Kunstig intelligens & mønstergenkendelse i patologien

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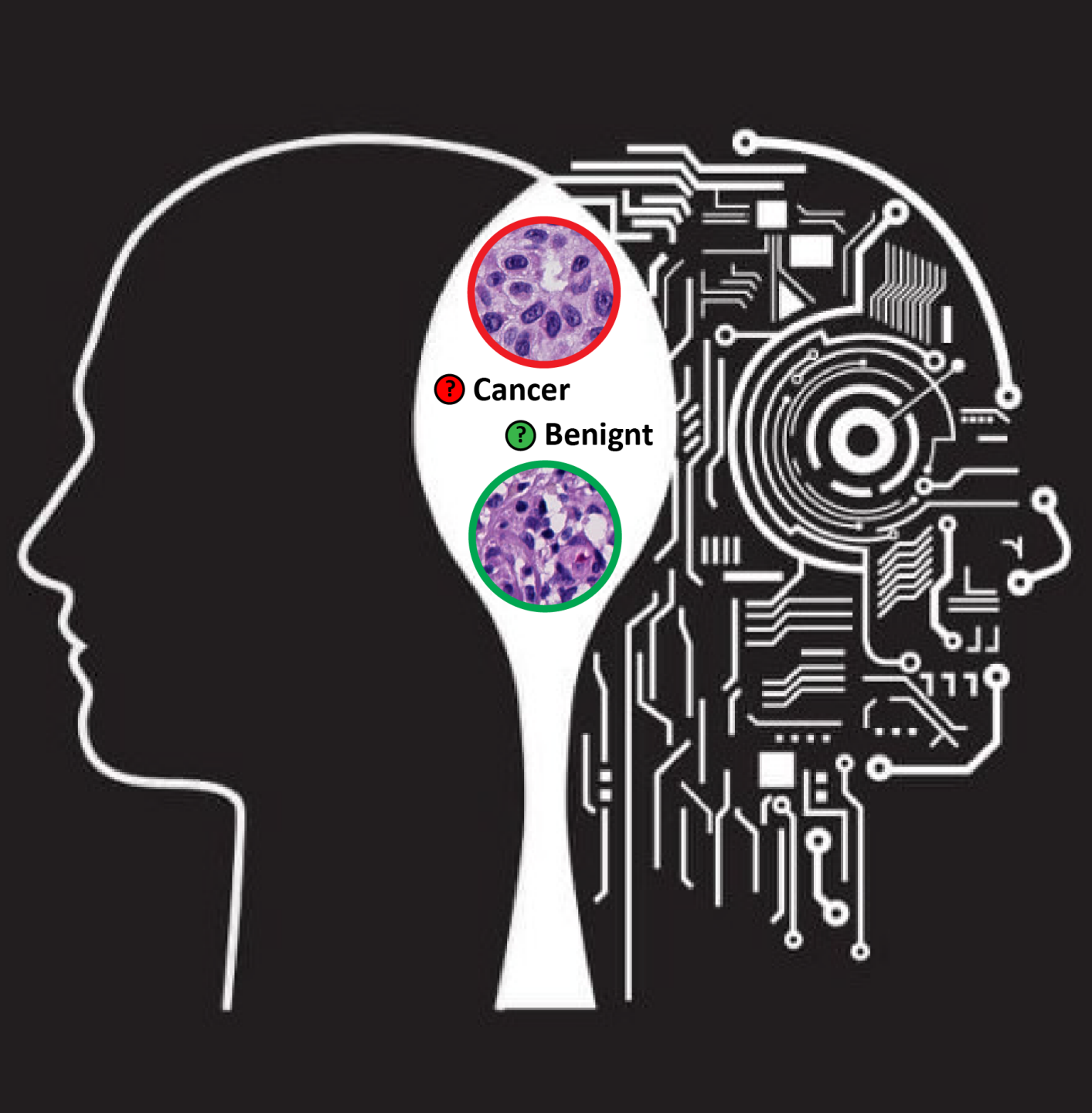
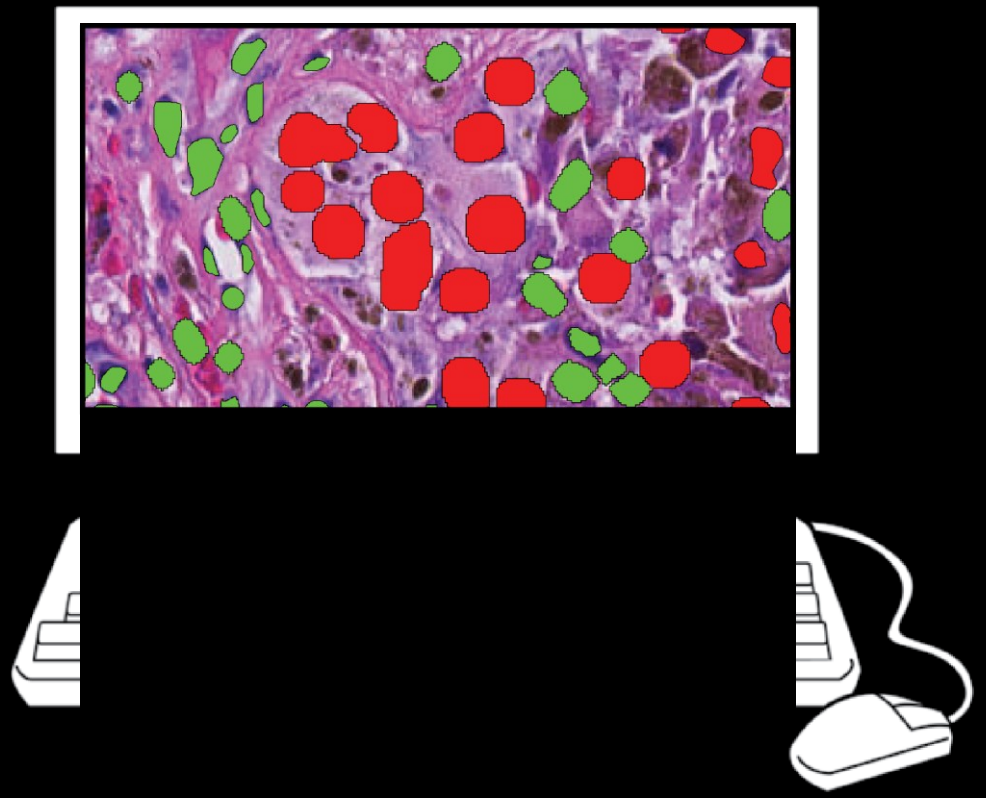
AARHUS UNIVERSITET



Digital patologi

- Digitale fuldsnit fremfor mikroskopiglas
  - Dannelse
  - Håndtering
  - Deling
  - Evt. digital fortolkning



Digital patologi

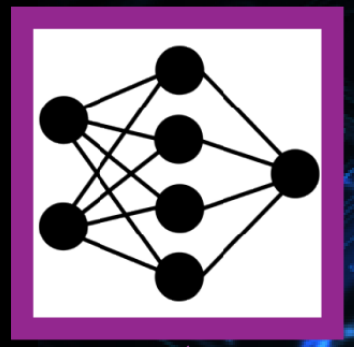
- Repetérbart
- Tidsbesparende
- Nemt at udveksle, annotere og arkivere

Mikroskopi

1600

Telepatologi

1980



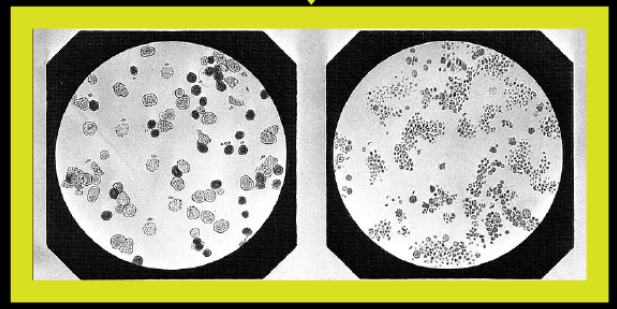
Deep learning

2010

Fremtiden

1900

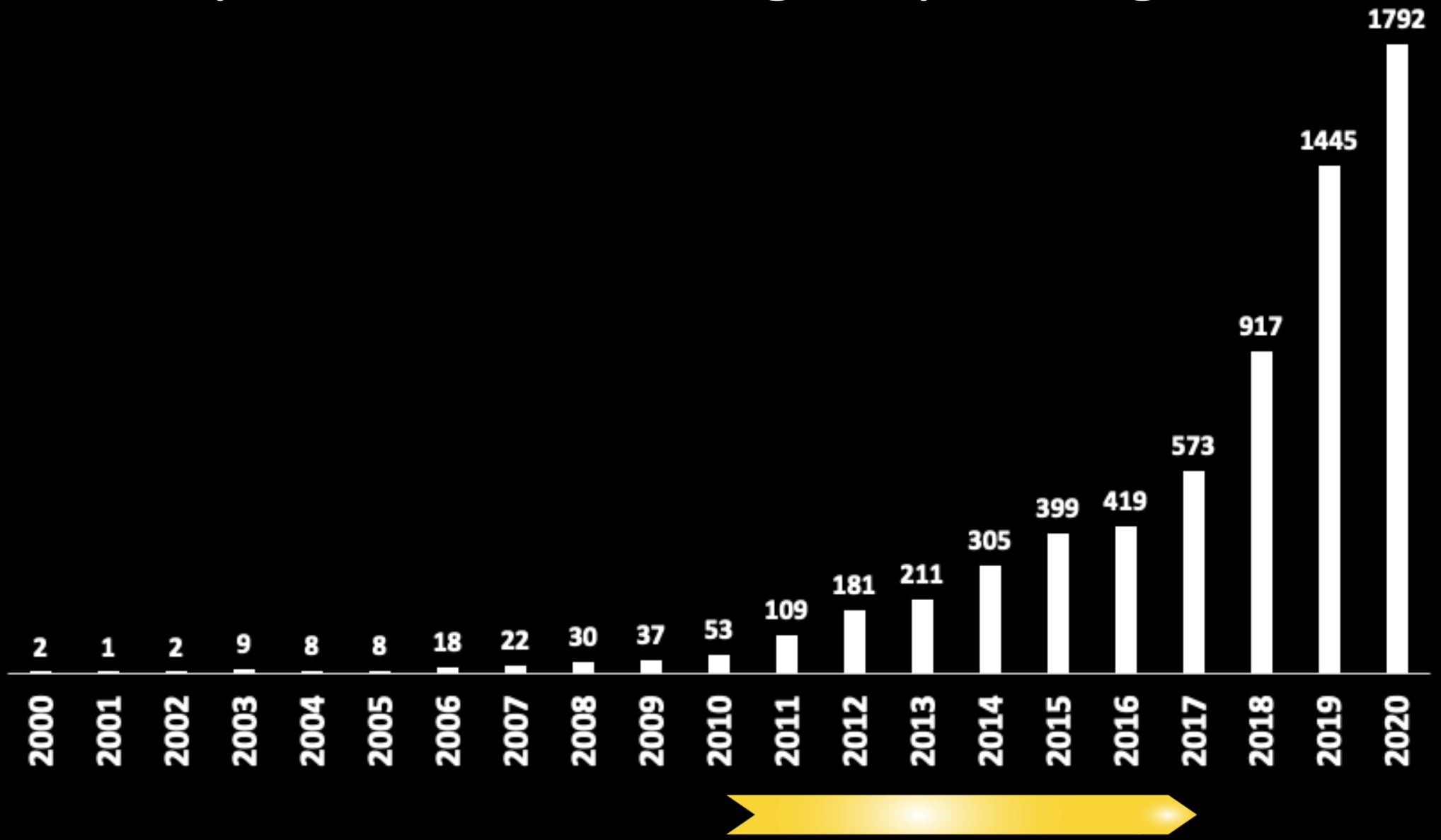
Mikrofotografi

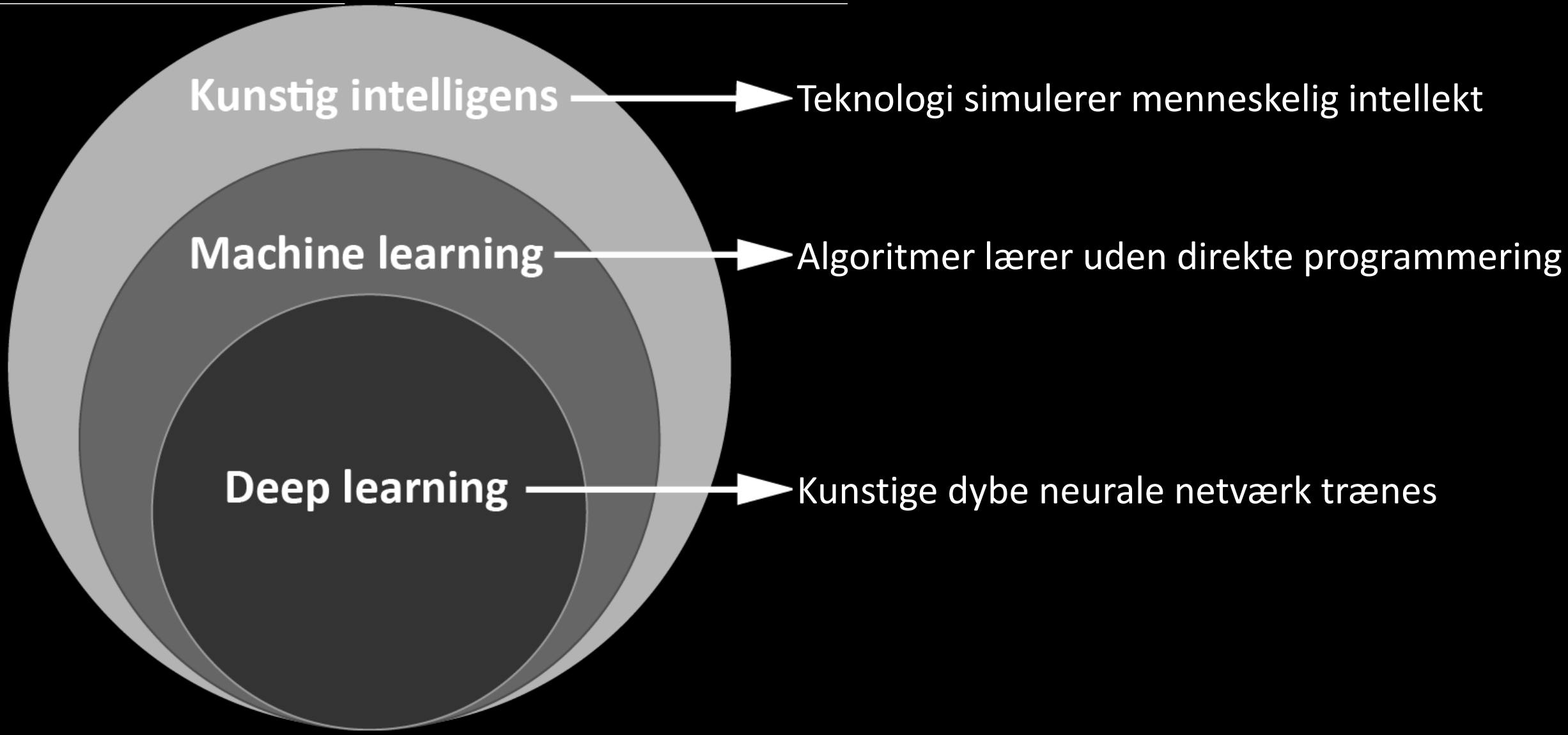


2000

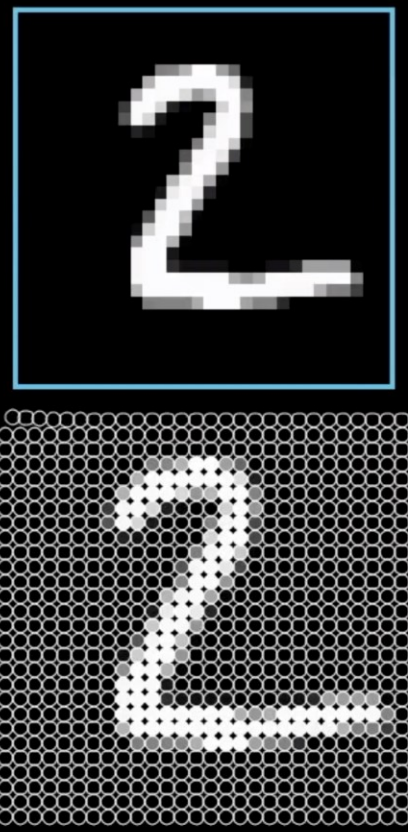
Digital patologi

Antal publikationer i digital patologi

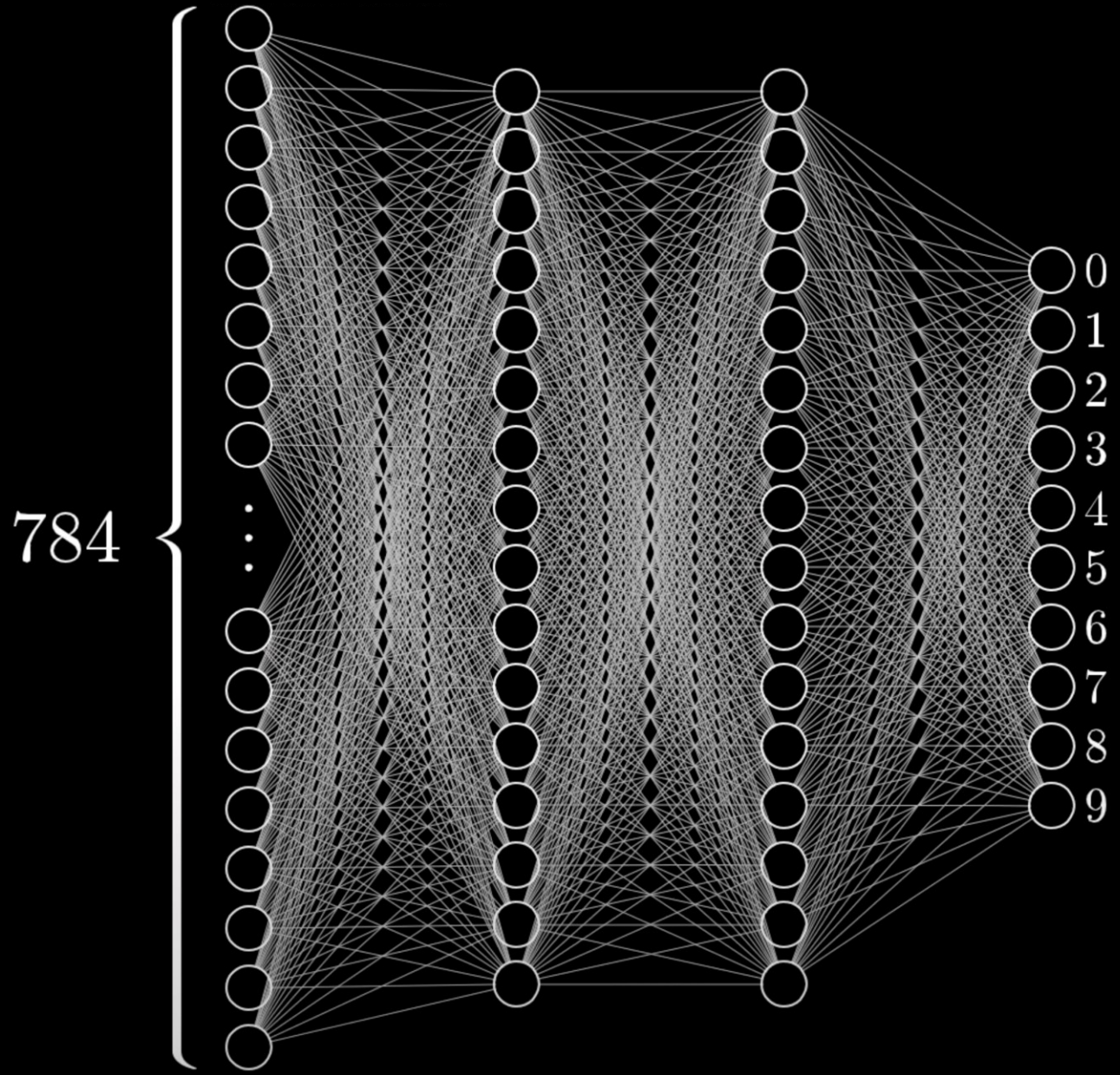



Kunstig intelligens
Teknologi simulerer menneskelig intellekt
Machine learning
Algoritmer lærer uden direkte programmering
Deep learning
Kunstige dybe neurale netværk trænes

Kunstigt neuralt netværk

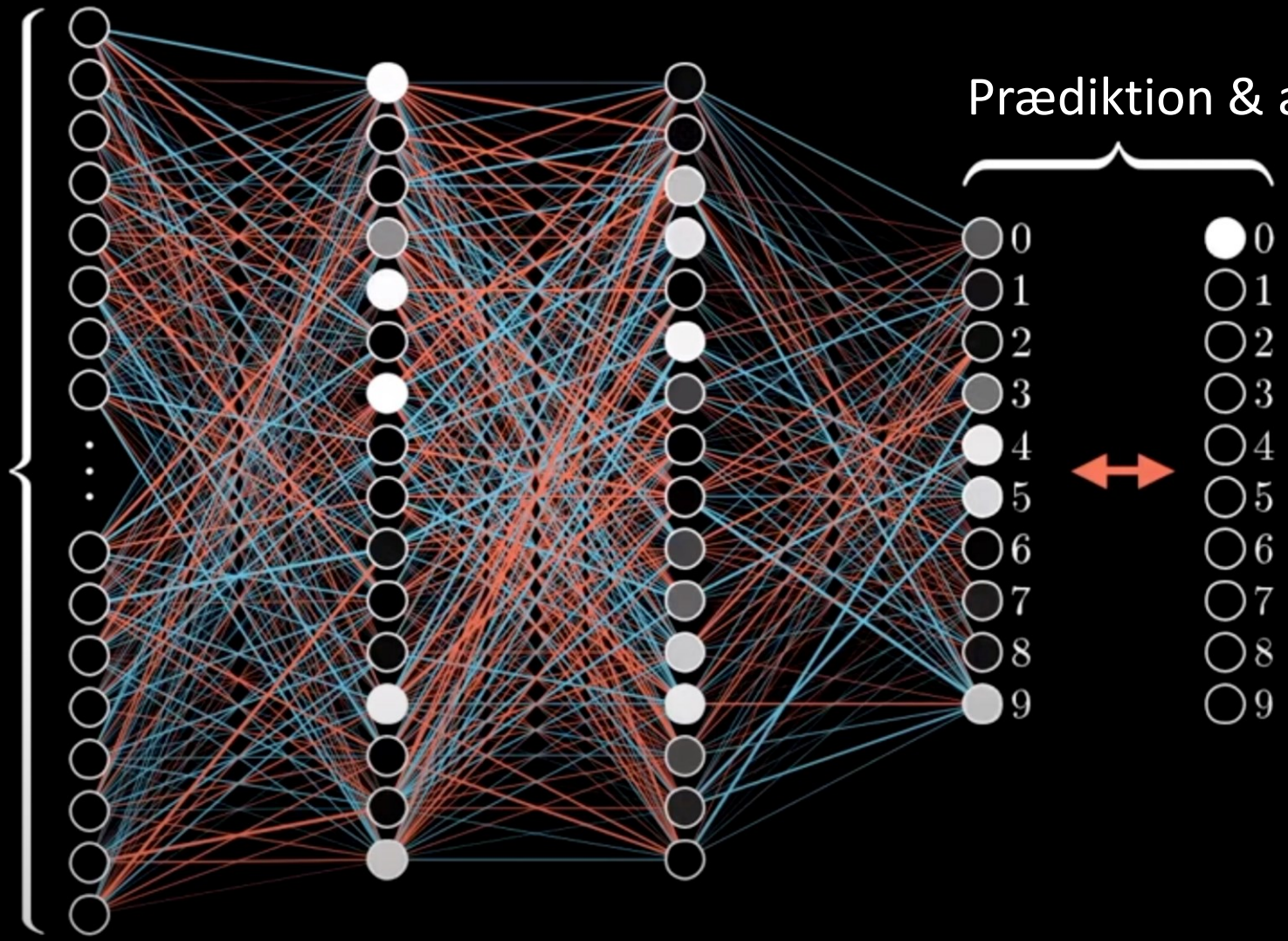


28 x 28 pixels

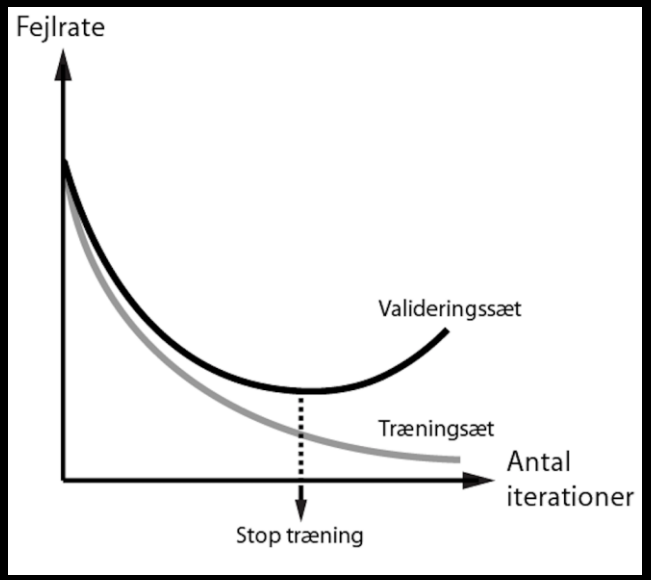


Fra 3Blue1Brown

Deep learning



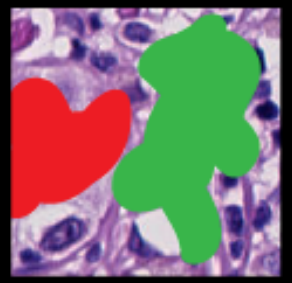
Prædiktion & aktuel klasse sammenlignes



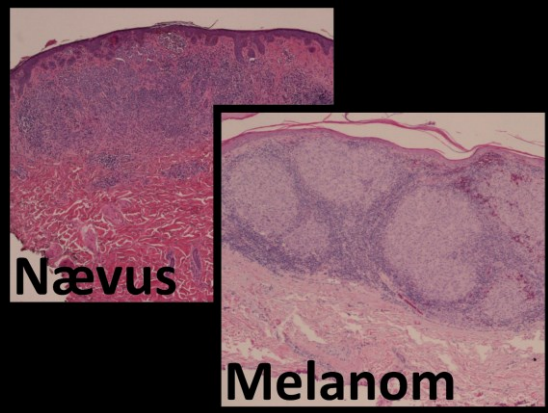
Fra 3Blue1Brown

Deep learning

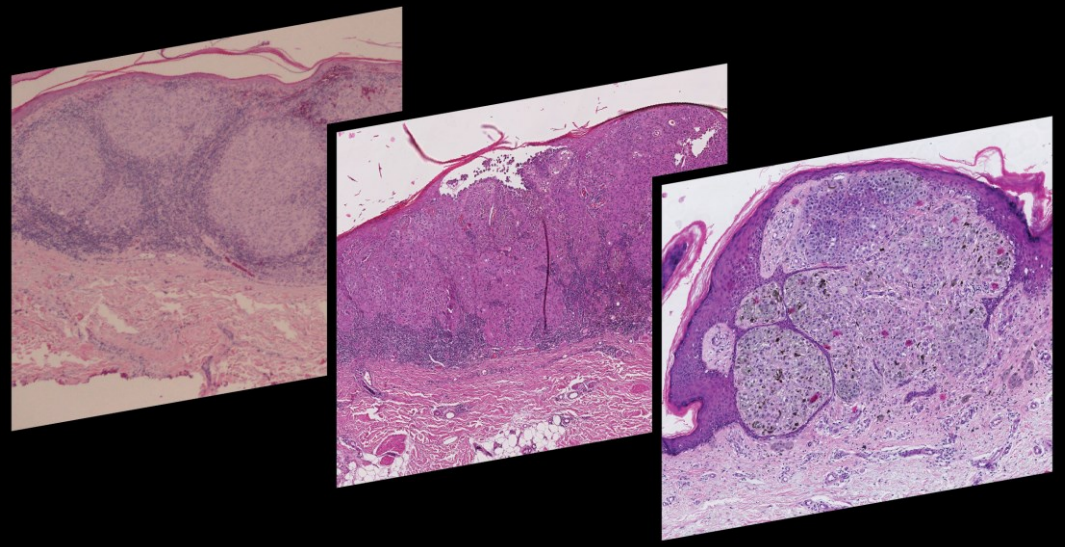
- Superviseret
  - Annotationer



  - Klasser

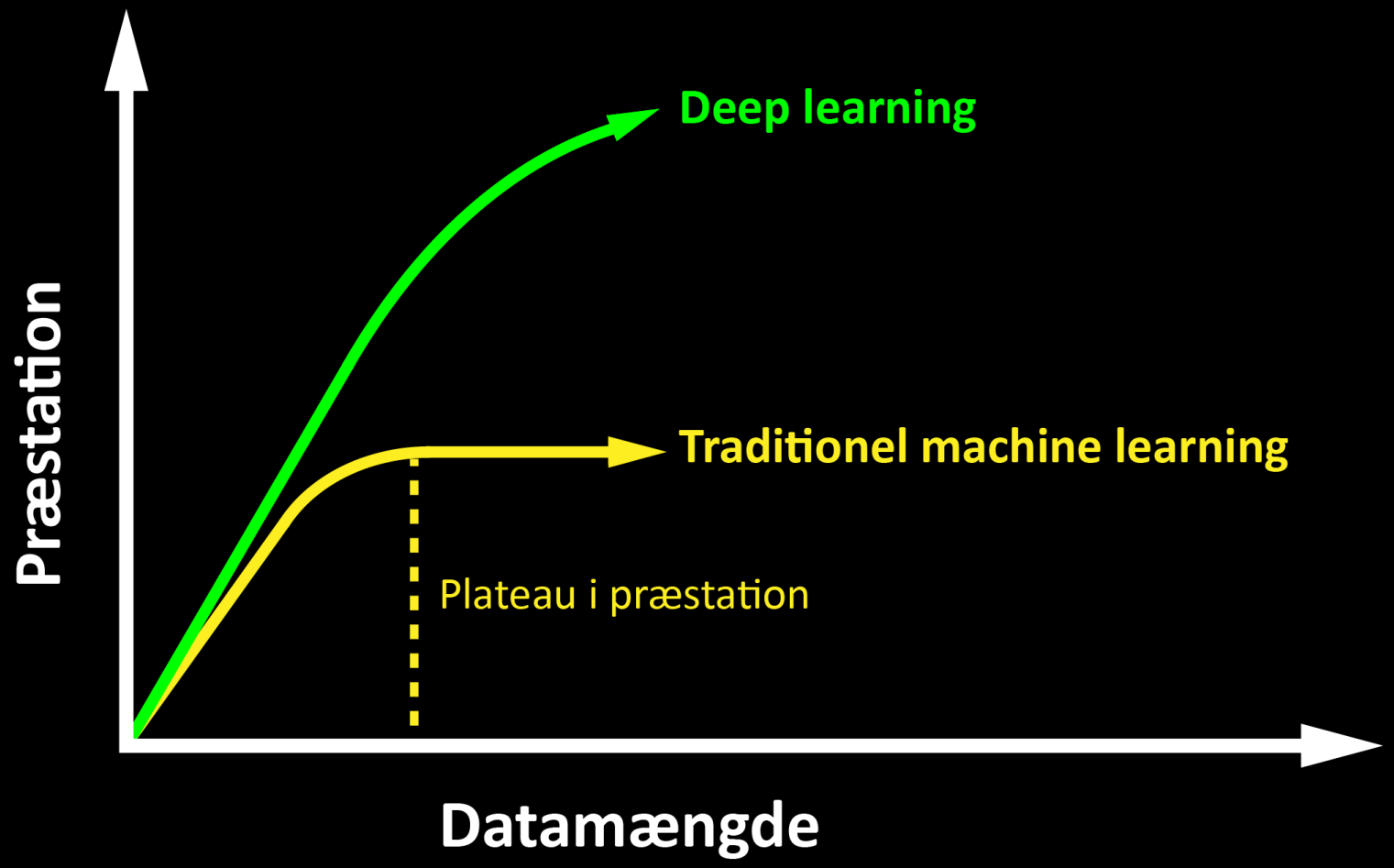


- Usuperviseret



→ Ukendte mønstre eller egenskaber

Fordele ved deep learning



Fordele ved deep learning

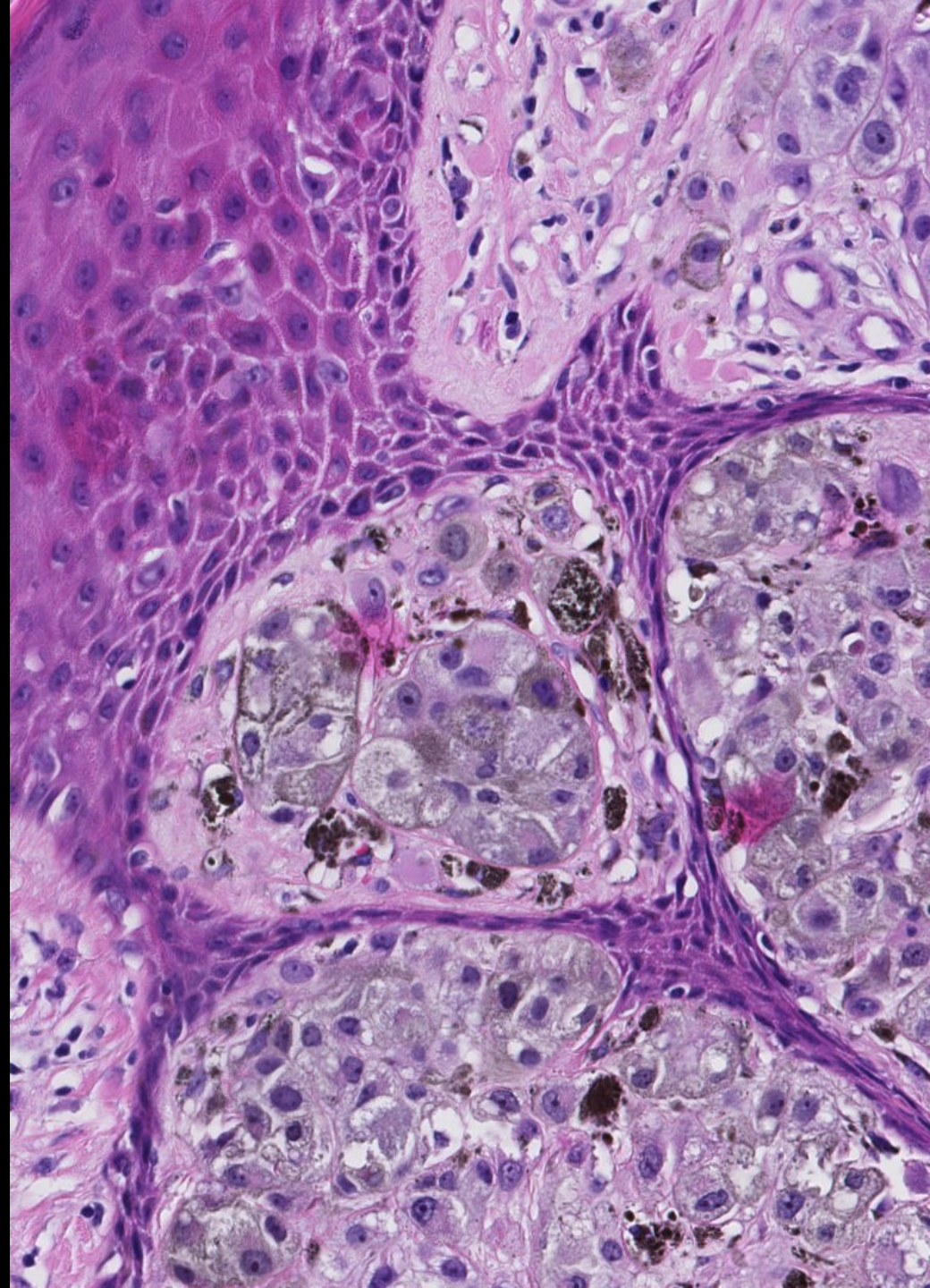
- Kan håndtere billeder af høj kompleksitet

fx **H&E**

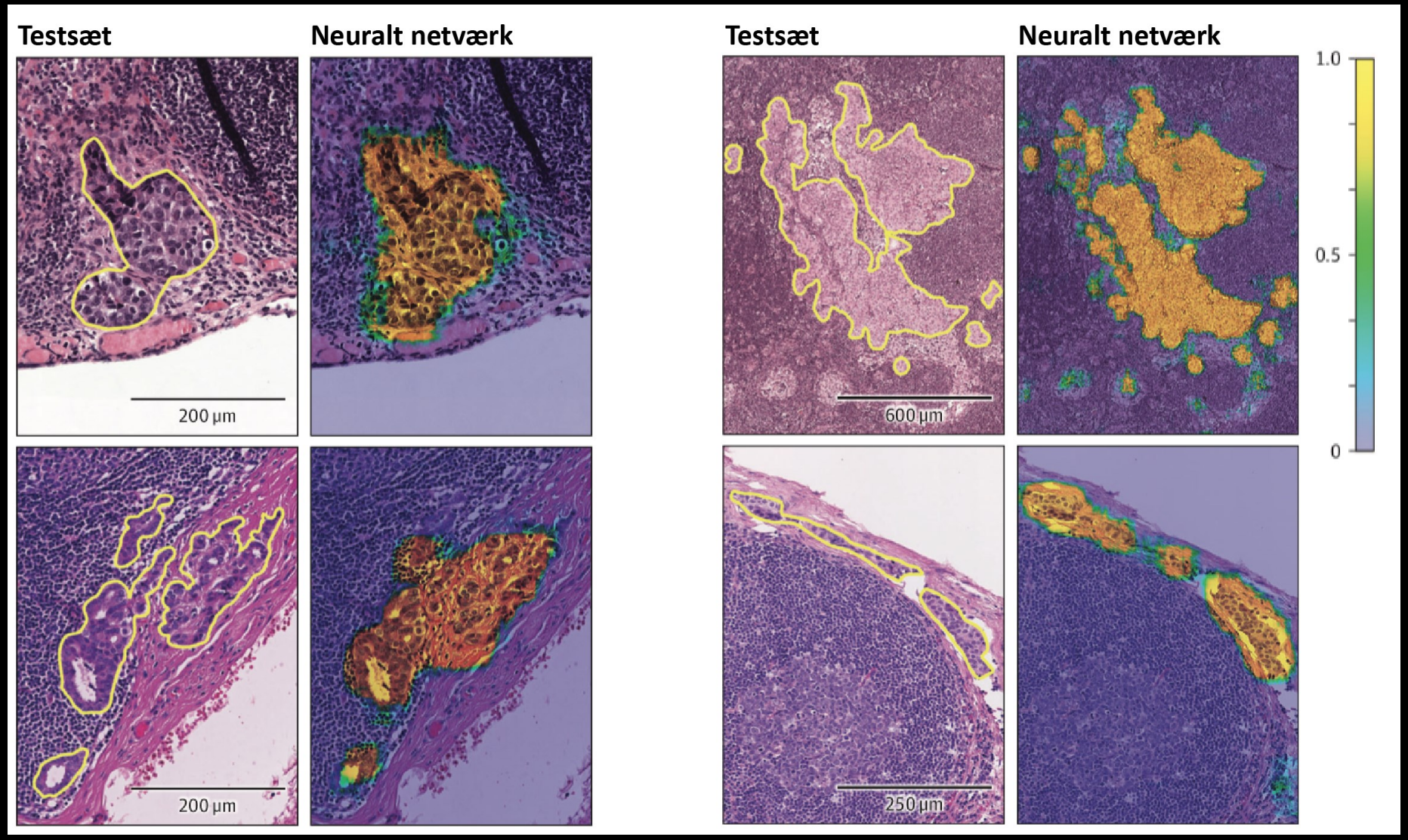
-primær farvning til rutinediagnostik

-nem, hurtig og billig at udføre

-tilgængelig på alle patologiafdelinger



Anvendelse: Lymfeknude metastaser

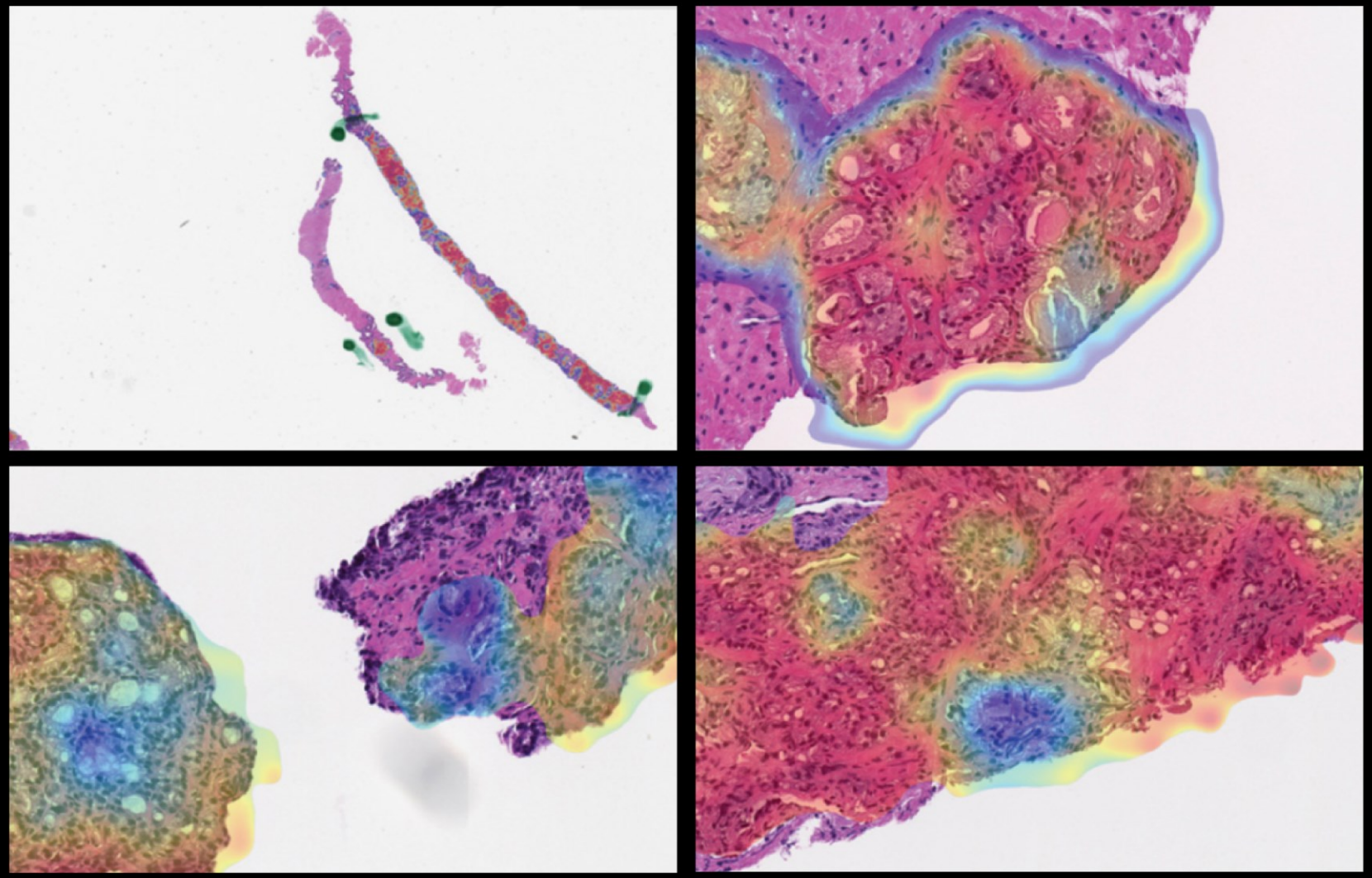


NN bedre eller lig patologer

Testsæt, N=129

Bejnordi BE et al. JAMA 2017.

Anvendelse: Prostacancer inkl. Gleason gradering



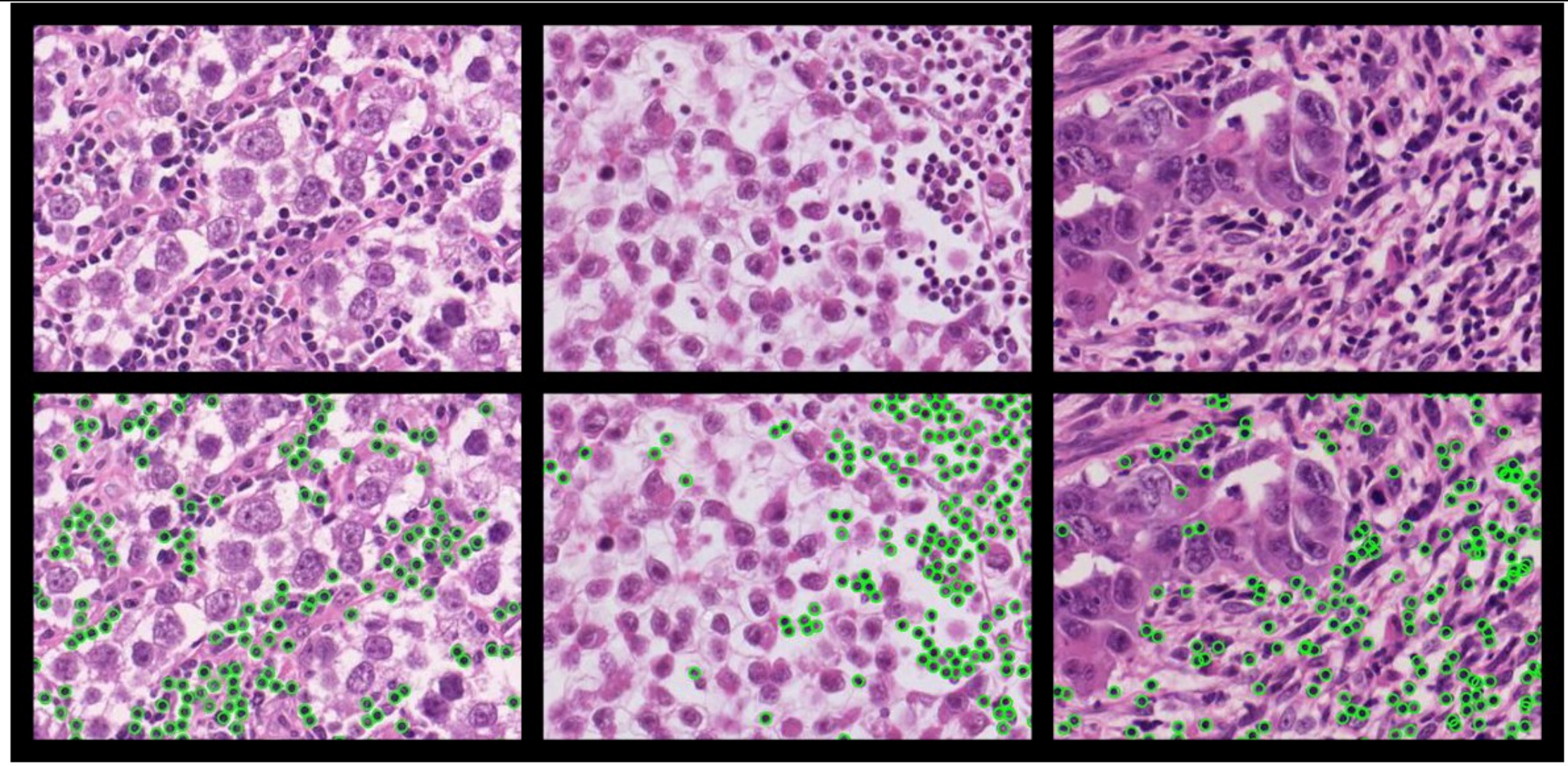
11.500 rutine H&E

9% revurderet

1 falsk negativ

Pantanowitz L et al. Lancet Digit Health 2021.

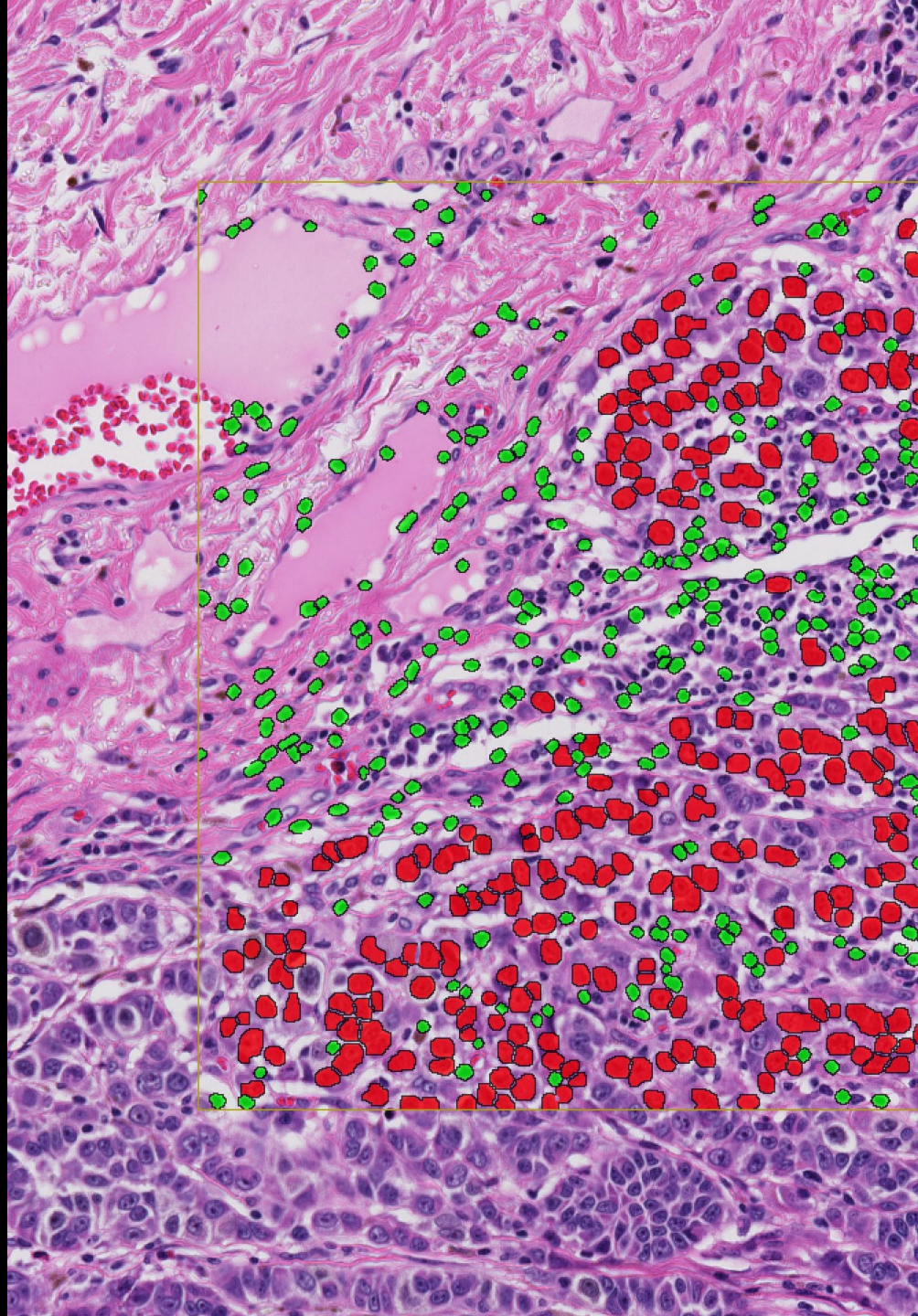
Anvendelse: Tumor infiltrerende lymfocytter



Linder N et al. J Clin Pathol 2017.

Ulemper ved deep learning

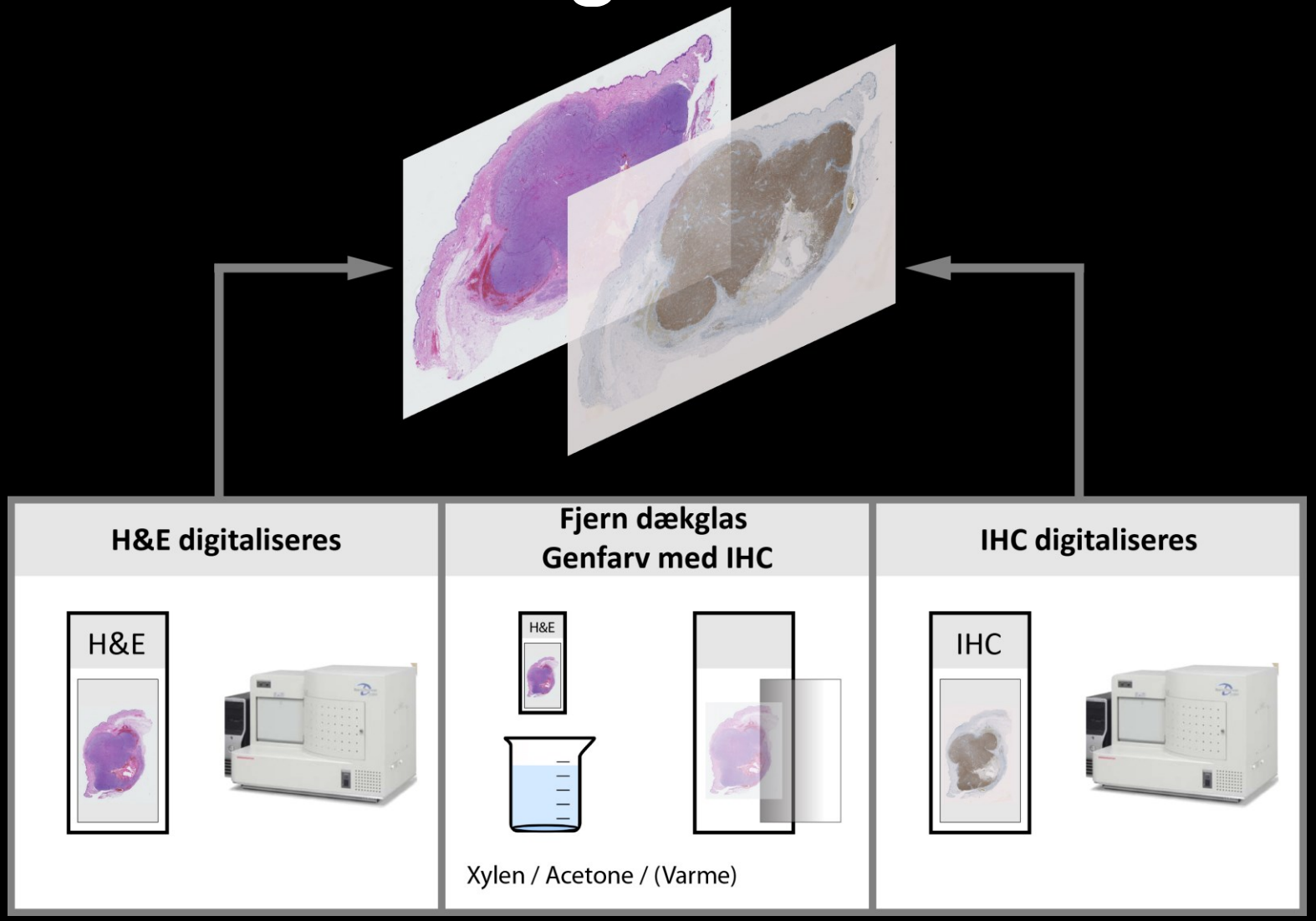
- Kræver store annoterede træningssæt
  - Arbejdskrævende
  - Erfarne patologer bør kvalitetssikre data



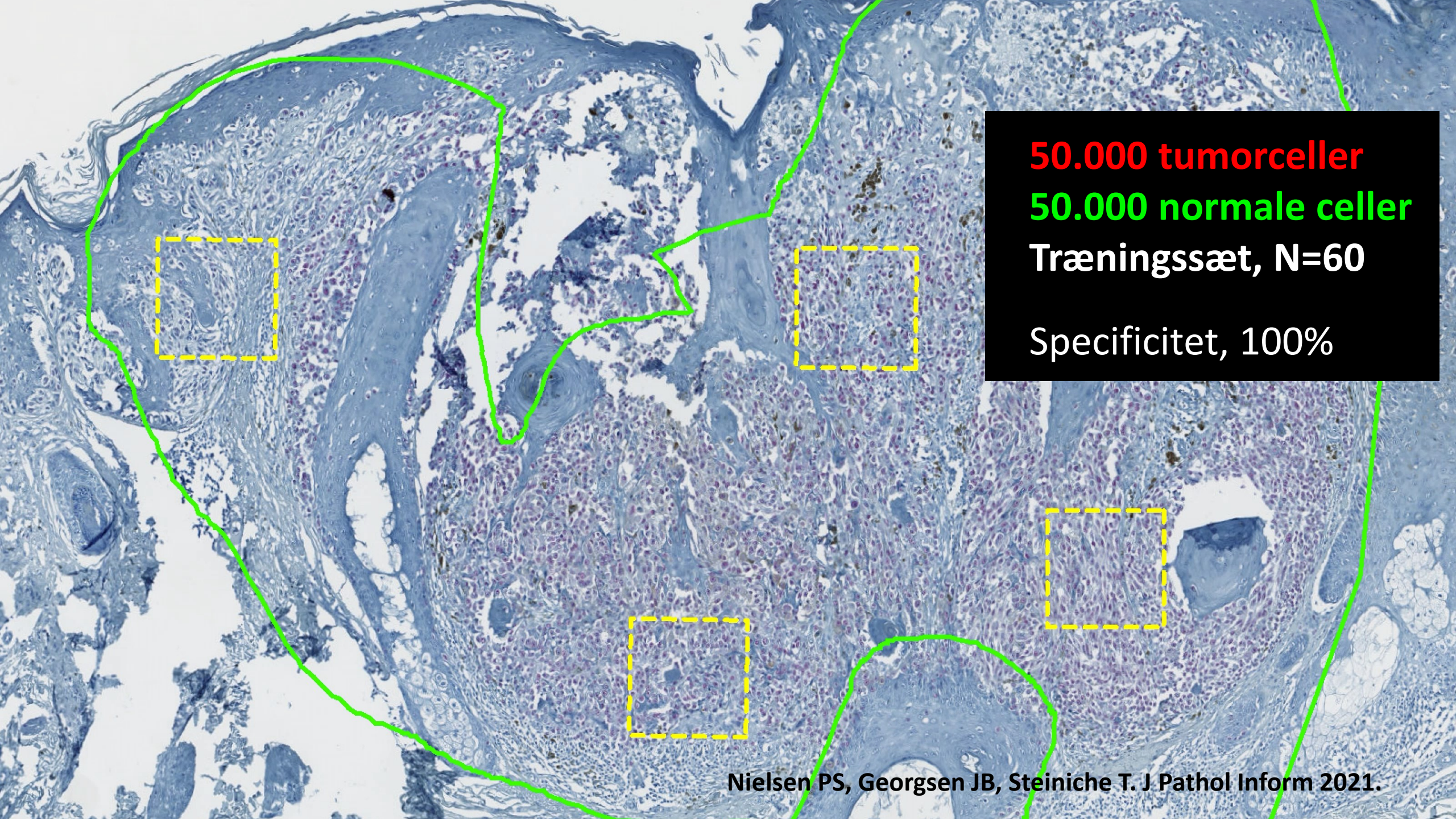
H&E:

tumorceller, normale celler

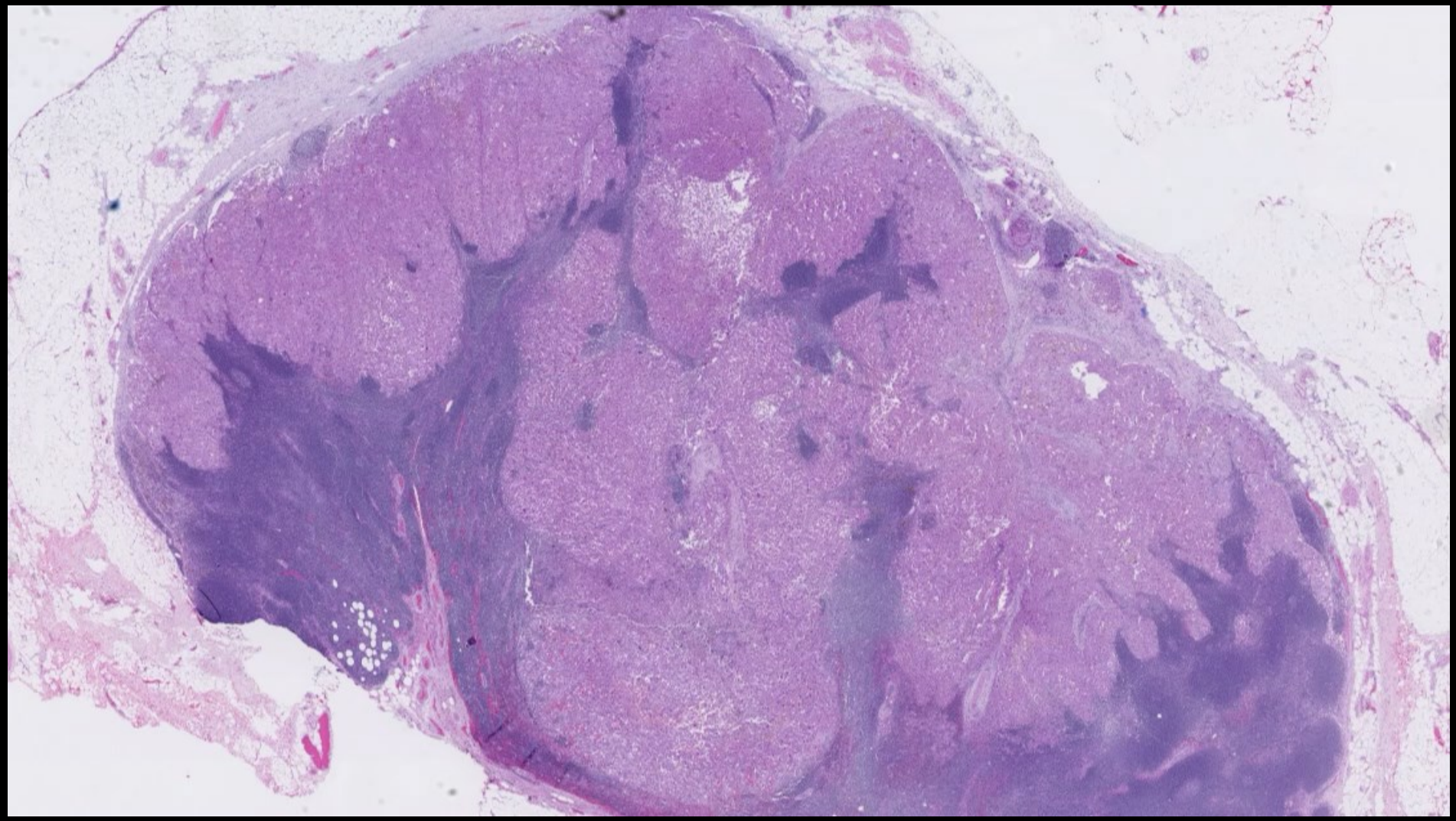
Virtuelle multifarvninger



Nielsen PS, Georgsen JB, Steiniche T. J Pathol Inform 2021.


50.000 tumorceller
50.000 normale celler
Træningssæt, N=60
Specificitet, 100%
Nielsen PS, Georgsen JB, Steiniche T. J Pathol Inform 2021.

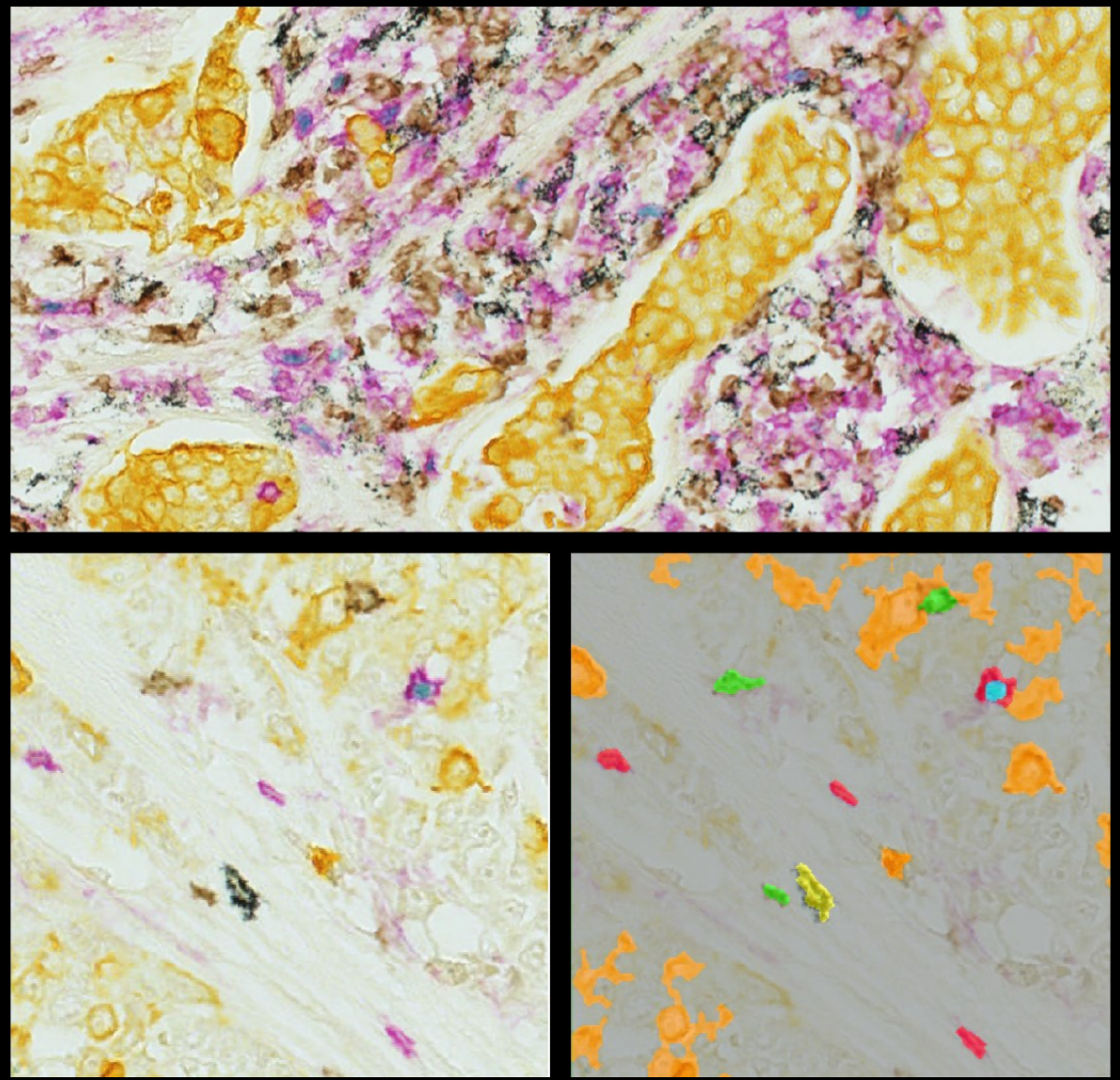
Anvendelse: Detektion af tumorceller vs. normale celler



Testsæt, N=15;
5 primære melanomer
10 melanom-metastaser
(resektater)

Sensitivitet: 70%, 70%
Specificitet: 80%, 75%

Georgsen JB, Nielsen PS, Steiniche T (work in progress).



5-pleks immunhistokemi i coloncancer

CD8

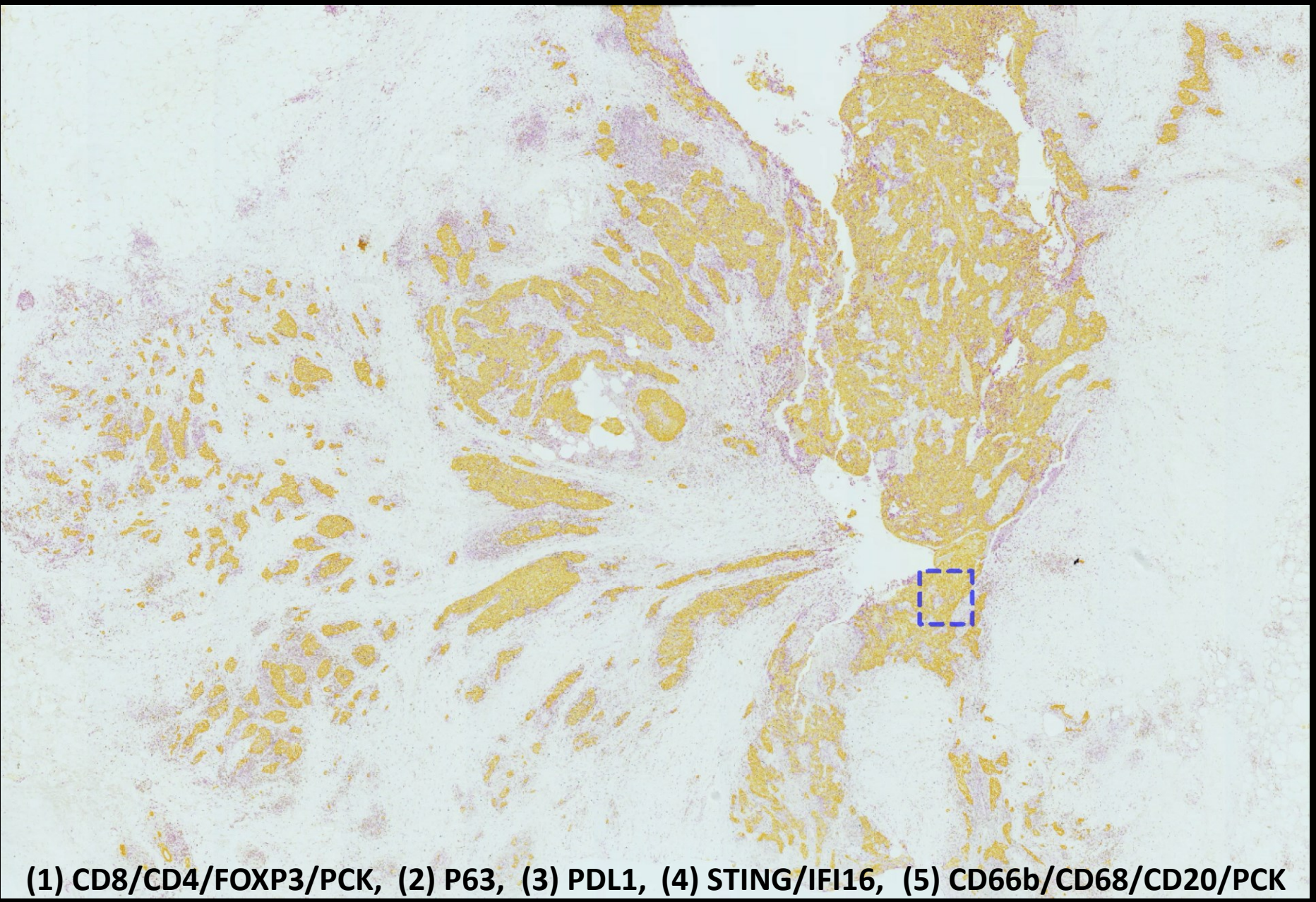
CD4

FOXP3

CD20

PCK (tumor)

Køstner AH, Nielsen PS, Georgsen JB et al. Front Immunol 2021.



(1) CD8/CD4/FOXP3/PCK, (2) P63, (3) PDL1, (4) STING/IFI16, (5) CD66b/CD68/CD20/PCK

Multipleks-IHC i brystkræft

CD8

CD8/PCK

CD4

CD4/PCK

FOXP3/CD4

FOXP3/CD4/PCK

FOXP3/PCK

PCK (tumor)

Tramm T, Nielsen PS et al. (work in progress).

Perspektiv

Rutine diagnostik:

- Automatisk måling af immunhistokemi (fx PDL1, Ki67, immunpaneler)
- Automatiske målinger på H&E, fx mitoser
- Cancer *alert heatmaps*

Forskning:

- Udvikling af net fortsætter
- Identificering af ukendte mønster
- *Reverse-engineering*

En særlig tak til

- Anne Helene Køstner, cand.med., Onkologisk Afd., Sørlandet Hospital, Norge
- Jeanette Bæhr Georgsen, cand.scient., Patologi, Aarhus Universitetshospital
- Torben Steiniche, dr.med., Patologi, Aarhus Universitetshospital
- Trine Tramm, cand.med., ph.d., Patologi, Aarhus Universitetshospital

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Tak for jeres opmærksomhed