Check The Oven

Core Imaging Lecture – Obstetric Sonography

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AD · MAJOREM · DEI · GLORIAM 1870

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DISCLOSURES

No financial disclosures to report.

Session Overview

- Review of Gestational Development
- Approach to Obstetric Sonography
- AI-Powered Medical Computer Vision
- Future of Smart Sonography

CORE IMAGING: OBSTETRIC SONOGRAPHY

Gestational Development

NEW PATIENT ROOMED

22yo F presents with n/v, missed menstrual period.

Home pregnancy test was positive.

GESTATIONAL DEVELOPMENT

Signs & Symptoms

Amenorrhea

Nausea (+/- vomiting)

Frequency of urination (w/o dysuria)

Breast enlargement & tenderness

Fatigue

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

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Symptoms develop abruptly and occur daily.

Prospective Study (n=221)

60% had s/s by 5-6 weeks past LMP

90% symptomatic by 8 weeks

Source: Sayle AE, et al. *A prospective study of the onset of symptoms of pregnancy.* J Clin Epidemiol. 2002;55(7):676.

GESTATIONAL DEVELOPMENT

First Trimester Exam & Evaluation

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Abdominal Exam / Uterus

12 wk = fundus palpable above symphysis

16 wk = fundus halfway between symphysis & umbilicus

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

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Fetal Cardiac Activity

Usually detectable @ 10-12wk gestation with handheld Doppler / TAUS

Fetal heart size <7mm @ 10-12wk

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

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Beta hCG

Doubles q29-53h during first 30 days after implantation of a viable IUP

Peak @ 8-10wk (60k-90k), wide normal range

[!] slower rise = consider ectopic, early embryonic demise

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

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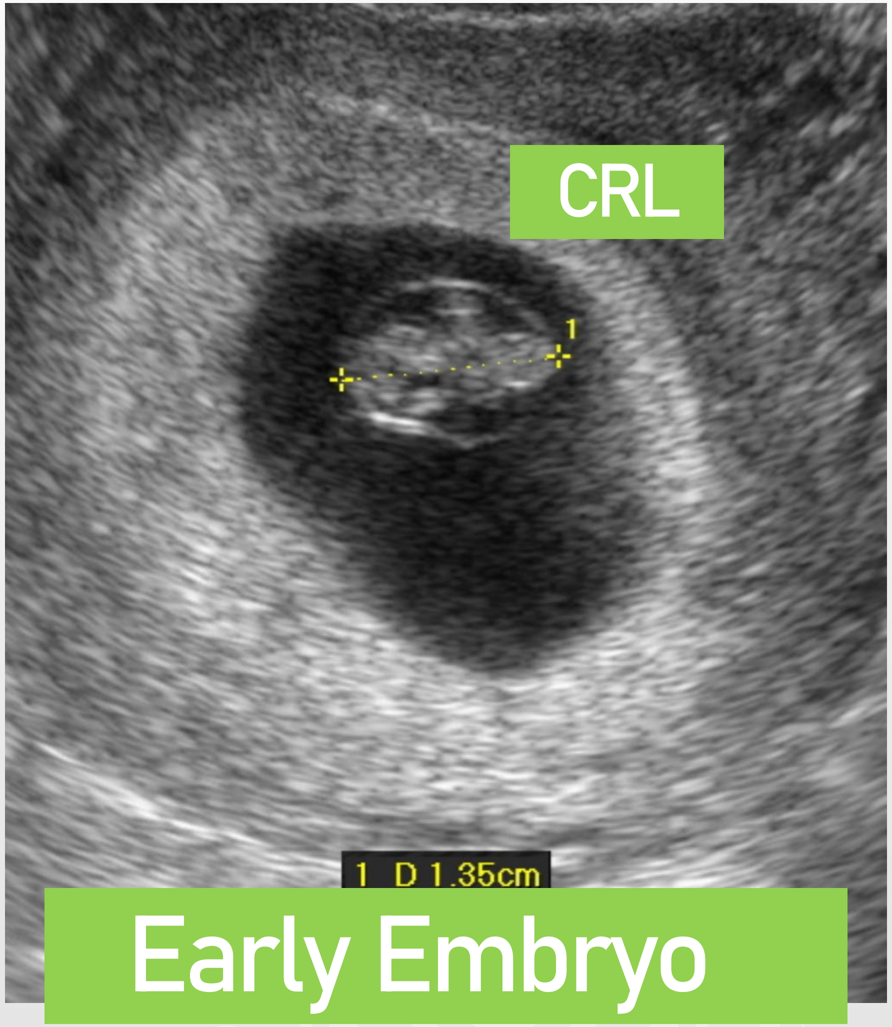
Ultrasound (TVUS)

4-5 wk = gestational sac, intrauterine fluid
5-6 wk = yolk sac, fetal pole
+cardiac activity

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

TVUS EVALUATION @ 5-6 WK



Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

GESTATIONAL DEVELOPMENT

Diagnosis of Pregnancy

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Formal diagnosis is based on any of the following:

Detection of hCG in blood or urine

Identification of pregnancy by TVUS/TAUS

+Fetal cardiac activity by Doppler/US

Source: Bastian LA & Brown HL. *Clinical manifestations and diagnosis of early pregnancy.* UpToDate.

CORE IMAGING: OBSTETRIC SONOGRAPHY

Approach to Obstetric Sonography

Indications for 1TUS

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Confirm presence of an intrauterine pregnancy
Evaluate suspected ectopic pregnancy
Evaluate vaginal bleeding/pelvic pain
Estimate gestational age
Diagnose/evaluate multiple gestations
Confirm cardiac activity
Assess fetal anomalies / uterine abnormalities
Evaluate suspected hydatidiform mole

Source: *ACOG Practice Bulletin No. 175: Ultrasound in Pregnancy.* Obstet Gynecol. 2016;128(6):e241.

US is safe for the fetus when used appropriately

Should be used when medical assessment needed

[ALARA]

[!] ultrasound energy delivered to fetus cannot be assumed to be completely innocuous; theoretical concerns about thermal effects, cavitation, vibration

Source: *ACOG Practice Bulletin No. 175: Ultrasound in Pregnancy.* Obstet Gynecol. 2016;128(6):e241.

APPROACH TO OBSTETRIC SONOGRAPHY

ED Scope of OB US

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SCOPE OF STANDARD OB US EXAM IN THE ED

4-8 WEEKS GA

size, location, number of gestational sacs
yolk sac @ ~5.5 wk
embryo @ ~6 wk +/- cardiac activity

BEYOND 8 WEEKS GA

fetal number, presentation, anatomy, movement
fetal cardiac activity (FHR calculation)
fetal biometry (EGA/EFW calculation)

Source: Shipp TD. *Overview of ultrasound examination in obstetrics and gynecology.* UpToDate.

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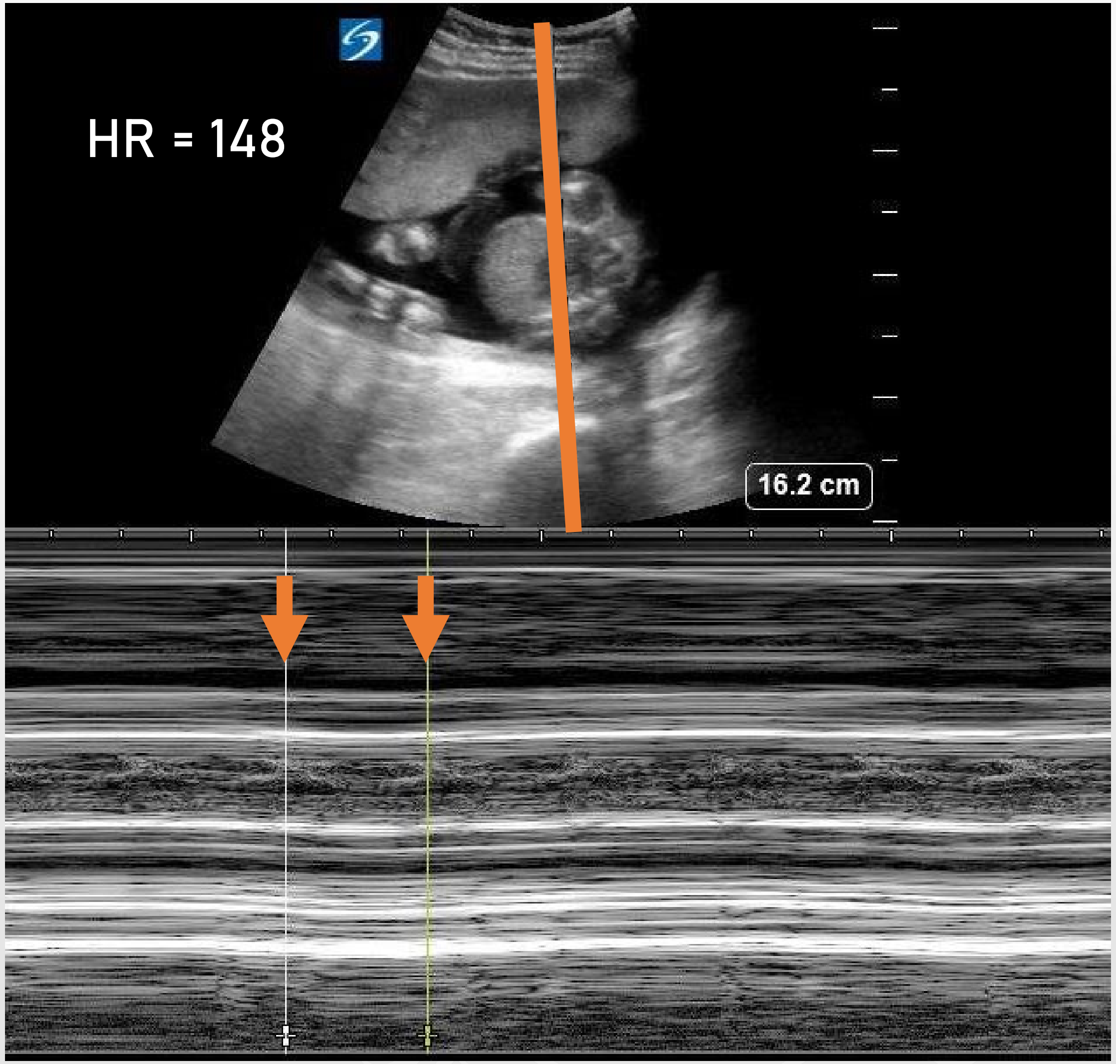
FHR CALCULATION

find fetal heart motion
drop M-mode gate
FHR mode: peak to peak

[!] don't use Doppler (ALARA)



Source: *M-Mode (Yes) vs Doppler (No) / ALARA / Fetal Heart Rate.* Everyday Ultrasound Blog.

EGA CALCULATION (CRL)

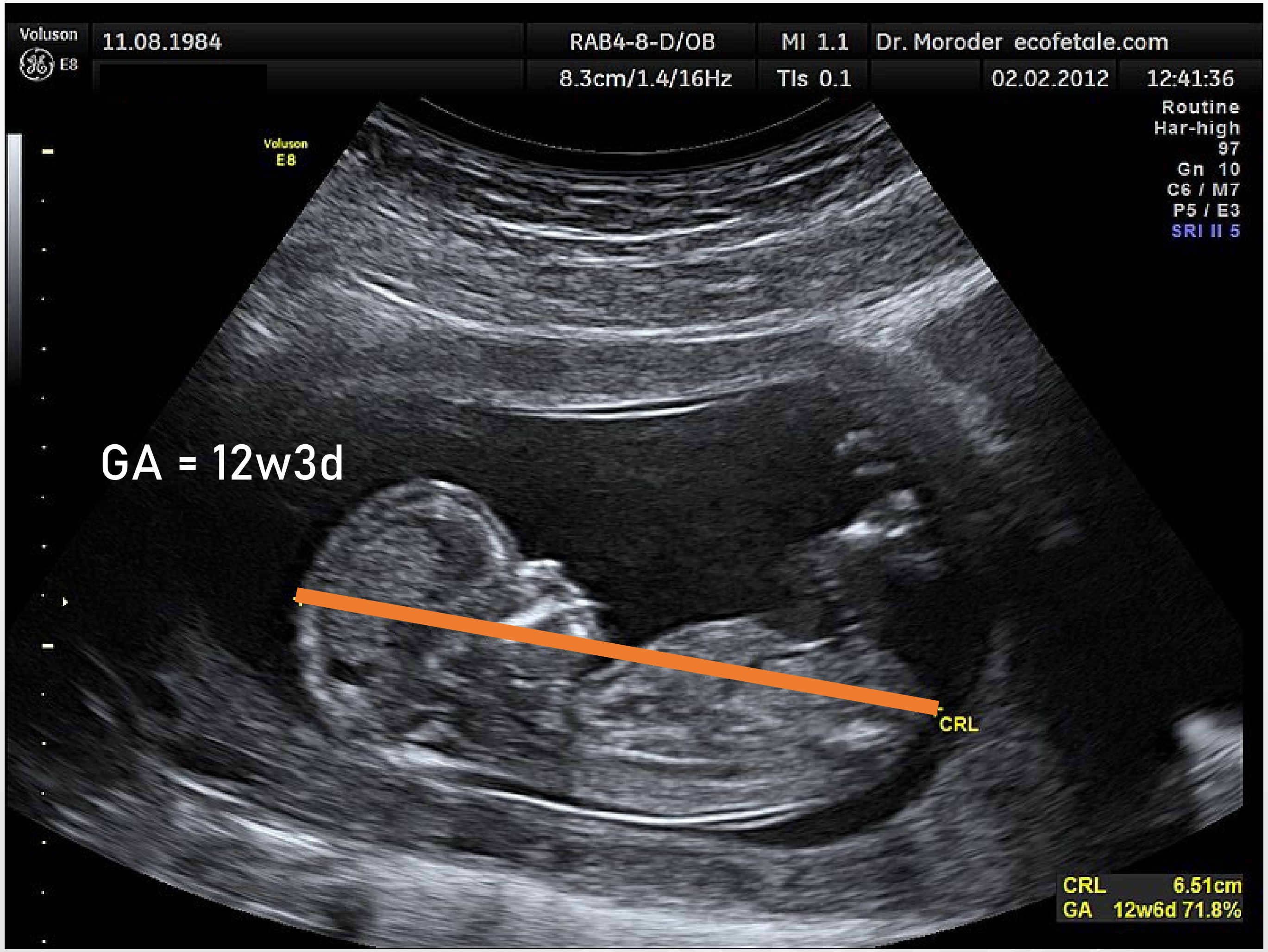
find sagittal view

caliper/distance tool

CRL/GA mode

CRL most accurate in 1T (up to 14wk)

if CRL >84mm, use BPD



Reference: MacKenzie AP et al. *Prenatal assessment of gestational age, date of delivery, and fetal weight.* UpToDate.
Image: Moroder W. *Ultrasound image of the foetus at 12 weeks of pregnancy in a sagittal scan.* Wikimedia Commons.

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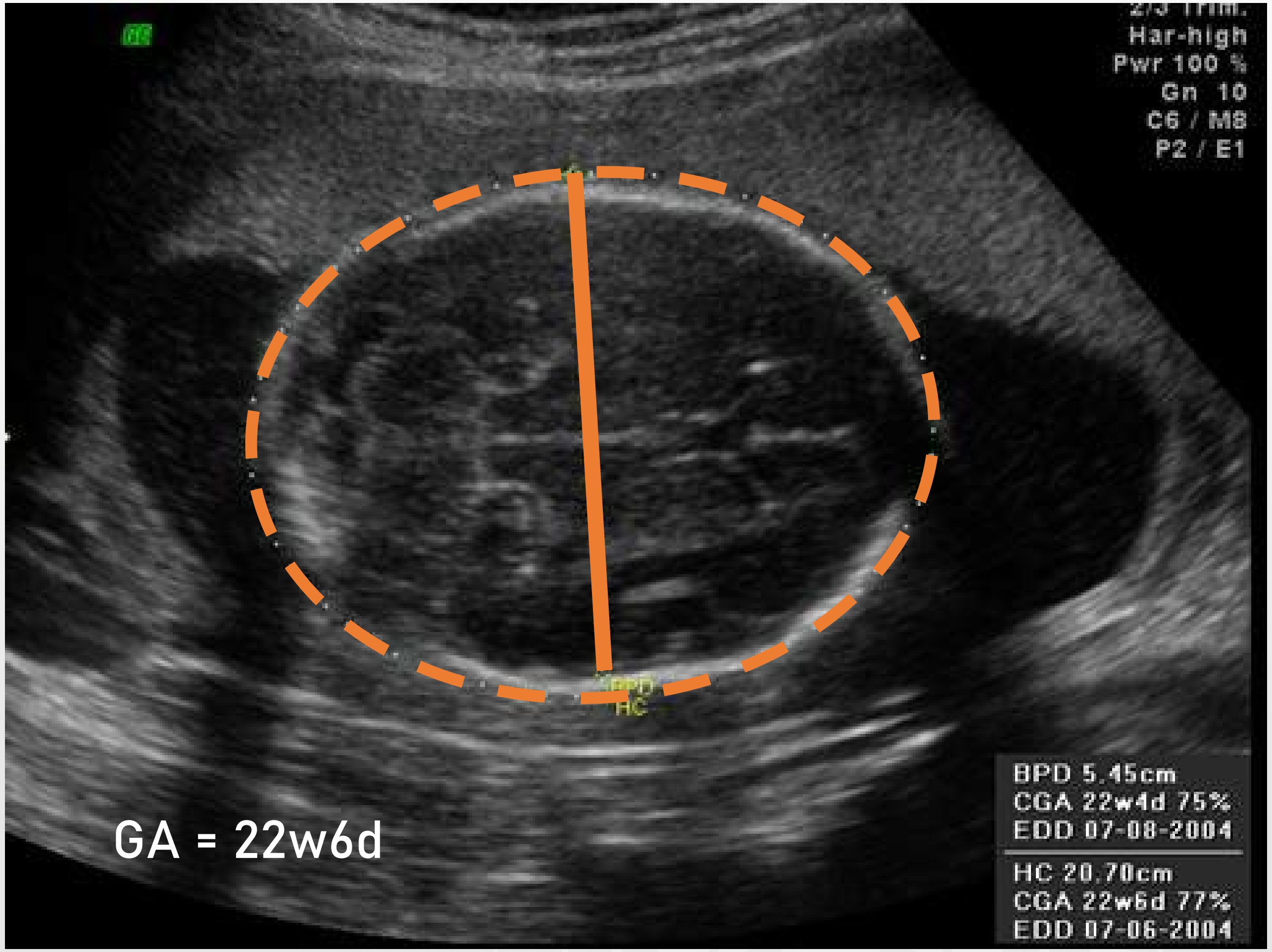
EGA CALCULATION (BPD/HC)

find axial view

caliper/distance tool
(outer edge to inner)

BPD/HC mode



Reference: MacKenzie AP et al. *Prenatal assessment of gestational age, date of delivery, and fetal weight.* UpToDate.
Image: *Fetal Head Measurements.* FetalUltrasound.com.

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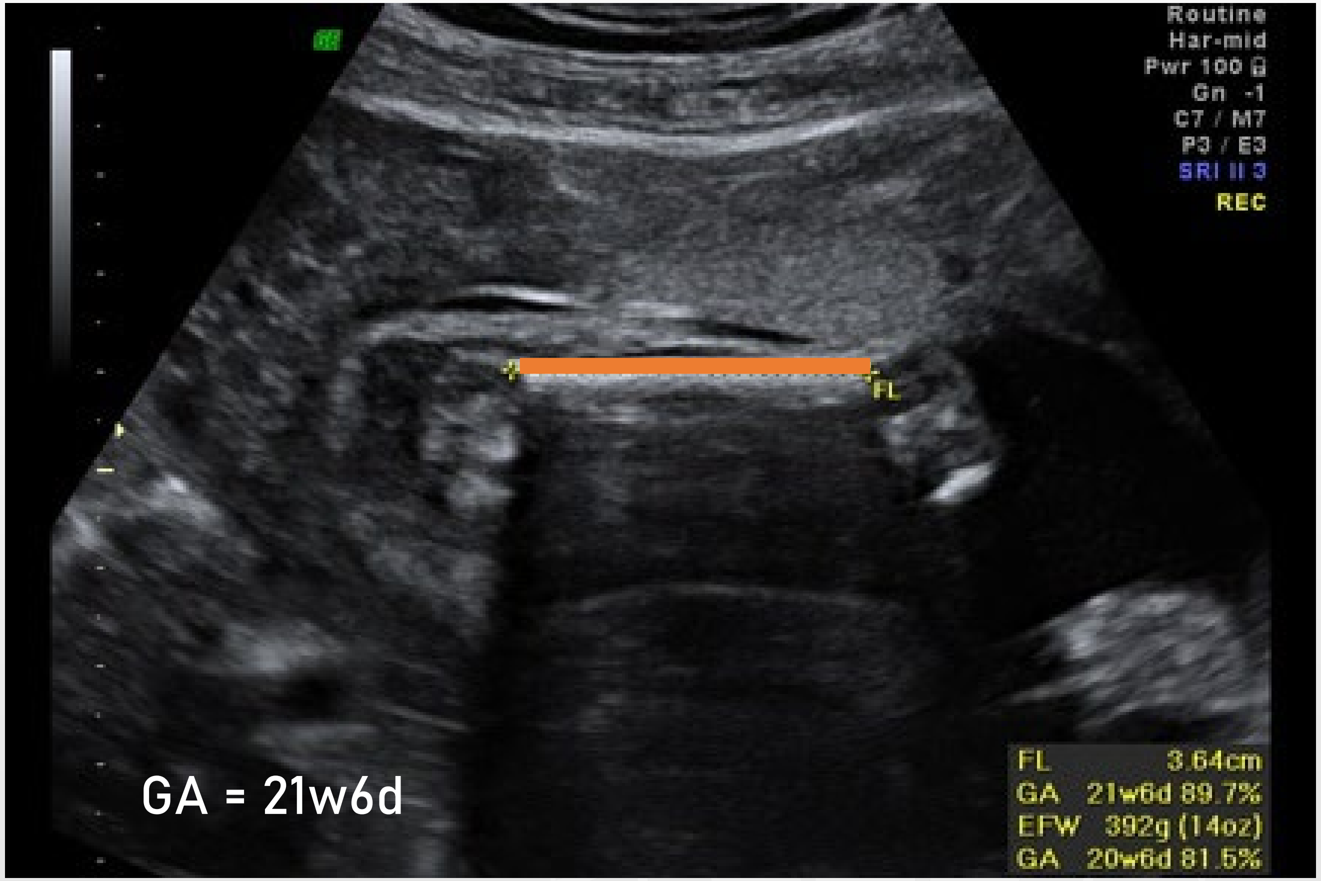
EGA CALCULATION (FL)

locate femur
longitudinal view
caliper/distance tool
FL mode

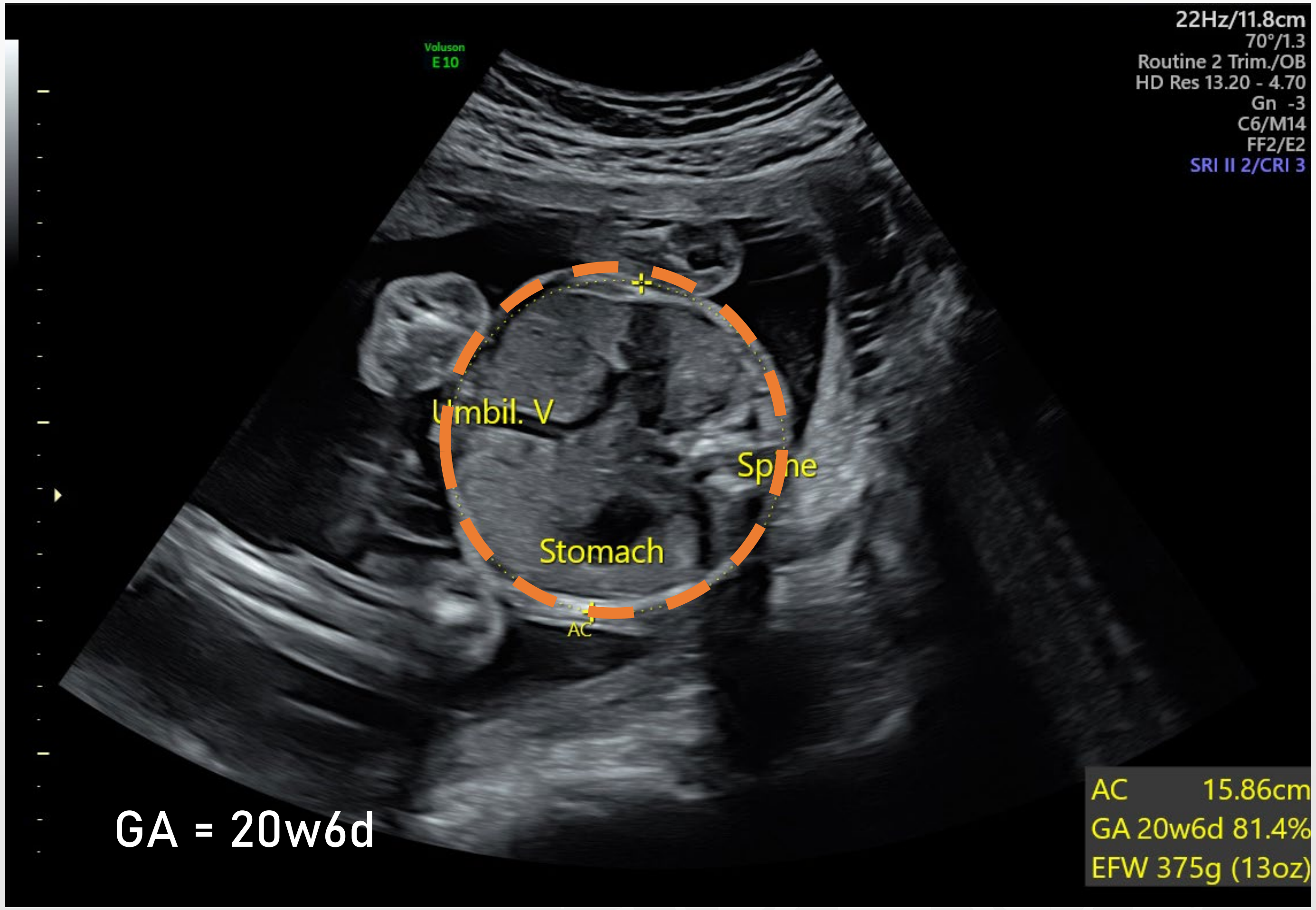


Reference: MacKenzie AP et al. *Prenatal assessment of gestational age, date of delivery, and fetal weight.* UpToDate.
Image: Jones J. *Femur length (obstetric ultrasound).* Radiopaedia, rID 26433.

EGA CALCULATION (AC)

abdomen, axial view
AC mode

least accurate
if used alone



Reference: MacKenzie AP et al. *Prenatal assessment of gestational age, date of delivery, and fetal weight.* UpToDate.
Image: Leung TN. *Fetal biometry in ethnic Chinese.* Ultrasound Obstet Gynecol. 2008;31:321-7.

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COMBINED CALCULATIONS

System dependent, can use any/all measurement parameters

EGA :

MSD, CRL, BPD, OFD, HC, AC, TAD, APAD, FL, HL,
Ulna (UL), Tibia (TL), Foot (FT), FTA, BinocD (BN)

EFW :

HC/AC, TCD/AC, LVW/HW, BPDa, FL/AC, FL/BPD, CI, AFI, A XT

Source: Siemens ACUSON Juniper Ultrasound System Datasheet, 2018.

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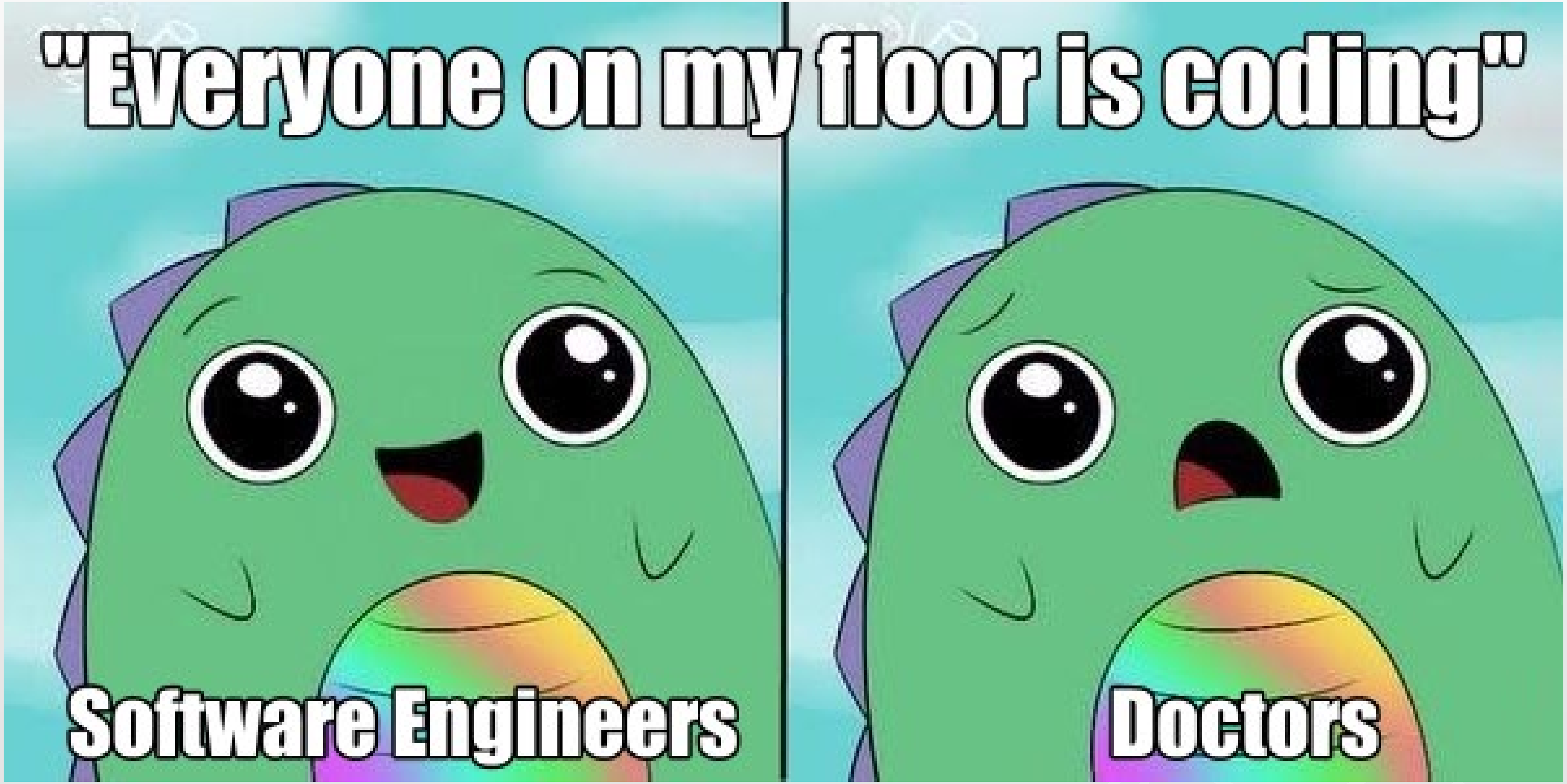
AI-Powered Medical Computer Vision

SOFTWARE ENGINEERS VS PHYSICIANS



npj Digital Medicine

www.nature.com/npjdigitalmed

REVIEW ARTICLE OPEN

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Deep learning-enabled medical computer vision

Andre Esteva[1] ✉, Katherine Chou[2,5], Serena Yeung[3,5], Nikhil Naik[1,5], Ali Madani[1,5], Ali Mottaghi[3,5], Yun Liu[2], Eric Topol[4], Jeff Dean[2] and Richard Socher[1]

A decade of unprecedented progress in artificial intelligence (AI) has demonstrated the potential for many fields—including medicine—to benefit from the insights that AI techniques can extract from data. Here we survey recent progress in the development of modern computer vision techniques—powered by deep learning—for medical applications, focusing on medical imaging, medical video, and clinical deployment. We start by briefly summarizing a decade of progress in convolutional neural networks, including the vision tasks they enable, in the context of healthcare. Next, we discuss several example medical imaging applications that stand to benefit—including cardiology, pathology, dermatology, ophthalmology–and propose new avenues for continued work. We then expand into general medical video, highlighting ways in which clinical workflows can integrate computer vision to enhance care. Finally, we discuss the challenges and hurdles required for real-world clinical deployment of these technologies.

npj Digital Medicine (2021)4:5 ; https://doi.org/10.1038/s41746-020-00376-2

AI-POWERED MEDICAL COMPUTER VISION

Brief Sidenote: Neural Networks

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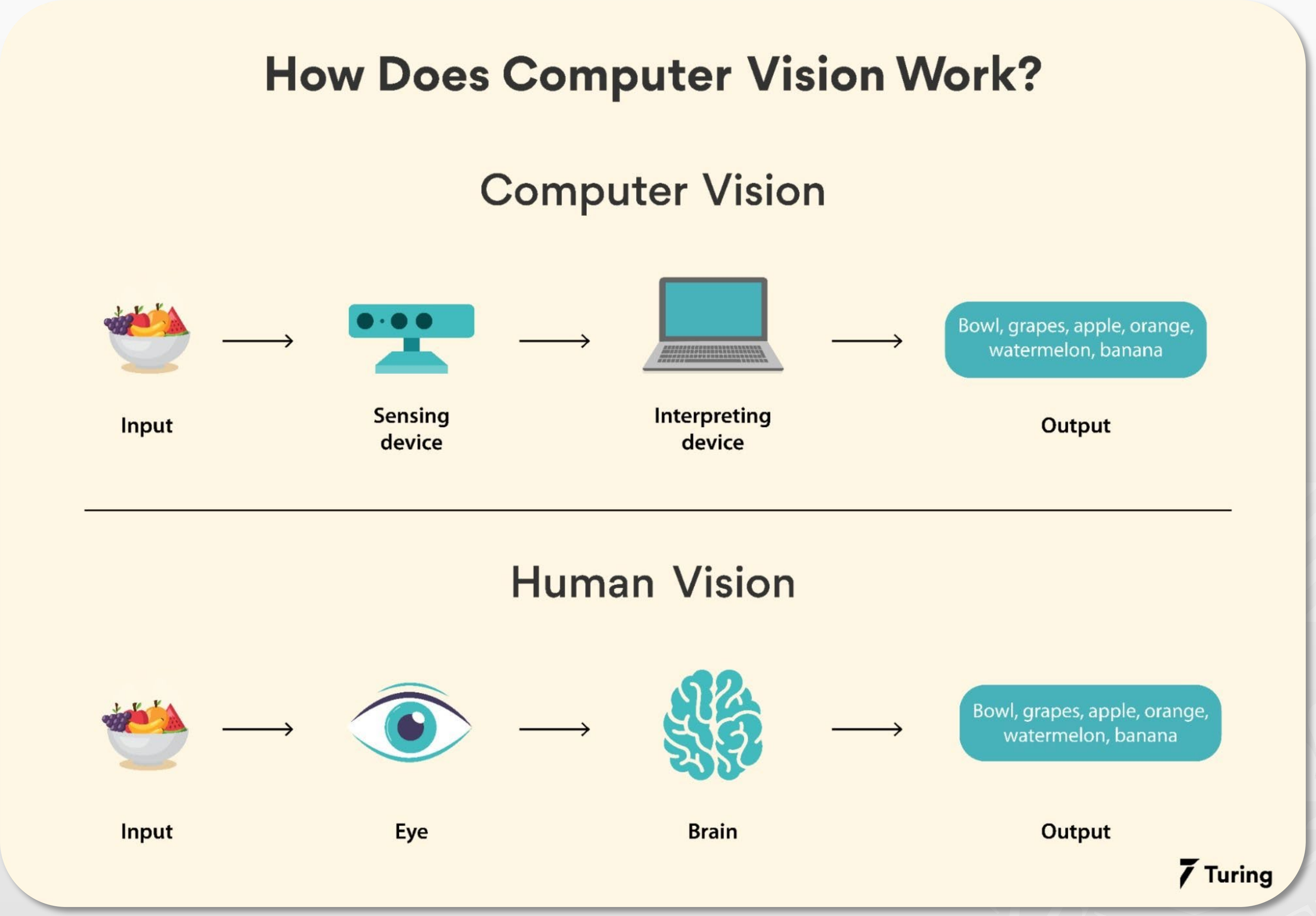
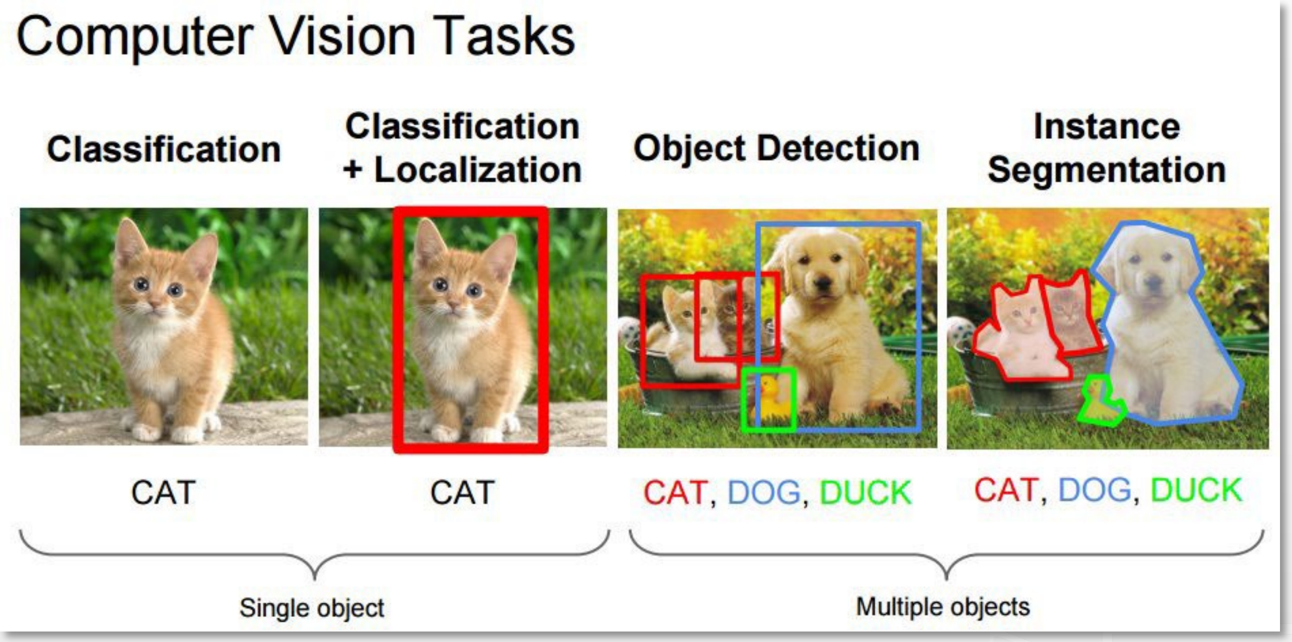
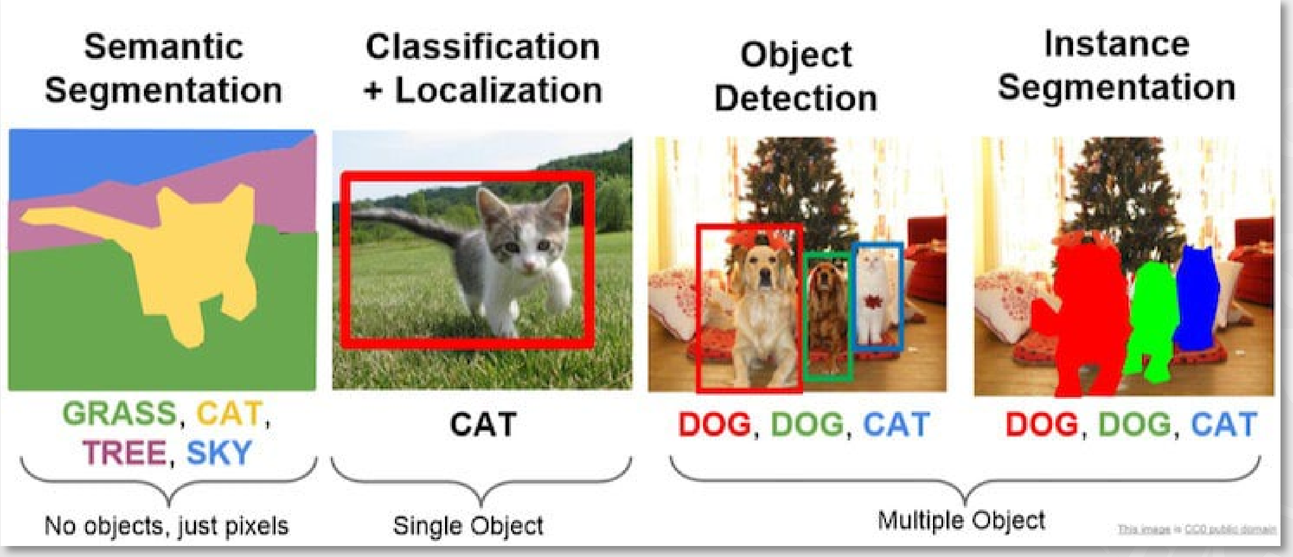
BRIEF SIDENOTE: NEURAL NETWORKS

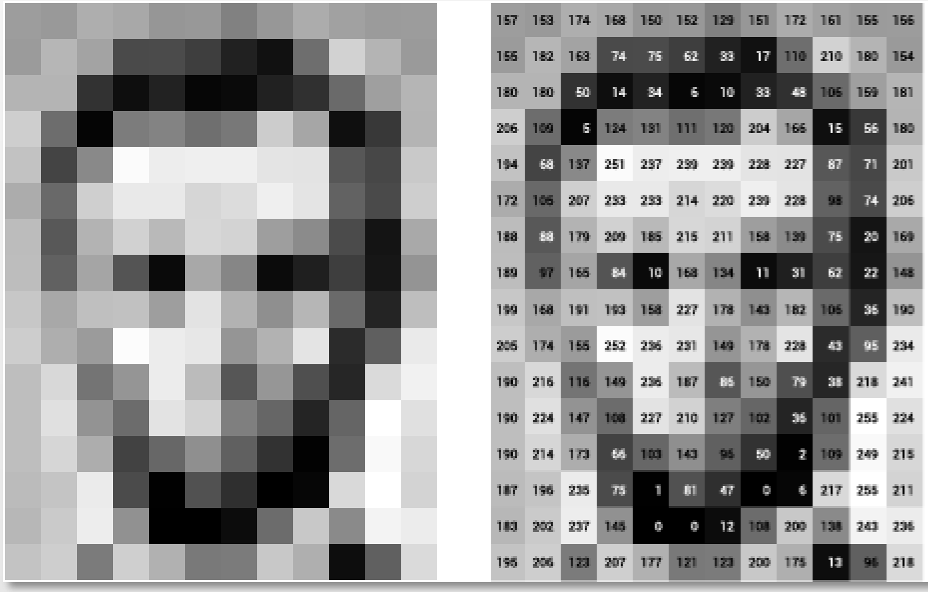


BRIEF SIDENOTE: NEURAL NETWORKS





BRIEF SIDENOTE: NEURAL NETWORKS



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

BRIEF SIDENOTE: NEURAL NETWORKS

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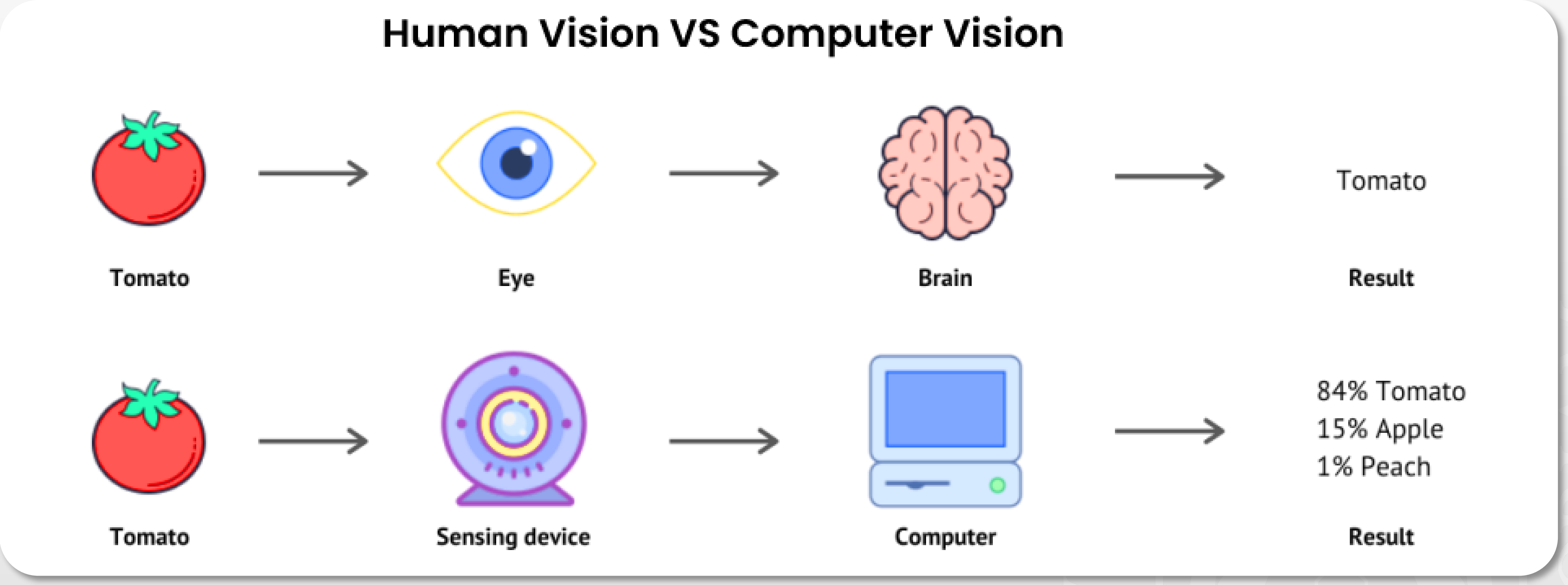

AI-POWERED MEDICAL COMPUTER VISION

Computer vs Physician

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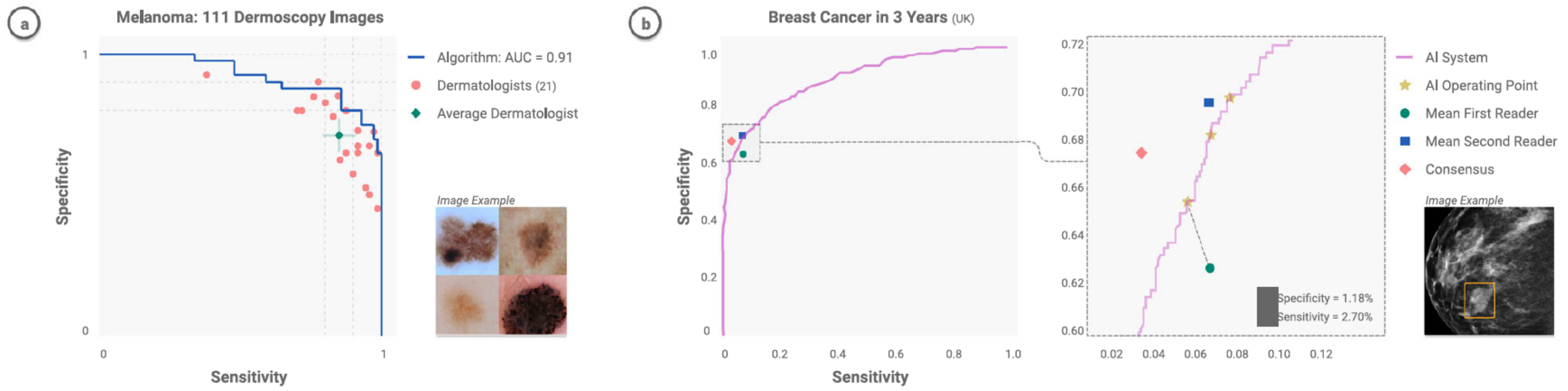

Fig. 2 Physician-level diagnostic performance. CNNs—trained to classify disease states—have been extensively tested across diseases, and benchmarked against physicians. Their performance is typically on par with experts when both are tested on the same image classification task. **a** Dermatology[7] and **b** Radiology. Examples reprinted with permission and adapted for style.

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The Future of Smart Sonography