Digital representasjon

IN1020 — maskinvaredelen — 7. oktober 2026



Alle lysark er laget med claude og openAI

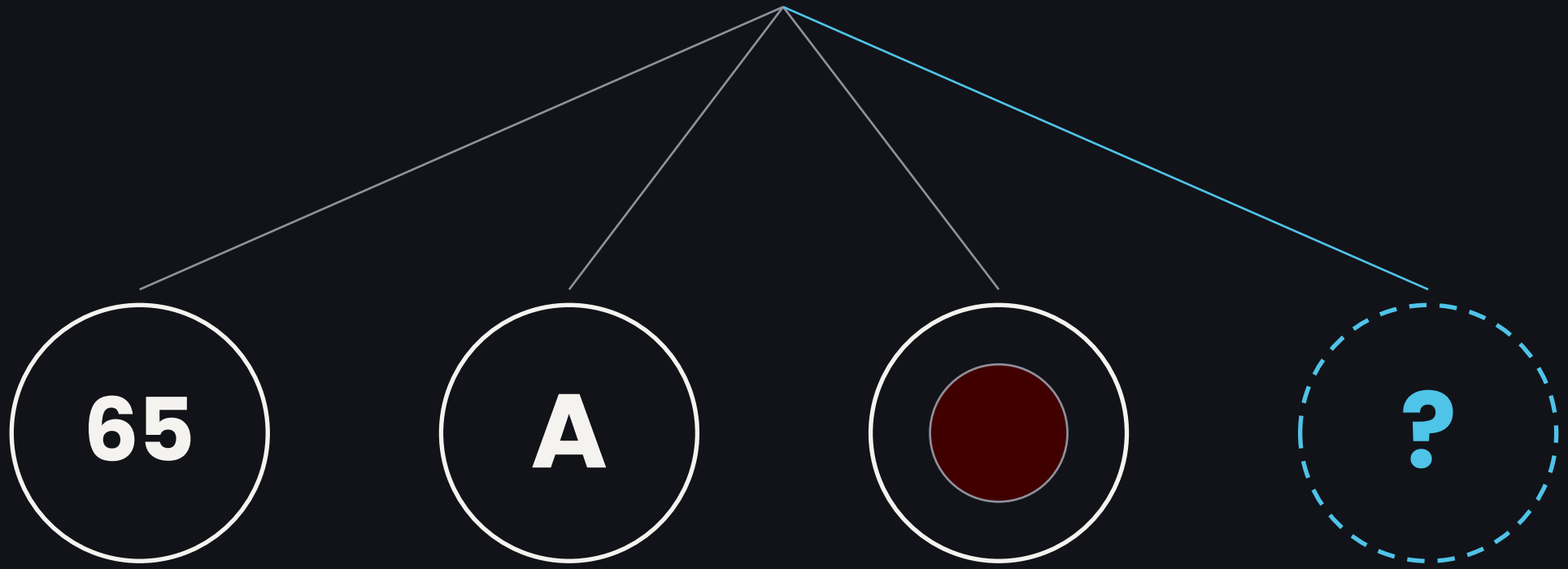
01000001

Hva betyr dette?

0 1 0 1 0 0 1 1 1 1 0 0 1 1 1 0 1 **0 1 0 0 0 0 0 1** 1 1 1 1 1 1 1 1 0 0 1 1 1 0 1 1 0



0 1 0 0 0 0 0 1



som tall

som tegn

som farge

#410000

som instruksjon

om to uker

Et bitmønster betyr ingenting i seg selv.

Det er tolkningen som gir det mening.

0 1 0 0 0 0 0 1

Du kan dette allerede

3	4	0	7
1000	100	10	1
10^3	10^2	10^1	10^0

$$3 \cdot 1000 + 4 \cdot 100 + 0 \cdot 10 + 7 \cdot 1 = 3407$$

Samme regel, annen base

1	1	0	0	1
16	**8**	**4**	**2**	**1**
2^4	2^3	2^2	2^1	2^0

basen opphøyd i posisjonen

Og andre veien?

25	: 2	=	12	rest	1
12	: 2	=	6	rest	0
6	: 2	=	3	rest	0
3	: 2	=	1	rest	1
1	: 2	=	0	rest	1



leses nedenfra

$$25_{10} = 11001_2$$

Hvilken desimal verdi har dette binære tallet?

1 1 0 0 1



én million

1 1 1 1 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0

20 bit

Fire bit blir ett siffer

1 1 1 1 | 0 1 0 0 | 0 0 1 0 | 0 1 0 0 | 0 0 0 0

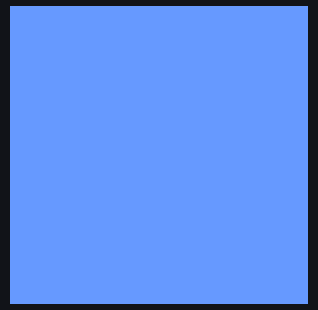
Fire bit blir ett siffer

1111	0100	0010	0100	0000
F	4	2	4	0

`0xF4240`

0000 **0**	0001 **1**	0010 **2**	0011 **3**
0100 **4**	0101 **5**	0110 **6**	0111 **7**
1000 **8**	1001 **9**	1010 **A**	1011 **B**
1100 **C**	1101 **D**	1110 **E**	1111 **F**

Hva er rødkomponenten binært?



`0x6699FF`



Hvor langt kommer du?

1 byte 2^8 0 – 255



2 byte 2^{16} 0 – 65 535



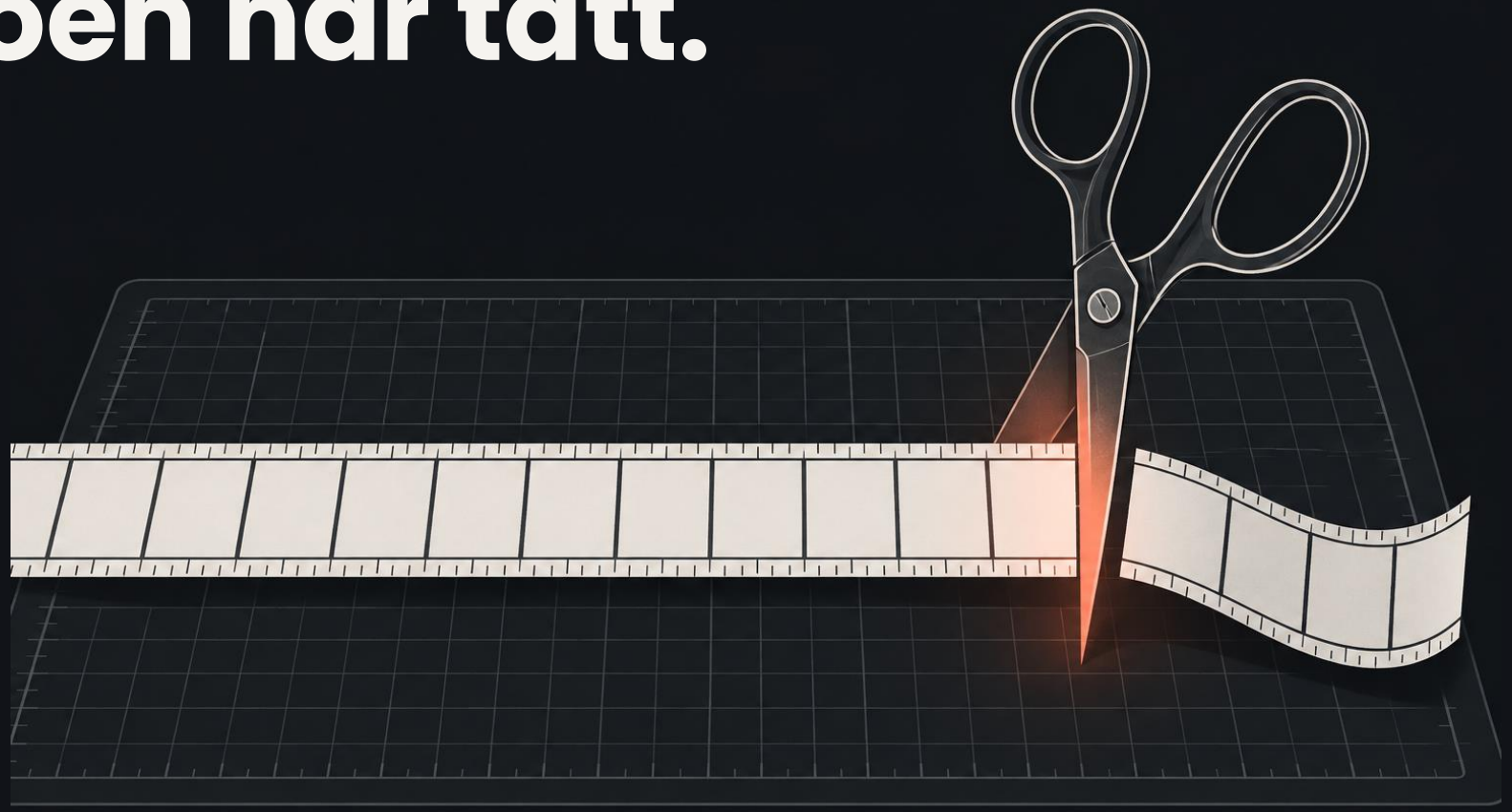
4 byte 2^{32} 0 – 4,3 milliarder



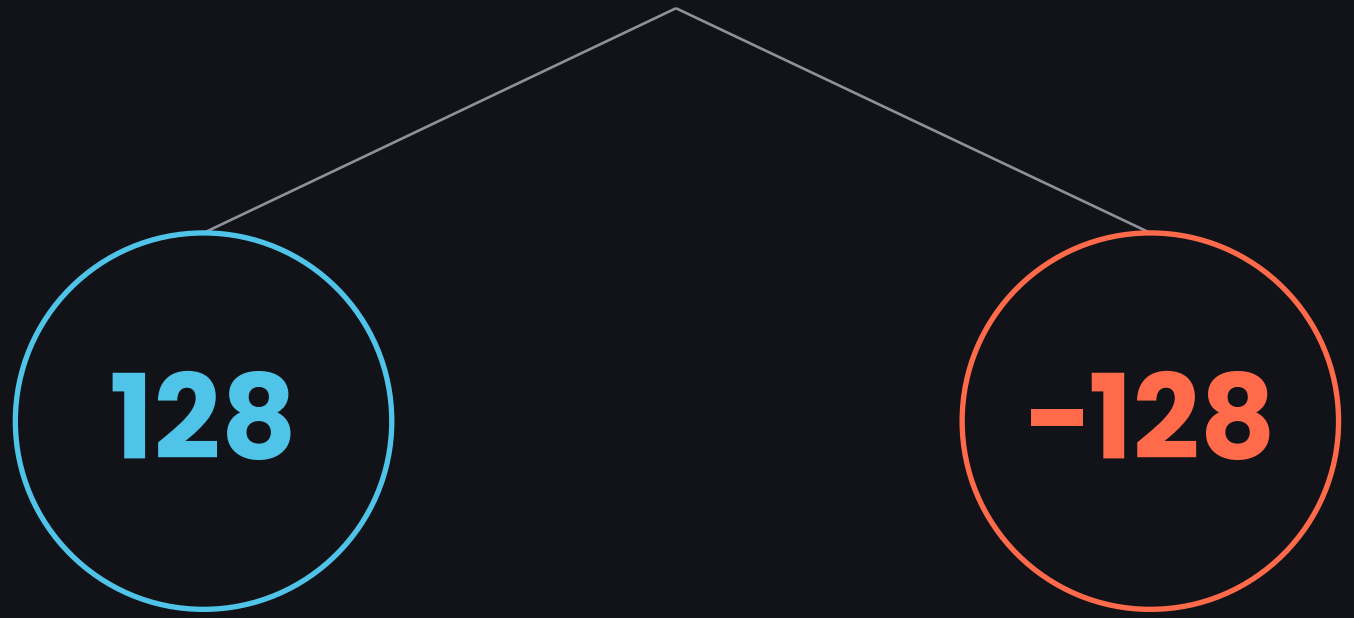
8 byte 2^{64} 0 – $1{,}8 \cdot 10^{19}$



Hvor mange bit du bruker, er et valg noen har tatt.



1 0 0 0 0 0 0 0



Øverste bit har negativ vekt

1	0	0	0	0	0	0	0
−128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

$$1 \cdot (-128) + 0 = -128$$

8 bit i toerkomplement



Bitmønstrene i stigende rekkefølge

Bitmønsteret sier ikke hvordan det skal leses.

Det gjør typen.



01000001

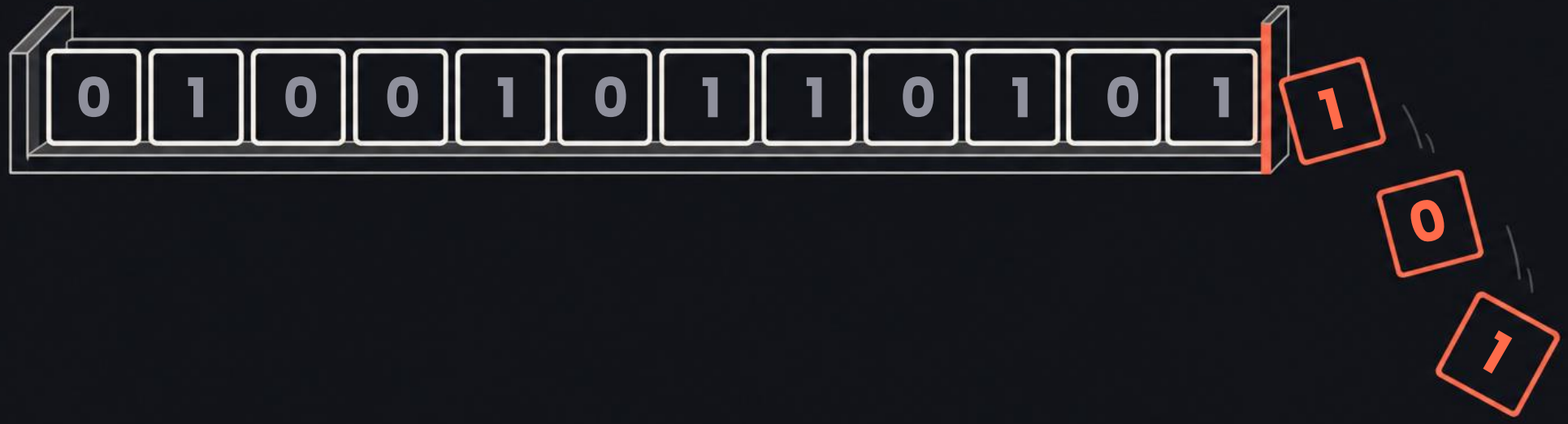
Maskinen nektet ikke.



lydspiller

bildeprogram

Og hva skjer når tallet ikke får plass?



TIME 2

Når representasjonen ikke strekker til





Ariane 501 · 4. juni 1996

39 sekunder etter motorstart

© ESA/CNES

Hva skriver Java ut?

```
int v1 = 1000;
int v2 = 1000 * 1000;
int v3 = 1000000 * 1000000;
```

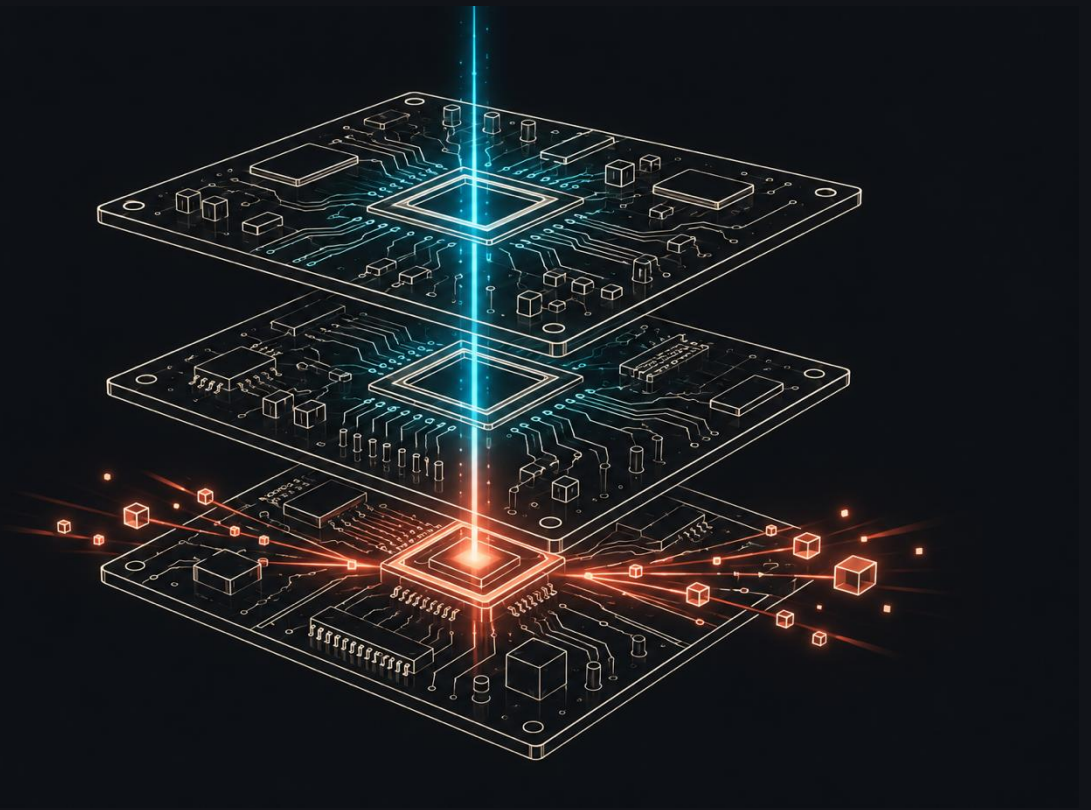
```
int v1 = 1000;
int v2 = 1000 * 1000;
int v3 = 1000000 * 1000000;

1000
1000000
-727379968
```

-727 379 968

Hvorfor ble svaret negativt?

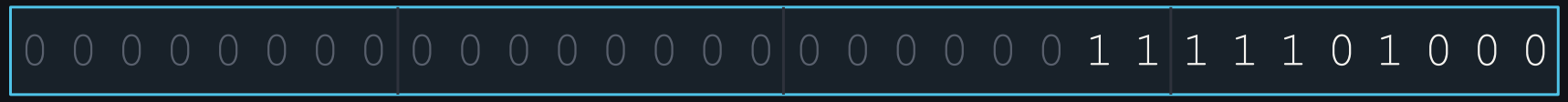
```
-727379968
```



Det som ikke fikk plass

1 000

32 bit
passer godt



1 000 000

passer



1 000 000 000 000

passer ikke

1 1 0 1 0 1 0 0

8 bit forsvinner



1 betyr negativt

−727 379 968

Python gjør det ikke

```
>>> 10**12 * 10**12
1000000000000000000000000
```

1 000	10 bit
10^{12}	40 bit
10^{24}	80 bit



Tryggheten koster tid.

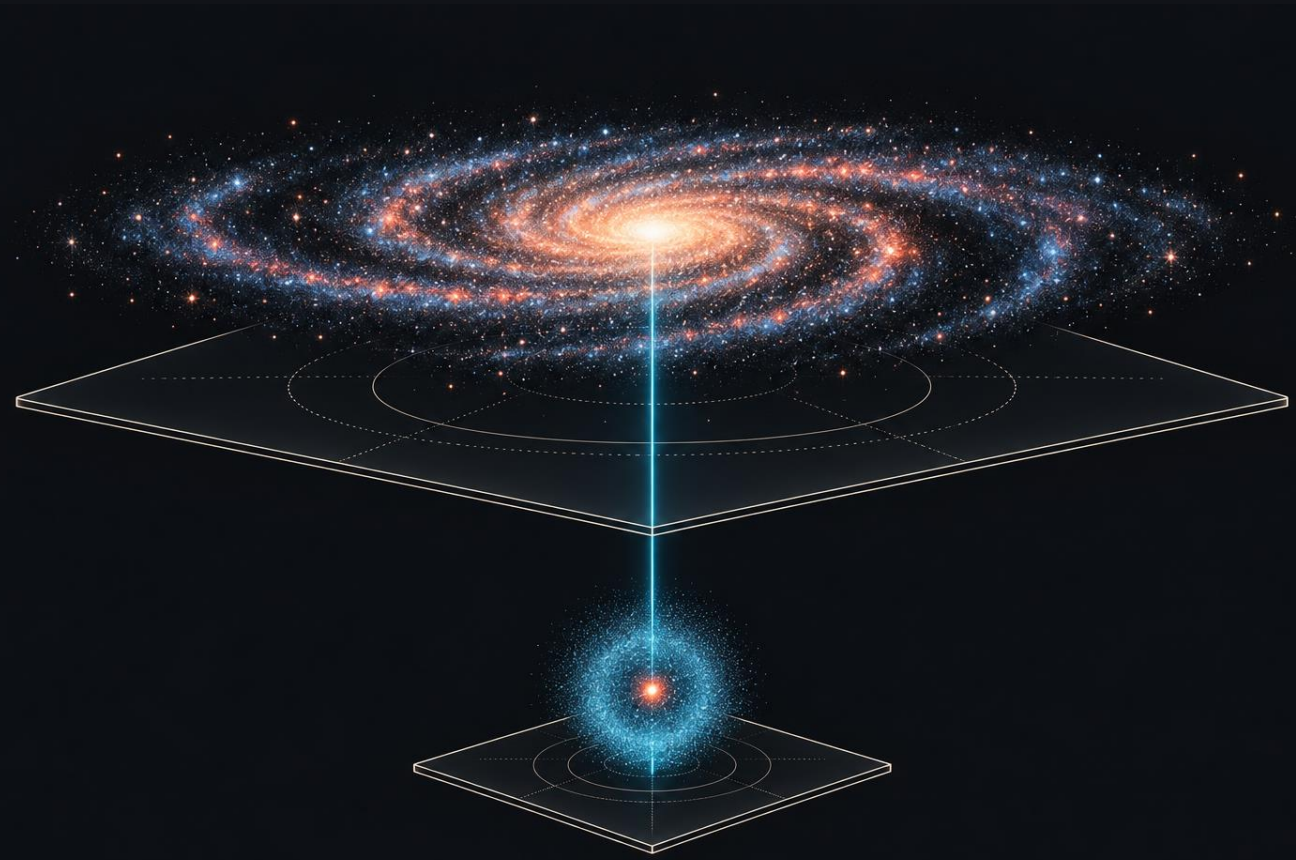
Store og små tall i samme program

Avstand til Andromeda

≈ 2,4 · 10¹⁹ km

Et hydrogenatom

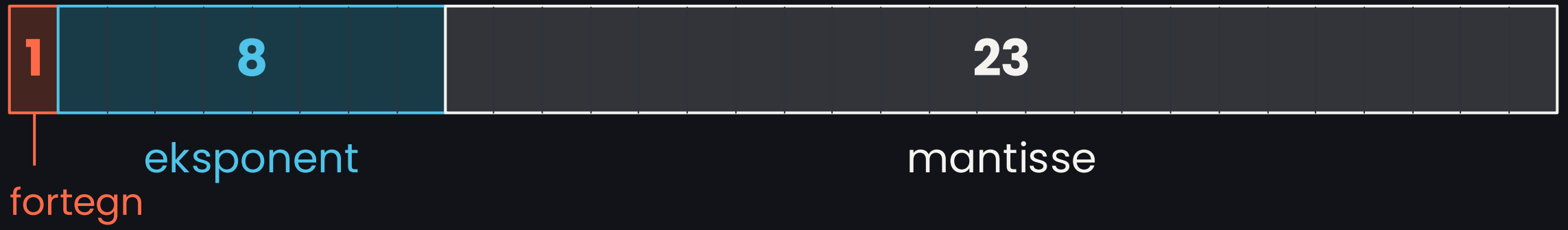
≈ 0,000 000 000 1 m



π = 3,14159265358979 3…

Flytt kommaet

$$\text{tall} = \text{mantisse} \cdot 2^{\text{eksponent}}$$





dobbel presisjon
64-bits

Hva skriver Python ut?

```
>>> 0.1 + 0.2
```

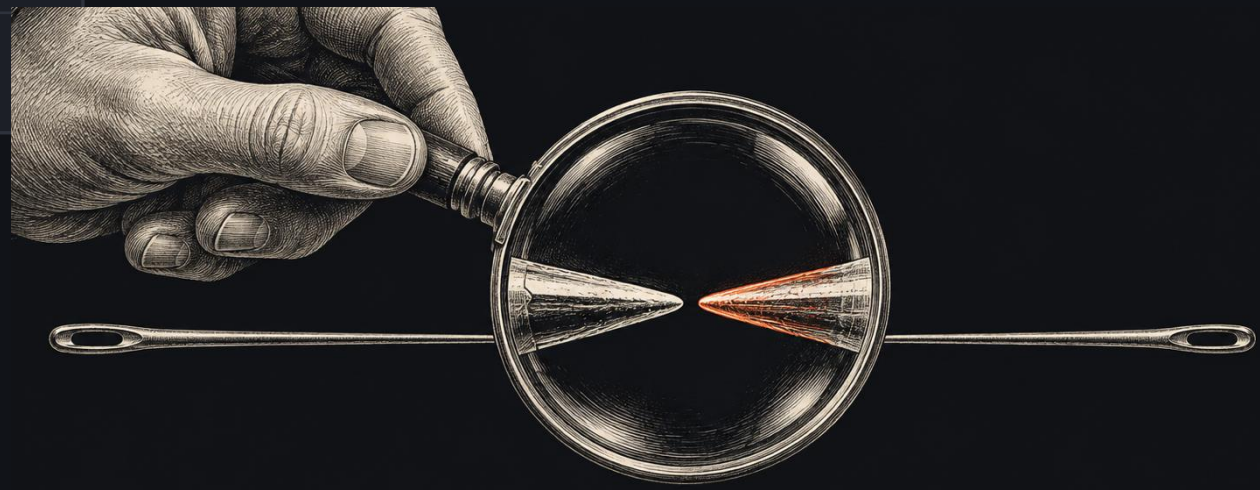



Hva skriver Python ut?

```
>>> 0.1 + 0.2
0.30000000000000004
```

Sammenlign aldri flyttall med ==
Sammenlign med toleranse.

```
if abs(a - b) < 1e-9:
```



Tekst er en avtale



01011011	Æ
01011100	Ø
01011101	Å

NS-4551 — norsk 7-bit

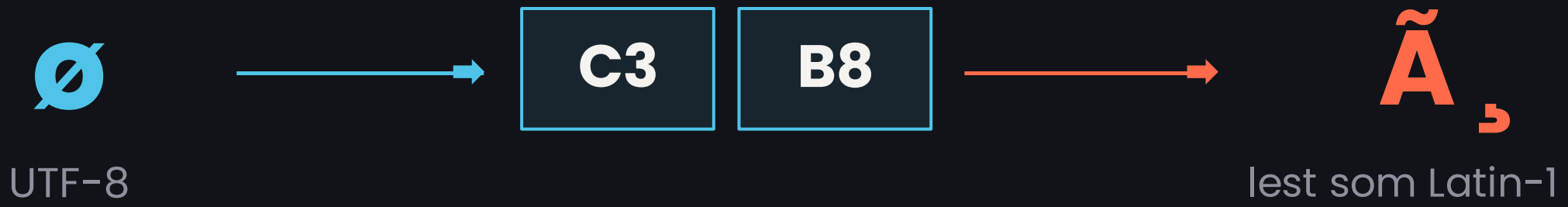
01011011	[
01011100	\
01011101	]

ASCII

Har du sett dette før?

GjÃ¸vik

Gjøvik

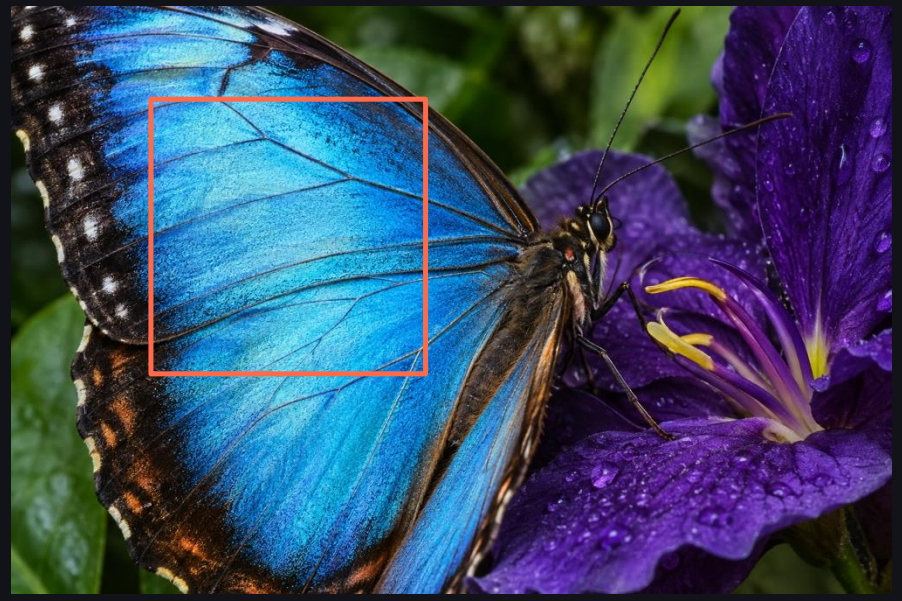


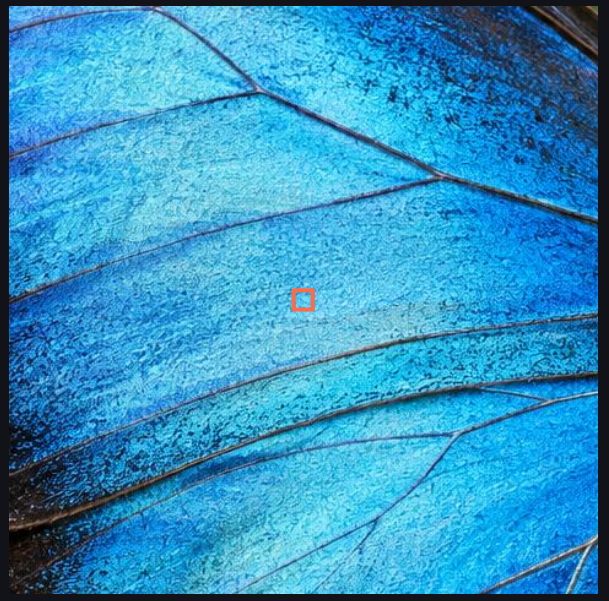
Ett tegn er ikke én byte

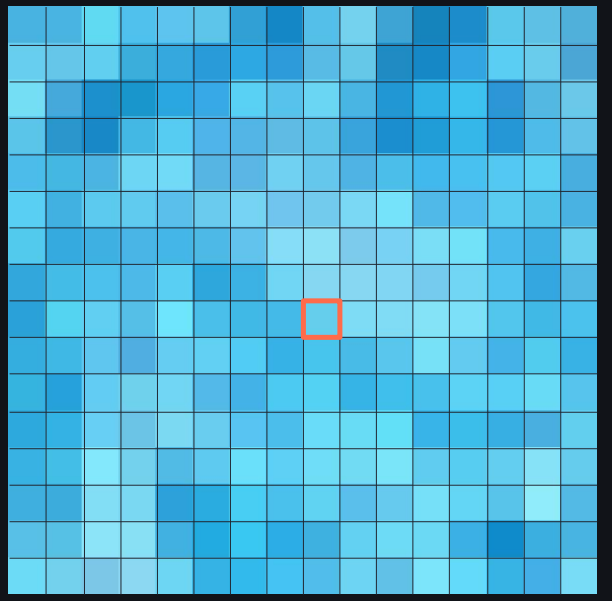
A	ø	€	
U+0041	U+00F8	U+20AC	U+1F600
41	C3 B8	E2 82 AC	F0 9F 98 80
1 byte	2 byte	3 byte	4 byte

Unicode sier hvilket nummer et tegn har.
UTF-8 sier hvordan nummeret lagres.

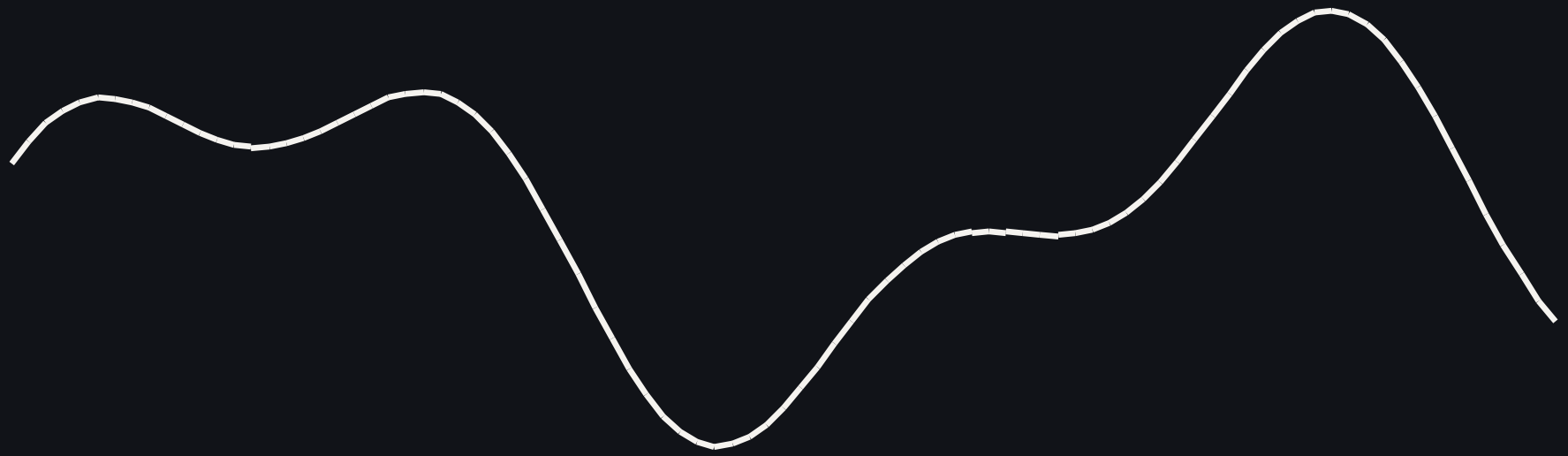
Zoom langt nok inn



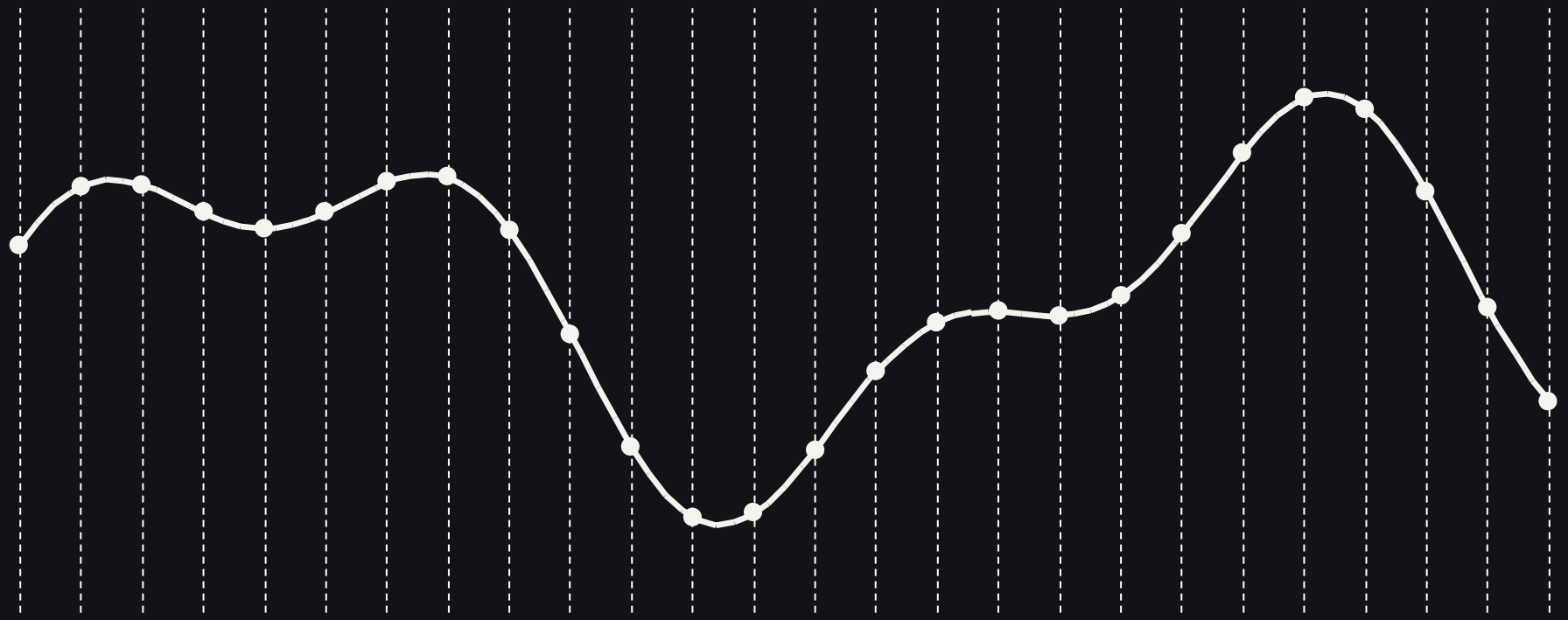




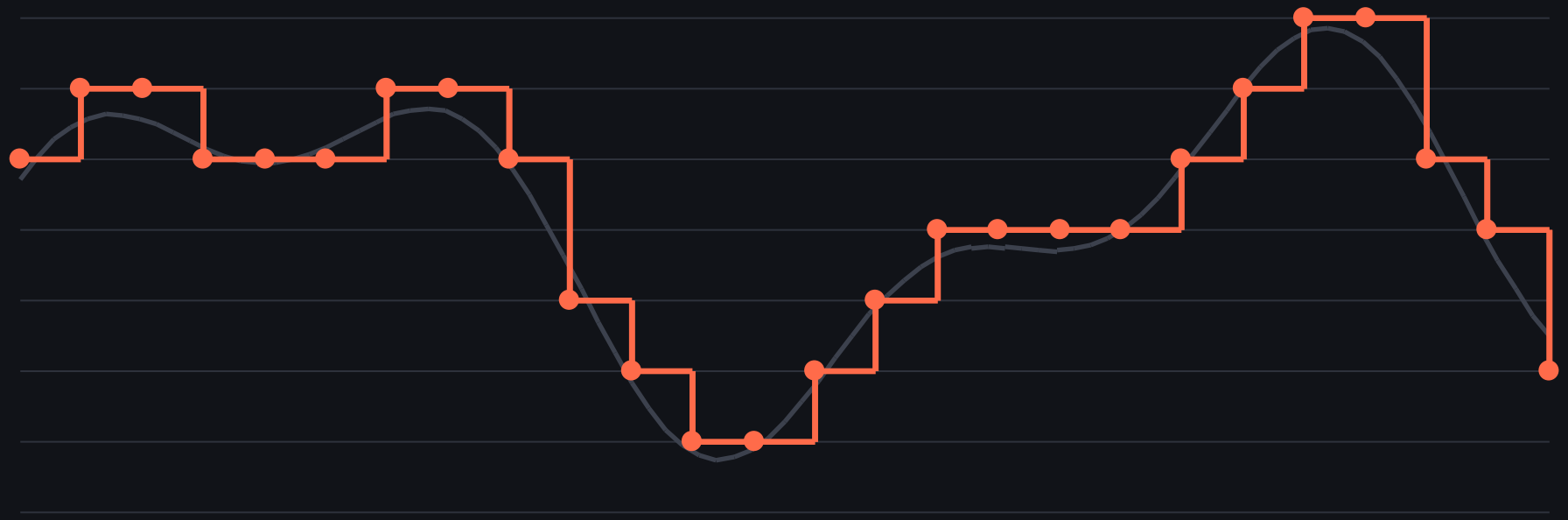
RGB (101, 206, 237)

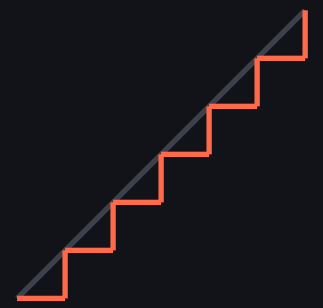


Del opp.



Del opp. Rund av.





samme grep
på en bildekant

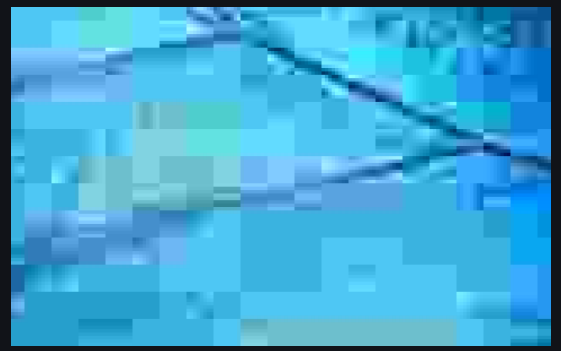
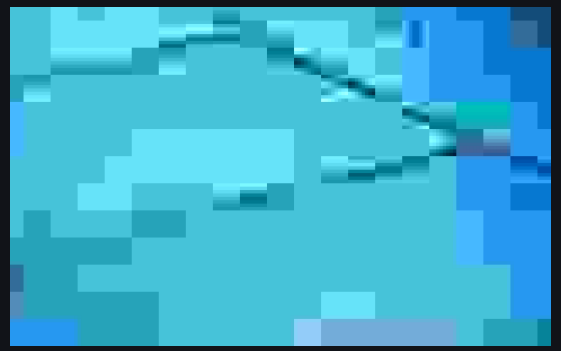
Hvor mye kan vi kaste?

JPEG-kvalitet (0–100)







100 376 kB **20** 28 kB **5** 10 kB **1** 7 kB

 **heltall**	rekker ikke høyt nok	Ariane 5
 **flyttall**	treffer ikke presist	0.1 + 0.2
 **tegn**	trenger en avtale	GjÃ¸vik
 **bilde og lyd**	må deles opp	JPEG

Hver representasjon har en grense.
Grensa er et valg noen har tatt.