Artificial Intelligence In Clinical Skill Training And Medical Education

Prof. Dr. Arun Jamkar

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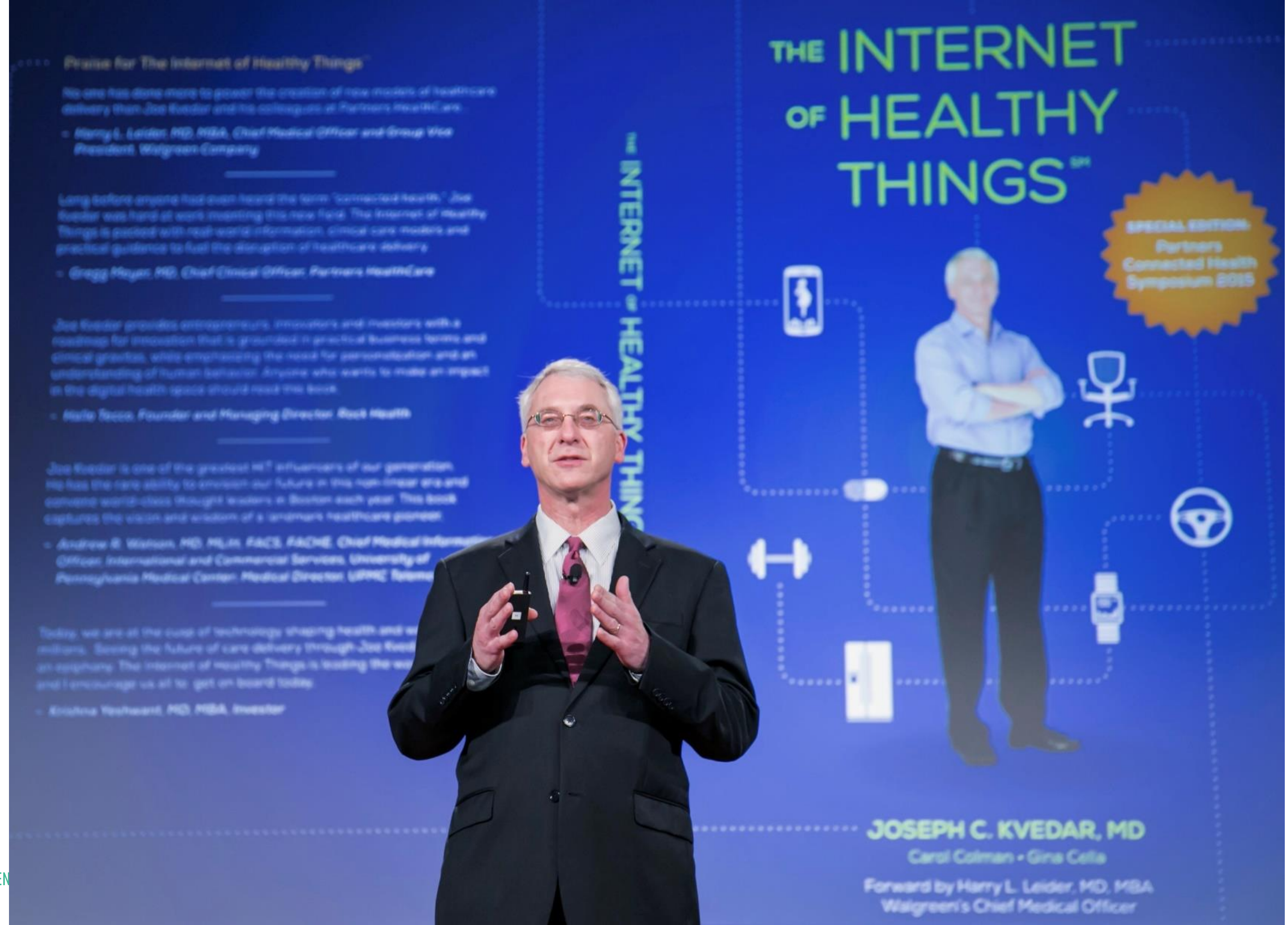
www.arunjamkar.com

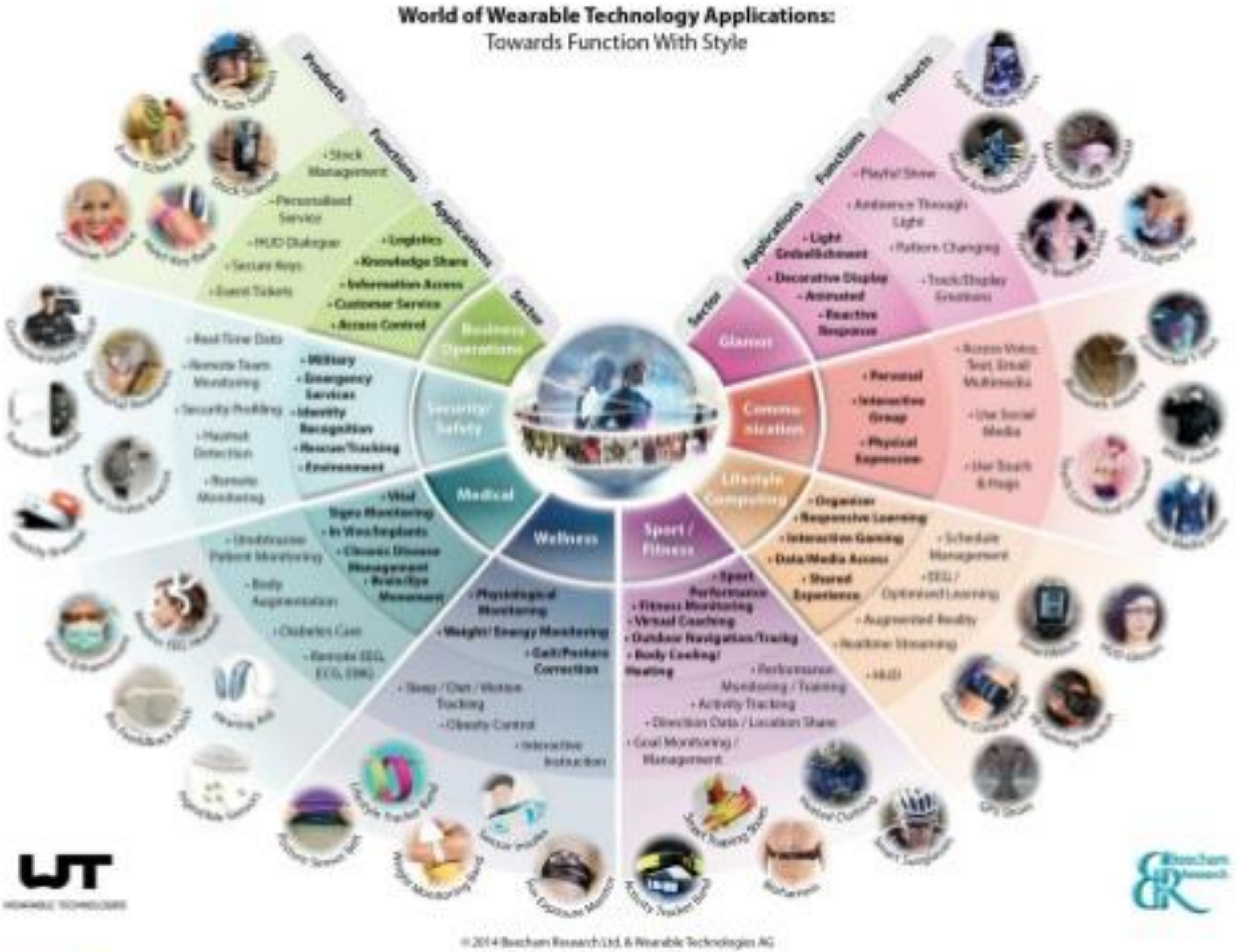
https://youtu.be/IdMdidmrC5Y

Kuva 1. Internet of Things. Lähde: Huffington Post

The Internet Of Things (Iot) Is The Network Of Devices, Vehicles, And Home Appliances That Contain Electronics, Software, Actuators, And Connectivity Which Allows These Things To Connect, Interact And Exchange Data.


THE INTERNET OF HEALTHY THINGS SM
THE INTERNET OF HEALTHY THINGS
SPECIAL EDITION:
Partners Connected Health Symposium 2015
JOSEPH C. KVEDAR, MD
Carol Colman • Gina Cella
Forward by Harry L. Leider, MD, MBA
Walgreen's Chief Medical Officer

Wearable Applications and Markets



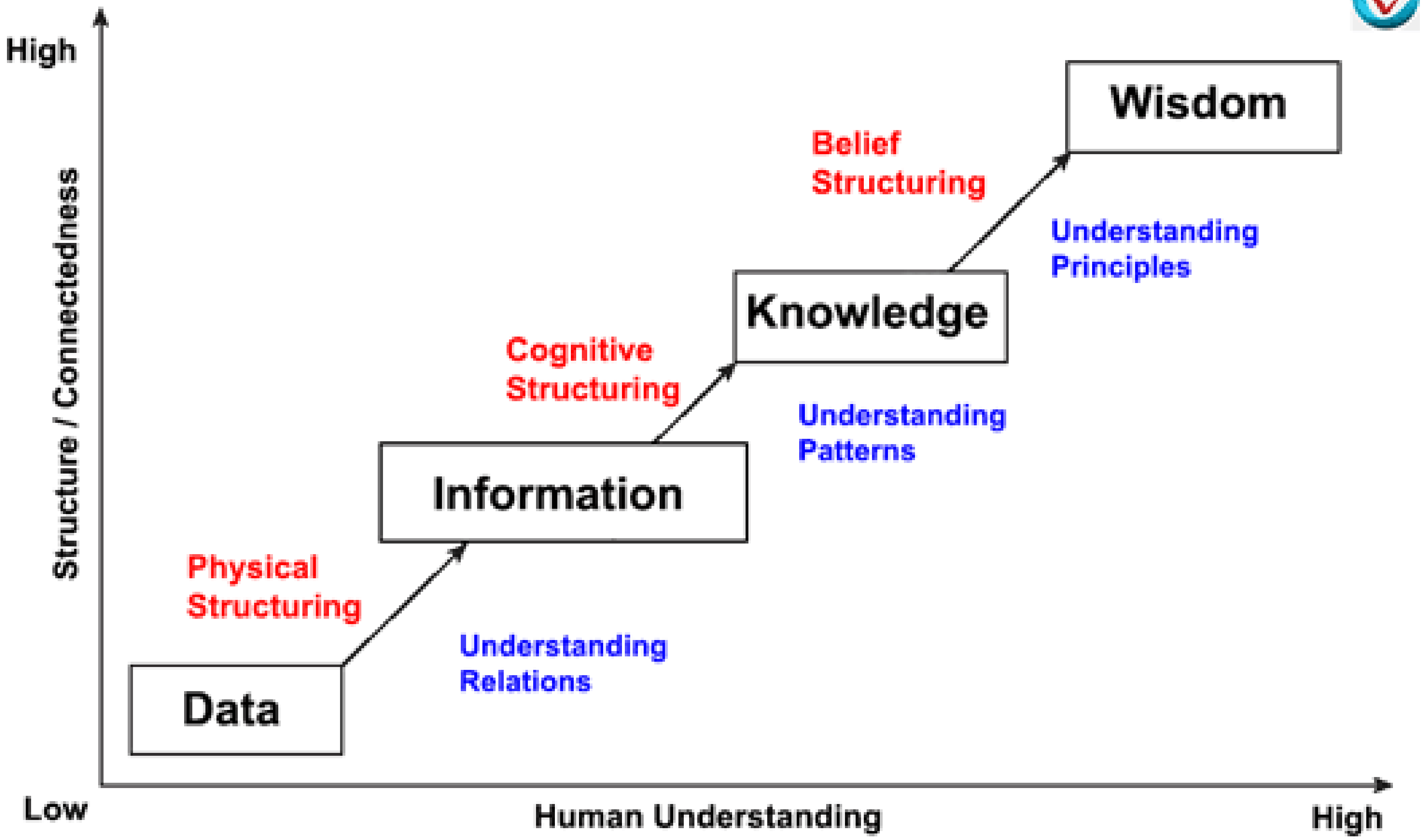
Artificial Intelligence (AI)
As Defined By   John Mccarthy In 1955

The term AI, is defined as a machine with intelligent behaviour such as perception, reasoning, learning, or communication and the ability to perform human tasks

Artificial wisdom is a software system that can demonstrate one or more qualities of being wise.

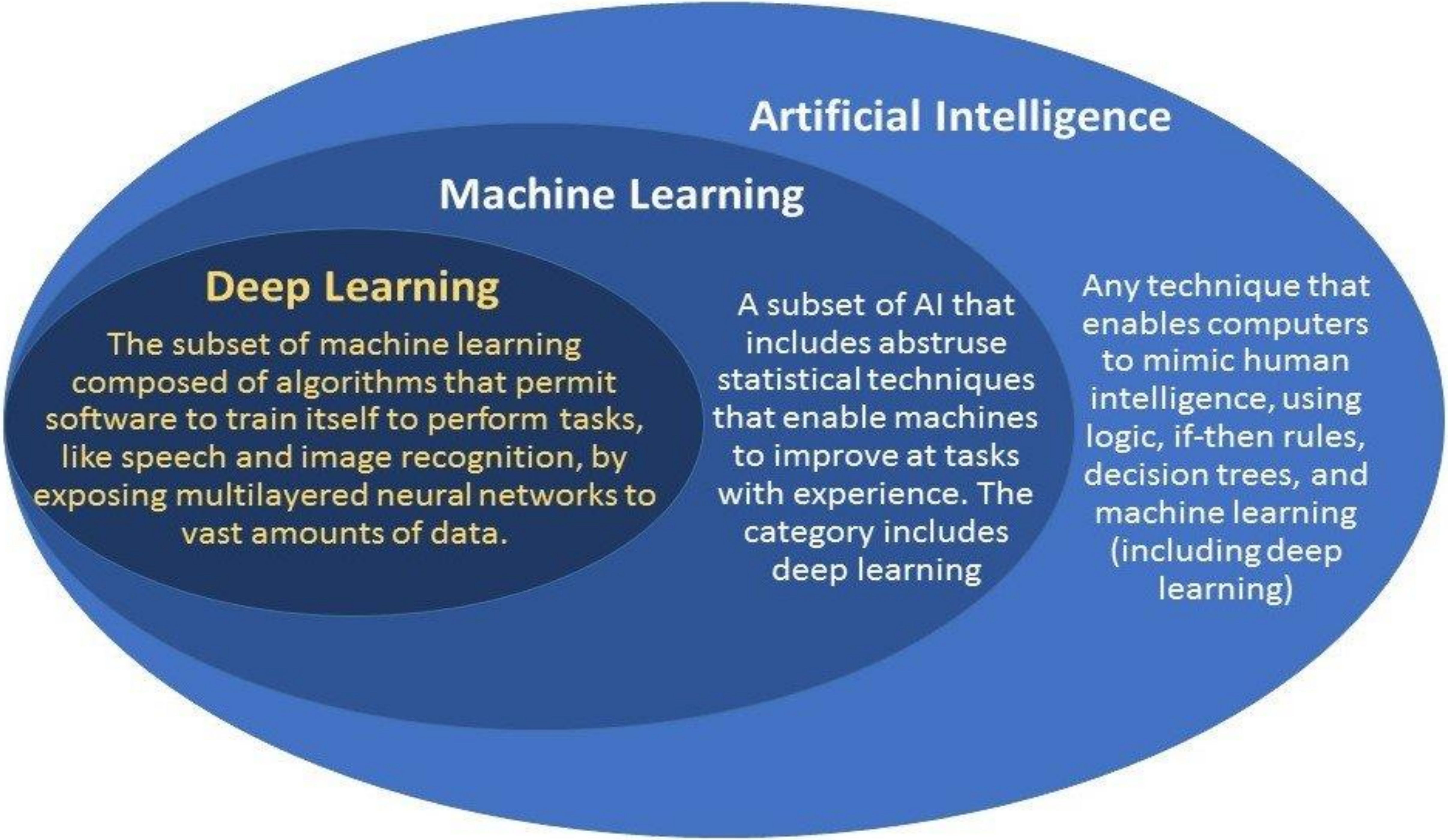
Artificial wisdom can be described as **artificial** intelligence reaching the top-level of decision-making when confronted with the most complex challenging situations.

Machines lack human qualities such as empathy and compassion, and therefore patients must perceive that consultations are being led by human doctors. Furthermore, patients cannot be expected to immediately trust AI; a technology shrouded by mistrust.”

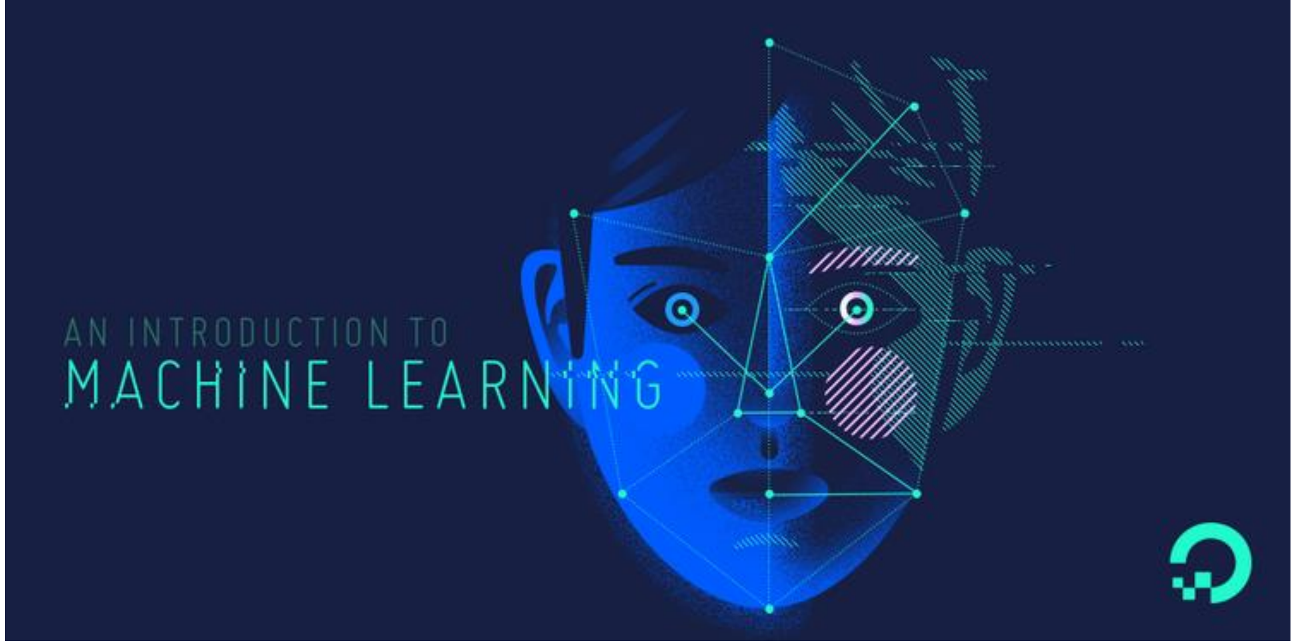


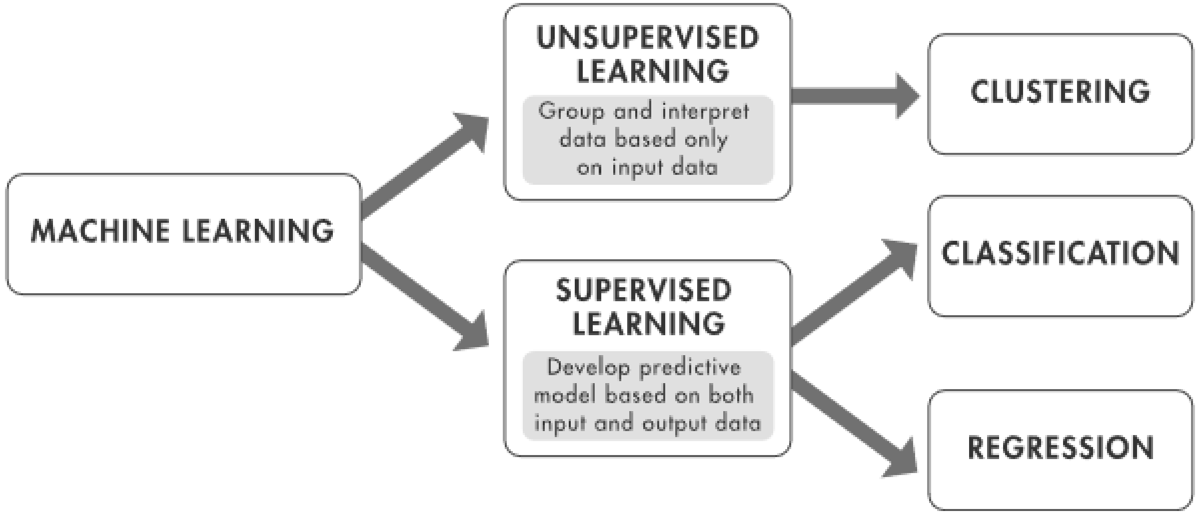
DIKW Hierarchy Model Flow
CertGuidance.com

Medical Education and Clinical skill Training needs Augmented Intelligence leading to Artificial wisdom

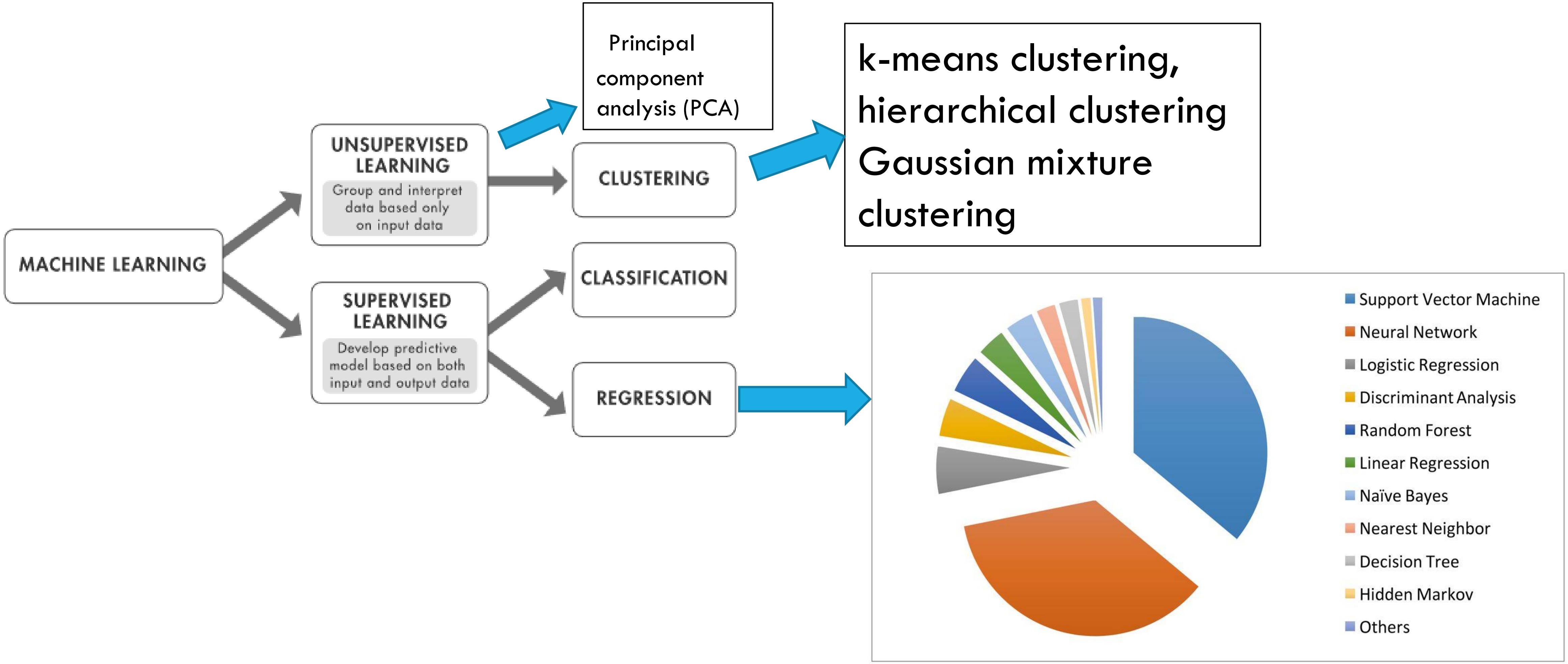

Artificial Intelligence
Machine Learning
Deep Learning
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.
A subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning
Any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning)

Machine learning is an application of artificial **intelligence** (AI) that provides systems the ability to <u>automatically learn and improve from experience</u> without being explicitly programmed.
Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.



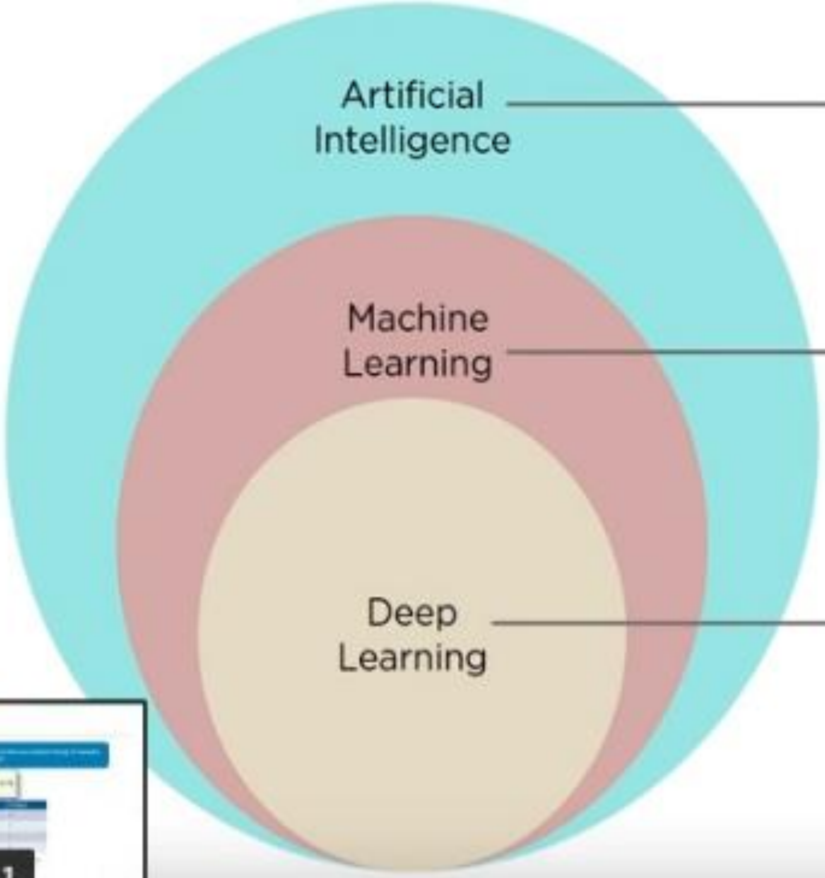


THE MACHINE LEARNING ALGORITHMS USED IN THE MEDICAL LITERATURE

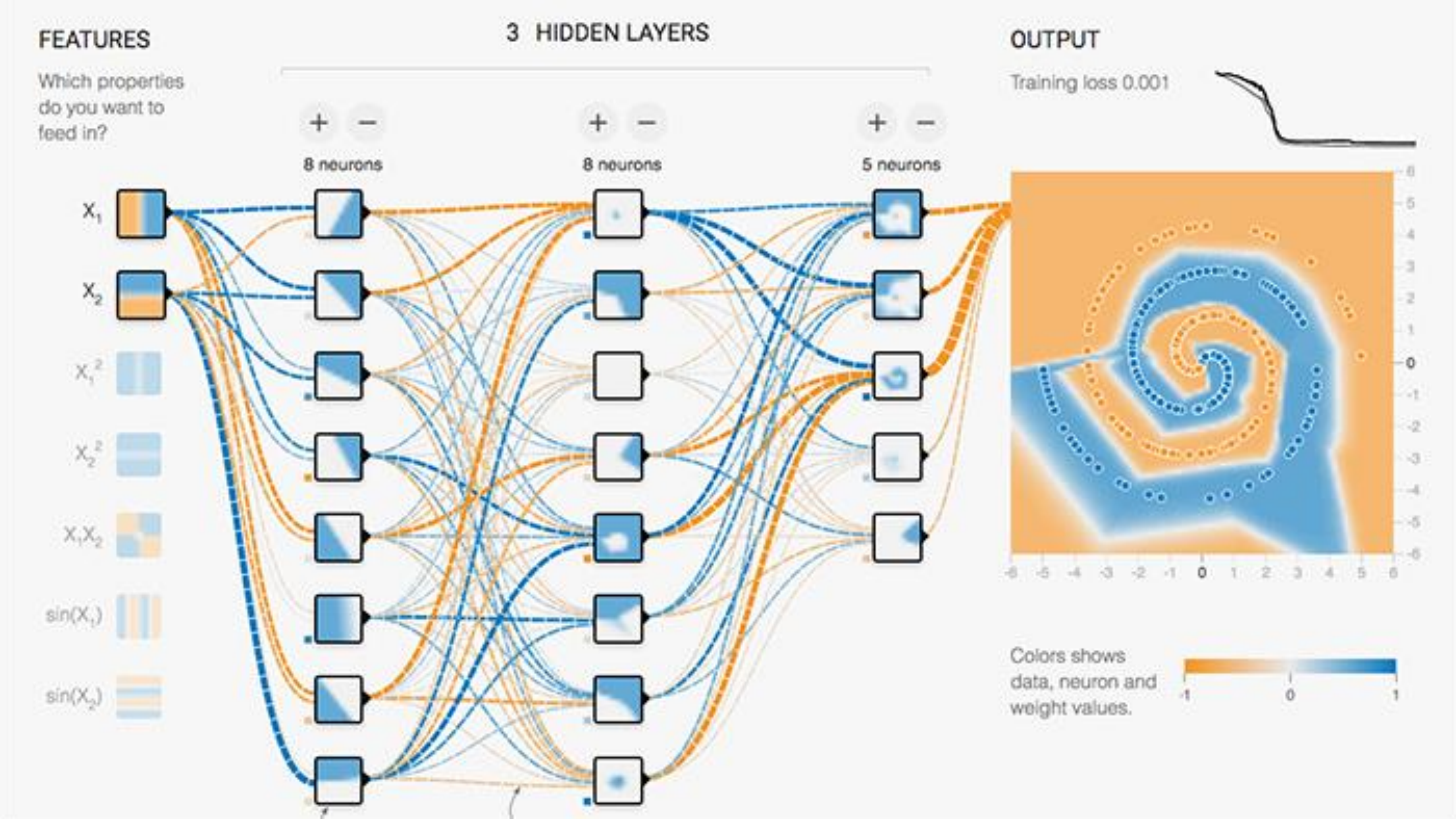


What is Deep Learning?

Deep Learning is a subset of Machine Learning that has networks which are capable of learning from data that is unstructured or unlabeled and works similar to the functioning of a human brain.



- Ability of a machine to imitate intelligent human behavior
- Application of AI that allows a system to automatically learn and improve from experience
- Application of Machine Learning that uses complex algorithms and deep neural nets to train a model

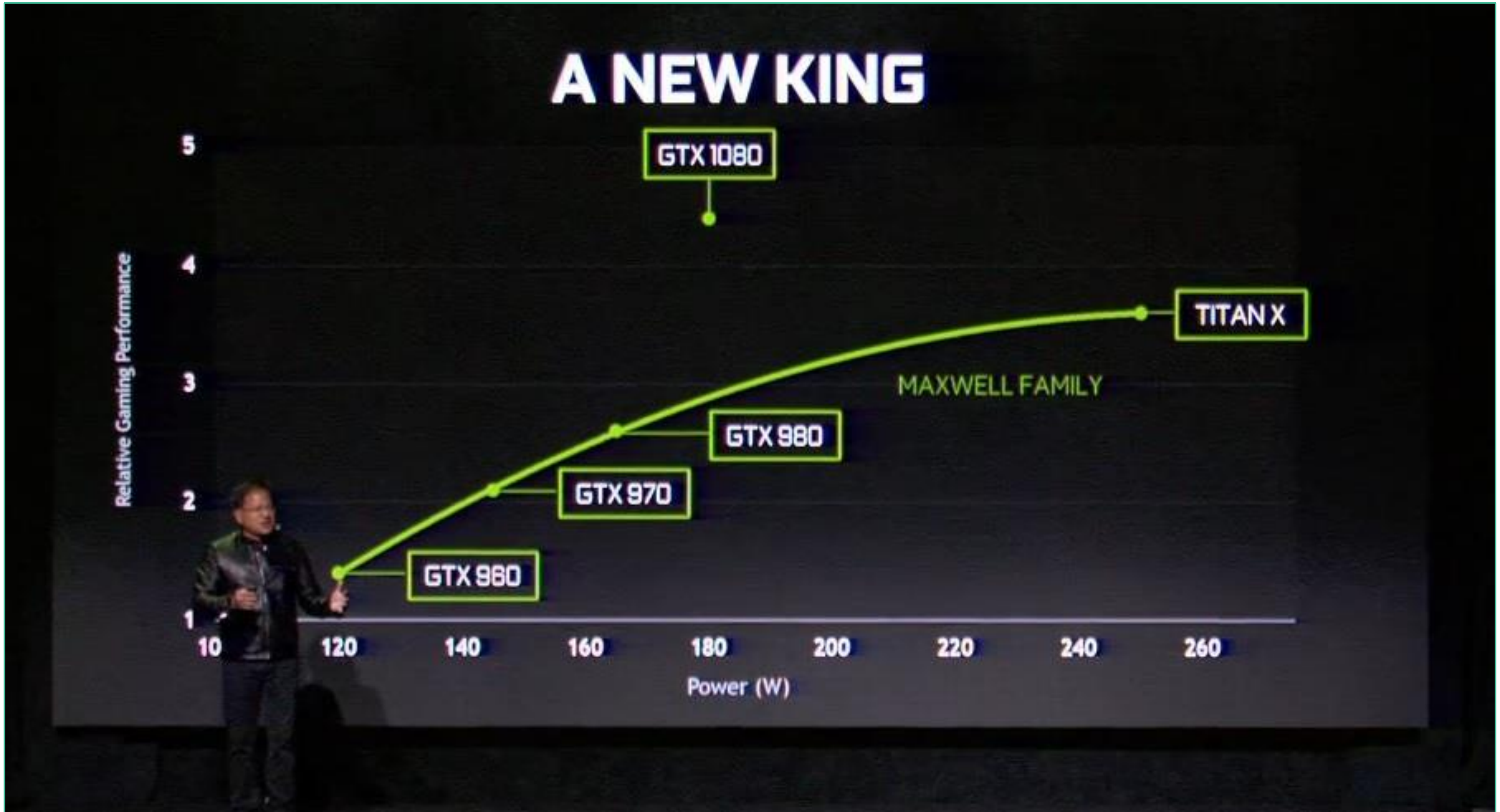


FEATURES
Which properties do you want to feed in?
X_1
X_2
X_1^2
X_2^2
X_1X_2
$\sin(X_1)$
$\sin(X_2)$
3 HIDDEN LAYERS
+ −
8 neurons
8 neurons
5 neurons
OUTPUT
Training loss 0.001
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
Colors shows data, neuron and weight values.
-1 0 1

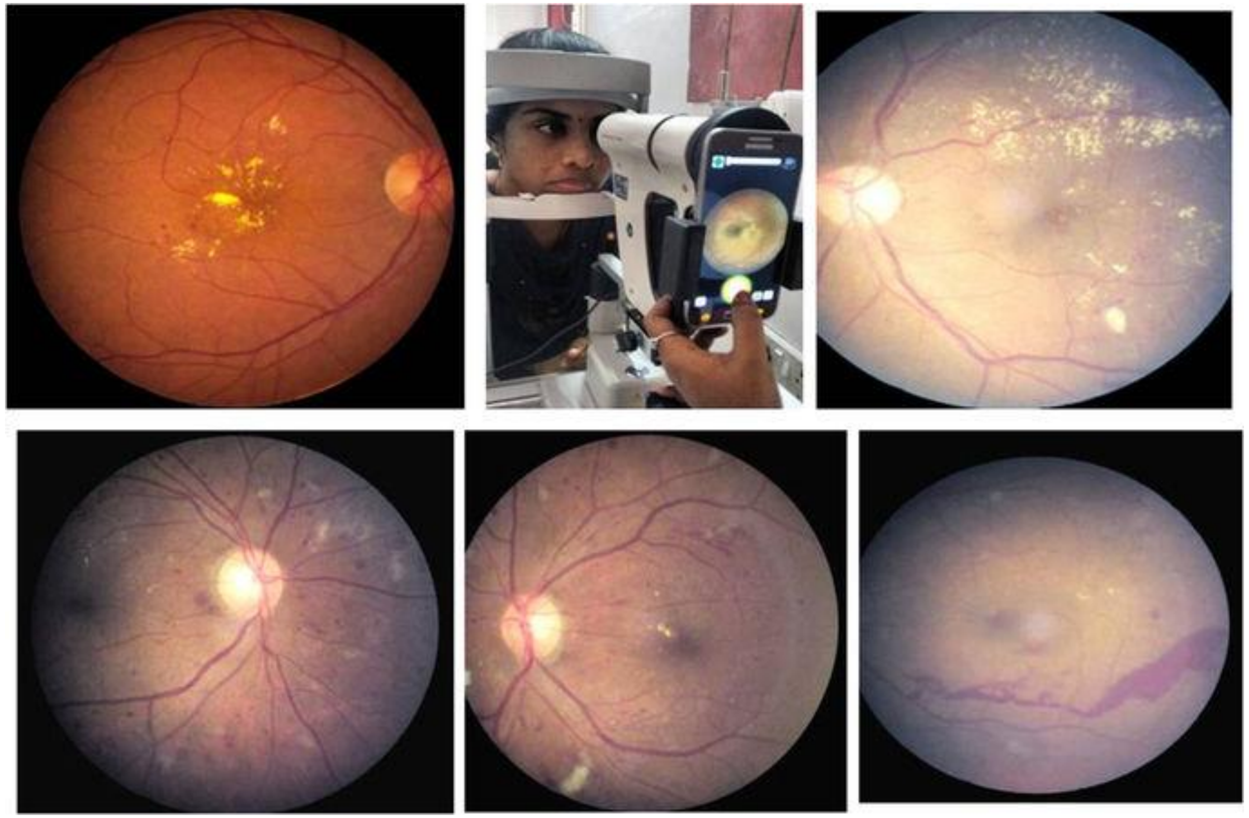

iam ai

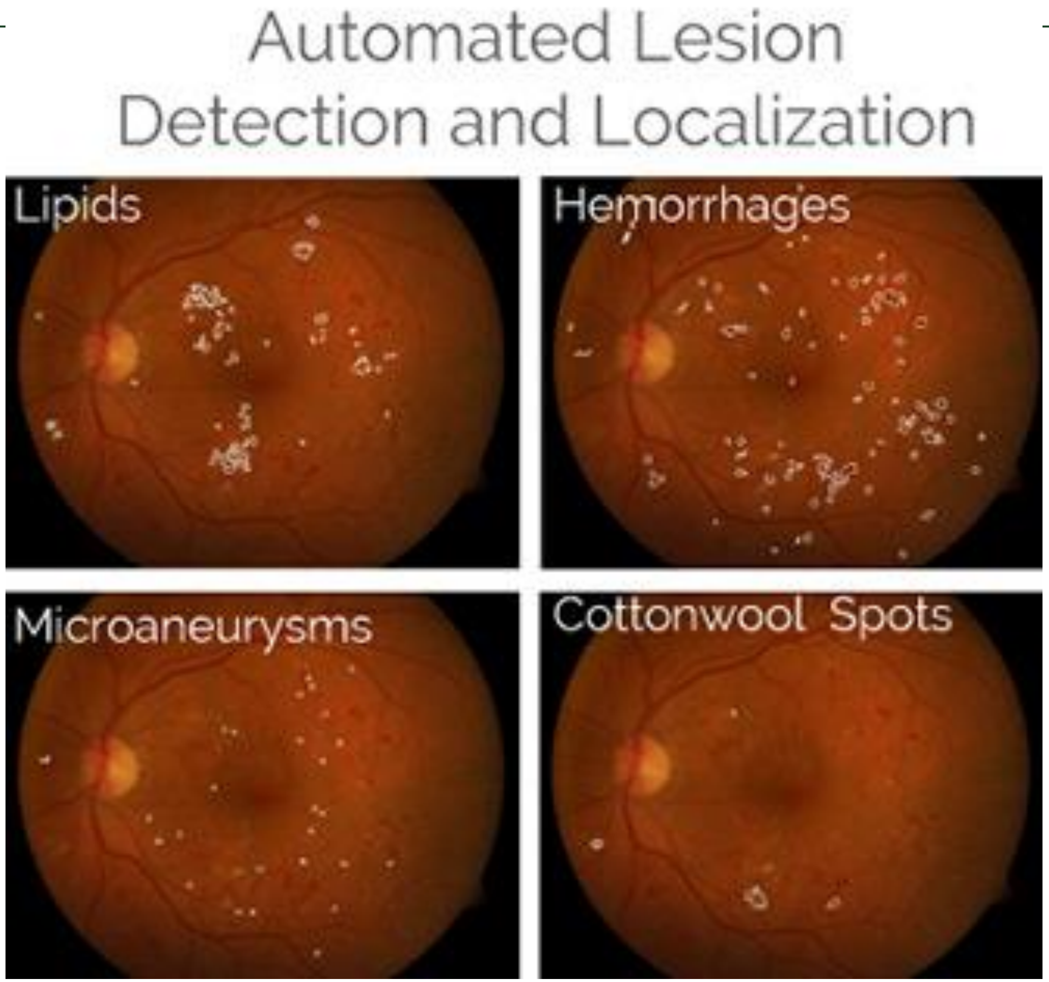

NVIDIA
iamai

NVIDIA REVEALS NEW GPU, GEFORCE GTX 1080 IS FASTER THAN THE TITAN X



EYENUK INC.'S AI-BASED DIABETIC RETINOPATHY SCREENING SOFTWARE EYEART™ TESTED WITH PORTABLE SMARTPHONE-BASED IMAGING DEVICE IN NEW STUDY INDICATING POTENTIAL FOR HIGHLY SENSITIVE YET COST-EFFECTIVE MASS RETINAL SCREENING





DETECTING AND CLASSIFYING LESIONS IN MAMMOGRAMS WITH DEEP LEARNING-1

- Authors:
  - **Dezső Ribli1,**
  - **Anna Horváth**
  - **Zsuzsa Unger**
  - **Péter Pollner**
  - **István Csabai**

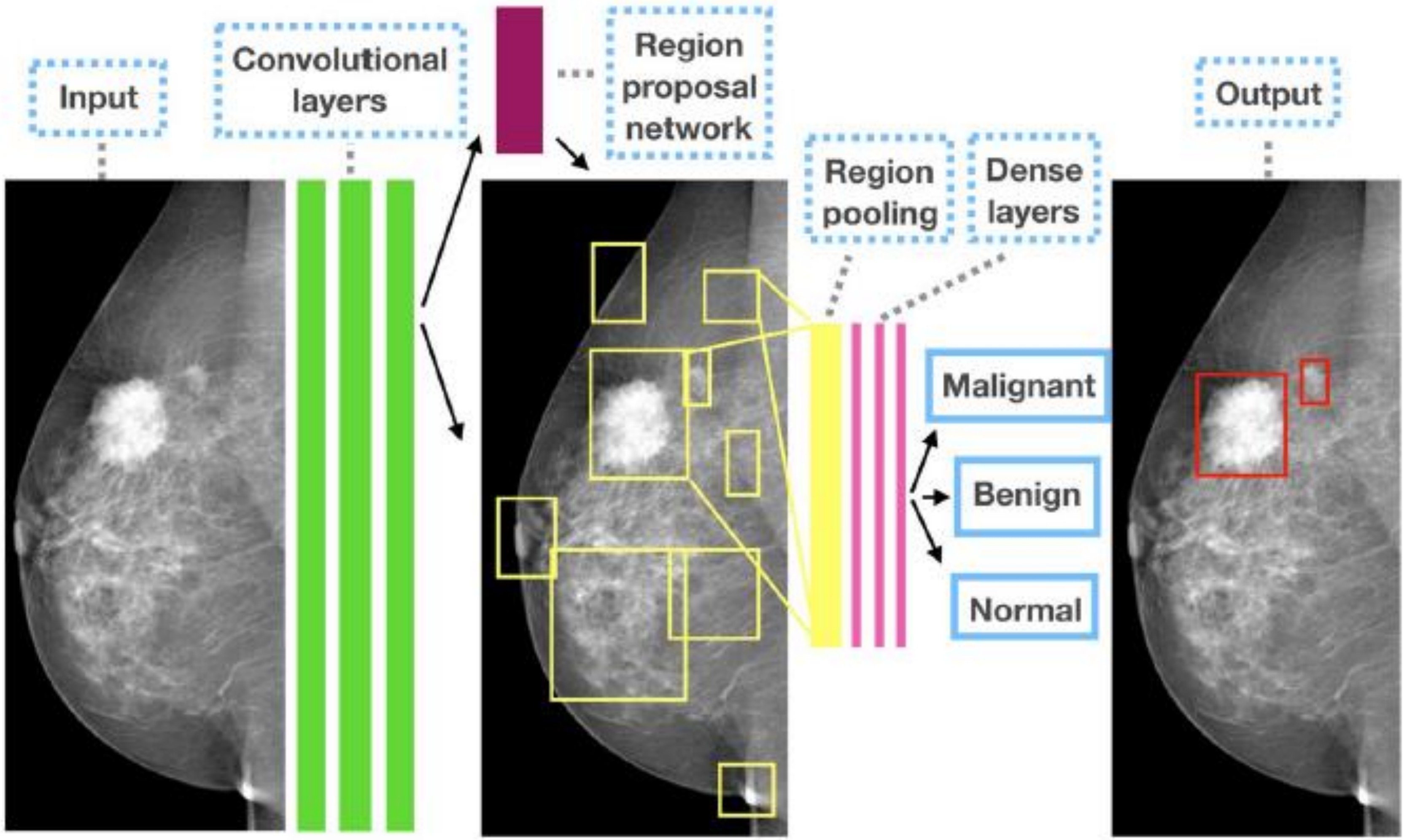
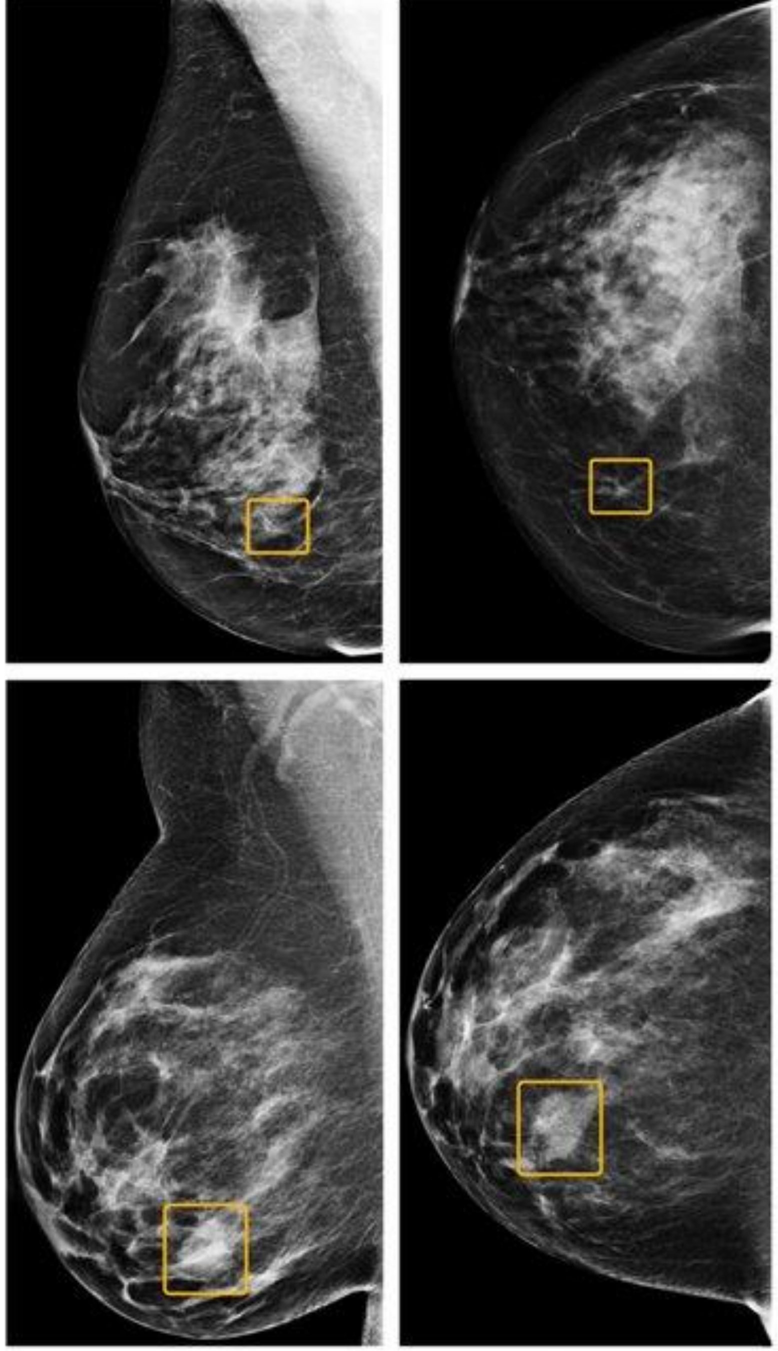


Figure 1. The outline of the Faster R-CNN model for CAD in mammography.

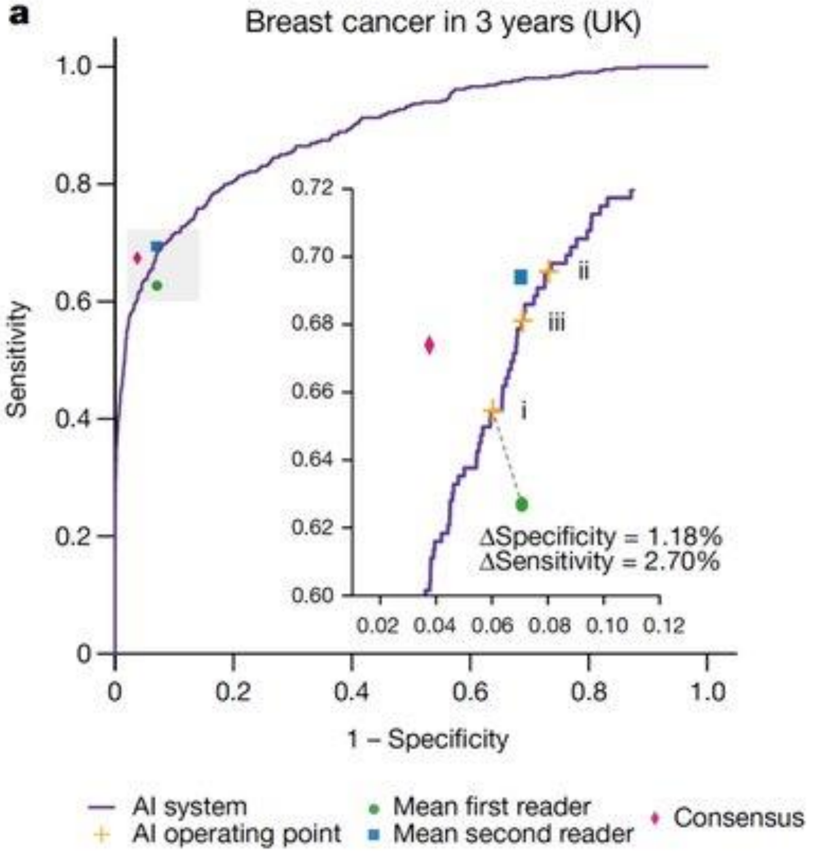
International evaluation of an AI system for breast cancer screening

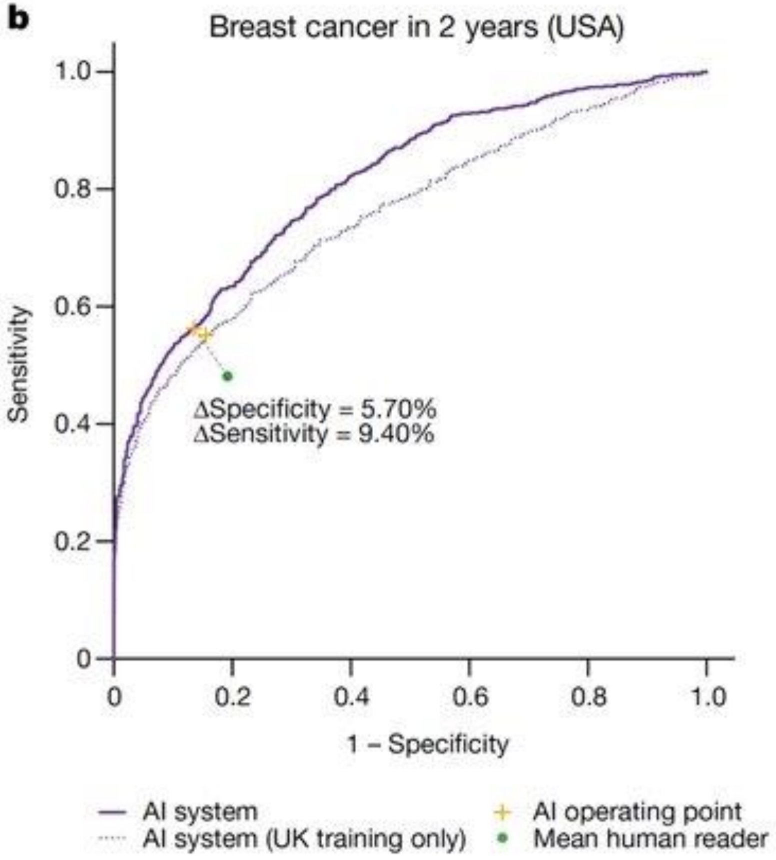


Discrepancies between the AI system and human readers.

25,856 women
AUC 0.889

3,097 women
AUC 0.810





nature 1 January 2020

Artificial Intelligence Systems In Medical Education

- AI systems in Curriculum
- AI systems in Academic Goverence
- AI systems Dynamic Real time assessment of student
- AI systems in Self Directed Learning
- AI system In Assessment
- AI systems for CPE of CBME
- AI systems in Resource Management

OVERVIEW OF THE CURRENT USES OF ARTIFICIAL INTELLIGENCE IN MEDICAL EDUCATION IDENTIFIED FROM REVIEW OF 37 FULL-TEXT ARTICLES.

Focus and advantages of use	Total number of articles
Comprehensive analysis of the curriculum	1
Learning	
Feedback for learning	21
Evaluation of the learning process with guided learning pathway	18
Decreased costs	8
No harm to patients	6
Less teacher supervision required	3
Assessment	
Quicker assessment	4
Objective assessment	3
Feedback on assessment	2
Decreased costs	1

AI Techniques Can Be Implemented At 3 Levels Of Medical Education: Tushar Garg, Medical Student quoting Noorbakhsh-Sabet

- Curriculum development and analysis, learning, and assessment.
- In curriculum assessment,
  - the use of AI helps to decrease the time needed to evaluate multiple curriculums,
  - solve multidimensional problems, provide greater classification accuracy, and establish a relationship between different variables.
- AI can be used to check the effectiveness of the curriculum and overall satisfaction of the medical students with the program, as this is important in training future doctors.
- In the learning process,
  - AI can help to provide students with adaptive and personalized educational content, which is further improved with student feedback and this, therefore, allows students to identify knowledge gaps and respond to them effectively
- Assessment of learning with the help of AI can help make the process of evaluation
  - more objective, fast, cost-efficient, and
  - provide extensive individualized feedback.

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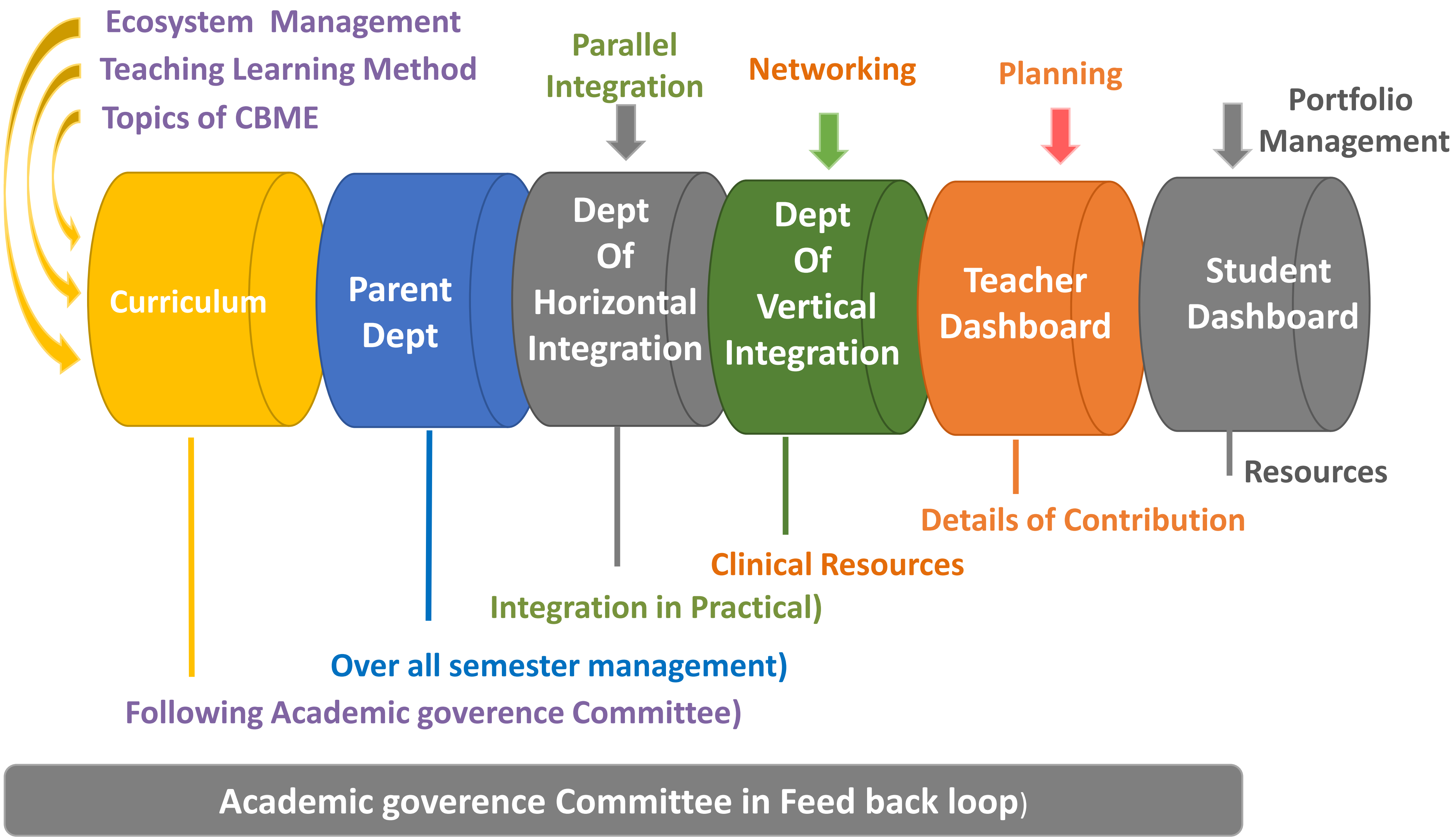
Academic Governance



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Aim Of AI system in Assessment

- To create a question paper based on designated Assessment parameters from a validated Question bank
- Multiple question papers need to be created based on Difficulty index and differentiation index
- Graded question paper, Progressive Difficult questions
- To follow routine procedure of Setting up a question paper
- Each exam center can have a different set of question paper so that problem of leakage to be addressed
- To use advanced methods like scenario based question / Real time patient scenario
- Question bank should have all types of assessment methods to suitably address desired competency

Calculation of Difficulty index and differentiation index of past question papers designing New Question paper using AI systems

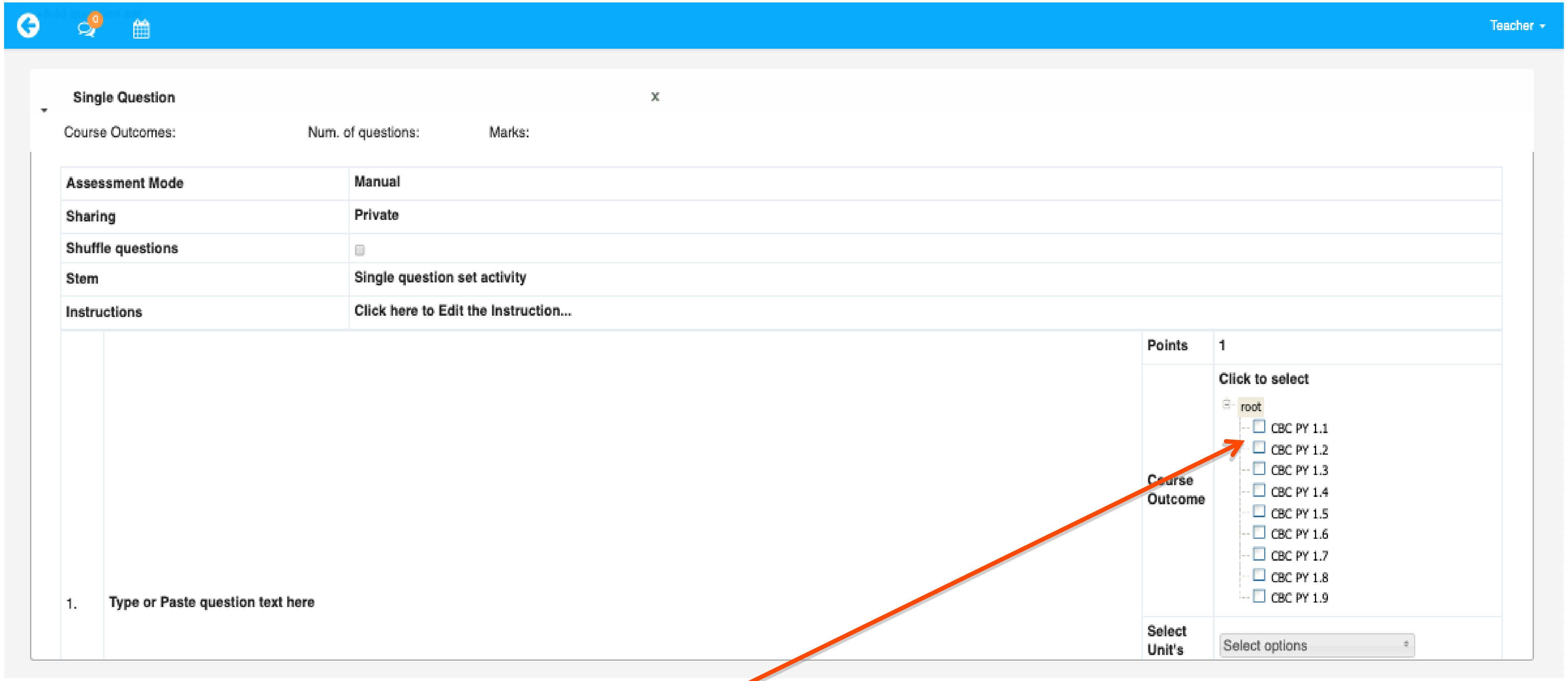
Creating Rubric for Assessments

Title	**Hydraulic Mechanics Rubric**
Description	**Description**

Criteria

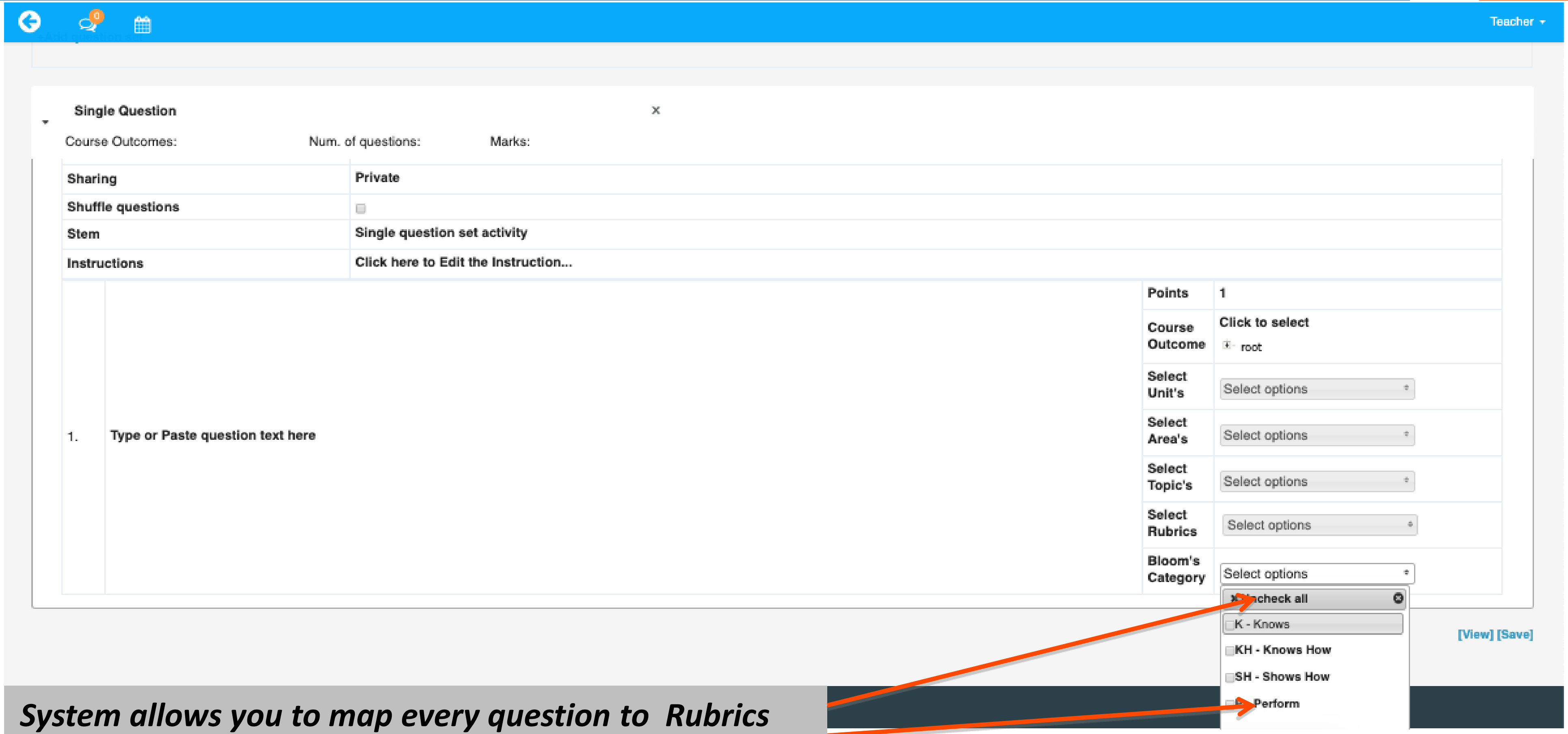
Criteria	Weightage (%)	Exceeds Expectation 92 - 100 %	Meets Expectation 72 - 91 %	Below Expectation 48 - 71 %	Below Expectation 0 - 47 %
		Lower Range:91	Lower Range:72	Lower Range:48	Lower Range:0
Writing Journal	40	Completed with Neat diagrams, observations and correct answers of post lab questions and conclusion	Fairly completed with neat diagrams, observations and correct answers of post lab questions and conclusions	Either of diagram / post lab questions is incomplete Completed after guidance from the Professor	Partially incomplete write-ups
Performance in lab	40	Designs and simulates independently with clear concepts	Designs and simulates independently but after trial and error	Designs and simulates with help of Professor	Not able to design and simulate even after help
Viva	20	All the concepts regarding the experiment are clear	All the concepts regarding the experiment are partially clear	All the concepts regarding the experiment are not clear	Very bad fundamental knowledge.

Mapping Questions to Competencies



System allows you to map every question to Competencies

Mapping Rubrics and Level of Competency



System allows you to map every question to Rubrics and level of Competencies

Assignments

More Capture Types

Assignments details for: PY - 2019 - Year I - General Physiology

Category	Assignments	Assigned/Start date	Due Date	Duration	Effort	Class Performance (avg.)
Exam	General Physiology Test	1/21/2019 8:31 PM	2/5/2019 8:31 PM	1:10 hrs		Avg: 7.47 (37.33%)
External	Functions of the cells and its products, its communicati…	1/22/2019	2/5/2019 11:59 PM	-		Avg: 5.43 (54.33%)
External	General Physiology Assignment	1/21/2019	2/4/2019 11:59 PM	-		Avg: 3.01 (75.17%)
External	Yenepoya Exam	1/23/2019	2/6/2019 11:59 PM	-		Avg: 3.36 (33.57%)
Lab	Functions of the cells and its products, its communicati…	1/22/2019	2/28/2019 11:59 PM	-		Avg: 5.43 (54.33%)
Project	Molecular basis of resting membrane potential and acti…	1/22/2019	2/28/2019 11:59 PM	-		Avg: 6.33 (63.33%)
Project	Transport mechanisms across cell membranes	1/22/2019	2/28/2019 11:59 PM	-		Avg: 5.97 (59.67%)
Test	Apoptosis – programmed cell death	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 5.97 (59.67%)
Test	Concept of pH and Buffer systems in the body	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 6.3 (63%)
Test	Fluid compartments of the body, its ionic composition a…	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 5.97 (59.67%)
Test	Intercellular communication	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 6 (60%)
Test	Principles of homeostasis	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 6.37 (63.67%)
Test	Structure and functions of a mammalian cell	1/22/2019 12:00 AM	2/28/2019 11:59 PM	1:0 hrs		Avg: 6 (60%)

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Reliability of tools

Testing time in hours	MCQ (1)	Case Based Essays (2)	PMP (1)	Oral Exams (3)	Long Case (4)	OSCE (5)	Mini-CEX (6)
1	0.62	0.68	0.36	0.50	0.60	0.47	0.73

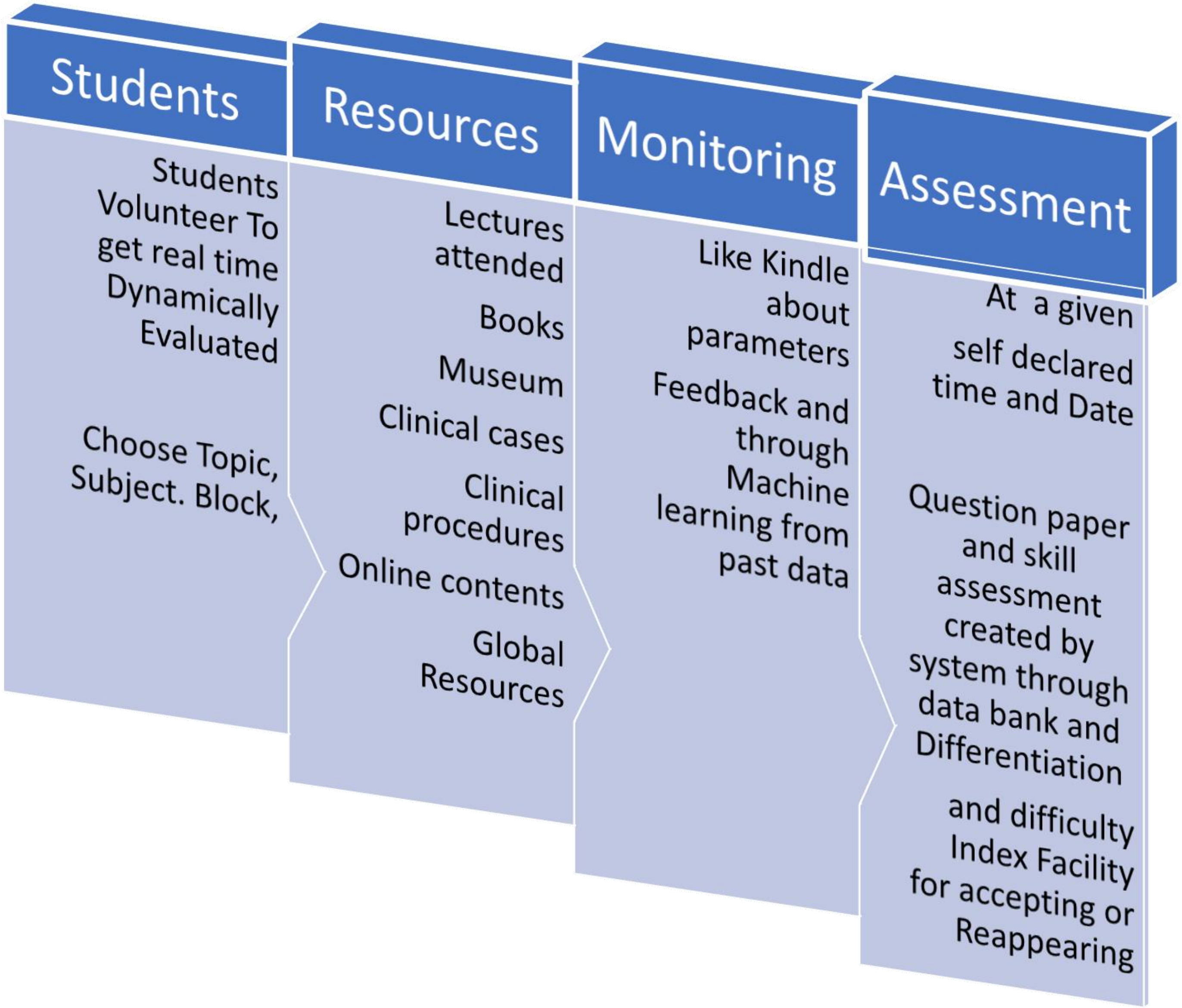
Role of subjectivity in Competency based Learning Dr Tejinder Singh

Reliability of tools

Testing time in hours	MCQ (1)	Case Based Essays (2)	PMP (1)	Oral Exams (3)	Long Case (4)	OSCE (5)	Mini-CEX (6)
1	0.62	0.68	0.36	0.50	0.60	0.47	0.73
2	0.76	0.74	0.53	0.69	0.75	0.64	0.84
4	0.93	0.84	0.69	0.82	0.86	0.78	0.92
8	0.93	0.84	0.82	0.90	0.90	0.88	0.96

1 Norcini et al., 1985; 2 Stalenhoef-Halling et al., 1990; 3 Swanson, 1987; 4 Wass et al., 2001; 5 Petrusa, 2002; 6 Norcini et al., 1999

Dynamic Real time assessment of student



Student

Quiz-Test 1 I Not submitted

[Start Time : 0.00] - [Test Duration : 00:00:00] - [Time Left : 0:00]

More Capture Types

Question Set 1 Of 1

Previous Next **Submit**

1 2

1. A newly posted junior doctor had difficulty in finding out base deficit/excess for blood in a given patient. An experienced senior resident advised a quick method to determine acid base composition of blood based on PC02- Which of the following is the likely method he suggested to predict acid base composition of blood? (1)

   A. Red ford normogram
   B. DuBio's normogram
   C. Goldman constant field equation
   D. Siggard-Andersen normogram

2. A newly posted junior doctor had difficulty in finding out base deficit/excess for blood in a given patient. An experienced senior resident advised a quick method to determine acid base composition of blood based on PC02- Which of the following is the likely method he suggested to predict acid base composition of blood? (1)

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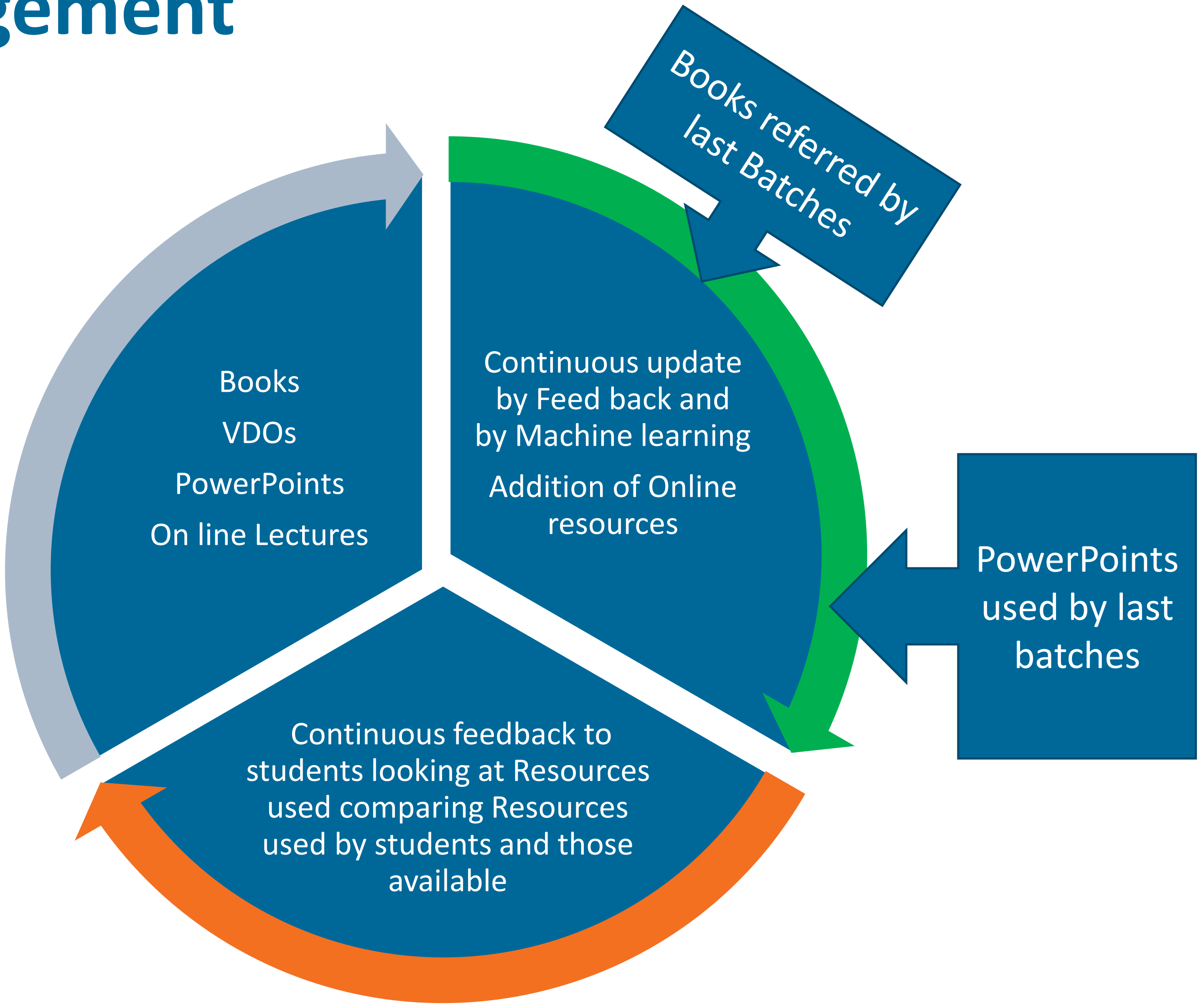
Resource management for Student

- Books
- Recorded VDOs
- Global Resources
- Online PowerPoints
- Live chat
- Related patient in Ward
- Related Operation in OT blocks

- Related patient in Ward
- Connect with EMR system of Medical college Hospitals
- SMS to student as per his area of study

- Related Operation in OT blocks
- Connects OT list of all Theater
- SMS to student as per his area of study

Resource management for Student



Artificial Intelligence Systems In Skill Training

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- AI system In Chatbots in medical education
- AI systems in Communication Skills
- AI systems in Direct Observation of Procedure Skills
- AI systems in Virtual Reality Technology
- AI systems in Training through Robotics
- AI systems in Clinical Diagnostic skills


SCENE SYSTEMS
US Airways flight 1549 leaves New York's
www.scenesystems.com

Laparoscopy simulators

Laparoscopy simulators Models Available

da Vinci Skills Simulator	dV-Trainer	RoSS	RobotiX Mentor
			

Current status of validation for robotic surgery simulators – a systematic review

Hamid Abboudi, Mohammed S. Khan, Omar Aboumarzouk*, Khurshid A. Guru†, Ben Challacombe, Prokar Dasgupta and Kamran Ahmed

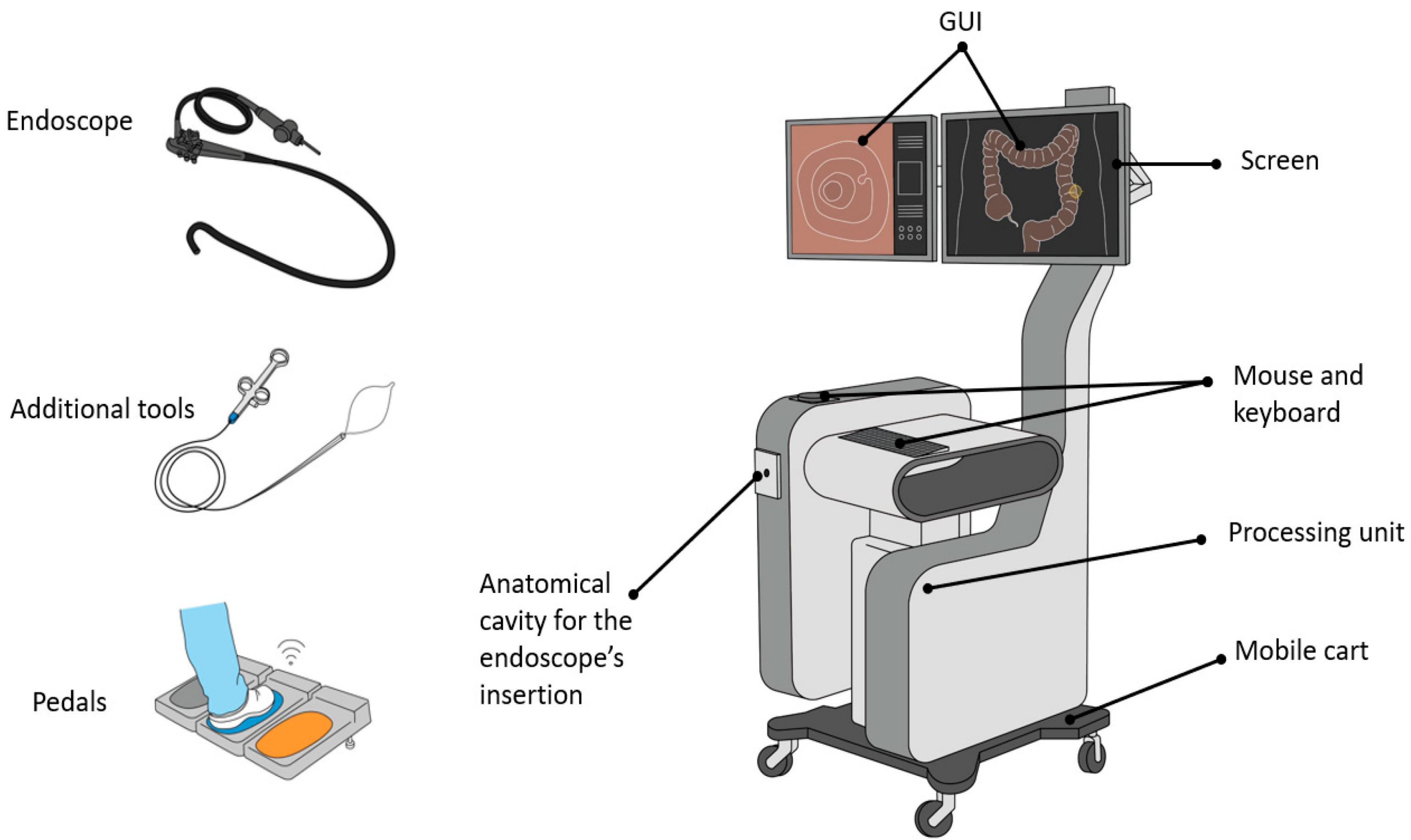
*MRC Centre for Transplantation, King's College London, King's Health Partners, Department of Urology, Guy's Hospital, London, *Department of Urology, Aberdeen Royal Infirmary, Aberdeen, UK, and †Department of Urology, Roswell Park Center for Robotic Surgery, Roswell Park Cancer Institute, Buffalo, New York, USA*

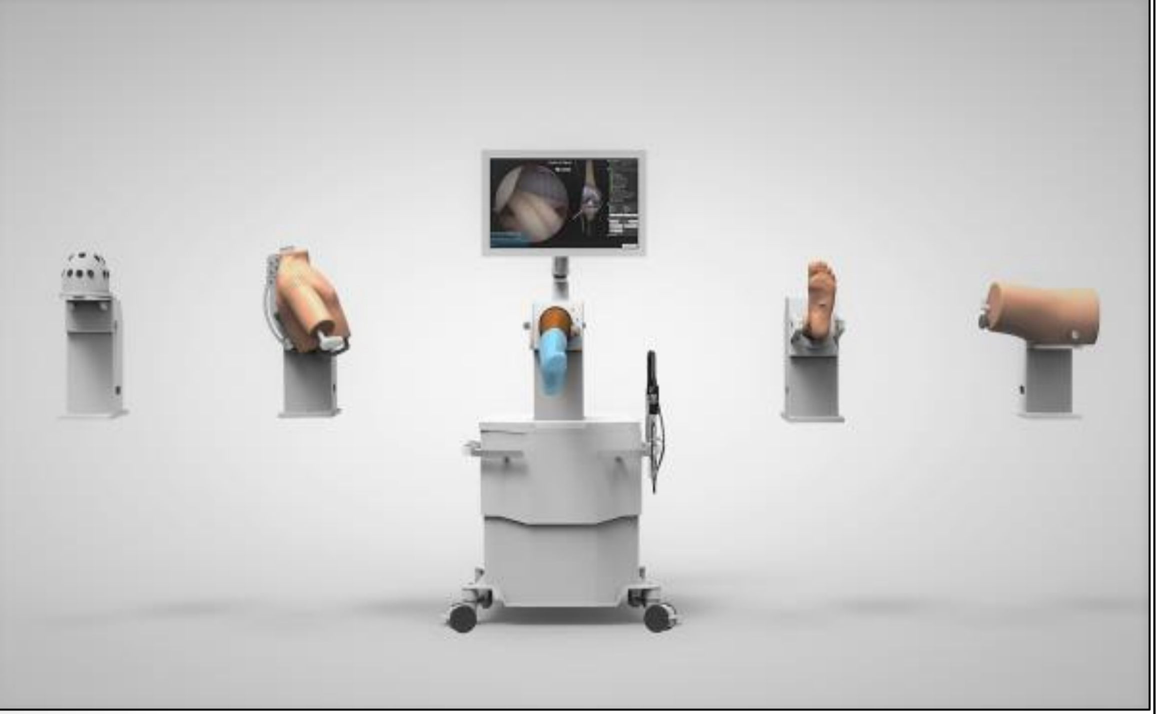
BJU International | 111, 194–205 |

Simulator Name	RoSS	SEP	ProMIS	MdVT	dVSS
Developer	Simulated surgical systems	Sim surgery	CAE healthcare	Mimic	Intuitive surgical
Endowrist manipulation	Yes	Yes	No	Yes	Yes
Camera and clutching	Yes	No	No	Yes	Yes
Fourth arm integration	Yes	No	No	Yes	Yes
System settings	Yes	No	Yes	Yes	Yes
Needle control and driving	Yes	No	Yes	Yes	Yes
Energy and dissection	Yes	No	No	Yes	Yes
Performance feedback	Yes	Yes	Yes	Yes	Yes
Developed for robotic surgery	Yes	Yes	No	Yes	Yes
Cost, USA dollars	120 000	62 000	35 000	158 000	89 000

AI guided Surgical orientation System

- AISOS is being developed
- Image data of all laparoscopically identifiable organs is loaded.
- Station and location of the instrument is identified.
- The system will guide you based on AI data of the organs surrounding.
- It will guide you toward the desired organ giving a hint of structures around lap Instruments.
- Ultrasonic tip will help you with the contents, vessels around, structure etc
- It will be like Google Maps instructions in Driving


Endoscope
Additional tools
Pedals
GUI
Screen
Mouse and keyboard
Processing unit
Anatomical cavity for the endoscope's insertion
Mobile cart



Orthopedics
Meet the VirtaMed ArthroS™ knee, shoulder, hip, and ankle simulator for arthroscopic skill training using an original arthroscope, camera and other surgical instruments adapted for simulation.

LaparoS™ Essential Skills
The perfect setup to practice essential laparoscopic skills while benefiting from mixed reality training. Objective feedback metrics provide proficiency-based feedback to help residents accelerate their learning curve.

Using a simulated 0° and 30° optic, residents can become proficient in camera navigation, eye-hand coordination, and development of ambidextrous psychomotor skills. All instruments have authentic ring handles and virtual instrument tips such as clip applicators, scissors, needle holder and atraumatic graspers.

VirtaMed UroS™ provides simulation training for TURP, TURB, and Laser Enucleation of the Prostate with Thulium (ThuLEP) or Holmium (HoLEP). Urologists learn to master instruments and manage complications without involving live patients. Didactic content and expert movies exemplify best techniques. Individual courses allow for personalized urologic surgery training.

Covers the entire spectrum of OB/GYN training: from obstetric ultrasound, to hysteroscopy, embryo transfer, and IUD placement
Validated to accelerate the learning process and improve student performance
Provides the most realistic training environment possible with photorealistic graphics and natural haptic feedback
Reduces training time and cost with proficiency-based training and assessment

Simulation Technology for Skills Training and Competency Assessment in Medical Education

Ross J. Scalese, MD, Vivian T. Obeso, MD, and S. Barry Issenberg, MD

The new outcomes-based educational paradigm serves as a suitable framework for considering the best applications of simulation technology for testing purposes.
The Accreditation Council for Graduate Medical Education (ACGME) in the US describes 6 domains of clinical competence:

1) patient care,
2) medical knowledge,
3) practice-based learning and improvement,
4) interpersonal and communication skills,
5) professionalism,
6) systems-based practice.[24]

Evaluators may use simulations to assess various knowledge, skills, and attitudes within these domains.

During a ward rotation for Internal Medicine residents, for example, faculty can test
1. aspects of trainees' patient care:
using a cardiology patient simulator, demonstrate the ability to perform a focused cardiac examination and identify a fourth heart sound or a murmur.
We can evaluate medical knowledge: using a full-body simulator during a simulated cardiac arrest, verbalize the correct steps in the algorithm for treatment of pulseless electrical activity.
We can assess interpersonal and communication skills and professionalism: during a simulation integrating an SP with a plastic mannequin arm,demonstrate how to draw blood cultures while explaining to the patient the indications for the procedure.

Virtual reality simulation training for health professions trainees in gastrointestinal endoscopy :
Rishad Khan, Joanne Plahouras, [...], and Cochrane

Endoscopy has traditionally been taught with novices practicing on real patients under the supervision of experienced endoscopists. Recently, the growing awareness of the need for patient safety has brought simulation training to the forefront. Simulation training can provide trainees with the chance to practice their skills in a learner-centered, risk-free environment. It is important to ensure that skills gained through simulation positively transfer to the clinical environment.

Virtual reality endoscopy simulation training versus no training: There was insufficient evidence to determine the effect on composite score of competency (MD3.10, 95% CI-0.16 to 6.36; 1 trial, 24 procedures; low-quality evidence).
The composite score of competency was based on a 5-point Likert scale assessing seven domains:
atraumatic technique, colonoscope advancement, use of instrument controls, flow of procedure, use of assistants, knowledge of specific procedures, and overall performance.
The scoring range was from 7 to 35, a higher score representing a higher level of competence.

- Virtual reality training compared to no training likely provides participants with some benefit, as measured by independent procedure completion (RR 1.62, 95% CI 1.15 to 2.26; 6 trials, 815 procedures; moderate-quality evidence).
- We evaluated the overall rating of performance (MD 0.45, 95% CI 0.15 to 0.75; 1 trial, 18 procedures),
- visualization of mucosa (MD 0.60, 95% CI 0.20 to 1.00; 1 trial, 55 procedures),
- performance time (MD -0.20 minutes, 95% CI -0.71 to 0.30; 2 trials, 29 procedures),
- and patient discomfort (SMD -0.16, 95% CI -0.68 to 0.35; 2 trials, 145 procedures),
- No trials reported procedure related complications or critical flaws (e.g. bleeding, luminal perforation) (3 trials, 550 procedures; moderate-quality evidence).

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Artificial Intelligence and Virtual Reality (VR)

- A support vector machine algorithm was used on the data gathered from the hemi-laminectomy done on VR by different surgeons of varying surgical skills. It achieved 97.6% accuracy
- AI based VR training has also been used in neurosurgery. Using 4 metrics of safety of safety and movement a framework called virtual operative assistant was created.
- This provides a metric wise assessment based on weight of each metric. This can be applied to evaluate the skill level of the trainees3
- Another AI aided VR study was carried out for neurosurgical tumor resection skill assessment. Using machine learning participants were classified into 4 levels based on their skill level with an accuracy of 90%38.
- Similarly VR simulated anterior cervical discectomy was done in which 21 individuals participated. Using 16 metrics neural network was trained which classified the participants according to their skill levels with testing accuracy of 83.3% and training accuracy of 100% 39.

MLASE (Machine Learning to Assess Surgical Expertise

- MLASE (Machine Learning to Assess Surgical Expertise) checklist was designed to bridge the gap between different specialties.
- The checklist includes 4 sections i.e.
- Quality of discussion, design of the Study,
- Structure of Data
- Supervised Machine Learning
- Further divided into subsections which are given certain points.
- This checklist provides a scoring system to assess the AI based VR system capable of assessing surgical expertise.
- . AI based VR systems are very useful for surgical training, but it is very difficult to develop them and inter-specialty communication is not good.

Year	Article	Author(s)	Research method	Themes Identified
2020	Video Commentary & Machine Learning: Tell Me What You See, I Tell You Who You Are	Mohamed S Baloul , Vicky J-H Yeh , Fareeda Mukhtar	Secondary Analysis Study	Using AI to find a Correlation between Individual's skill and Video commentary score
2020	Machine Learning and Artificial Intelligence in Surgical Fields	Melissa Egert , James E Steward , Chandru P Sundaram	Literature review	A review of use of ML and AI in different surgical fields
2019	Artificial intelligence and robotics: a combination that is changing the operating room	Iulia Andras , Elio Mazzone , Fijs W B van Leeuwen	Narrative literature review	Application of Artificial intelligence in robotics
2020	Development of an artificial intelligence system using deep learning to indicate anatomical landmarks during laparoscopic cholecystectomy	Tatsushi Tokuyasu , Yukio Iwashita , Yusuke Matsunobu	Prospective study	AI assisted detection of anatomical structures; Application of AI in procedures
2019	Artificial Intelligence in Medical Education: Best Practices Using Machine Learning to Assess Surgical Expertise in Virtual Reality Simulation	Alexander Winkler-Schwartz , Vincent Bissonnette , Nykan Mirchi	Prospective study	AI based skill assessment in Virtual Reality (VR) and Simulations
2020	The era of artificial intelligence and virtual reality: transforming surgical education in ophthalmology	Shaunak K Bakshi , Shawn R Lin , Daniel Shu Wei Ting	Review article	Use of AI in ophthalmology
2020	The digital surgeon: How big data, automation, and artificial intelligence will change surgical practice	James Wall , Thomas Krummel	Review article	Artificial intelligence shaping the future of surgery
2020	VR and machine learning: novel pathways in surgical hands-on training	Domenico Veneziano , Giovanni Cacciamani , Juan Gomez Rivas	Systematic Review	AI based skill assessment in Virtual Reality (VR) and Simulations
2019	Machine Learning Identification of Surgical and Operative Factors Associated With Surgical Expertise in Virtual Reality Simulation	Alexander Winkler-Schwartz , Recai Yilmaz , Nykan Mirchi	Prospective study	AI based skill assessment in Virtual Reality (VR) and Simulations
2020	Evaluation of Deep Learning Models for Identifying Surgical Actions and Measuring Performance	Shuja Khalid , Mitchell Goldenberg , Teodor Grantcharov	Prospective study	AI based surgical skill assessment
2019	Surgical skill levels: Classification and analysis using deep neural network model and motion signals	Xuan Anh Nguyen , Damir Ljuhar , Maurizio Pacilli	Prospective study	AI based surgical skill assessment
2019	Video-based surgical skill assessment using 3D convolutional neural networks	Isabel Funke , Sören Torge Mees , Jürgen Weitz	Prospective study	AI based surgical skill assessment
2020	A machine learning approach to predict surgical learning curves	Yuanyuan Gao , Uwe Kruger , Xavier Intes	Prospective study	AI based prediction of surgical learning curves
2019	Accurate and interpretable evaluation of surgical skills from kinematic data using fully convolutional neural networks	Hassan Ismail Fawaz , Germain Forestier , Jonathan Weber	Prospective study	AI based skill differentiation from kinematic data
2020	Automated Surgical Instrument Detection from Laparoscopic Gastrectomy Video Images Using an Open Source Convolutional Neural Network Platform	Yuta Yamazaki , Shingo Kanaji , Takeru Matsuda	Prospective study	AI based detection of surgical instrument manipulation in video recording
2020	Artificial Neural Networks to Assess Virtual Reality Anterior Cervical Discectomy Performance	Nykan Mirchi , Vincent Bissonnette , Nicole Ledwos	Prospective study	AI based skill assessment in Virtual Reality (VR) and Simulations

Artificial Intelligence Systems In Skill Training

- AI systems in Simulation Technology
- AI system In Chatbots in medical education
- AI systems in Communication Skills
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- AI systems in Training through Robotics
- AI systems in Clinical Diagnostic skills

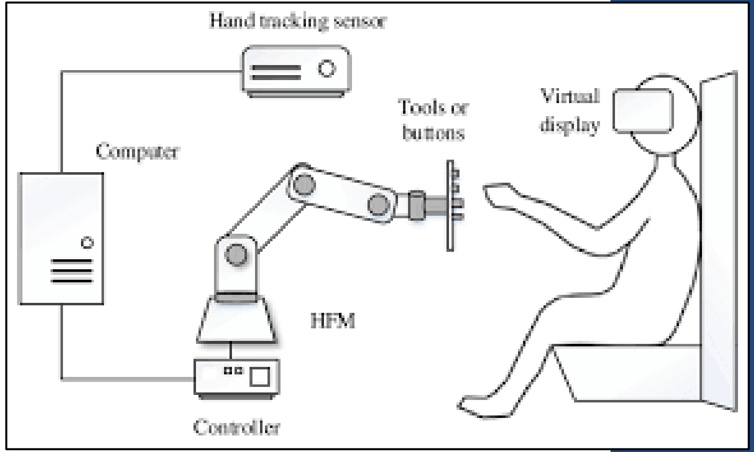
AI systems in Training through Robotics

Surgical Skill Assessment:

- With the advances in robotic surgery, it is possible to get data from the robot in many forms.
- It can be in form of video data or in form of kinematic data.
- Processing this vast amount of data is an expensive and time taking task but with the use of machine learning it is doable.
- Initial studies used kinematic data for skill assessment.
- For AI based surgical skill evaluation, kinematic data using global movement metrics i.e. depth perception, task completion time, smoothness of motion, length of path, velocity, curvature etc. have been used20
- The surgeon’s movement style can also be used to assess the surgical skill.
- This can be done by using electromagnetic sensors attached on the shoulders, wrists and hands of the surgeon
- Robots like Da Vinci can collect data like motion of camera and surgical instrument which can be classified by machine learning according to the surgical skill of trainee
- Tool based metrics and cognitive based metrics have also been applied to classify expert and non-expert surgical trainees by machine learning.

Haptic Feedback

Haptics generally describes **touch feedback, which may include kinesthetic (force) and cutaneous (tactile) feedback**. In manual minimally invasive surgery (MIS), surgeons feel the interaction of the instrument with the patient via a long shaft, which eliminates tactile cues and masks force cues.



- Modality of touch is very important in surgical training.
- Robotics have made it possible to gauge the tactile force being applied by the surgeon.
- Machine learning has been applied to develop a system which gives warning of suture breakage when the tactile force is strong enough to break the suture.
- This ML based system was successful in decreasing the rate of suture break 25,26.

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Video analytics for DOPS
Direct Observation of Procedure Skills

- Video analytics are being used for sport skill training.
- Tennis and Cricket players used this to study movements and counter action
- Result of the study was to determine the effects of video modeling on skill acquisition in learning the handball shoot.5-weeks of Video modeling significantly improved the accuracy in handball shot. Furthermore, the finding showed no effect in shoot power. Then video modeling may not be associated with muscle strength
- Hand motion entropy and timing metrics discriminate levels of surgical skill and training, and these findings are congruent with individual procedure score evaluations. These measures can be collected using consumer-level cameras and analyzed automatically with free software. Hand motion with video timing data may have widespread application to evaluate resident performance and can contribute to the range of evaluation and testing modalities available to educators, training course designers and surgical quality assurance programs

Fig. 1 The centers of the minimum rectangular boxes defined by the glove colors (shown as red dot) were calculated for each video frame to define the position of the hand. Shannon joint entropy was used to calculate speed (pixels/s), acceleration (change in speed/s) and change of direction (degree) with a resolution of 1 s

Table 1 Metrics derived from observational video analysis and computationally derived hand motion entropy

	Anatomists $n = 2$	Experts $n = 2$	Residents pre-training $n = 2$	Residents post-training $n = 2$	Residents retention $n = 2$
Total time in seconds (range)	1030 (815–1246)	315 (303–328)	Both > 1200	619 (328–911)	461 (413–509)
Mean incision time to pectoralis minor	99	64	842	120	120
Active time (range)	968 (785–1152)	307 (294–320)	> 1200	589 (308–871)	425 (391–460)
Idle time as a percent of active	5.6	2.9	5.1	5.1	8.3
Active/idle time ratio	15:1	33:1	19: 1	20:1	12:1
Number of instrument changes (range)	67 (45–89)	23 (22–23)	97 (50–143)	35 (25–44)	50 (44–55)
Dissection sharp/blunt	1.6:1	2.4:1	7.3:1	4.5:1	5:1
IPS score [5–8]	NA both anatomists were study evaluators	79%	49%	75%	62%
Joint entropy (speed/acceleration/direction)	9.15/9.17/3.29	7.29/7.31/3.25	NA. No colored gloves worn	8.55/8.62/3.36	8.47/8.63/3.40

Resident retention = data obtained 12 or 18 months after training. Values are shown as means with ranges in parentheses. Timing (ranges) in seconds and joint entropy measures compared with values of individual procedure score (IPS). NA = not available

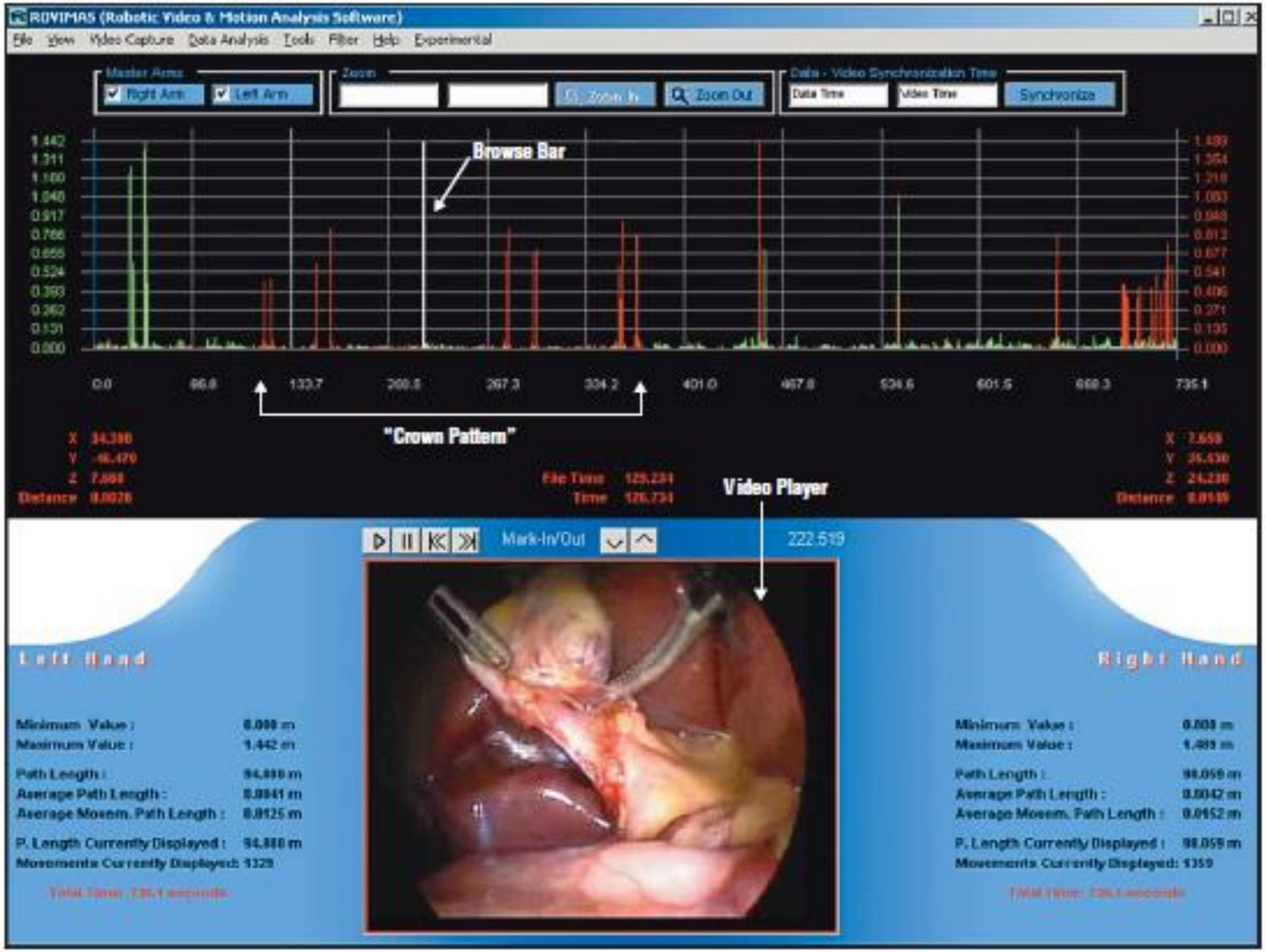


Figure 3. Snapshot of the Robotic Video and Motion Analysis Software (ROVIMAS) showing the crown pattern during a laparoscopic cholecystectomy case in which each pair of 2 high-velocity peaks represents extraction-insertion of the scissors-stapler instrument. Users can browse these data using the "browsing bar" and watch the corresponding video frames from the video player. P indicates path.

ORIGINAL ARTICLE

Synchronized Video and Motion Analysis for the Assessment of Procedures in the Operating Theater

Aristotelis Dosis, MSc; Rajesh Aggarwal, MRCS, Eng; Fernando Bello, PhD; Krishna Moorthy, MD; Yaron Munz, MD; Duncan Gillies, PhD; Ara Darzi, MD

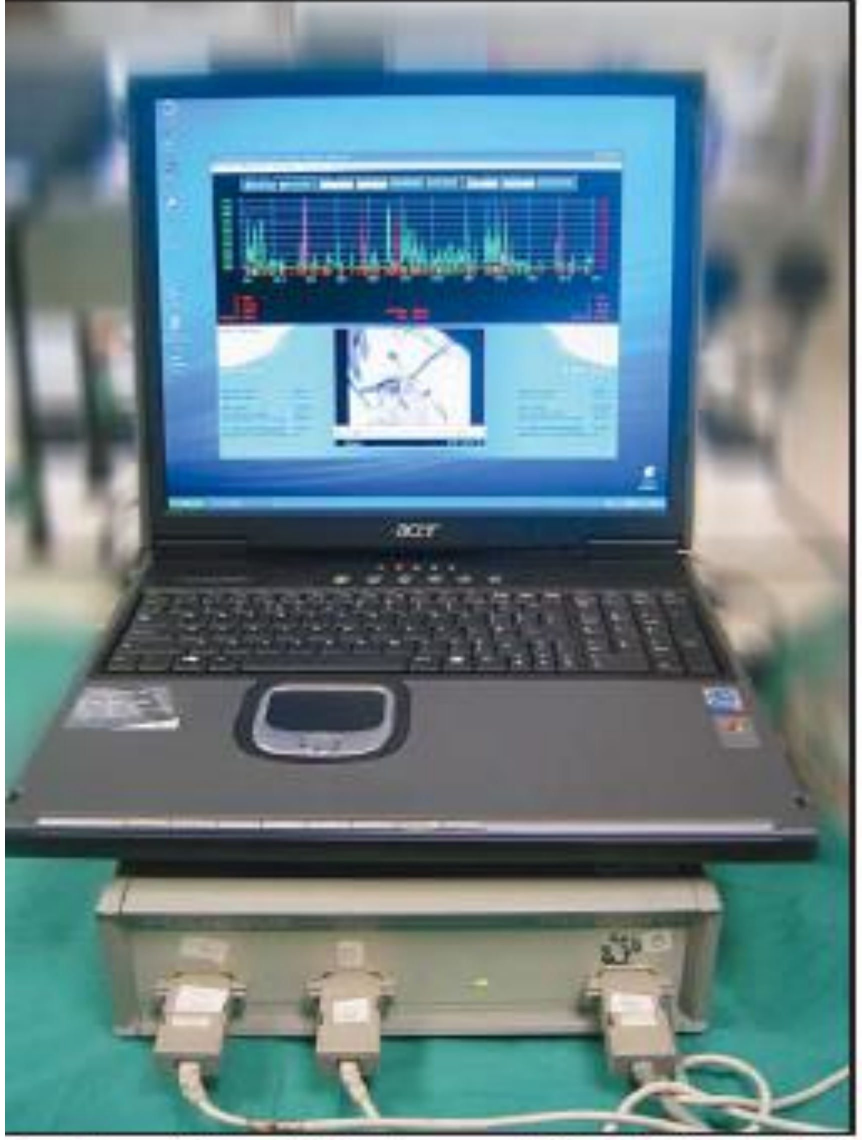
Hypothesis: Objective assessment of surgical skill has recently been shown to be possible through the use of dexterity-based and video analysis systems. The aim of this study was to synchronize these 2 modalities to produce a comprehensive surgical assessment tool.

Design: The Imperial College Surgical Assessment Device is a dexterity-based motion analysis device that has been developed in the Department of Surgical Oncology and Technology by the Surgical Computing and Imaging Research Group. Further advances to this system have been made to enable synchronized acquisition of hand kinematics and video from real procedures, and their concurrent analysis. To test the feasibility of the system, 10 laparoscopic cholecystectomies performed by 5 different surgeons on consenting patients were recorded. Analysis focused on the entire procedure and also on specific parts of the operation such as the clipping and cutting of the cystic duct and artery.

Results: Dexterity analysis was performed using the objective measures of time, path length, number of movements, velocities, and trajectories. Comparative analysis of a surgeon's dexterity was carried out on the whole procedure and by using the synchronized zoom facility in the software. Kinematic signals revealed rapid changes in velocity caused by alternating between different instruments or occurring after complications such as bleeding.

Conclusion: This new motion analysis system has been shown to be an effective tool for the comprehensive assessment of operative procedures.

Arch Surg. 2005;140:293-299



igure 1. Imperial College Surgical Assessment Device (ICSAD). The ICSAD ystem consists of 3 components. A commercially available electromagnetic racking system (Isotrak II; Polhemus Inc, Colchester, Vt) connected to a ortable computer through a standard RS-232 (serial) port, an independent notion acquisition software, and bespoke analysis software for converting he positional data of the trackers into dexterity measures. The Isotrak II ystem consists of an electromagnetic field generator and 2 sensors that vere attached to the dorsum of the surgeon's hands

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I-DOCTOR INTRODUCTION

i-Doctor, is an attempt to go beyond current telemedicine model and support Indian citizens to get affordable health care services within their vicinity.

Patient's Interaction

Intelligent Diagnosis

Medicine Dispensing

AADHAA

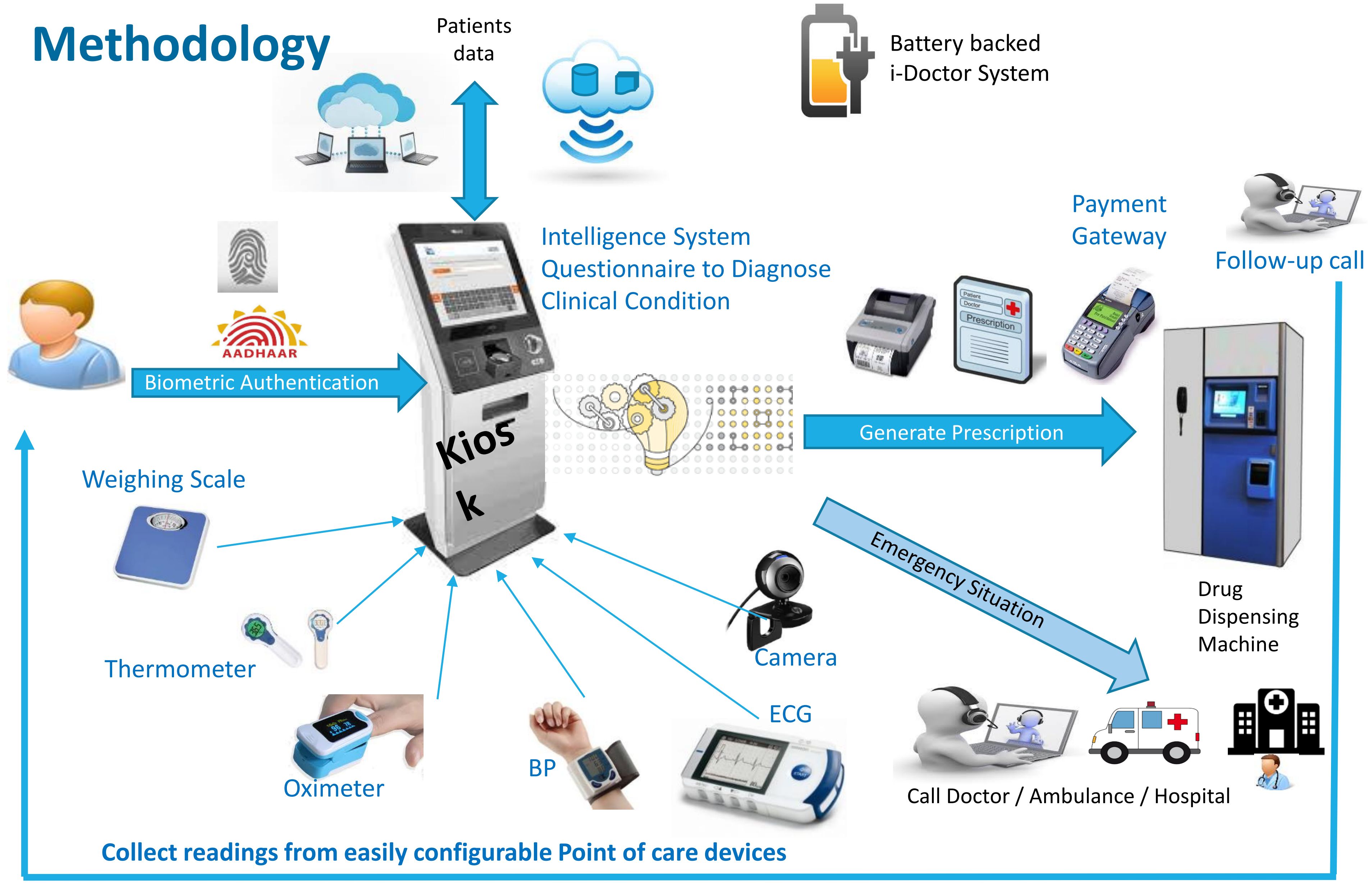
Point of Care devices

50+ Clinical Conditions

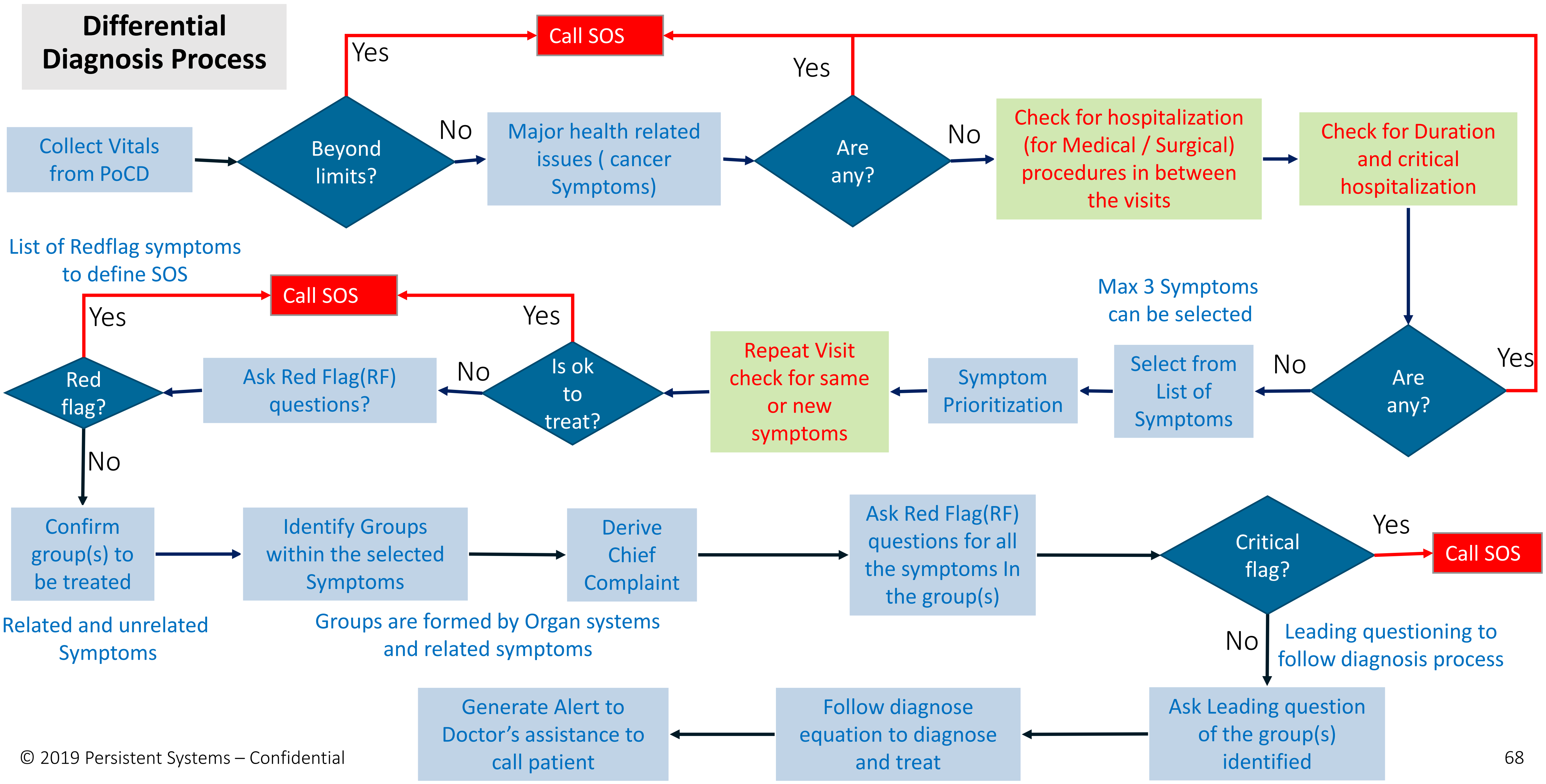
100+ Medicines

Battery backed i-Doctor System

i-Doctor Methodology



i-Doctor Diagnosis Process



Sample Workflow
Attributes and Combinations: Abdominal Pain

R1
Pain type
A) Dull aching
B) Throbbing
C) Colicky
D) Burning
E) Stabbing/Sharp shooting
F) Non specific

R2
Pattern of Pain
A) Continuous
B) Intermittent
C) Recurrent
D) Can't say

R3
Pain Site
A) Generalised
B) Localised

R4
Pain Radiating to
A) Yes
a)epigastric
b) Rt.hypochondriac
c) Lt.hypochondriac
d)Rt. Lumbar
e)Lt. Lumbar
f) Rt.Iliac
g) Lt.Iliac
h) umbilical
i)Hypogastric
j) Penis / Volva
B) No

R5
Pain Onset
A)Sudden
B) Gradual

R6
Pain Duration
A)<48hrs
B)2 - 7 days
C) 7 days - 30 days
D) more than 30 day

R7
Pain Severity
A) Mild - 1 to 3
B) Moderate - 4 to 7
C) Severe - 7 to 10

R8
Aggravating Factors
A) Yes
a) Empty stomach
b) After meals
B) No
2) Relieving Factors:
A) Yes
a) Empty stomach
b) After meals
c) Pressure
d) Bending
B) No

R9
Nausea
A) Yes
B) No

R10
Vomiting
A) Yes
B) No

R11
Current Medications
1) Yes
A) NSAIDS (Pain killers)
B) Steroids
C) Aspirin (Blood diluting medicines)
2) No

Combinations:
R1 (D) + R2 (A) + R3(A) + R4 (A)(a) +R5 (A) + R6 (A) + R7(B)/(C) + R8(A)(a) + R9(A) +R10(B) + R11 (1)(A)

Burning + Continuous + Generalised + epigastric + Sudden + <48hrs duration + (Moderate OR Severe) + Empty stomach aggravates + Nausea + No Vomiting + Current Medications: NSAIDS (Pain killers)

Provisional Diagnosis:
NSAIDS Induced Gastritis

Medication:
1) T- Ranitidin 300 mg
Or T- Omiprizol 20 mg
2 Times a Day

I doctor for teaching and Evaluating diagnostic skills

- This is an AI-based flow chart to have the differential diagnosis.
- It can be used for history taking of symptoms
- It can be used for the assessment of students to evaluate clinical diagnostic skills

Recent algorithm-based diagnostics approved by US FDA

PersistentLabs

PERSISTENT

Most of these approvals happened in last 12-18 months. Half of them in last 6 months.
It is a new trend and we (in India) can take the lead, while serving our own people.

Quantib	Medical imaging (MRI)
CureMetrix	Medical imaging (Mammography)
BrainScope	Concussion Assessment (multi-modal)
Apple	Atrial fibrillation detection
Aidoc	Medical imaging (CT scan)
iCAD	Medical imaging (Mammography)
Zebra Medical	Medical imaging (CT scan)
Bay Labs	Medical imaging (echocardiogram)
Neural Analytics	Device for Paramedic stroke Diagnosis
IDx	Diabetic retinopathy diagnosis
Icometrix	Medical imaging (MRI)
Imagen	Medical imaging (X-ray)
SyncThink	Eye movement disorders

Viz.ai	Medical imaging (CT scan)
Arterys	Medical imaging (MRI and CT)
MaxQ-AI	Medical imaging (CT)
Alivecor	Atrial fibrillation detection
DreaMed	Diabetes treatment decision
Arterys	Medical imaging (MRI)
Empatica	Warning of seizure risk
Subtle Medical	Medical imaging
Cognoa	Autism diagnosis
Healthy.io	Urinary tract infection diagnosis
Excel Medical	Remote monitoring
FibriCheck	Atrial fibrillation detection
ScreenPoint Medical	Medical imaging (Mammography)

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Using a computer simulation for teaching communication skills: A blinded multisite mixed methods randomized controlled trial

Frederick W. Kron, MD*,

MPathic-VR (an acronym derived from the grant Modeling Professionalism and Teaching Humanistic Communication in Virtual Reality, is a computer-based system designed to address this need.

- Each conversational exchange between the learners and virtual humans is based on learning objectives directed at specific communication skills includin: reflective listening, empathy enhancers, avoiding empathy blockers, appropriate use of facial expression (i.e., brow raises, smiles) or body language (i.e., nodding, body lean), which support the development of rapport [62].
- Learning objectives were drawn from established communication protocols,
- SPIKES (Set-up, Perception, Invitation, Knowledge, Emotion, Summary) emphasizes principles for breaking bad news,
- CRASH (Culture, Respect, Assess and Sensitivity and Self-awareness, Humility) emphasizes principles of cultural competence, and
- Team STEPPS (Team Strategies and Tools to Enhance Performance and Patient Safety) emphasizes

.

MPathic-VR virtual human simulation is not solely skills-based. It also allows for creativity, because learners can view themselves in conversation with virtual humans and repeat interactions, during which they are free to experiment with different dialogue, expressions, and body language

Investigators conducted a single-blinded, mixed methods, randomized controlled trial at three medical schools

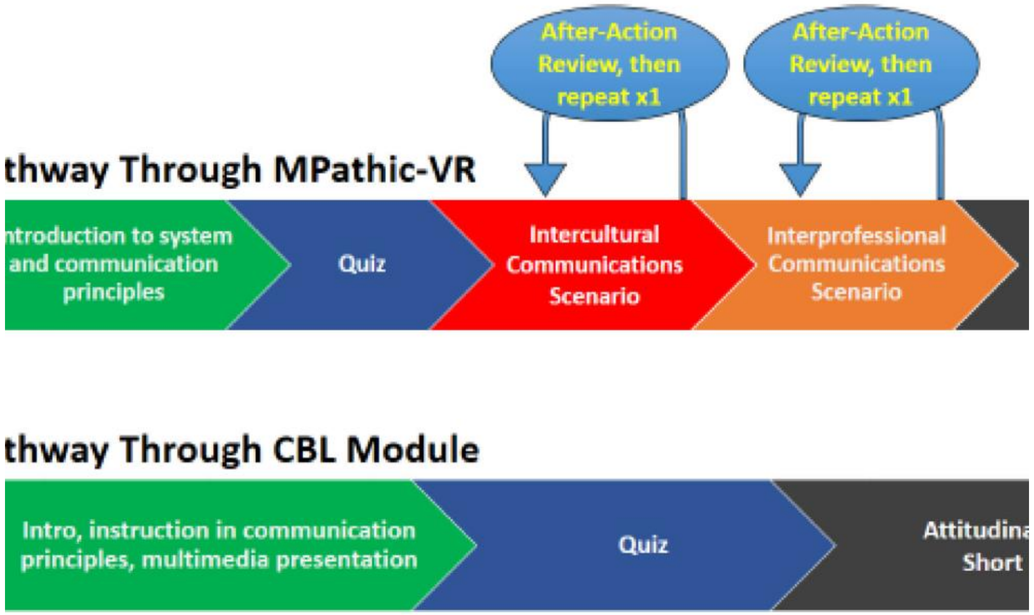

Figure 2.
Experience flow through the MPathic-VR computer simulation and the Computer-Ba Learning control

Comparison of Communication Skills on the Advanced Communication OSCE

- A higher score on the advanced communication OSCE represented better performance.
- A MANOVA showed a main effect for module, Pillai's trace=0.04, $F(4, 411)=4.08$, $p=.003$, $\eta 2 =0.0382$.
- A post hoc univariate analysis was conducted with $\alpha=.05/4=.0125$, revealing a main effect for the nonverbal communication scale, $F(1,414)=13.70$, $p=.0002$, $\eta 2 =0.0320$.
- all of the means for the MPathic-VR students were higher than those of the CBL students, and some of the univariate effects approached significance.
- The investigators therefore created a global composite from the four OSCE rating scale items and conducted an ANOVA on the global composite.

- Coefficient alpha [130] for the OSCE items was $\alpha=0.82$. This analysis indicated a main effect for module, $F(1, 414)=6.09$, $p=.0140$, $\eta 2 =0.0145$. Thus, OSCE evaluators rated the communication skills of MPathic-VR-trained students significantly higher ($M=.806$, $SD=.201$), than CBL students ($M=.752$, $SD=.198$).

Highlights

- Students improved their communication skill with repeated use of MPathic-VR.
- Knowledge transferred from MPathic-VR to a clinically realistic OSCE scenario.
- Attitudinal ratings were higher for MPathic-VR students than for CBL students.
- Evaluation of students' training experiences favored MPathic-VR over CBL.
- MPathic-VR may offer an effective and engaging way to train communication skills.

Cold technologies and 'warm' hands-on medicine need to walk hand-in-hand

- Technologies, such as deep learning , Machine Learning, and Artificial Intelligence (AI), promise benign solutions to thorny, complex problems; but this view is misguided.
- While AI has revolutionized aspects of technical medicine, it has brought in its wake practical, conceptual, pedagogical and ethical conundrums.
- For example, widespread adoption of technologies threatens to shift emphasis from 'hands on' embodied clinical work to disembodied 'technology enhanced' fuzzy scenarios muddying ethical responsibilities.
- Where AI can offer a powerful sharpening of diagnostic accuracy and treatment options, 'cold' technologies and 'warm' hands-on medicine need to walk hand-in-hand.

Medical Education Meets Artificial Intelligence: "Does Technology Care?"
A G Van der Nieta,b, A. Bleakleyc 2020

Conclusion

- Artificial Intelligence (AI), deep learning, Machine Learning, and promise solutions in skill training and Medical Education, Evaluation and governance
- Simulation technology, Virtual Real Technology, and Robotics can smoothen the process of skill Education.
- Communication skills and Skill Evaluation can be effective with AI.
- AI can add an edge in Clinical Diagnostic skills and other cognitive domains
- Machines lack human qualities such as empathy and compassion, and therefore patients must perceive that consultations are being led by human doctors. Furthermore, patients cannot be expected to immediately trust AI; a technology shrouded by mistrust


Thank You!