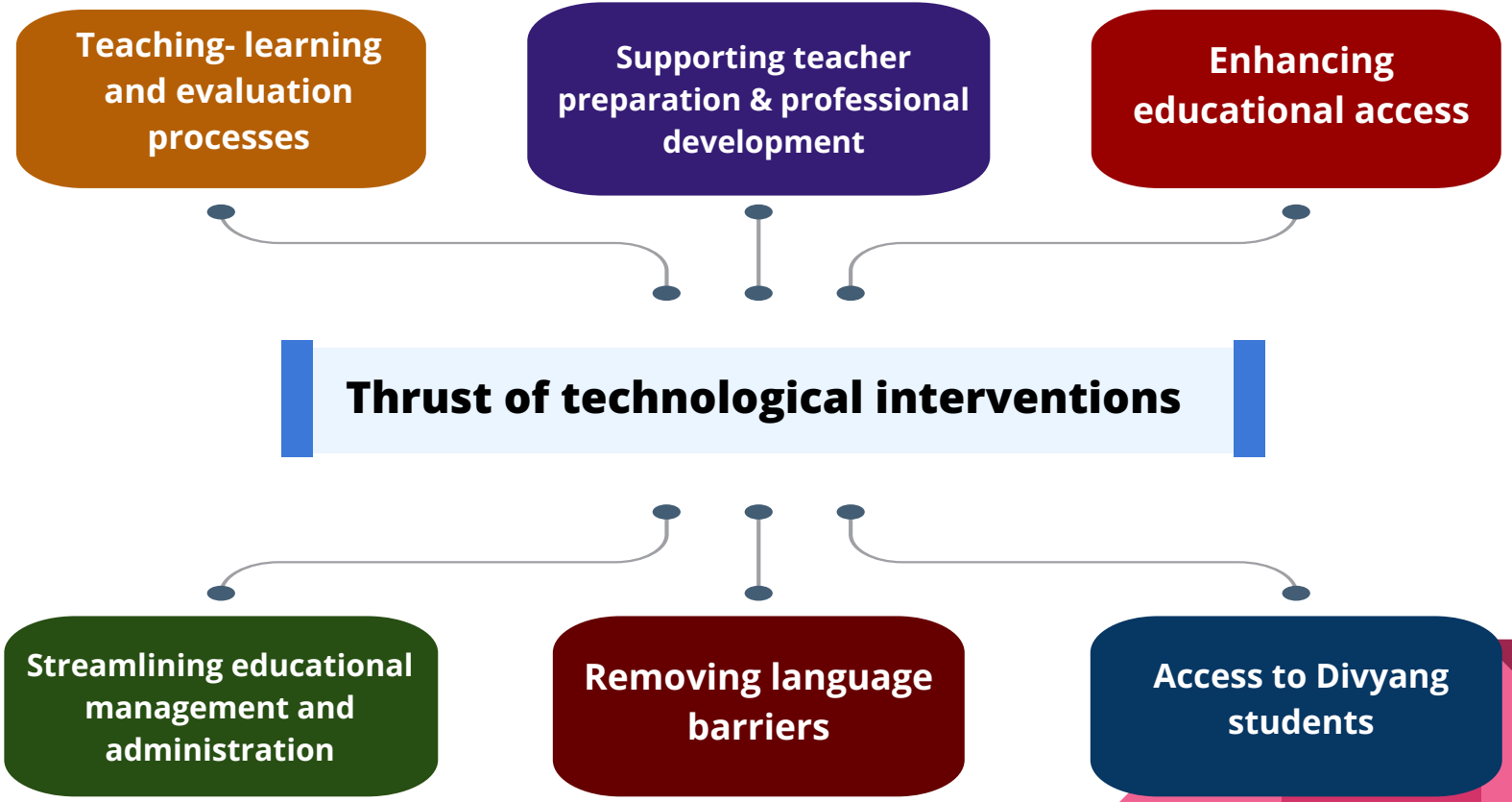
Learning Technologies

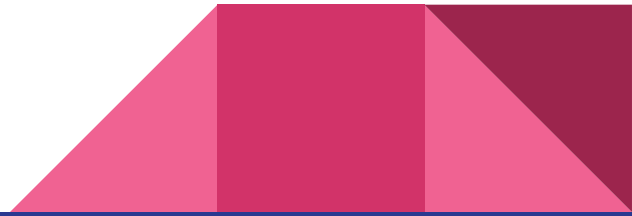
Dr. Rejaul Karim Barbhuiya
National Council of Educational Research and Training (NCERT)
New Delhi, India

National Education Policy 2020



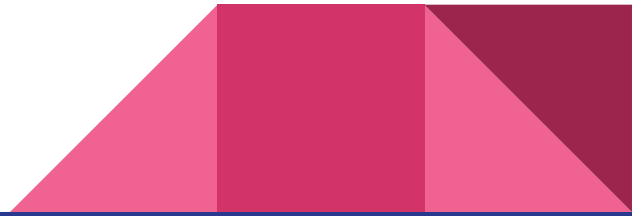
Artificial Intelligence

- Ability of computers (and Robots) to emulate/mimic human cognitive processes
- Analyse data, trigger action without human intervention
- Prominent AI techniques:
  - machine learning
  - deep learning
  - neural networks
  - computer vision
  - natural language processing



Human Cognitive Processes

- Perception (Visual and Auditory)
- Learning
- Reasoning
- Problem Solving
- Language Understanding and Generation
- Pattern Recognition
- Motor Control and Robotics



Machine Learning

Technologies and algorithms through which systems learn - identify patterns, make decisions, and improve themselves through experience and data.

DL is a branch of ML, applies advanced and complex Neural Networks

AI Application Domains

- Manufacturing Industry
  - Identify equipment errors
  - predicts maintenance/repair requirements of machines
- Banking
  - detect and prevent fraud and cybersecurity attacks
  - biometrics and computer vision to authenticate user identities
  - chatbots and voice assistants to automate customer service

AI Application Domains

- Health Care
  - Analyzing electronic health records using ML to provide clinical decision support
  - Analyse images of various scan to detect disease
- Education
  - Personalised Learning
  - Automate admission, Transfer
  - Holistic Evaluation and guidance

Core AI and ML Applications in Mimicking Human Cognition

- **Predictive analytics** - predict trends and behavioral patterns by discovering cause-and-effect relationships in data.
- **Speech recognition and natural language understanding** - identify words in spoken language, and recognize meaning in written or spoken language.
- **Recommendation engines** - data analysis to recommend products that someone might be interested in.

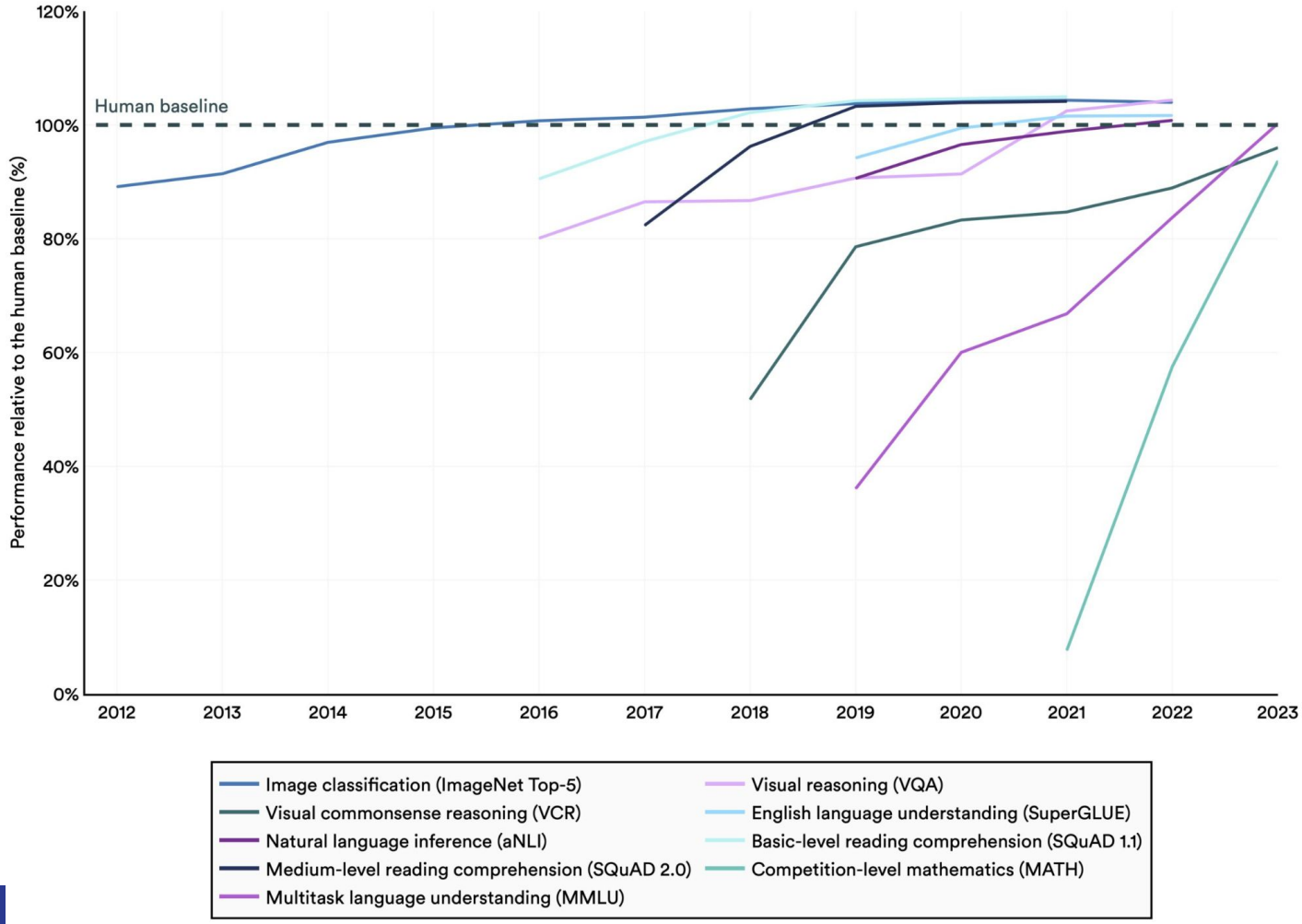
Core AI and ML Applications in Mimicking Human Cognition

- **Image and video processing -** recognize faces, objects, and actions in images and videos, and implement functionalities such as visual search.
- **Sentiment analysis** - identify and categorize positive, neutral, and negative attitudes that are expressed in text.
- **Autonomous Systems** - Self-driving cars, drones, and robotic automation

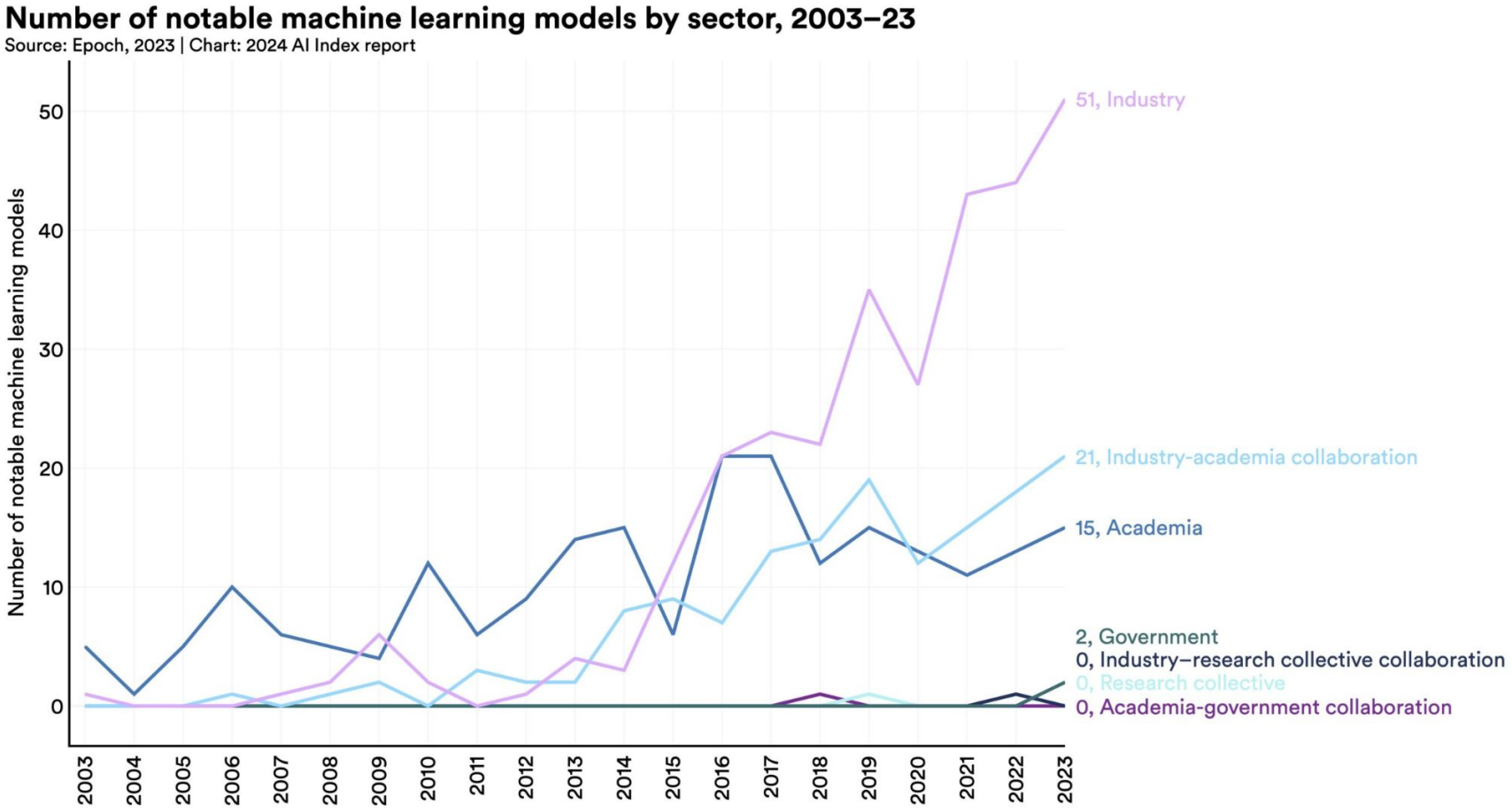
AI Index
By Stanford

Select AI Index technical performance benchmarks vs. human performance

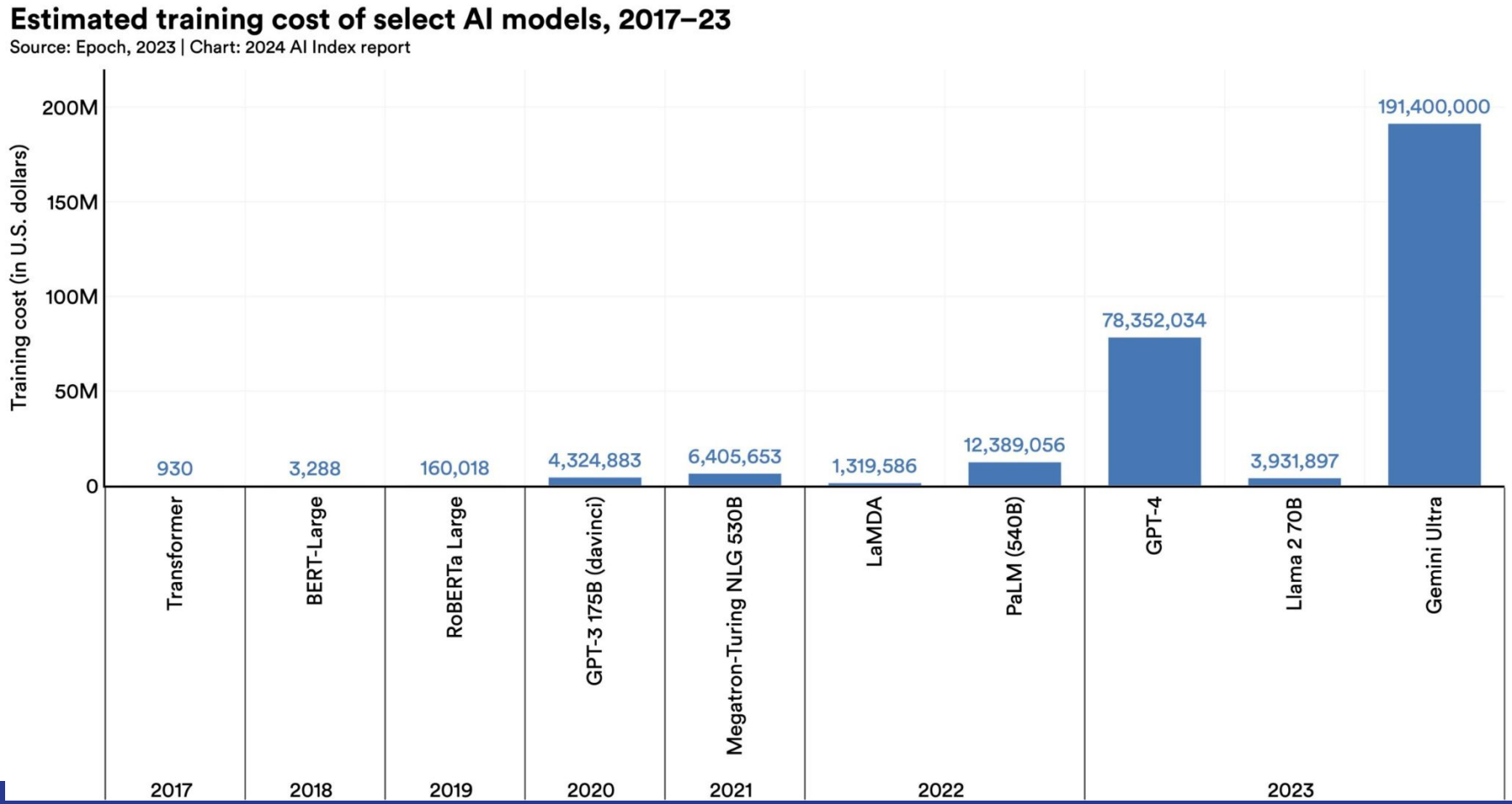
Source: AI Index, 2024 | Chart: 2024 AI Index report



Importance of Industry-Academic collaboration



Research is increasingly costly



Definition of Learning Technology

- Use of technology to enhance teaching, learning and assessment processes
- Use of technology to understand how people learn
- Use of technology to increase access to learning resources

Where Tech can help in Education?

Designing of

- interactive learning platforms;
- intelligent tutors; personalized and adaptive learning systems
- authoring tools for learning materials; educational games; simulations;
- collaborative learning tools; support for peer tutoring;
- Ensure anytime, anyplace learning through mobile devices, wearable devices;
- tools for formative and summative assessment;
- tools for learning analytics and educational data mining;

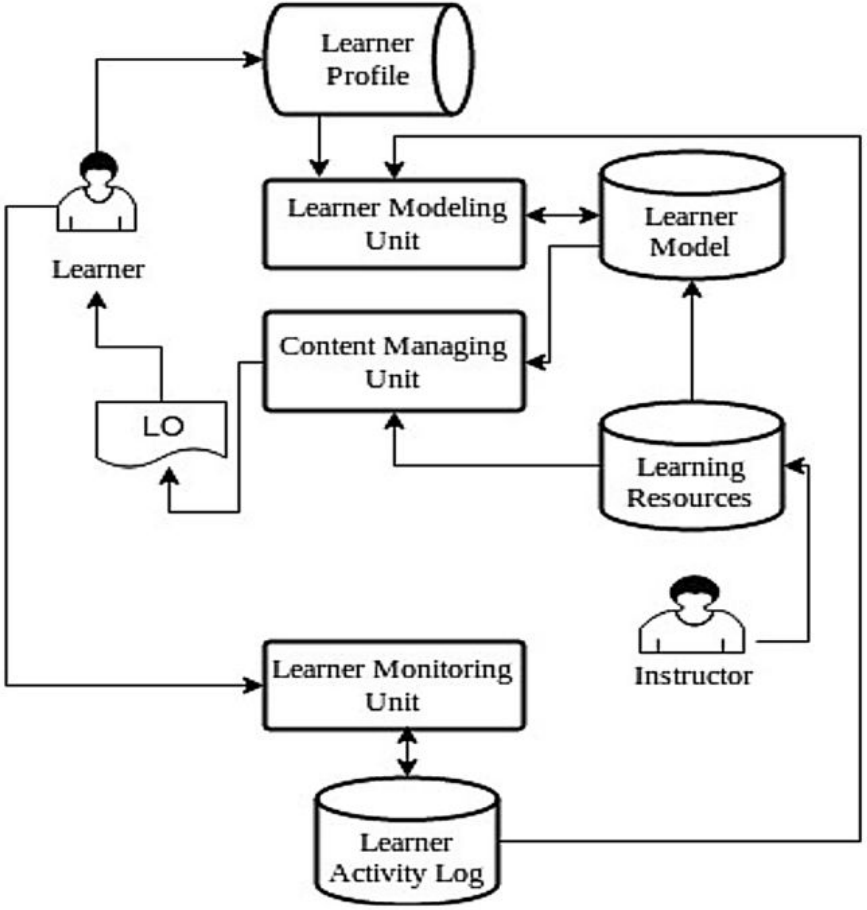
Personalized Learning Systems

- Technologies that adapt to individual learner needs, preferences, and progress.
- Data analytics and AI to tailor content and pacing.
- Adaptive Content Delivery - based on performance, learning style, and preferences
- Real-time Feedback and Assessment
- Customization of Learning Pathways

Intelligent Tutoring Systems (ITS)

- Provide personalized, one-on-one instruction using AI and cognitive science principles
- specifically designed to provide one-on-one tutoring to learners, simulating the experience of having a personal expert human tutor.
- typically used in scenarios where deep, subject-specific guidance is required.

Adaptive content recommender system

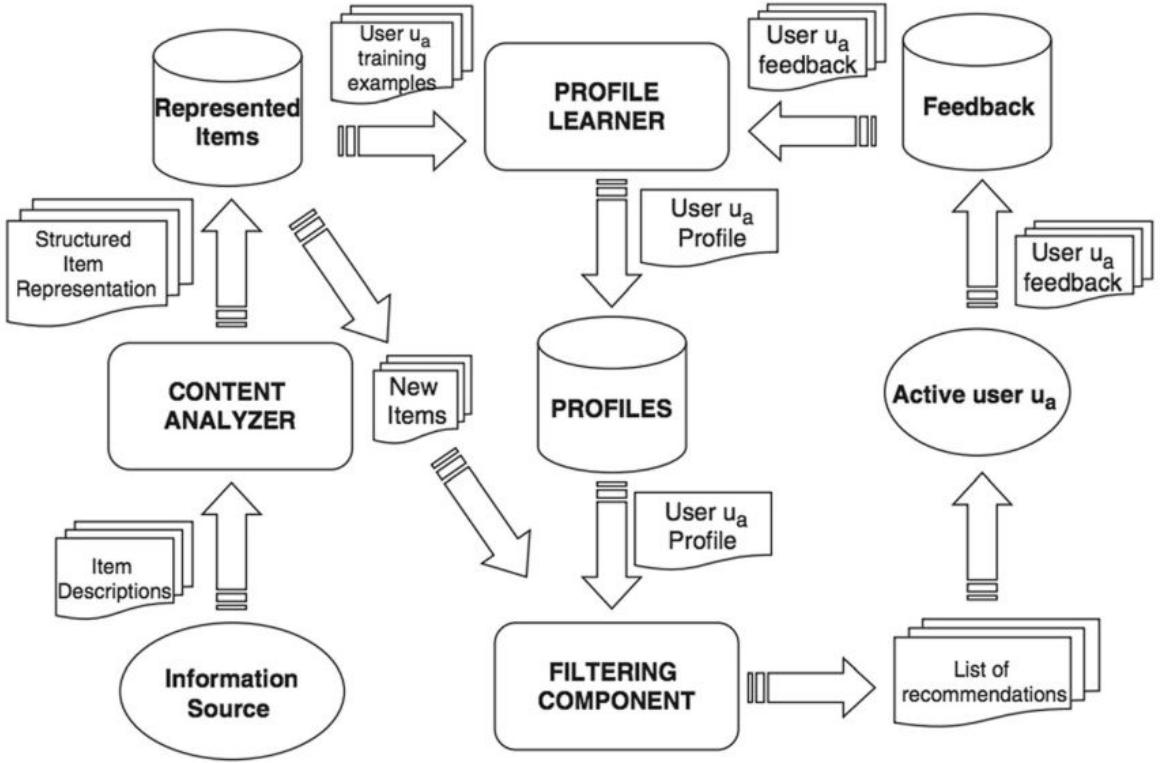


Steps for a Recommender system

- Develop the learner and learning object (LO) model.
- Group learners in terms of similarities. Identify rules by which learners and LOs can be mapped.
- Generate top ’N’ learning object recommendations.
- Identify the learning paths from the learner activity log.
- Revisit the mapping between learner and LO based on feedback.

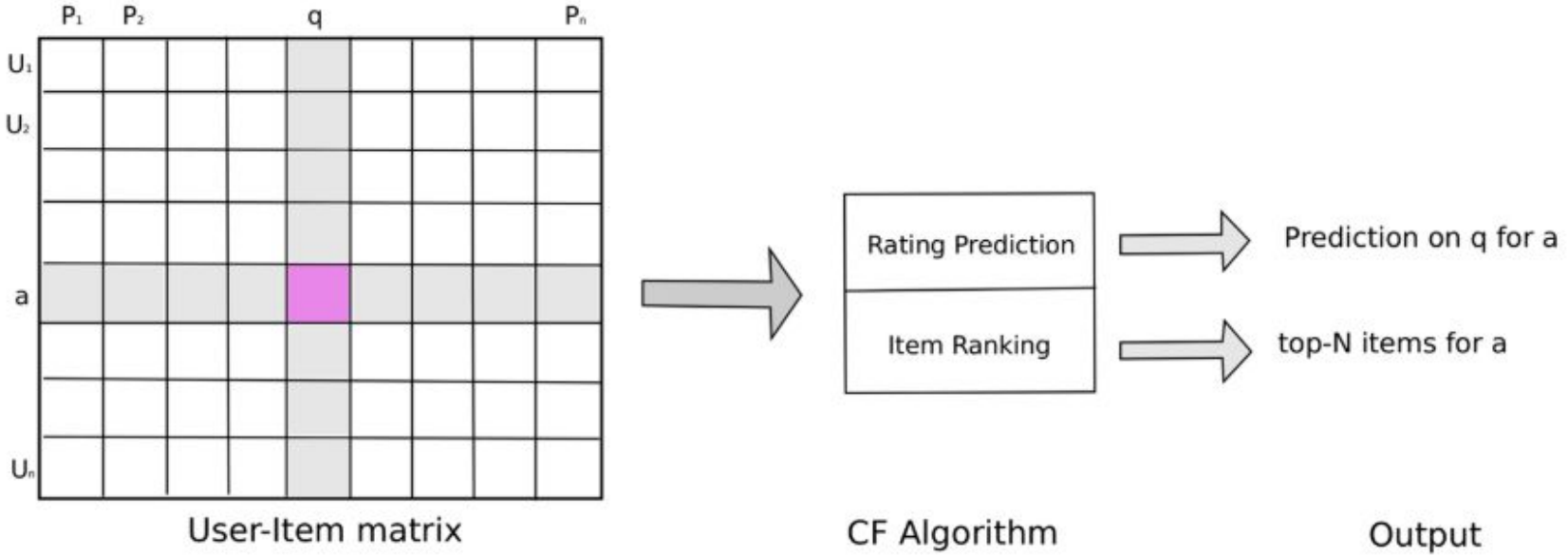
Recommendation Techniques -Content based

Identifying characteristics that are like those a user has preferred in the past and make recommendations accordingly



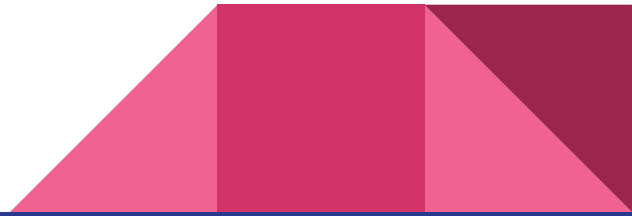
Recommendation Techniques -Collaborative Filtering

Based on user behavior or user ratings of recommended items. It recommends items liked by similar users



ML Algorithms for Content Recommendation

- K-Nearest Neighbor
- K-Means
- Association Rule Mining/Apriori
- Sequence Mining Algorithm
- Pattern Mining
- Genetic Algorithm
- Shortest Path Algorithm

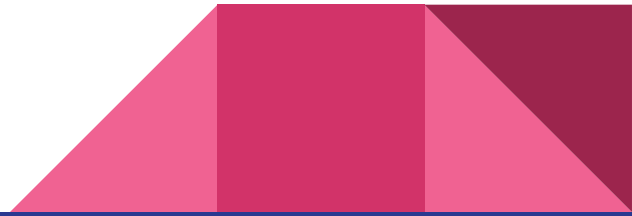


Content Recommendation Approaches

- Learning Style based - most common
- collaborative filtering (based on rating history) - if users' tastes were similar in the past, they would have similar tastes in the future
- multi-agent-based clustering technique (Firefly, differential evolution algorithm)
- Data mining (k-means, firefly algorithms, AprioriAll algorithm)
- Rule-Based
- Ontology Model - shortest path algorithm
- Deep Learning-based - Deep Belief Networks (DBN) classifier

Similarity Measuring techniques

- Euclidean distance similarity,
- Jaccard Coefficient,
- Cosine Similarity,
- Ontological Similarity,
- Pearson Correlation Coefficient,
- learner parameters-based similarity



How to Prepare Content for Adaptation?

- Granularity
- Alignment
- Discreteness
- Modularity
- Volume

Granularity

- smallest meaningful level at which to track students' knowledge
- How to recommend a content, how students' interactions on it can be communicated back to the system
- Size of each content - Chapter -> Topic -> Concept
- Mapping with Learning Objective (Learning Outcomes and Competencies), mark as proficiency

Alignment

- Alignment of Instructional Content and Assessment with the corresponding LO

figure 1

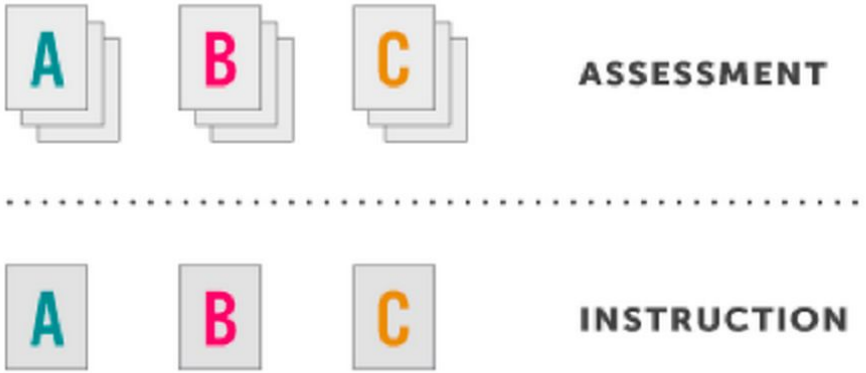
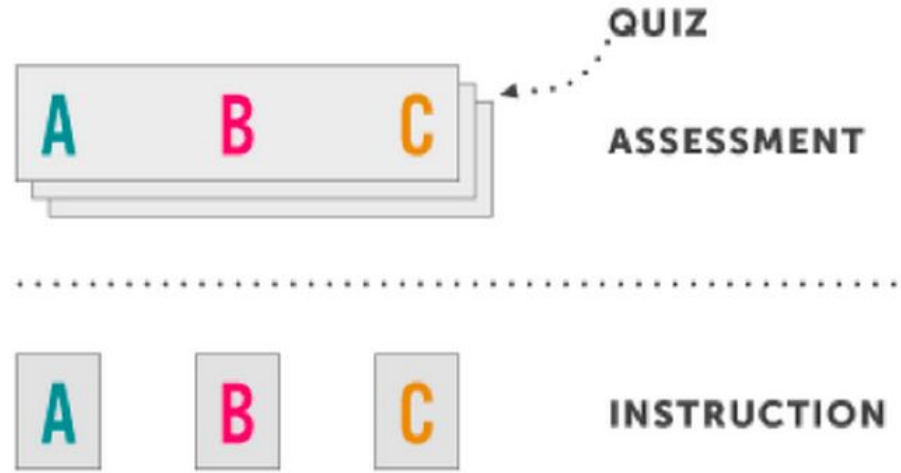


figure 2

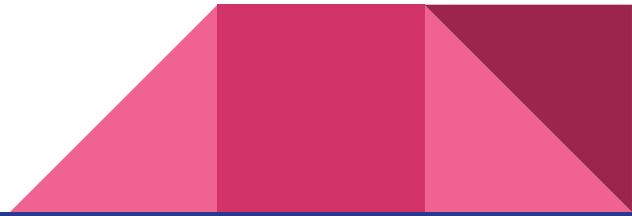


Discreteness

- Content should be developed for and mapped for distinct learning objectives
- discrete content has minimal overlap among both
  - learning objectives, and
  - the content that is aligned to these learning objectives.

Modularity

- No restriction of sequential consumption/delivery
- Find ideal learning path for each student
- course-level pre-tests, post-tests, and upfront diagnostics



Volume

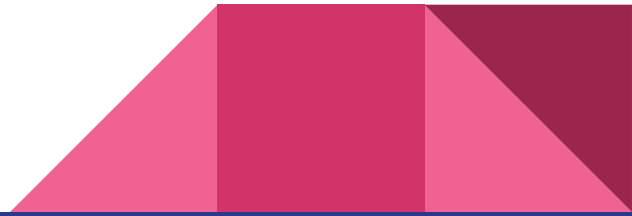
- amount of content available for system to recommend.
- greater volume of instructional content means options to present same learning objective/concept to a struggling student in a variety of ways
  - Difficulty level
  - Learning style

Prediction of student behavior and in-class performance

- Identity performance based on marks/grades, learning difficulties
- Correlate students and schools’ characteristics with student's performance

Predictive Methods

- Linear Regression
- Logistic Regression
- Classification
- Decision Trees
- Random Forest
- Support Vector Machine
- Graphical Models



Student retention and dropout

Based on factors like engagement, attendance, workload, family pressure, mental health performance, socio-economic background, etc.

In case of MOOC, additional factors can be time spent watching video, participation in forum discussions

Automated Grading

grade student assignments and exams

using machine learning algorithms, natural language processing, and predictive analytics