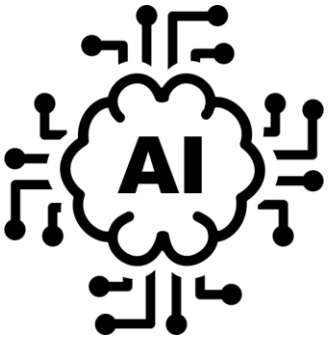
College of Engineering & Applied Science
University of Cincinnati

Complex Adaptive Systems Laboratory



How to Develop an AI Strategy for Pakistan?

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Image from pixabay.com

What should we think of in developing an AI strategy?

- What is AI today – and tomorrow?
- Why is AI important?
- Why does Pakistan need an AI strategy?
- What issues should the strategy address?
- What are the essential components of the strategy?
- How should academia contribute to its success?

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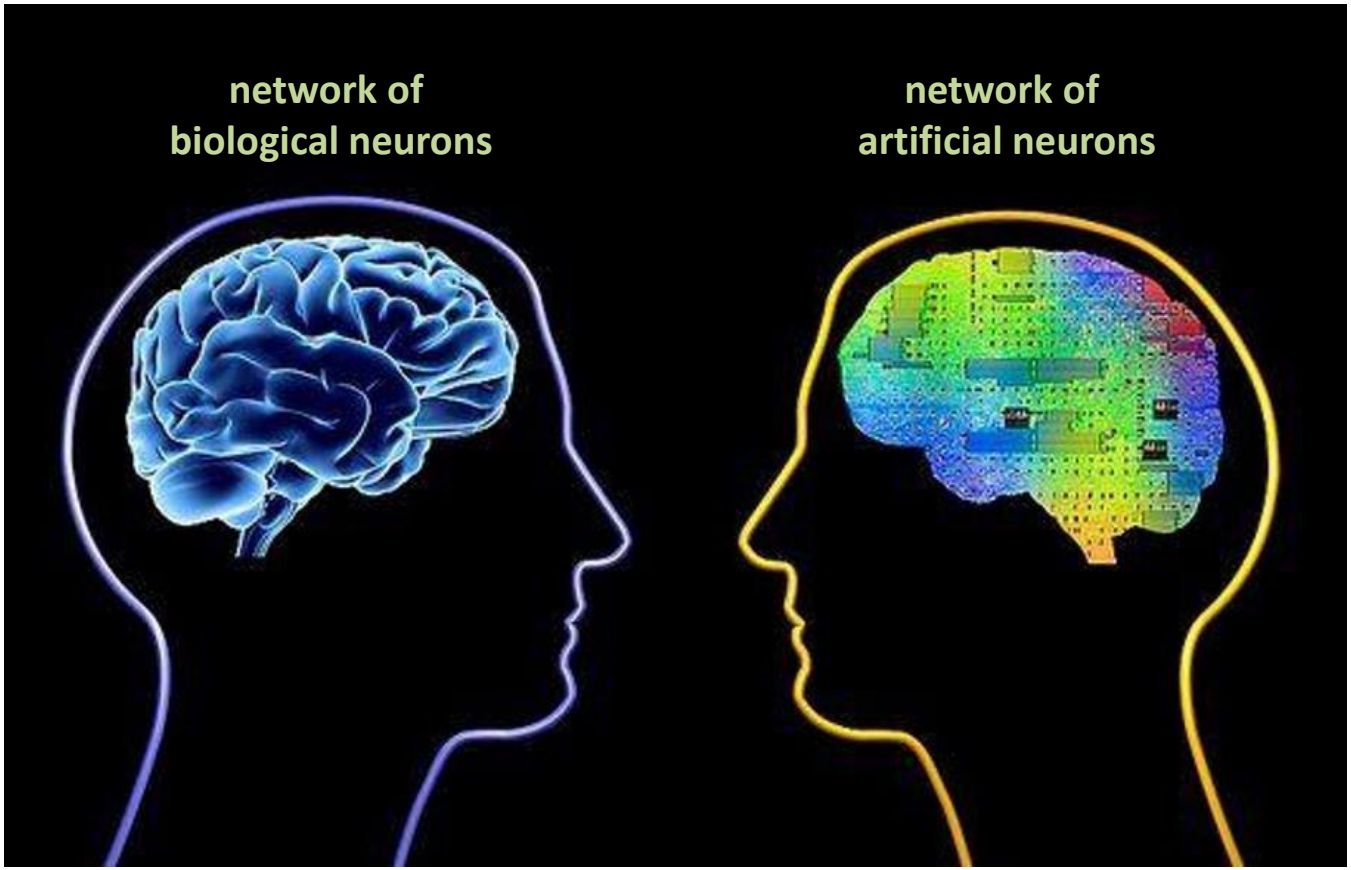
AI Today

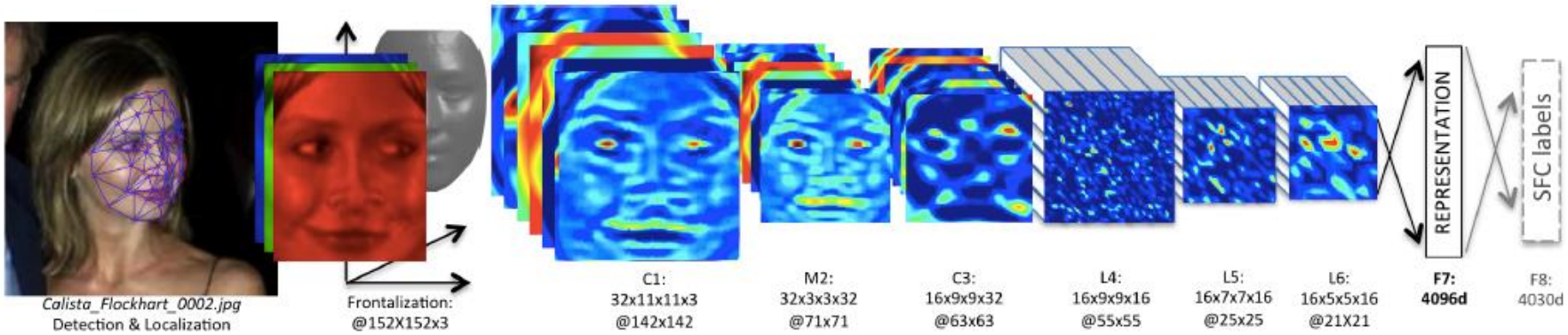


Most AI today uses ***neural networks*** – inspired by the brain – as the basis of ***machine learning***.

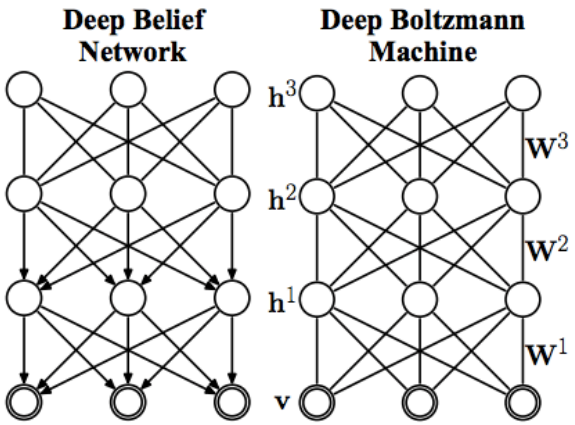
Image from KDNuggets

The New AI: Deep Learning

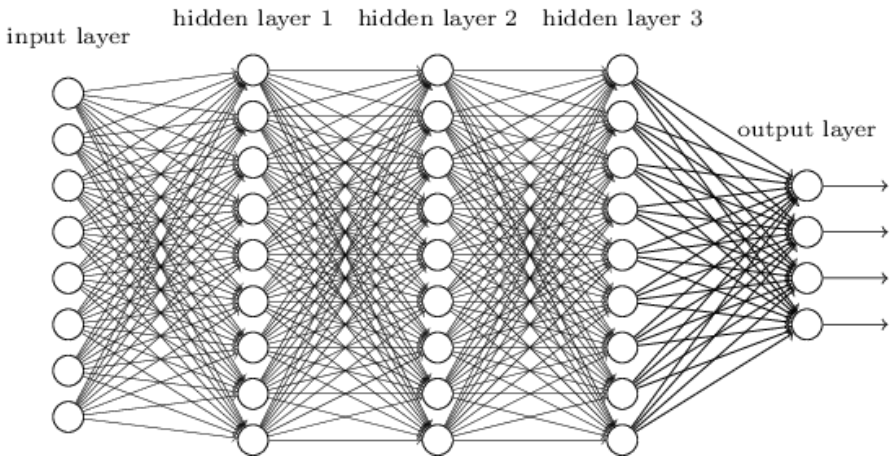
- ***Deep learning systems are neural networks*** with many layers of neurons.
- Different layers may performs distinct functions.



https://gigaom.com/2015/03/06/how-paypal-uses-deep-learning-and-detective-work-to-fight-fraud/



https://www.quora.com/What-is-the-difference-between-a-deep-Boltzmann-machine-and-a-deep-belief-net



http://neuralnetworksanddeeplearning.com/chap6.html

What makes the new AI possible?

What makes the new AI possible?

Machine Learning

+

Big Data

+

Extremely Fast Computing

+

Frameworks & Libraries

What makes the new AI possible?

Machine Learning

- Neural networks / deep learning
- Statistical / Bayesian models
- Graphical models
- Generative models

+

Big Data

+

Extremely Fast Computing

+

Frameworks & Libraries

What makes the new AI possible?

Machine Learning

+

Big Data

- On-line / streaming data.
- Distributed databases.
- Analytics.
- Visualization.

+

Extremely Fast Computing

+

Frameworks & Libraries

What makes the new AI possible?

Machine Learning

+

Big Data

+

Extremely Fast Computing

- GPU systems.
- Cluster computing.
- Neuromorphic chips.

+

Frameworks & Libraries

What makes the new AI possible?

Machine Learning

+

Big Data

+

Extremely Fast Computing

+

Frameworks & Libraries

- Tensorflow, PyTorch
- Scikit-learn
- OpenAI
- Hadoop / MapReduce

"AI is the new electricity"

Andrew Ng

Image from pixabay.com

Image from pixabay.com

What does "AI is the new electricity" mean?

It means that ***AI will be the next great integrator of our lives***.

Just as electrical power pervaded every aspect of life in the 20th century, AI will do so in the 21st - but unlike electricity, AI will also play with our minds and norms!

Pervasiveness of AI:

Now:
- Engineering
- Appliances
- Electronics
- Information technology
- Communication
- Entertainment
- Transportation
- Manufacturing
- Commerce
- Finance
- Cybersecurity
- Law enforcement ….

Soon:
- Education
- Art
- Design
- Science
- Innovation
- Politics
- Law
- Economics
- Policy-making
- Governance
- Geopolitics
- Warfare ….

Eventually:
- Social norms
- Morality & ethics
- Relationships
- Societal structure
- Civilization

Strategic Importance of AI

AI will become increasingly critical in many strategic dimensions.

National Security: Warfighting and autonomous munitions; cyberwarfare; intelligence gathering; cybersecurity; predictive threat assessment.

Infrastructure: Energy (smart grid); smart structures; intelligent transportation networks; smart cities; telecommunications; banking/finance; IoT.

Industry: Automation; supply chain optimization; industrial espionage.

Education: Remote learning; on-demand training; automated instruction.

Health: Drug design and targeting, personalized medicine; automated diagnosis; robotic surgery; brain-machine interface/prosthetics; disease control.

Law and Order: Cybercrime prevention; intelligent surveillance; predictive policing.

Having a robust domestic AI sector is a strategic imperative for every country

"AI has become a new focus of international competition. AI is a strategic technology that will lead in the future; the world's major developed countries are taking the development of AI as a major strategy to enhance national competitiveness and protect national security; intensifying the introduction of plans and strategies for this core technology, top talent, standards and regulations, etc.; and trying to seize the initiative in the new round of international science and technology competition. ….. [China] must …. firmly seize the strategic initiative in the new stage of international competition in AI development, to create new competitive advantage, opening up the development of new space, and effectively protecting national security.

AI has become a new engine of economic development. AI has become the core driving force for a new round of industrial transformation, [which] will advance the release of the huge energy stored from the previous scientific and technological revolution and industrial transformation, and create a new powerful engine, reconstructing production, distribution, exchange, consumption, etc., links in economic activities; with new demands taking shape from the macro to the micro within each domain of intelligentization; with the birth of new technologies, new products, new industries, new formats, new models; triggering significant changes in economic structure, profound changes in human modes of production, lifestyle, and thinking; and a whole leap of achieving social productivity."

China's New Generation Artificial Intelligence Development Plan

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China's New Generation Artificial Intelligence Development Plan

The Challenge for Pakistan

Two main questions:

How can Pakistan benefit from the AI revolution?

How can Pakistan withstand the AI revolution?

Elements of an AI Strategy for Pakistan:

Urgency: If "AI is the new electricity", imagine being a country without its own power generation system!

National Engagement: A national strategy will have to involve the government, industry, academia, civil society, ***and the public at large***.

Risk/Reward Balance: The strategy must focus not only on economic and national security benefits, but also on the societal disruption that AI will cause.

Vision of the Future: Timely and accurate anticipation of future trends is critical.

Pakistan's Advantages:

- Very large pool of exceptional human talent with access to professional education in English.
- A strong culture of entrepreneurship and innovative use of available resources.
- A resourceful, influential, highly-educated, and engaged diaspora.
- A strategic imperative to keep abreast of competitors and adversaries.

Pakistan's Impediments:

- Limited economic resources with huge demographic pressures.
- Lack of a systematically scientific mindset with depth and critical thinking.
- Uneven quality of education at all levels, with little emphasis on the development of deep knowledge and true scholarship.
- Too much focus on short-term benefits – "low-hanging fruit".
- An inherently conservative temperament of the society and the bureaucracy.

Solution Strategies

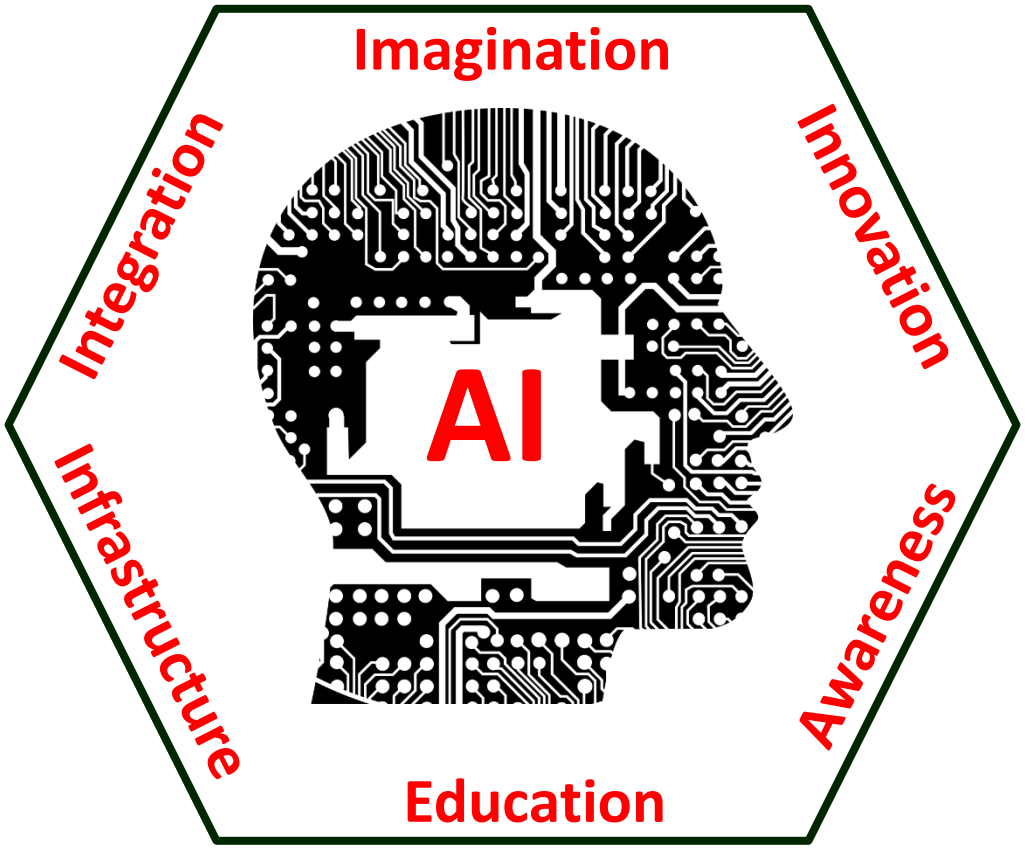

Image from pixabay.com

Solution Strategies

Education:

- Recognize that AI is based on ***science*** and ***mathematics***, ***AI is not IT*!**
- Emphasize ***scientific thinking*** throughout the educational system – from the primary to postgraduate levels.
- Bring the standards of scientific and technological education in line with international standards.
- Look to train ***scholars*** and ***innovators***, not just technicians.

Infrastructure:

- Understand that AI requires a ***significant computational infrastructure*** that is evolving rapidly.
- Provide engineering educational institutions with the computational infrastructure necessary for AI.
- Train engineers in the latest AI technology applied to all areas, including robotics, IoT, transportation, cybersecurity, etc.

Solution Strategies

Awareness:

- Promote ***general public awareness*** of AI's evolving role in daily life.
- Integrate awareness of AI and its implications into everyday thinking at all levels.
- Combat misconceptions and conspiracy theories that will arise inevitably.
- Set up a ***systemic regulation framework*** now to prevent misuse of AI technology in the future.

Integration:

- Recognize that AI is a ***global enterprise***, not a localizable industry.
- Integrate into the educational, industrial and research systems of the world while also developing a strong ***domestic AI capability***.
- Seek to become useful – and then indispensable – to the global tech enterprise.

Solution Strategies

Innovation:

- Realize that AI is still in its infancy.
- Recognize that, with imaginative thinking, huge advances in AI can still be made at relatively little cost.
- Promote collaboration and competition among innovators and entrepreneurs in AI with ***government support*** and ***venture capital***.
- Take advantage of the vast free/low-cost and open-source resources for AI.

Imagination:

- Think actively about the world of the near-future at the policy level.
- Be agile, responsive, and imaginative in policy-making – not hamstrung by old assumptions and ignorance.
- Know that, in the infinitely more complex world we are creating right now, ***resilience will be far more important than control***.

AI and Pakistani Academia

Image from pixabay.com

AI in Pakistani Academia: Observations

- Most major universities that offer computer science degrees include AI in their undergraduate and graduate curricula.
- A few universities (NUST, GIKI, Bahria) have comprehensive undergraduate and graduate programs focused exclusively on AI and related areas.
- There is a ***substantial*** and ***rising*** output of international-level research publications from Pakistan.
- ***Recent*** impact of Pakistan's international publications in AI is similar to that of peer countries such as Iran, Malaysia, Egypt, and Turkey.
- Computer Science departments at most universities are small, likely forcing non-specialists to teach specialized courses.
- In some cases, the material being covered in the courses is outdated.
- Many universities do not provide sufficient information about academics on their websites for quality to be evaluated.

AI *Journal* Publications and Citations - 2020

Rank	Country	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	China	25827	25585	17996	12452	0.7	300
2	India	12164	11865	5001	2239	0.41	155
3	United States	12198	11749	9852	4004	0.81	563
4	United Kingdom	3931	3741	4253	1217	1.08	298
13	South Korea	1781	1737	1373	359	0.77	144
15	Iran	1466	1439	1294	442	0.88	113
16	Turkey	1447	1431	938	254	0.65	142
19	Malaysia	1191	1171	719	202	0.6	92
20	Bangladesh	1092	1085	268	97	0.25	32
21	Saudi Arabia	1023	997	895	242	0.87	91
22	**Pakistan**	**1000**	**984**	**825**	**383**	**0.83**	**61**
23	Romania	987	963	143	55	0.14	58
24	Netherlands	963	912	905	235	0.94	170
25	Morocco	876	864	246	130	0.28	31
26	Poland	966	840	639	251	0.66	103
27	Singapore	870	830	1543	372	1.77	177
28	Egypt	790	763	612	209	0.77	71

Source: SJR Scimago Journal & Country Rank

AI *Journal* Publications and Citations - 2020

1996-2020

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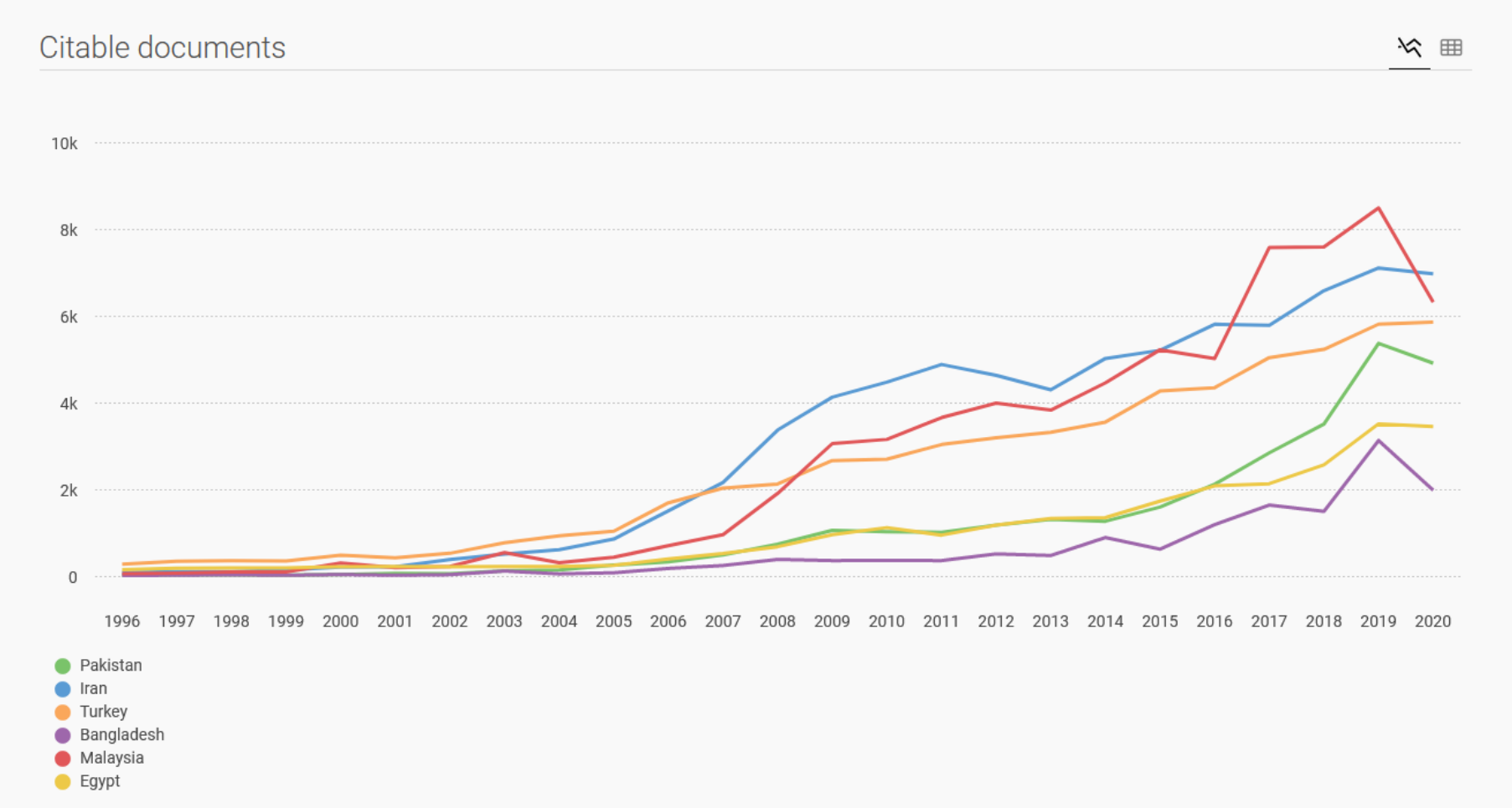
Source: SJR Scimago Journal & Country Rank

AI *Journal* Publications and Citations - 2018

Rank	Country	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	China	21194	21001	119427	78945	5.63	300
2	United States	12357	11885	92229	32332	7.46	563
3	India	11438	11144	29649	12126	2.59	155
5	United Kingdom	3943	3739	38130	7472	9.67	298
8	South Korea	2145	2121	9991	1818	4.66	144
9	Italy	2153	2003	15142	4586	7.03	183
12	Iran	1898	1866	8937	2825	4.71	113
13	Turkey	1872	1858	5227	1218	2.79	142
18	Malaysia	1257	1226	5801	1399	4.61	92
20	Singapore	1053	1020	11926	1684	11.33	177
25	Saudi Arabia	773	750	6677	934	8.64	91
26	Portugal	783	738	3378	883	4.31	99
27	**Pakistan**	**754**	**733**	**4341**	**1277**	**5.76**	**61**
28	Romania	699	689	1872	565	2.68	58
29	Switzerland	675	645	8200	1126	12.15	173
36	Morocco	508	499	1072	382	2.11	31
38	Bangladesh	448	445	1697	487	3.79	32

Source: SJR Scimago Journal & Country Rank

Citable *Journal* Publications in Computer Science



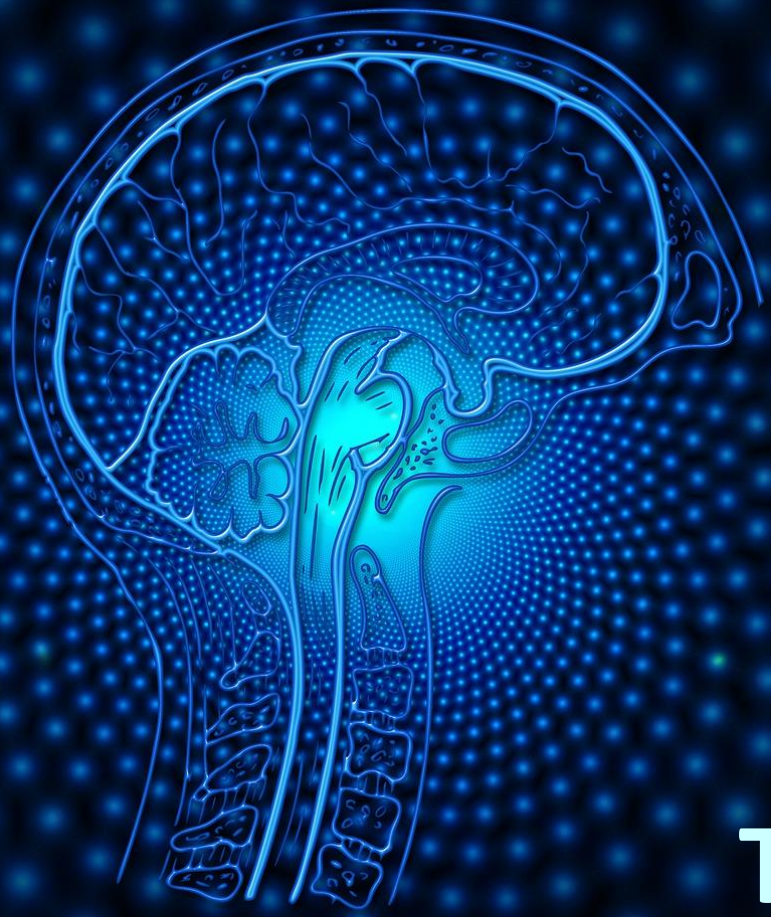
Source: SJR Scimago Journal & Country Rank

Solutions: Universities

- ***Increase faculty sizes*** for CS departments to 15-20 (or more).
- ***Have specialists teach specialized courses*** – especially at the graduate level.
- Provide the incentives and opportunities for faculty to ***stay abreast of their fields*** (publications, conferences, training).
- ***Avoid early over-specialization*** to train engineers with a broad base in the fundamentals (mathematics, theory, science).
- ***Focus on training scholars and innovators***, not just technicians.
- Incentivize students and faculty to ***engage with the international AI community*** (journals, conferences, visiting scholars, internships abroad).
- Incentivize students to participate in ***international competitions and hackathons***.

Solutions: Government

- Make universities part of an ***integrated long-term national strategy*** with AI, cybersecurity, data science, etc. as primary components.
- Reward ***institutional collaboration*** rather than unhealthy competition.
- Support universities in ***enforcing quality standards*** on faculty and students.
- Establish active, well-resourced, and high-quality ***national institutes*** and ***centers of excellence*** for AI.
- Establish high-quality ***national training programs*** for faculty and other researchers to keep abreast of a fast-moving fields such as AI.
- Support ***access to the international AI community*** for faculty and students (both academia and industry).
- Provide the ***critical tech infrastructure*** needed for AI.



Thank You

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