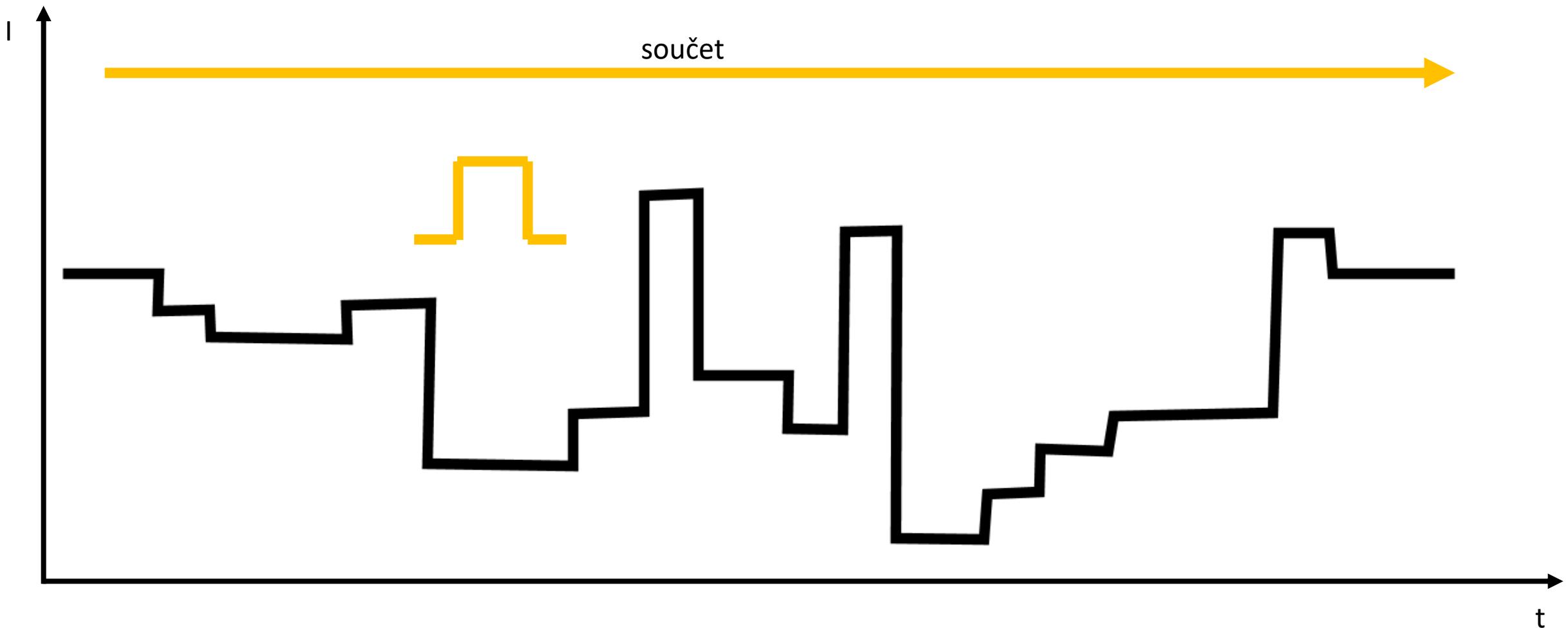
# Top-hat transformace



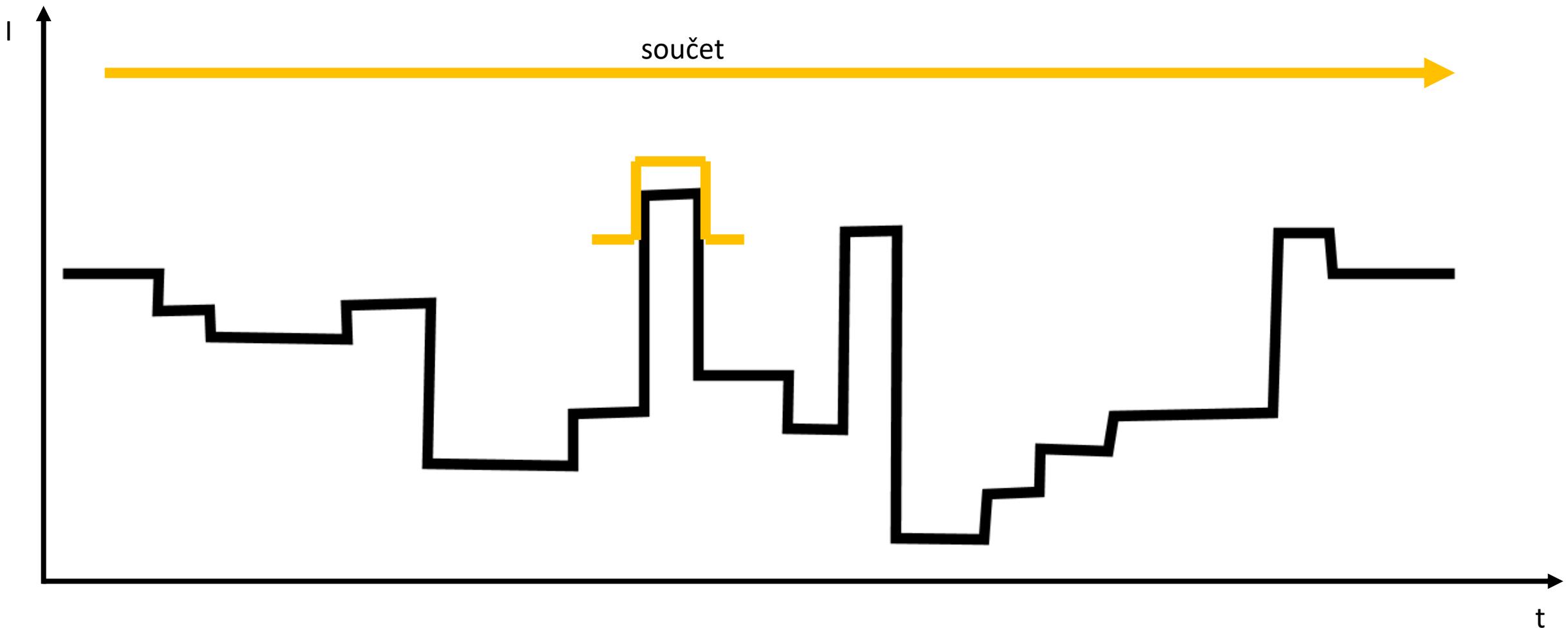
# Top-hat transformace



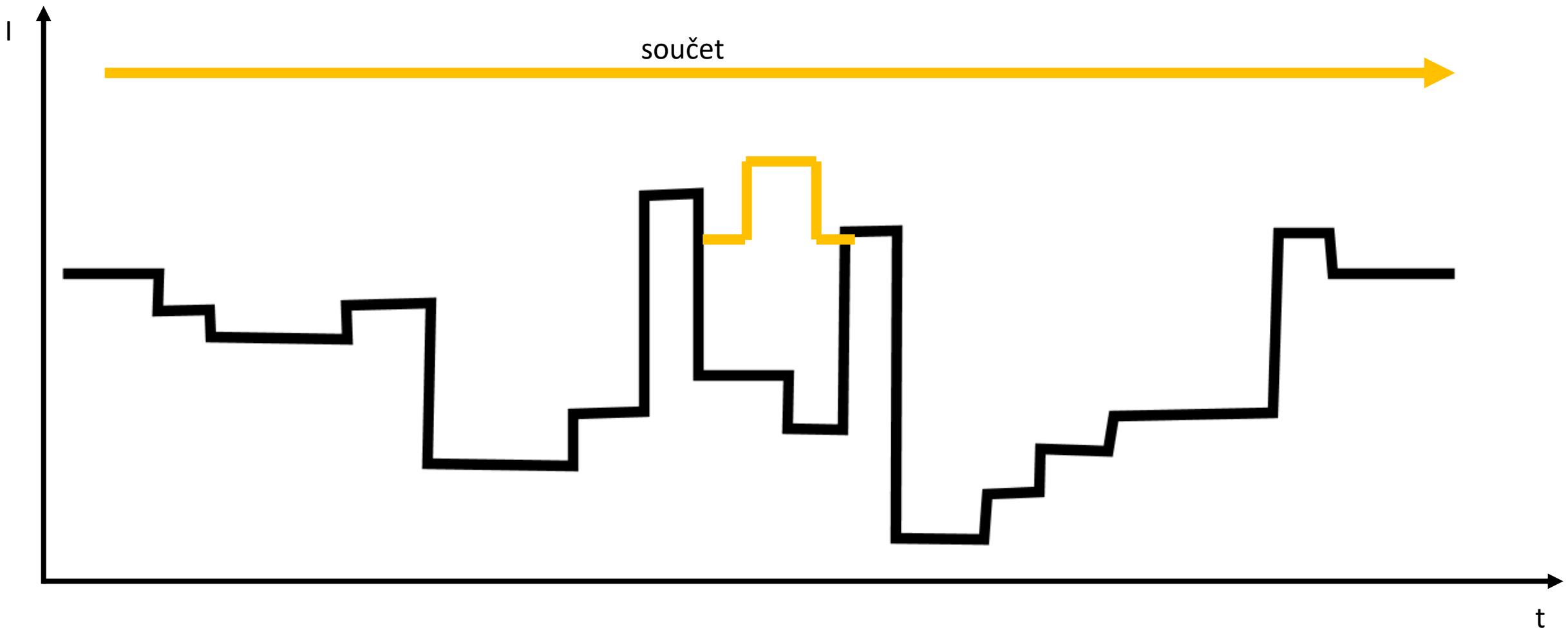
# Top-hat transformace



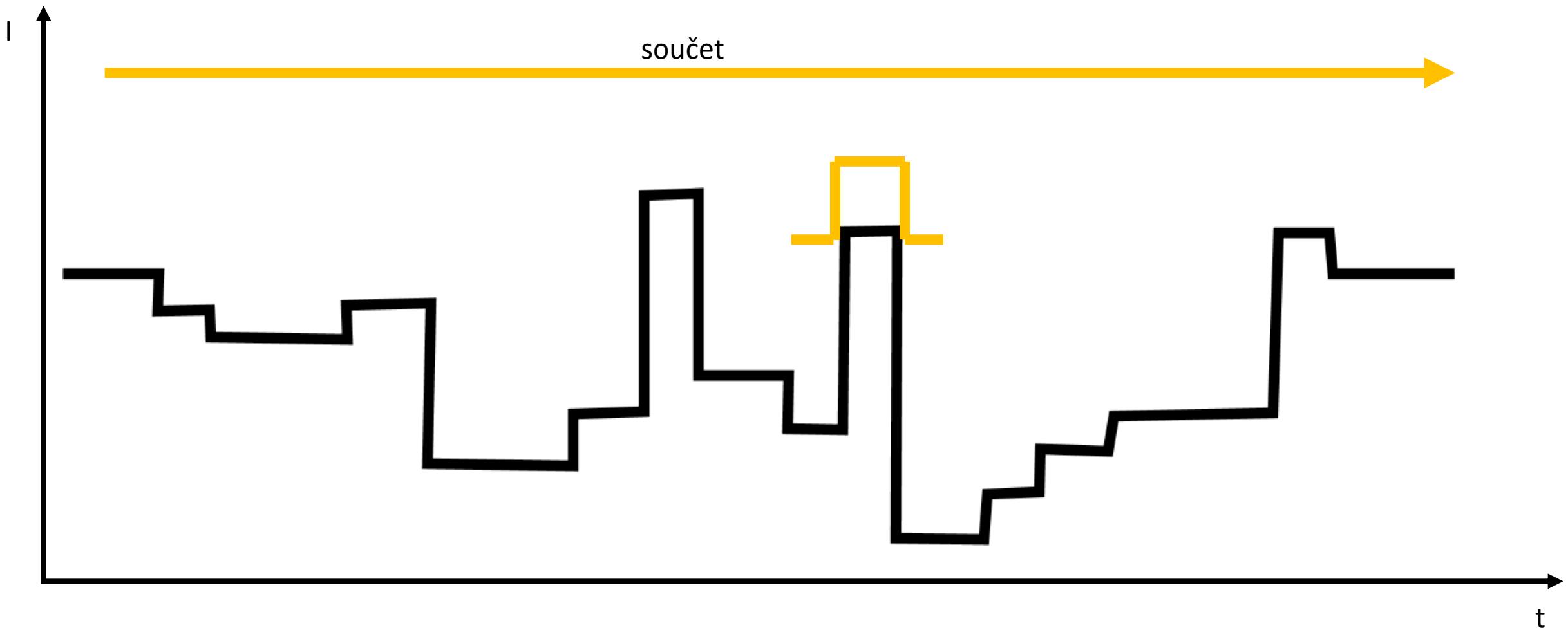
# Top-hat transformace



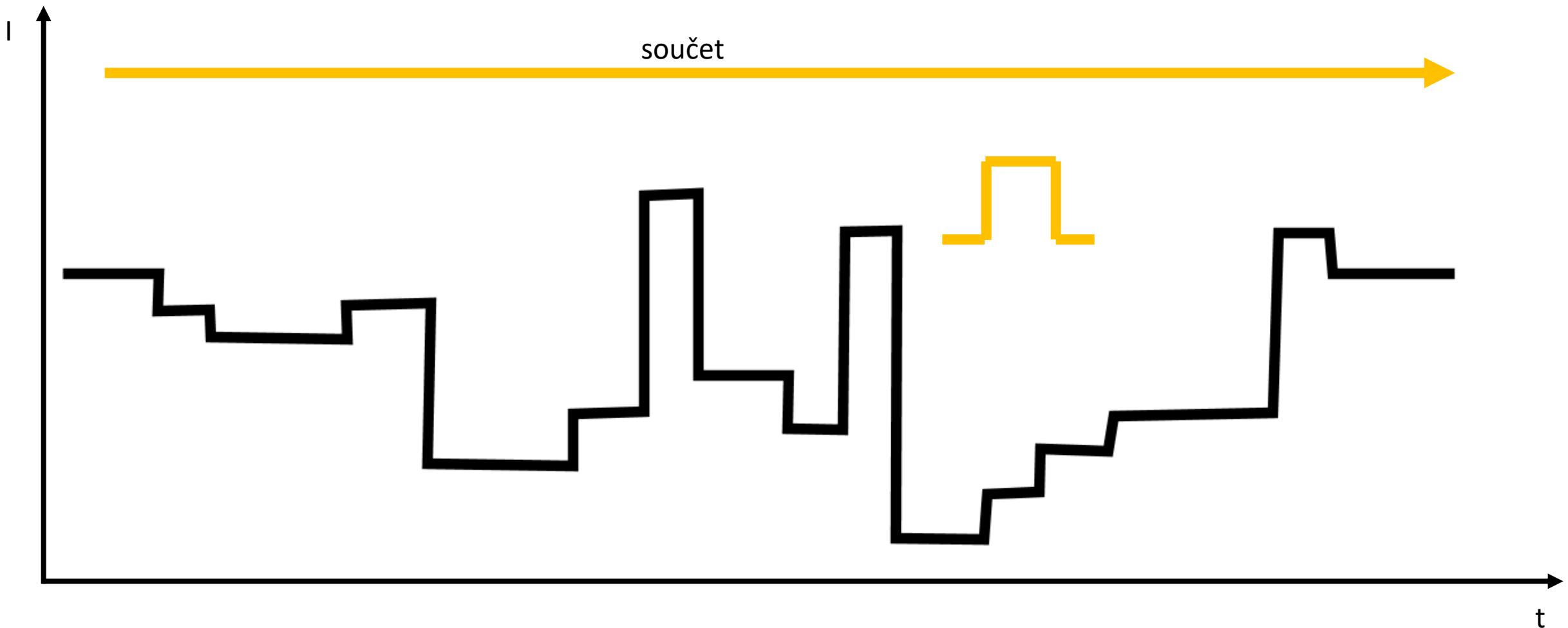
# Top-hat transformace



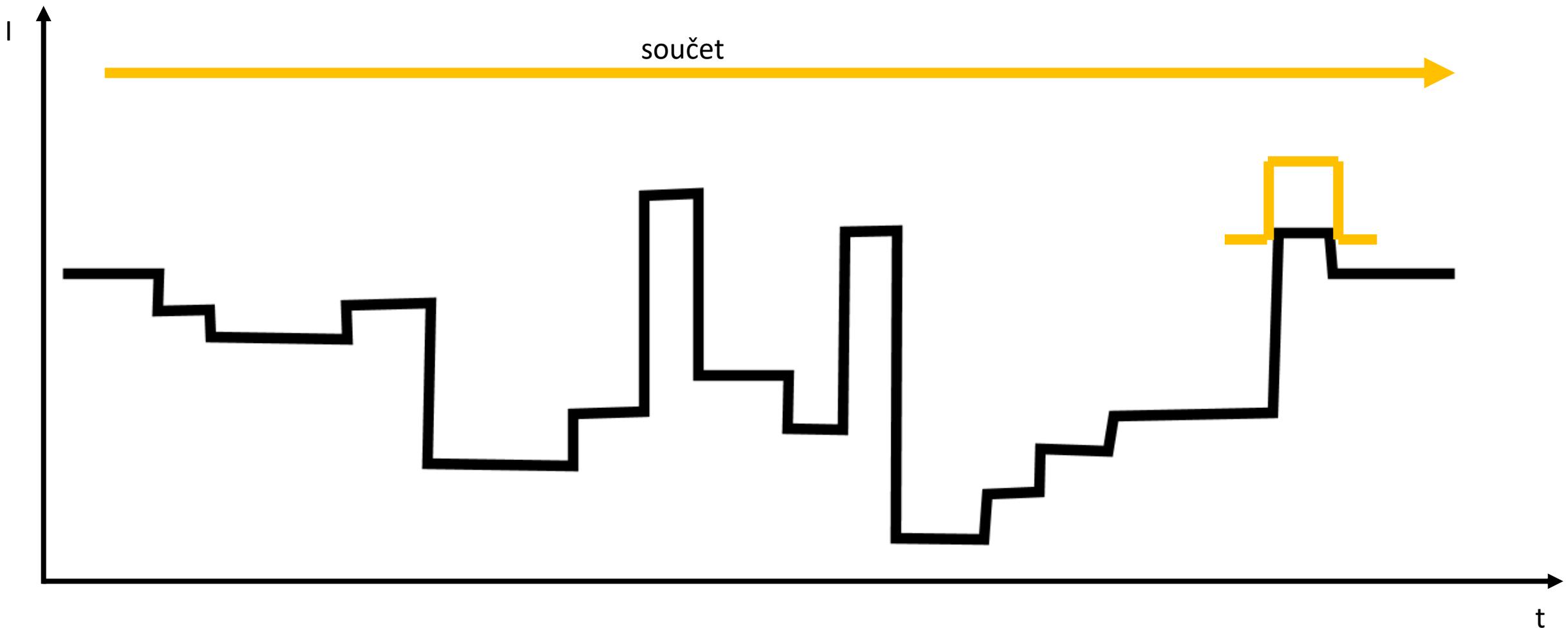
# Top-hat transformace



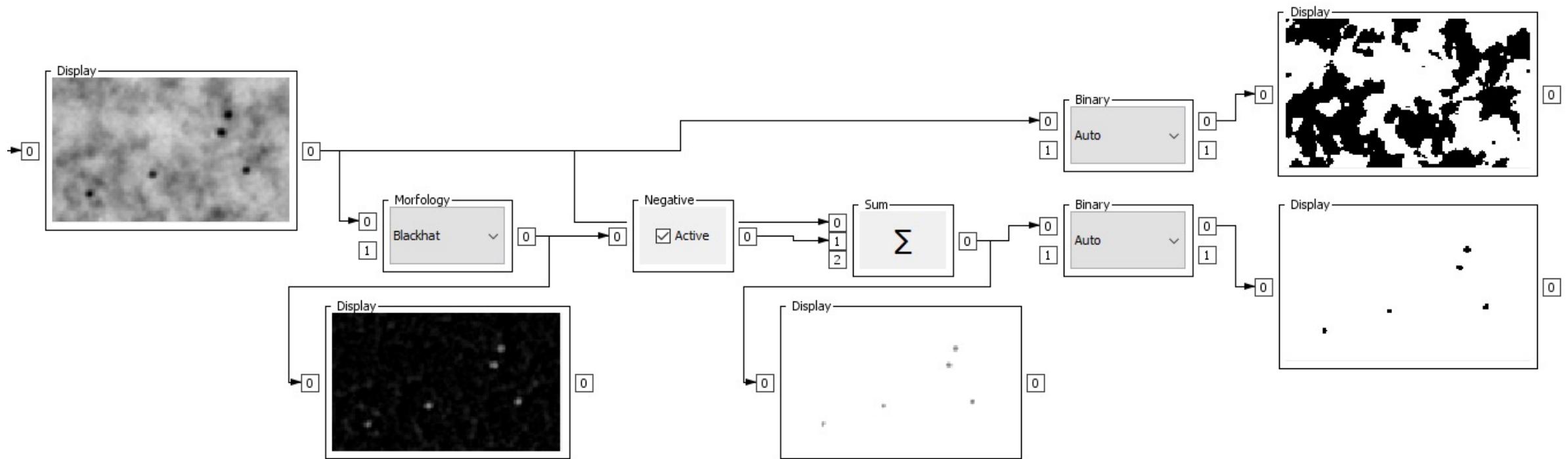
# Top-hat transformace



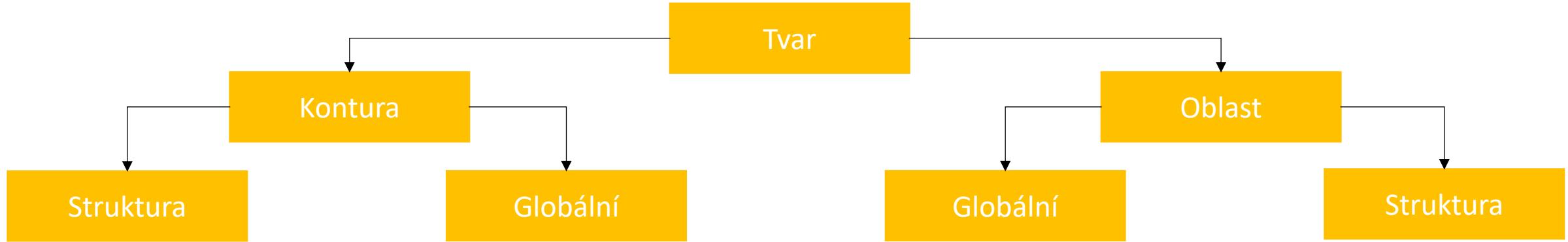
# Top-hat transformace



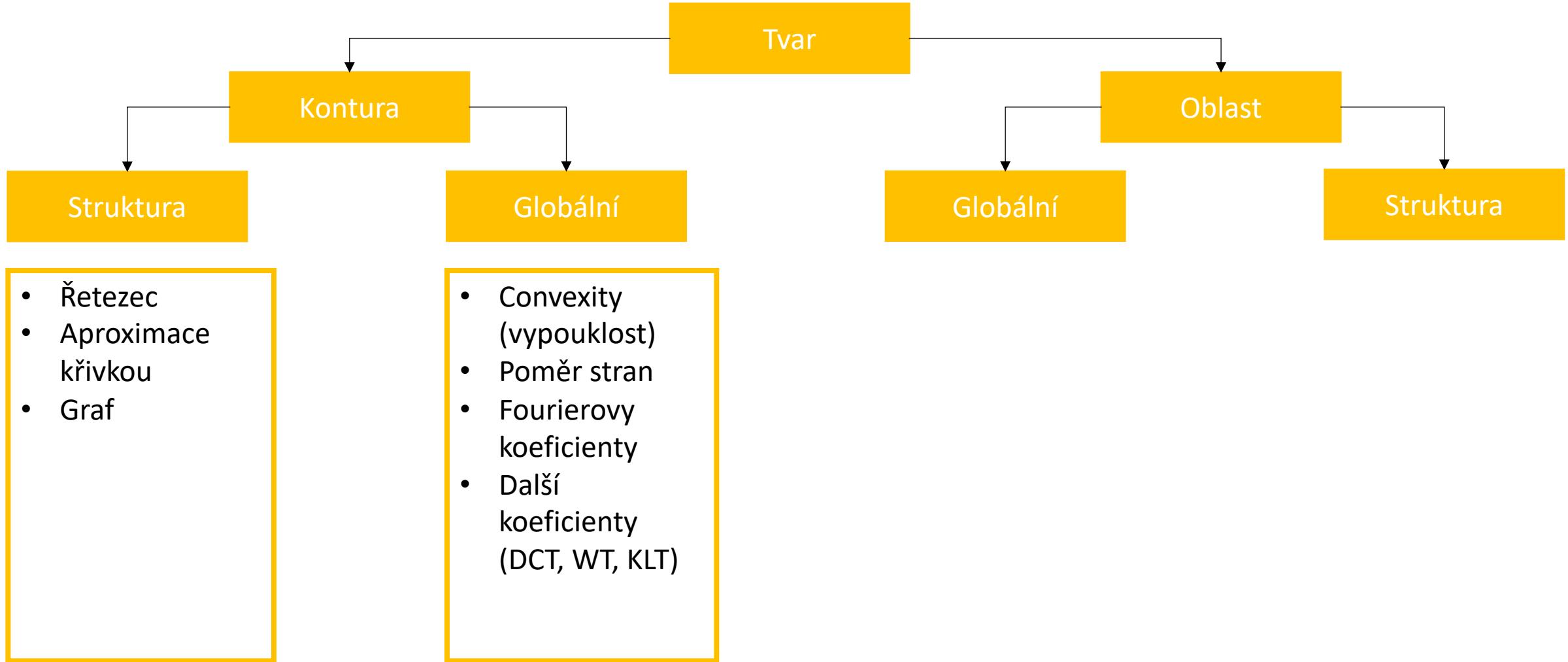
# Top-hat / black-hat (bottom-hat)



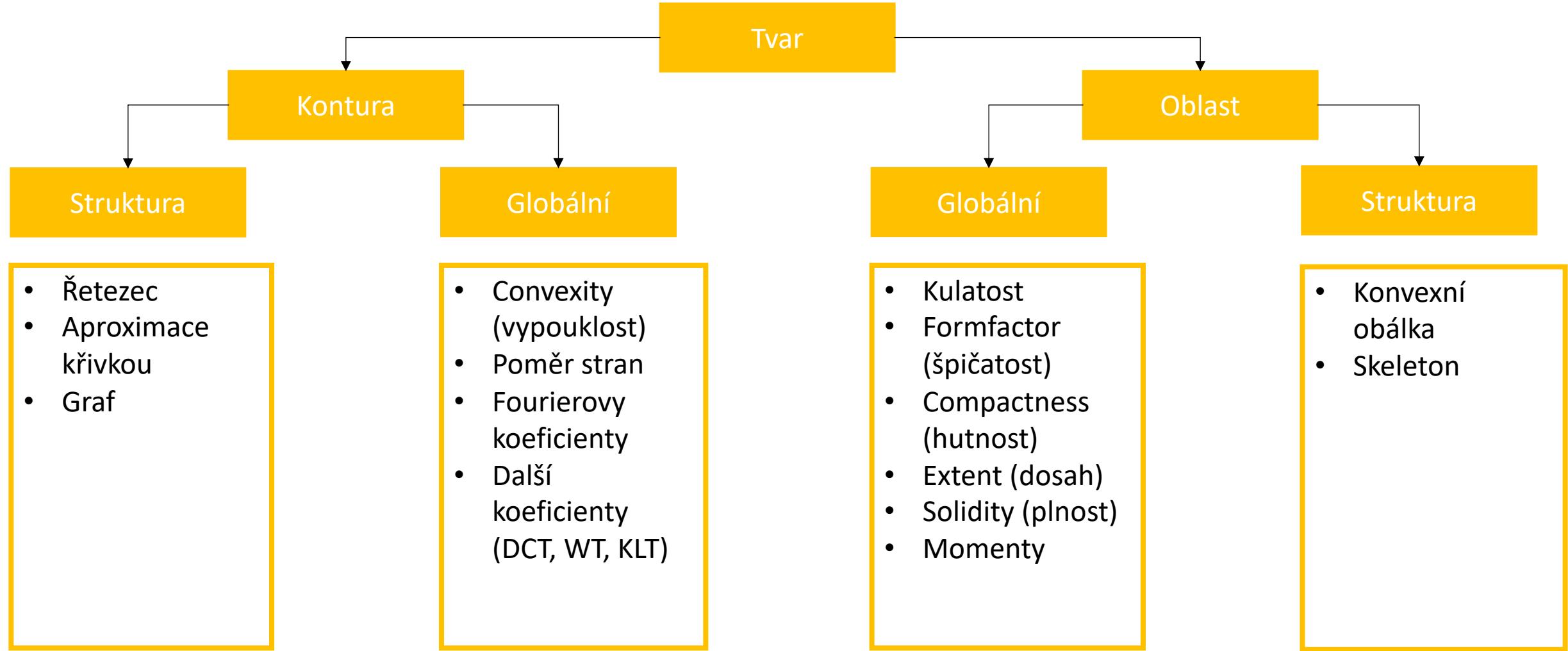
# Tvarové charakteristiky



# Tvarové charakteristiky



# Tvarové charakteristiky



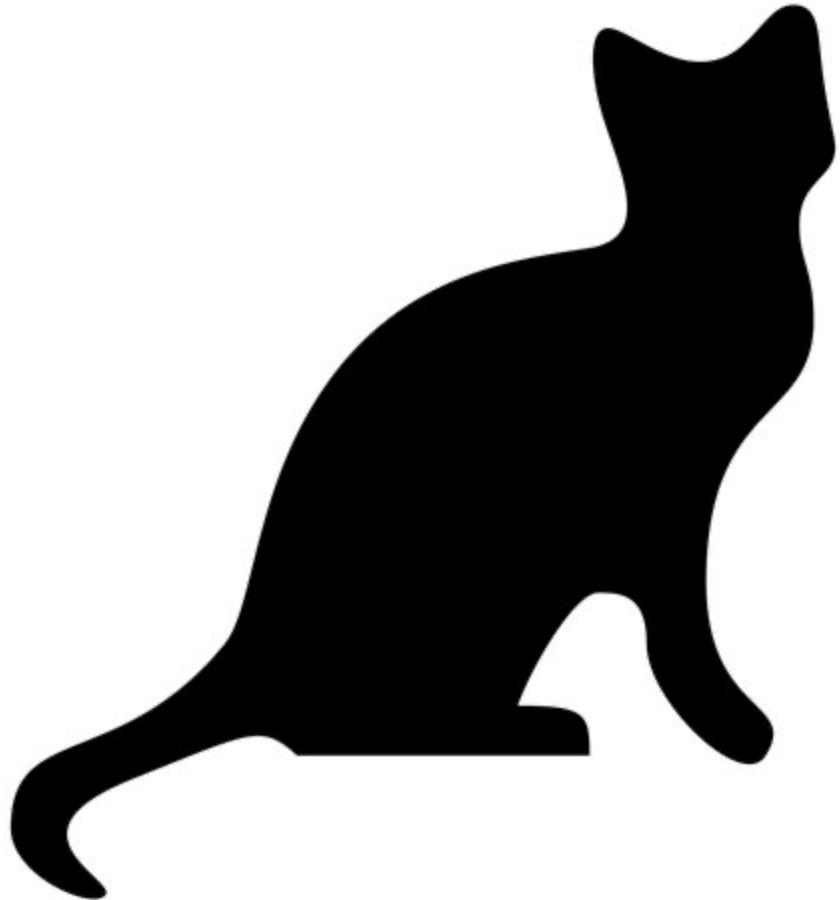
# Tvarové charakteristiky – vybrané

```
def form_factor(area, perimeter):  
    return (4 * PI * area) / (perimeter * perimeter)  
  
def roundness(area, max_diameter):  
    return (4 * area) / (PI * max_diameter * max_diameter)  
  
def aspect_ratio(min_diameter, max_diameter):  
    return min_diameter / max_diameter;  
  
def convexity(perimeter, convex_perimeter):  
    return convex_perimeter / perimeter
```

```
def solidity(area, convex_area):  
    return area / convex_area  
  
def compactness(area, max_diameter):  
    return sqrt(4 / PI * area) / max_diameter;  
  
def extent(area, bounding_rectangle_area):  
    return area / bounding_rectangle_area
```

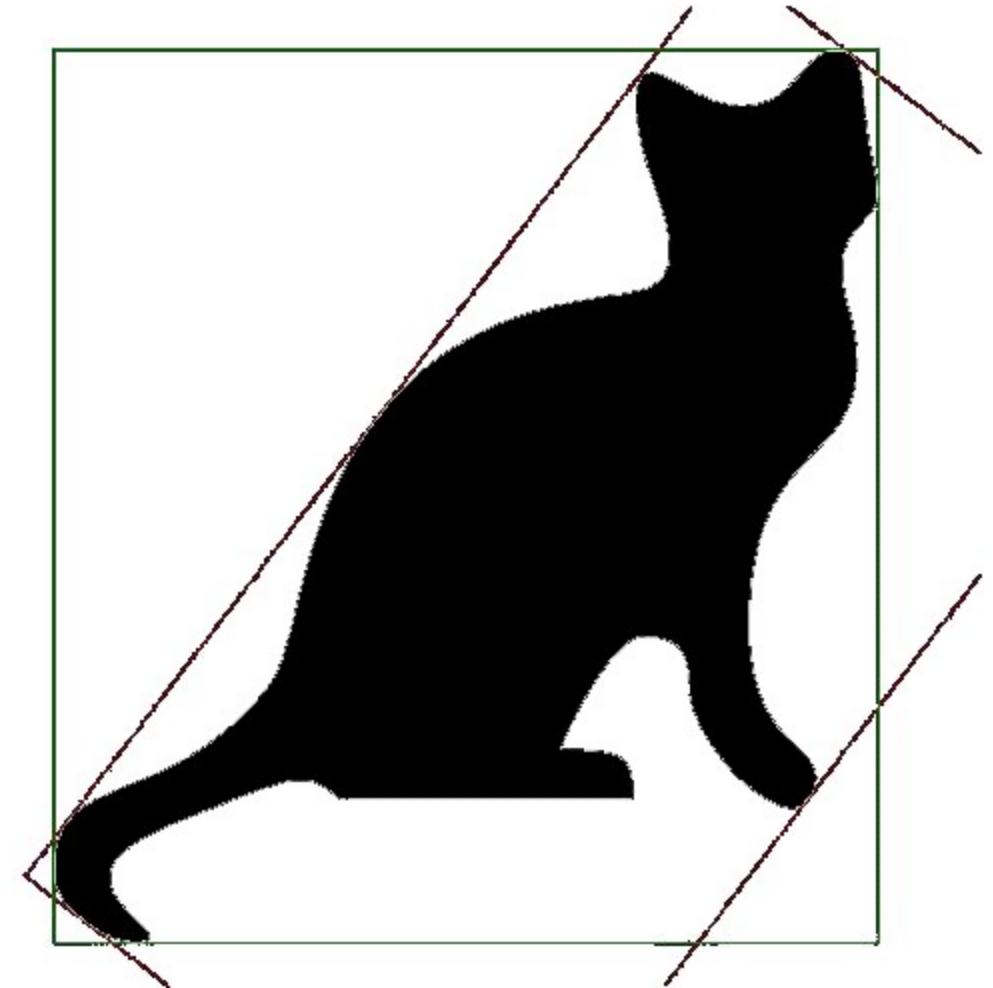
# Tvarové charakteristiky

- Průměr (větší menší)
- Šířka, Výška
- Obvod, Obsah



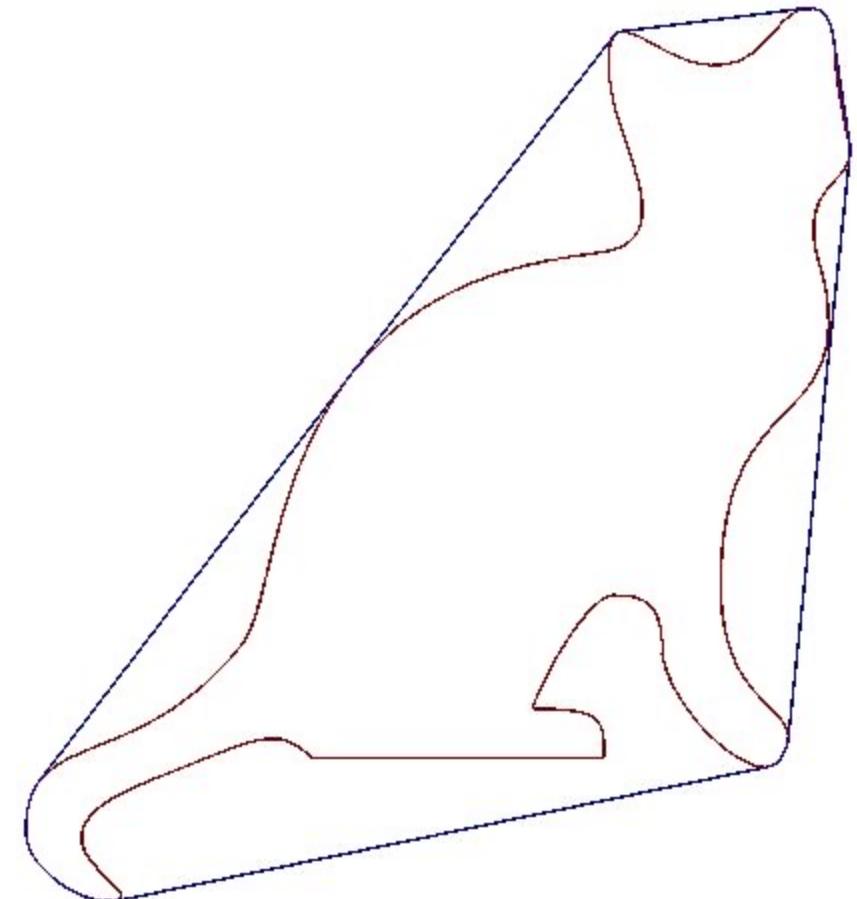
# Tvarové charakteristiky

- Průměr (větší menší)
  - Šířka, Výška
  - Obvod, Obsah
- 
- Bounding box
  - Minimal enclosing rectangle



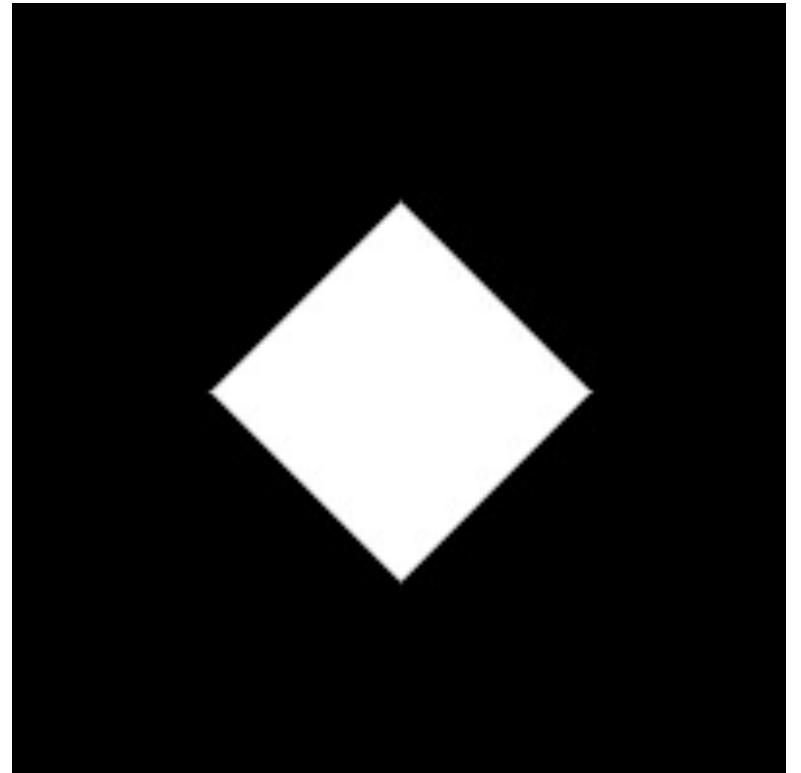
# Tvarové charakteristiky

- Průměr (větší menší)
  - Šířka, Výška
  - Obvod, Obsah
- 
- Kontura
  - Konvexní obálka



# Tvarové charakteristiky

- Průměr (větší menší)
- Šířka, Výška
- Obvod, Obsah



# Tvarové charakteristiky

- Průměr (větší menší)
  - Šířka, Výška
  - Obvod, Obsah
- 
- Min enclosing circle
  - Min enclosing ellipse

