

## Prelim Bits 07-05-2024 | UPSC Daily Current Affairs

### Diffusion transformer (DiT)

The new AI model 'Sora' is powered by Diffusion transformer (DiT)

- **Sora** - An AI model developed by OpenAI that process the prompts in natural language and generate minute-long videos in high definition using diffusion transformer model.

#### AI models

- They are essential architecture that have redefined the landscape of machine learning (ML), a subset of AI, applications.
- There are 2 models in AI innovation.
- **Transformer-based models** - It is used to change a simple picture bit by bit into something you want.
- **Diffusion models** - It is essentially the spreading of particles from a dense space to a lesser dense area.
- It have become the most preferred for AI that generates images.

- **DiT** - Diffusion transformer, is essentially a class of diffusion models that are based on the transformer architecture.
- **Developed by** - William Peebles at UC Berkeley.
- **Aim** - To improve the performance of diffusion models by switching the commonly used U-Net backbone with a transformer.

*U-Net is an architecture employed in diffusion models for iterative image denoising but it may not provide the best solution all the time.*

- **Principle**
  - **Use concept of diffusion** - For predicting videos
  - **Use the strength of transformers** - For next-level scaling
- **Working** - It make videos by breaking them down into smaller parts, adding a bit of randomness (noises), and then cleaning things up based on the text.
- **Latent diffusion process** - *Noise* is gradually transformed into the target image by reversing the diffusion process guided by a transformer network.
- **Diffusion timesteps** - It act like checkpoints and at each checkpoint, DiT looks at the picture and decides to make it better.

*Runway's Gen-2 and Google's Lumiere had previously showcased some breathtaking capabilities of video generation that could potentially replace filmmaking in the future.*

## Reference

[The Indian Express| Sora uses Diffusion Transformer AI Model](#)

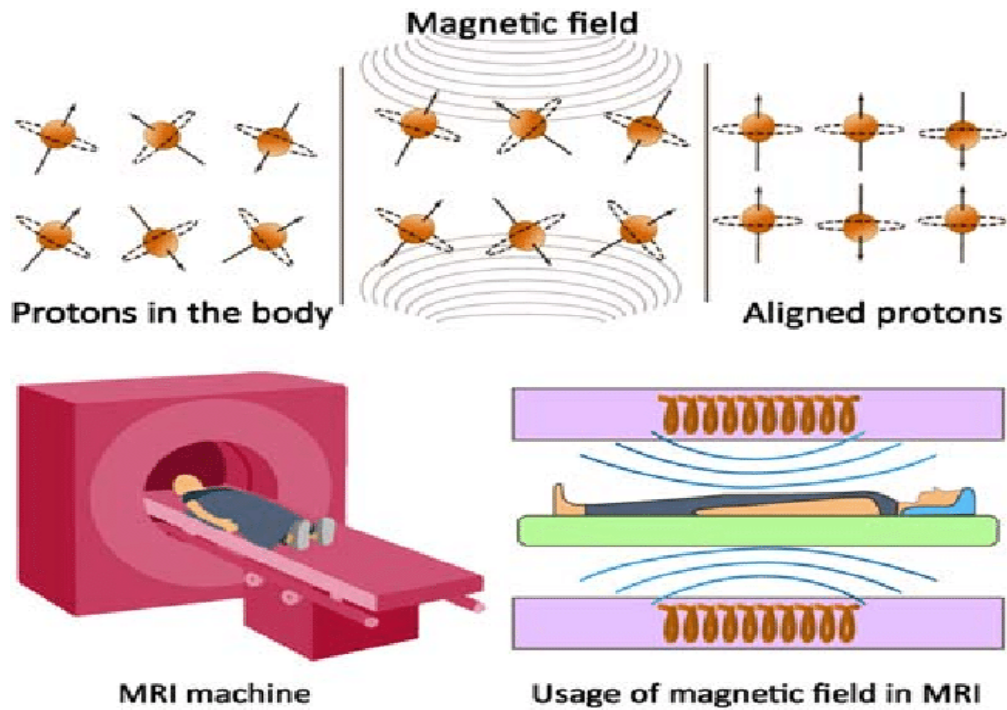
## Magnetic Resonance Imaging (MRI)

*An MRI procedure reveals an image of a body part using the hydrogen atoms in that part.*

- **MRI** - It is a *non-invasive diagnostic* procedure, used to obtain *images of soft tissues* within the body (tissue that hasn't become harder through calcification).

*Paul Lauterbur and Peter Mansfield refined the MRI machine and were awarded the medicine Nobel Prize in 2003.*

- **Principle** - *Using the hydrogen atoms*, which are present almost throughout the body but abundant in fat and water.
- A hydrogen atom spin with axes pointing in random directions but in a magnetic field, its *spin axis* will point along the field's direction.
- **4 essential components** - *Bore*, a hole in the centre, where the person whose body is to be scanned is inserted.
- A *superconducting magnet* inside the bore, which produce a powerful and stable magnetic field around the body.
- A *radiofrequency pulse emitter* and a *detector* to receive the emissions from the atoms present in the scanned part.
- **Working** - The magnetic field is applied, such that the axes of roughly 50% of the Hydrogen atoms are pointing one way and the other 50% are pointing the other way.
- Only a handful remain unmatched — i.e. a *small population of 'excess' atoms pointing one way or the other*.



- When the pulse is on, a fraction of excess atoms absorb it and gets excited and return to lower energy state by *emitting radiations* when switched off, this emitted radiation is converted *as images*.

**Larmor frequency** is the frequency of pulse the 'excess' atoms have to absorb. **T1 relaxation time**, the time duration when excited atoms emits energy and return to lower energy states.

- At times, a contrast agent like *gadolinium-based compound* is injected to the person to improve their visibility in an MRI scan.
- **Application** - In the observation & treatment of certain *cancers* like prostate cancer and to track various *neurological conditions*.
- MRI scans of *changes in blood flow* is used to infer the way the activity of neurons is changing in the brain.
- **Pros** - It don't pose any threat on the body and it scan portions that are just a few millimetres wide.
- **Cons** - Machines are expensive and so the scan costs.
- The individual is actually expected to lie still for tens of minutes as their movement may distort the images.
- **Challenges** - Since it uses strong magnetic fields, individuals with metallic implants may not be able to undergo MRI scans and its effects on pregnant women aren't as well-studied.

*During MRI scan, if the person have a credit card in their pocket, the magnetic fields will wipe its magnetic strip.*

## Reference

## Quarks

*Scientists have reported that the insides of most massive neutron stars is most likely made of an unusual state of matter called quark matter.*

- **Background** - All atoms are made of protons and neutrons inside the nucleus and electrons outside.
- Unlike electrons, *protons and neutrons are composite particles* because they are further *made up of quarks*.
- **Quarks** - They are called strongly interacting particles because they are bound by the strong force.
- **Properties** - They *can't exist in isolation*, even in the vacuum of empty space and can only be found in groups, such clumps of quarks are called **hadrons**.

*[Large Hadron Collider \(LHC\)](#) is the world's largest science experiment.*

- Clumps can of heavier quarks or lighter quarks like in protons and neutrons.
- **Rejects conventional particle-physics models** - As 3-quark clumps are more likely to form than 2-quark clumps, the consolidation of quarks is dependent of the particle environment.
- **6 types** - Up, down, top, bottom, strange, and charm and each quark can have one of 3 types of colour charge.
- **Antiquarks** - It is an antimatter versions.
- **Meson** - It is a quark-antiquark clump.
- **Baryons** - They are 3-quark clumps.
- **Gluons** - A set of particles that also held quarks together.
- **Quantum chromodynamics** - A theory that explains how the nuclear force holds quarks together.
- When lead ions were smashed against each other at very high energies, a state of matter called a *quark-gluon plasma* exists for a brief moment, suggest that the quarks are independent.

*According to the Big Bang theory, the universe was filled with this plasma before the particles clumped and formed the first blobs of matter.*

- **The force of gravity** - It arises from the star's mass, encourages the star to collapse under its own weight and implode.
- **The nuclear force** - It is released by fusion reactions at its core, pushes the star to blow up and outwards.
- **Star shines** - Normally, these 2 forces are equally matched.
- **Death of a star** - Once a star runs out of material to fuse, nuclear fusion weakens and gravity starts to gain the upper hand thus the star will 'die' and implode.
- **Afterlife of a star** - Depending on its size when it lived, it becomes a white dwarf, a neutron star or a black hole.
- **Neutron stars** - It will fuse all protons and electrons inside into neutrons, thus its name.
- A research study suggest that insides of most massive neutron stars have an 80-90% chance of being made of quark matter.

## Reference

[The Hindu| Quarks - A detailed study](#)

## ICUBE-Q

*Pakistan in collaboration with China launched its first-ever lunar mission iCube-Qamar recently.*

- It is a compact lunar cube *remote sensing satellite* that orbit the moon as part of Beijing's [Chang'e-6](#) mission.
- **Developed by** - Pakistan's Institute of Space Technology (IST) in collaboration with Pakistan's national space agency SUPARCO, and China's Shanghai Jiao Tong University (SJTU).
- **Weight** - 7kg.
- **Scientific instruments** - Two optical cameras designed to capture various images of the moon's surface.
- It will enable Pakistan to have its own satellite-based research imagery of the moon.
- **On-board Chang'e 6** - In 2022, the China National Space Administration (CNSA) invited member states via the Asia Pacific Space Cooperation Organization (APSCO) to include a student-built payload on the Chang'e 6 mission.
- Pakistan's ICUBE-Q was chosen for the above mentioned programme.

## CubeSats

- They are *diminutive satellites* known for their compact dimensions and uniform design.
- They are built in a cubic form, comprising modular components adhering to precise size limitations.
- **Features** - It typically weigh only a few kilograms and serve various purposes in space exploration, primarily aiding scientific research, technological advancement, and educational endeavours.
- Additionally, they support a broad spectrum of missions such as Earth observation, remote sensing, atmospheric studies, communication, astronomy, and technology testing.

*China has ambitious plans for its lunar exploration program, with aims to put astronauts on the moon by 2030.*

## References

1. [Business Standard | 'iCube Qamar' lunar mission](#)
2. [The Times of India | iCube-Qamar](#)
3. [Firts Post | iCube-Q](#)

## Marrakesh Agreement

*2024 marks the 30<sup>th</sup> anniversary of signing of Marrakesh Agreement.*

- An agreement that fundamentally reshaped the international trading system by introducing a more robust and comprehensive structure for trade relations.
- **Signed in** - **1994**, by 123 countries.
- **Shared vision** - To transform the world through trade.
- **Outcome** - Establishment of **World Trade Organization (WTO) in 1995**.
  - Headquarters - Geneva Switzerland
  - India is a member
- **Achievements** - While the GATT mainly dealt with trade in goods, the WTO and its agreements also cover *trade in services and intellectual property*.
- It has helped to bring about a major *expansion in global trade*, with the objective of raising living standards, increasing employment and promoting sustainable development.
- More than 1.5 billion people have been lifted *out of extreme poverty*.
- The WTO's membership has expanded to 164 members, representing over 98% of international trade.
- In 2015, the WTO reached a significant milestone with the receipt of its *500<sup>th</sup> trade dispute for settlement*.
- Expansion of the *Information Technology Agreement*.
- TRIPS Agreement amended to ease access to affordable medicine
- *Trade Facilitation Agreement (TFA)* enters into force.
- **Challenges** - Bias of favouring wealthier nations due to their greater negotiating power.
- Promoting policies that sometimes conflict with the economic interests and developmental needs of poorer countries.
- Issues such as agricultural subsidies remain highly contentious.

## References

1. [WTO| 30<sup>th</sup> anniversary of Marrakesh Agreement](#)
2. [WTO| Achievements of Marrakesh Agreement and WTO](#)



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