Digital, Robotics & Enabling Technology

Jean Chaoui, EMBA, PhD

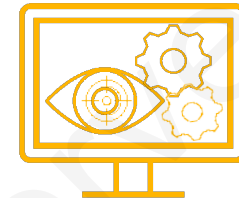# **Tech capabilities** and foundational infrastructure

Robotics

Guidance

Sensors
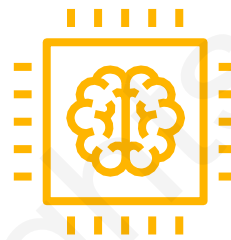
AR/VR

Computer vision

EHR integration

Cloud/ Connectivity

Product security and privacy

Agile and DevSecOps

AI/ML

Data intelligence

UI/UX

Digital IP

From Value in Product **to Value in Ecosystem**

Product
(Value creation)

Value in « Game changing tech »
Innovative products

Service
(Value co-creation)

Value in the « Use Concept »
Surgeons create part of the value

Platform
(Value connector)

Value in Community:
We provide an infrastructure that connects surgeons, patients, stakeholders,…

Ecosystem
(Value interoperability)

Value in Ecosystem:
APIs to connect portfolio solutions together and to external solutions

One Robot Multiple Applications
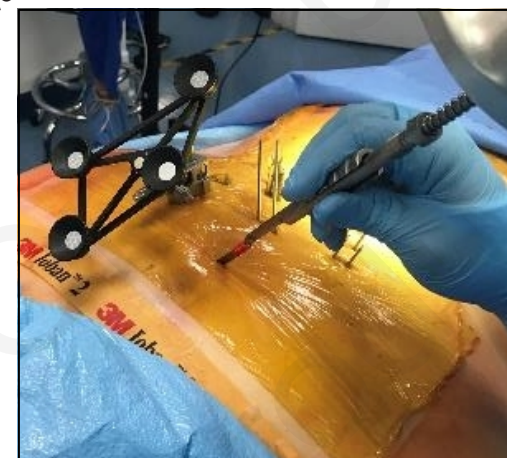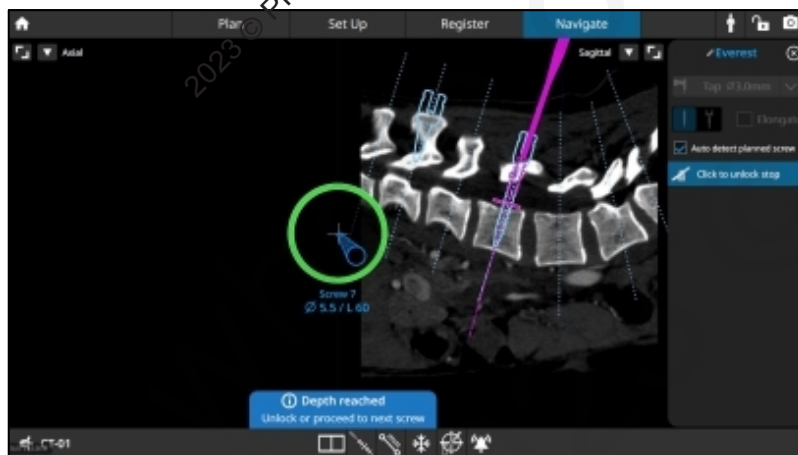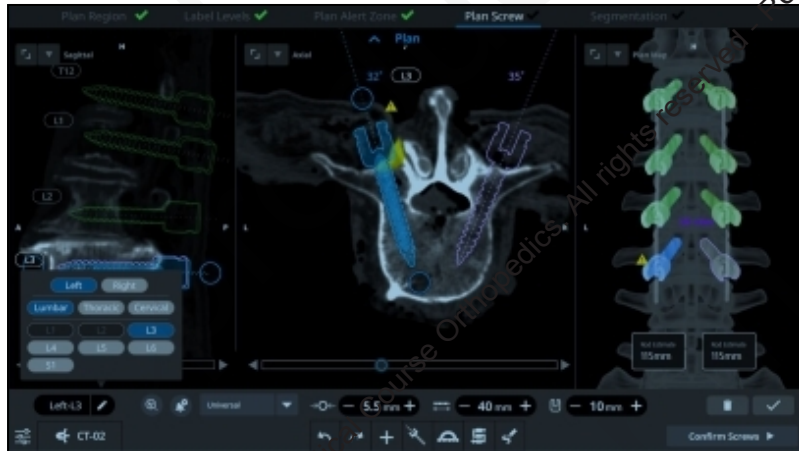
Next Generation Software | Robotics 2.0
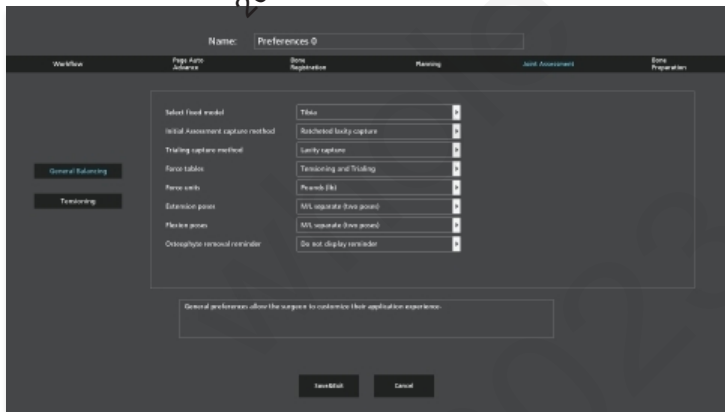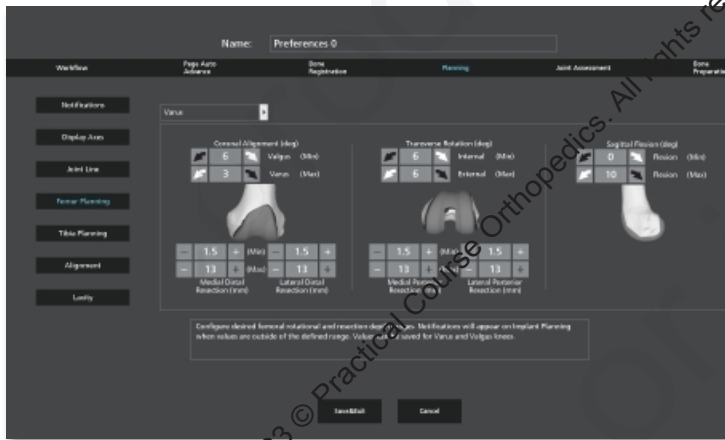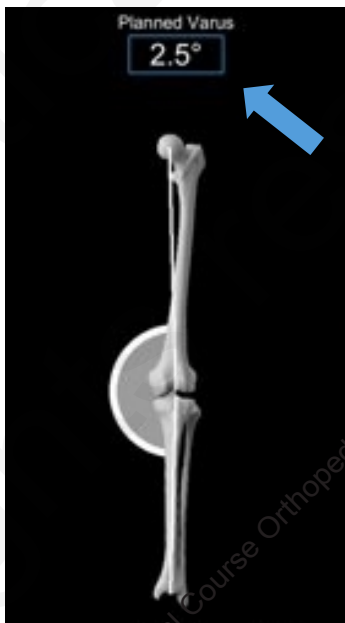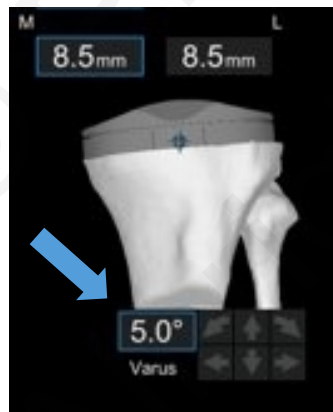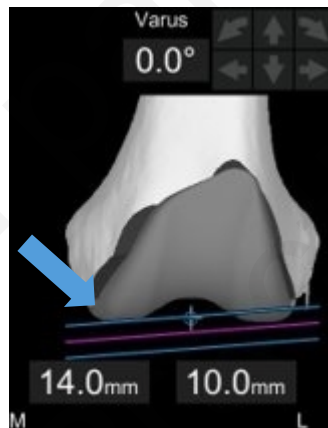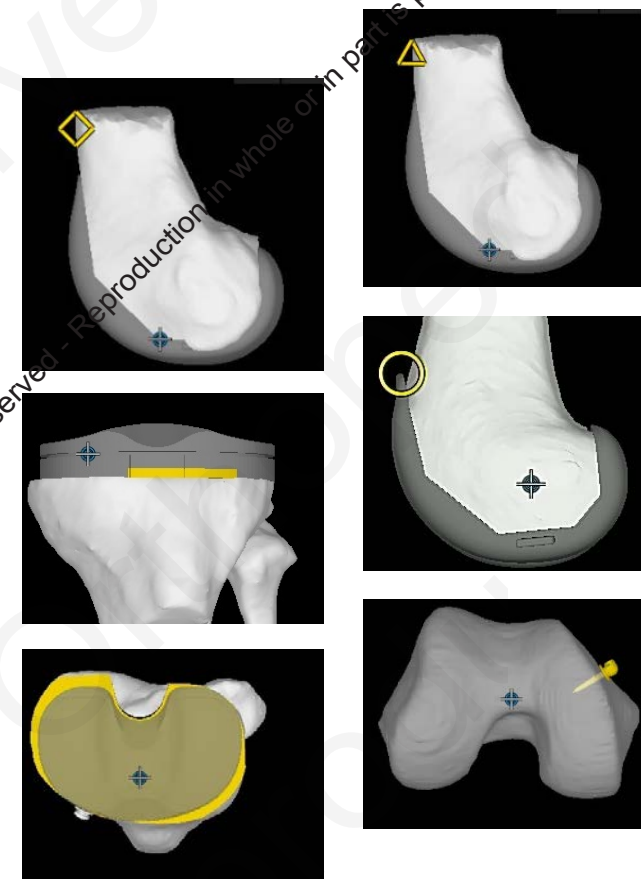
AI in Decision Making

AI Machines Have Beaten Moore's Law Over The Last Decade*
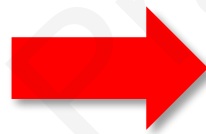
*According to Stanford University's AI Index report

Clinical Intelligence
Radiomics
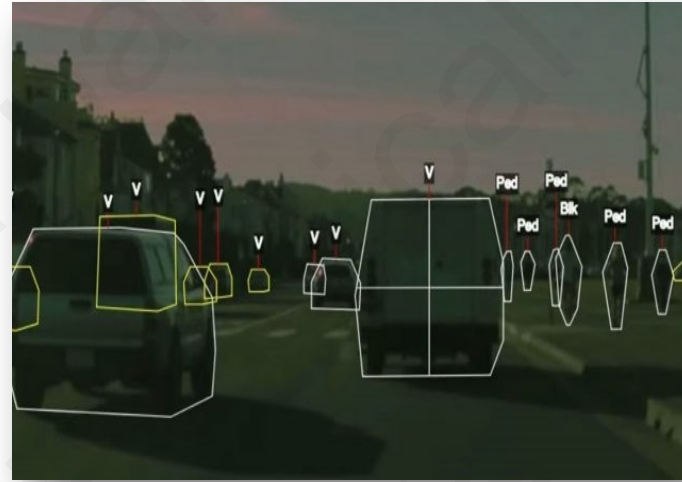
**From
Pixel/Frame** ➤ **To
Road Feature** ➤ **To
Auto Pilot**

We help our customers **rebuild lives.**™

Clinical Intelligence

Radiomics
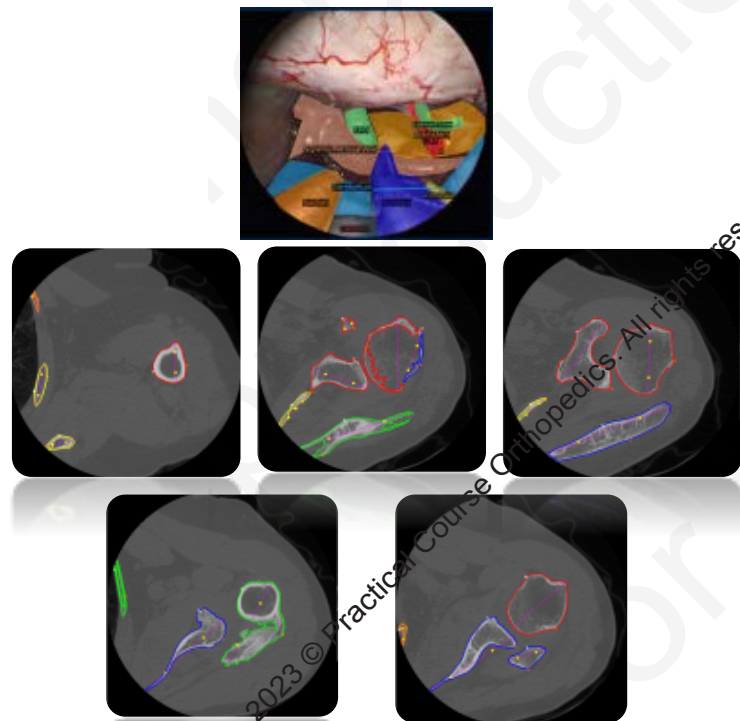
From Pixel/Voxel
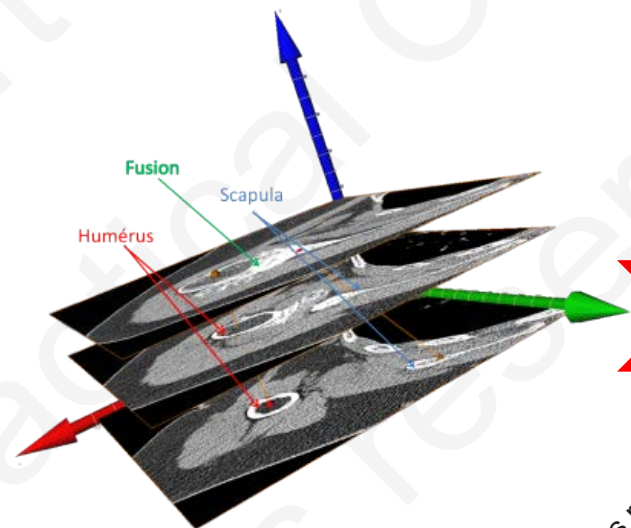
To Clinical Feature

To Smart Planning and Guidance

Fusion

Scapula

Humérus

AI in Decision Making

➤ During the training phase an AI system is fed thousands of labeled features of various cases learning to classify them.

➤ The prediction output would be surgical strategy, Implant type/size/placement.
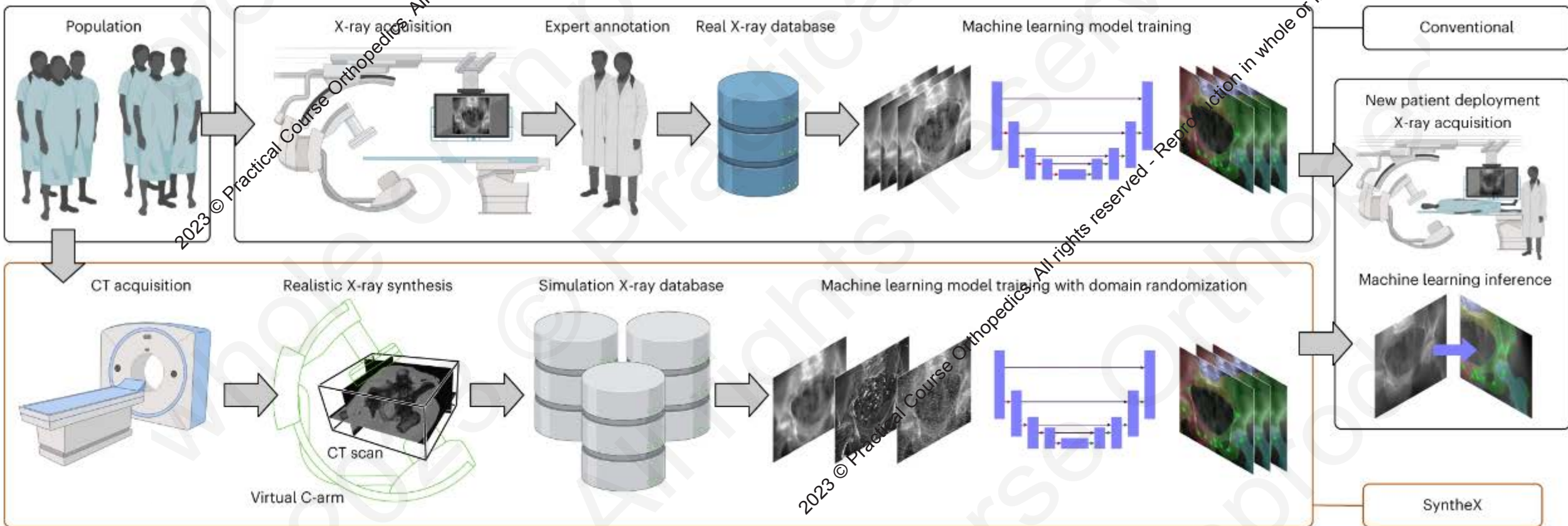
ARTIFICIAL
INTELLIGENCE

AI Validation/Testing Framework

Testing set – 210 PGHOA cases

70 PGHOA cases
A1,A2,B1,B2,B3,C,D

70 PGHOA cases
A1,A2,B1,B2,B3,C,D

70 PGHOA cases
A1,A2,B1,B2,B3,C,D

TSA / RSA
Vote

TSA / RSA
Vote

TSA / RSA
Vote

Testing set

TSA / RSA Ground truth
210 PGHOA cases

Results
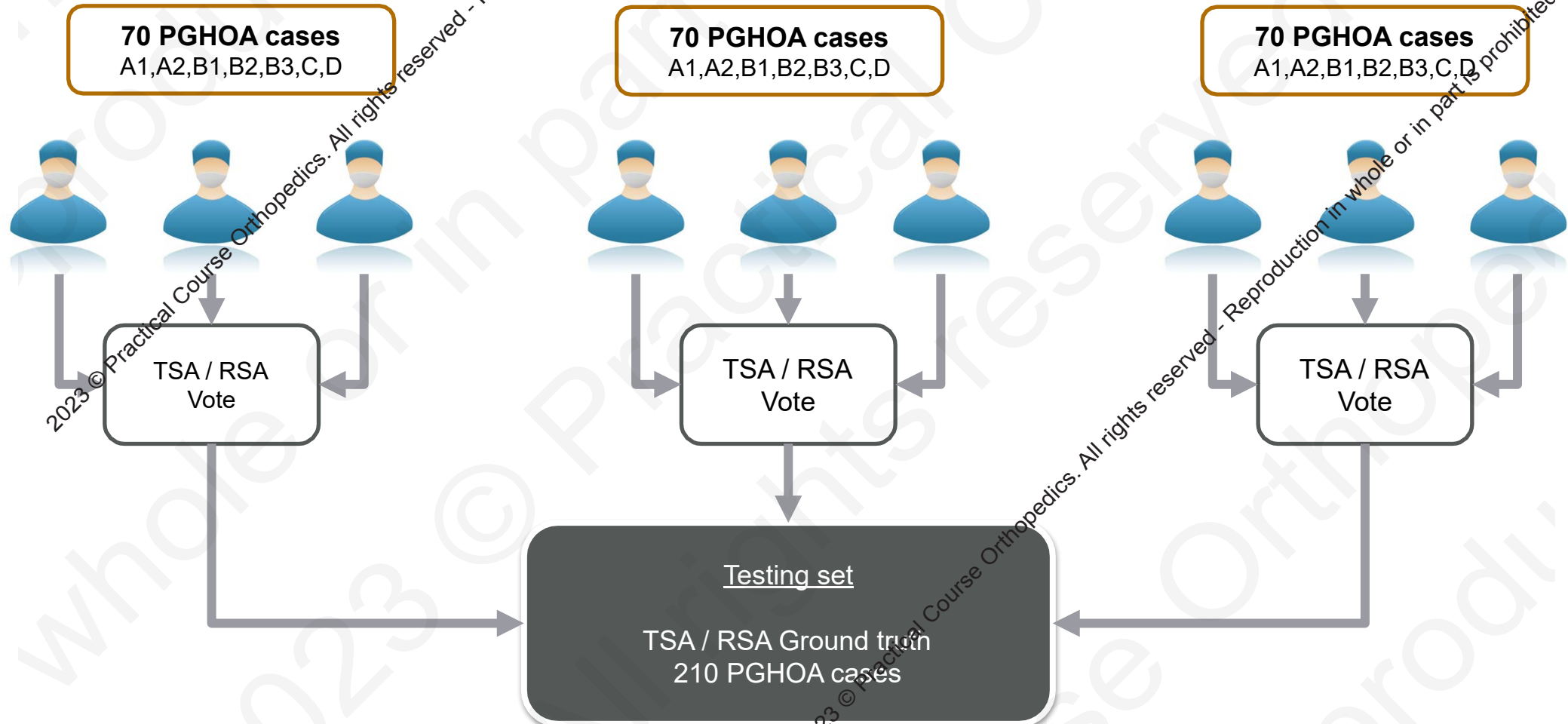
The average surgeon-to-surgeon Kappa was **K = 0.54** (moderate agreement).

The AI algorithm offered significantly higher agreement compared to any expert-to-expert agreement in cases of full and strong agreement votes, with Kappa of **0.78** and **0.70** respectively.

Can we predict a stem size to achieve rotational stability in metaphyseal fixation concept?

Bone Density Assessment

Cohort & Data

Cohort
Period   – 2014 to 2019   **Gender**   – 181 female patients (62%)   – 109 male (38%)   **Age**   – mean age at the time of the arthroplasty of 72 years (range, 34-99 years)   **Diagnosis**   – Primary glenohumeral osteoarthritis (66%, N=192)   – Massive rotator cuff tear (17%, N=48)   – Cuff tear arthropathy (17%, N=50)

Anatomical Neck — Metaphysis — Surgical Neck

Level 1 — M1 — M2 — 2 cm — Proximal Diaphysis — M3 — Level 2 — M4
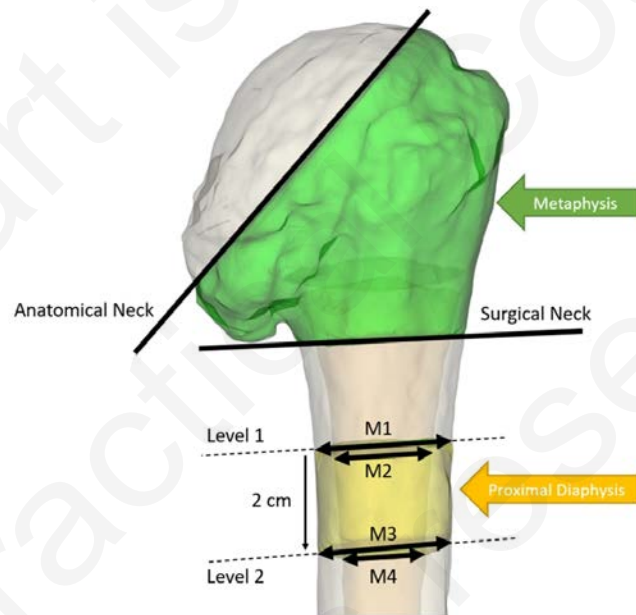
6 shape characteristics → **8 Bone density measures** → **Patient Age** → **Surgery Stem Size**

Results

Training on 80% of the cohort (248 cases)

Testing on 20% of the cohort (42 cases)

6 shape characteristics	8 Bone density measures	Patient Age

$R^2 = 0.63$

Surgery Stem Size

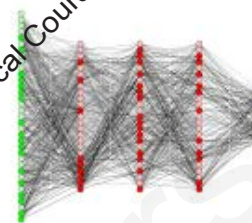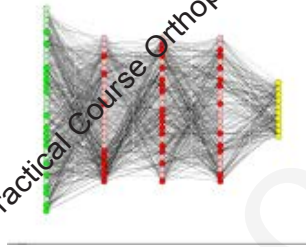The stem sizes obtained by the model were correct within <u>**one size**</u> variation for 40 cases (95%).

| Measure	Average	SD	Significant contribution to the Stem Size Prediction	Corresponding p-value
Patient Age	72 y	10 y	No	> 0.1
$M1$	24.1 mm	3.1 mm	No	> 0.1
$M2$	18.0 mm	3.1 mm	No	> 0.1
$M3$	21.5 mm	2.8 mm	No	> 0.1
$M4$	15.0 mm	2.7 mm	**Yes**	**< 0.0001**
Humerus Proximal Diaphysis Cortical Thickness	3.2 mm	0.6 mm	No	> 0.1
$HSSM_{\lambda1}$	-0.552	0.8990	**Yes**	**< 0.0001**
$HSSM_{\lambda2}$	0.00710	0.8166	No	> 0.1
$HSSM_{\lambda3}$	-0.0940	0.6671	**Yes**	**0.0027**
$HSSM_{\lambda4}$	0.370	0.8557	**Yes**	**< 0.0001**
$HSSM_{\lambda5}$	-0.200	0.7902	**Yes**	**< 0.0001**
$HSSM_{\lambda6}$	-1.017	1.0608	No	> 0.1
Humerus Metaphysis Cancellous Bone Density	22 HU	29 HU	**Yes**	**< 0.0001**
Humerus Metaphysis Cortical Bone Density	537 HU	93 HU	**Yes**	**0.0022**
Humerus Proximal Diaphysis Cortical Bone Density	1025 HU	134 HU	No	> 0.1
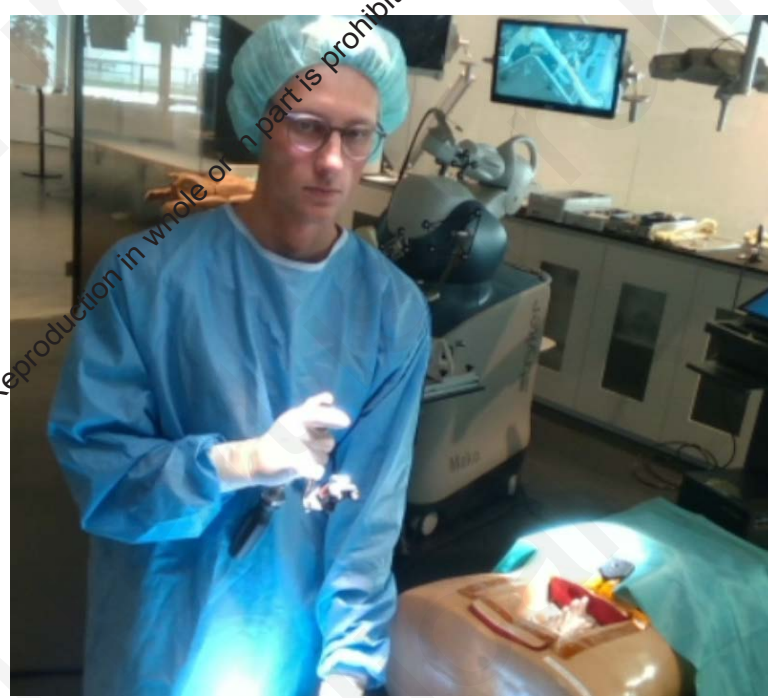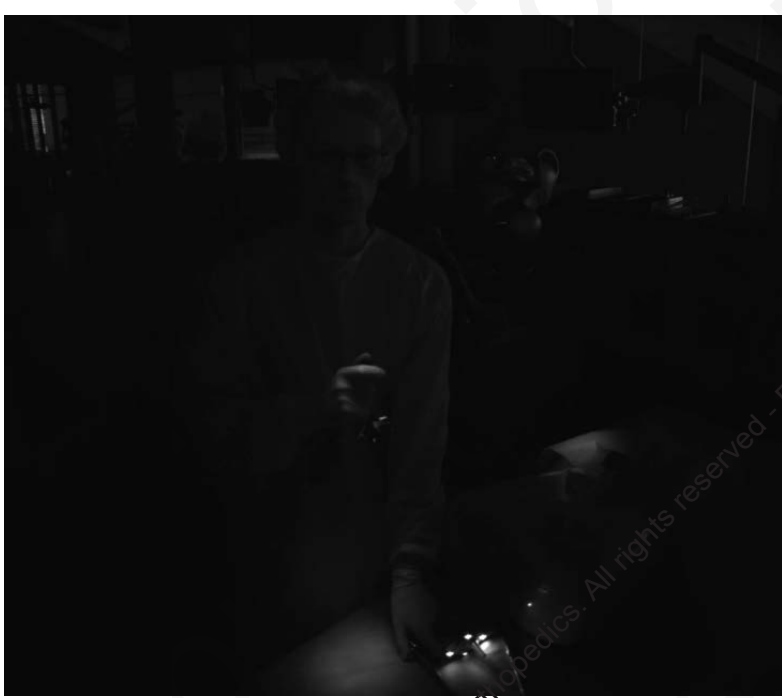
Machine **Vision**
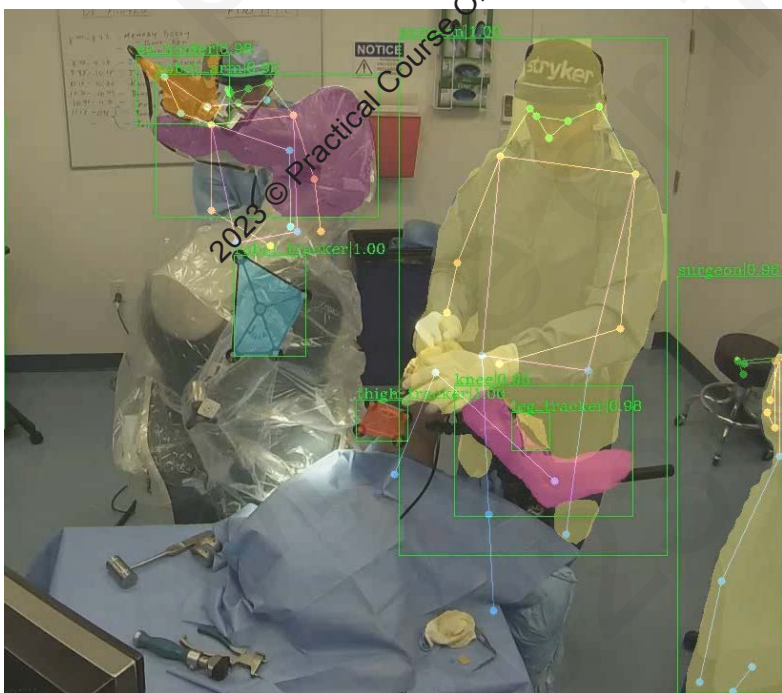
Spatial Computing & Mixed Reality
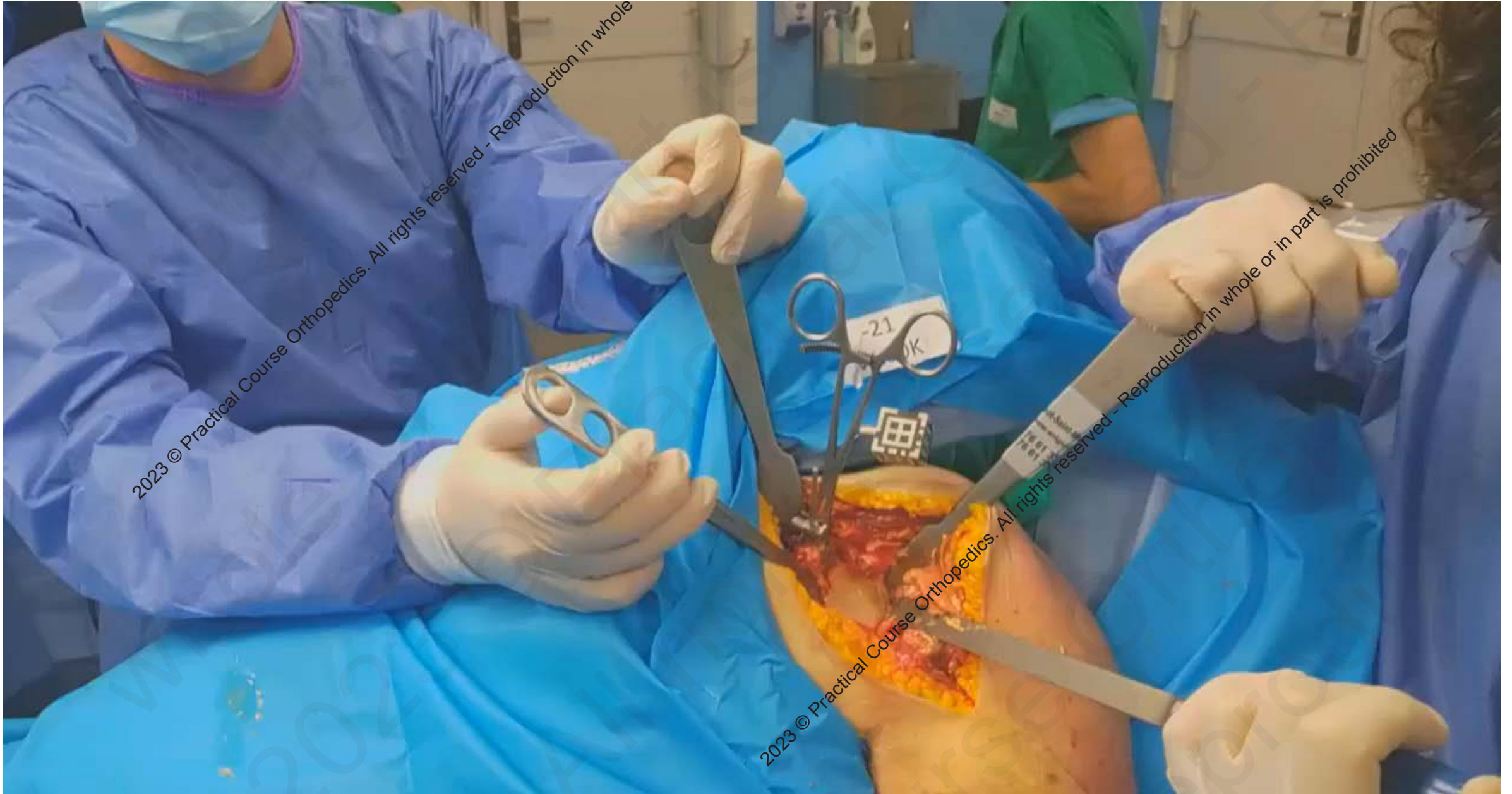
Robotics and Mixed Reality (XR)
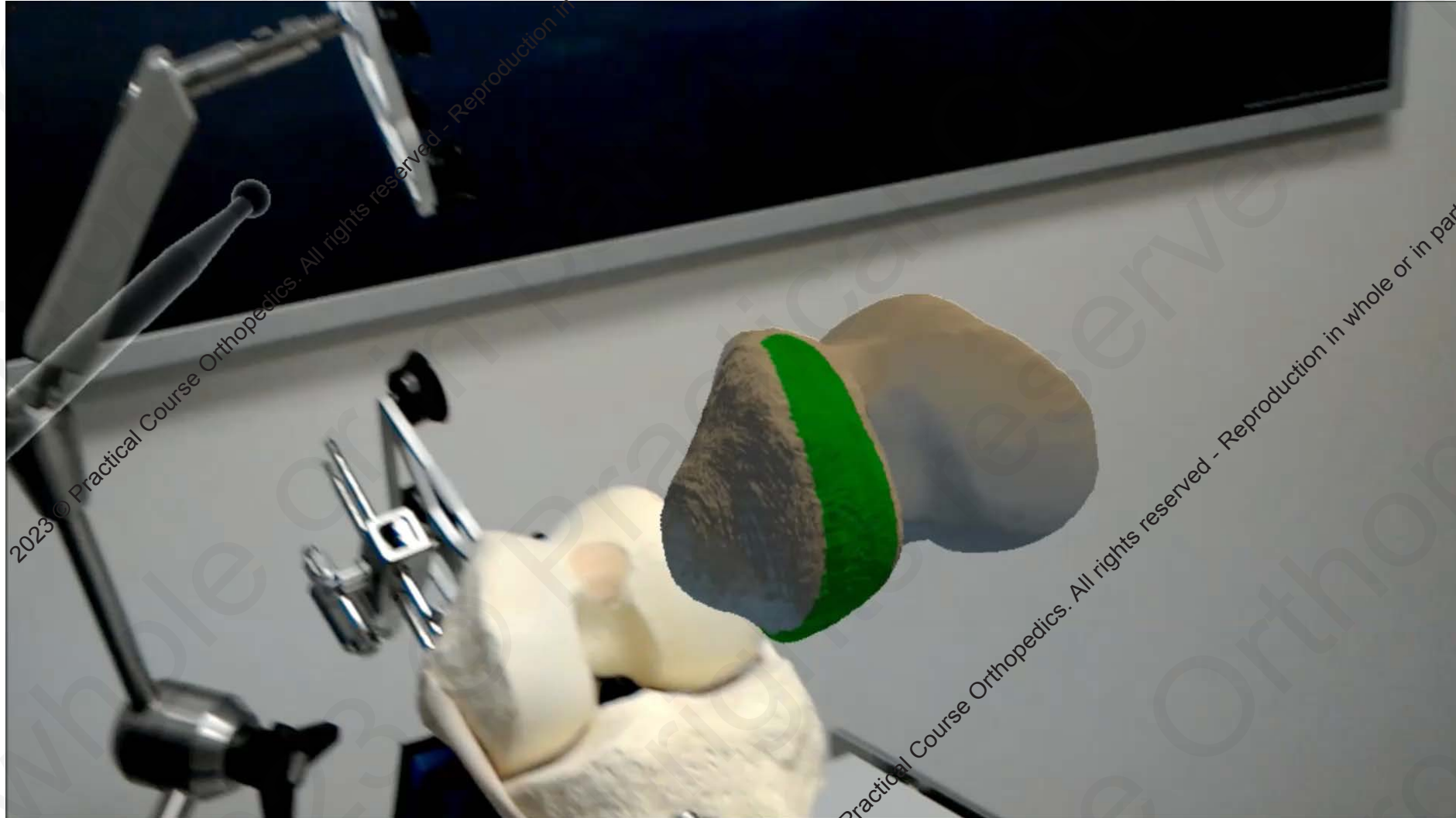
Downward cameras

IR illuminators

Side cameras

Generative AI

The Rise of Foundational Models
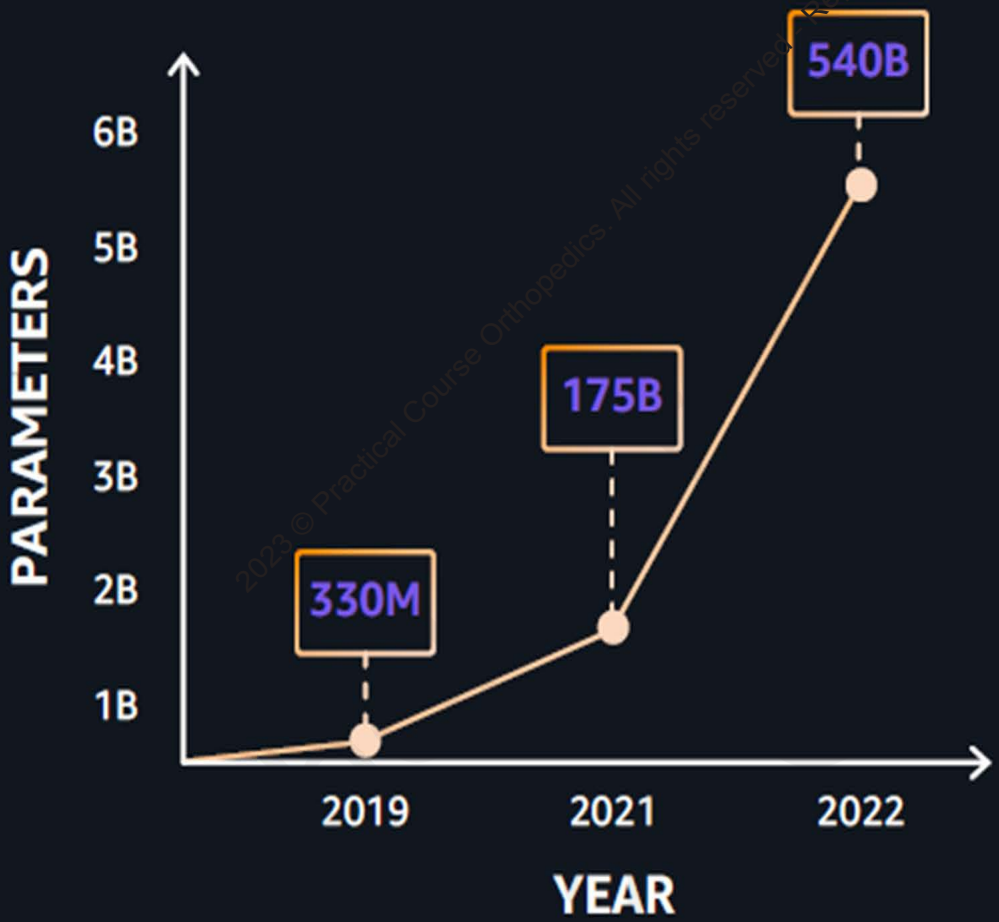
Generative AI is the fastest growing trend in AI

Q&A
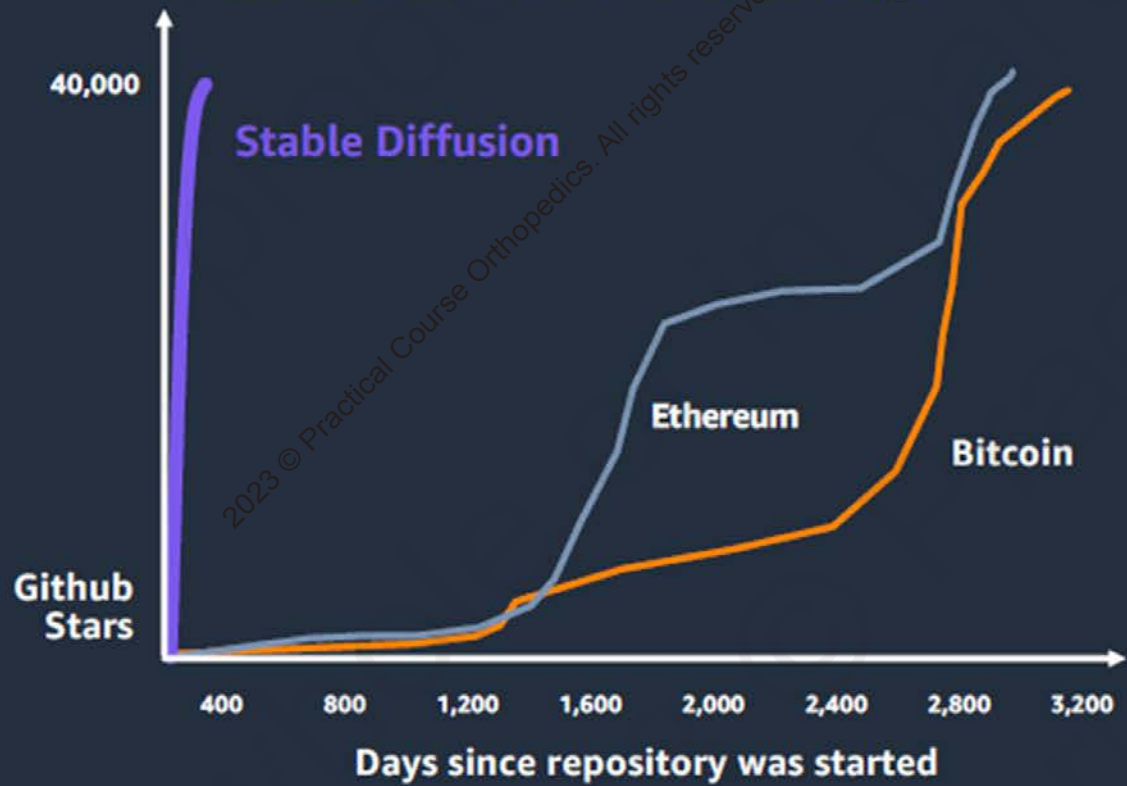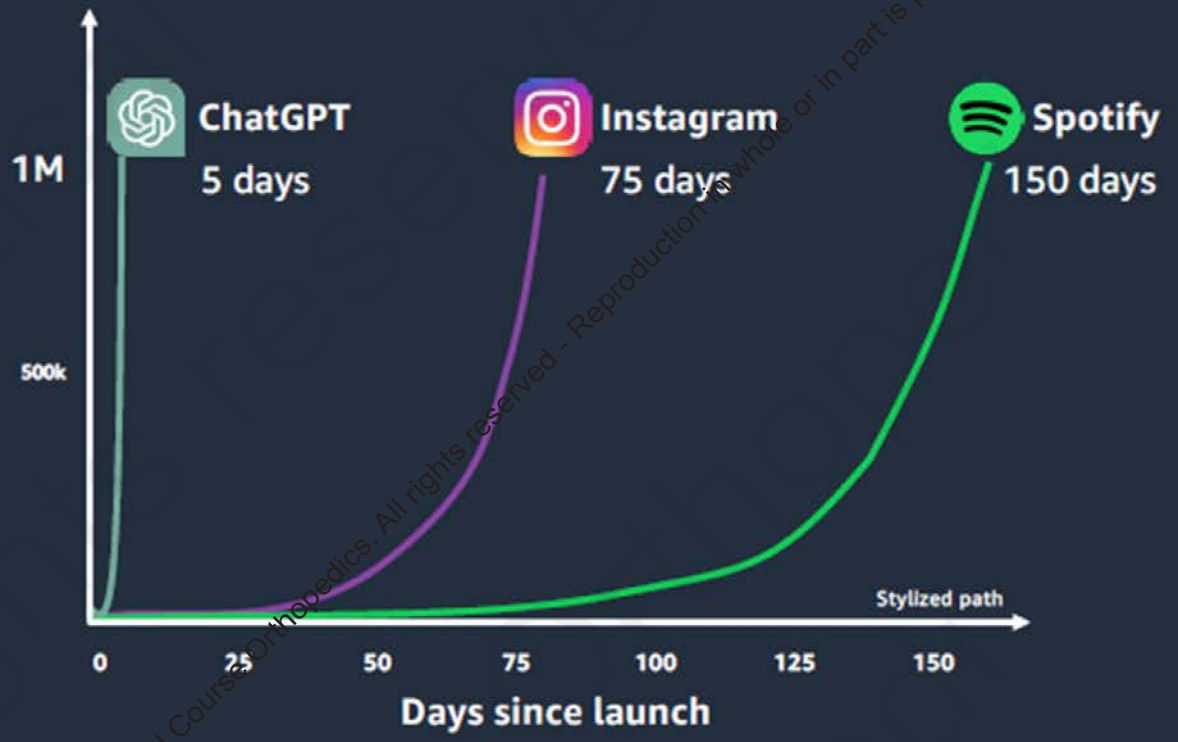
Publicly available

stability.ai

Models
Text2Image
Upscaling

Tasks
Generate photo-realistic images from text input
Improve quality of generated images

Features
Fine-tuning on SD 2.1 model

alexa

Models
AlexaTM 20B

Tasks
Machine translation
Question answering
Summarization
Annotation
Data generation

🤗

Models
Flan T-5 models (8 variants)
DistilGPT2, GPT2
Bloom models (3 variants)

Tasks
Machine translation
Question answering
Summarization
Annotation
Data generation

Proprietary models

co:here

Models
Cohere generate-med

Tasks
Text generation
Information extraction
Question answering
Summarization

LightOn

Models
Lyra-Fr 10B

Tasks
Text generation
Keyword extraction
Information extraction
Question answering
Summarization
Sentiment analysis
Classification

AI21 labs

Models
Jurassic-1 Grande 17B

Tasks
Text generation
Long-form generation
Summarization
Paraphrasing
Chat
Information extraction
Question answering
Classification