1. Google's GenCast AI: Revolutionizing Weather Forecasting

Introduction
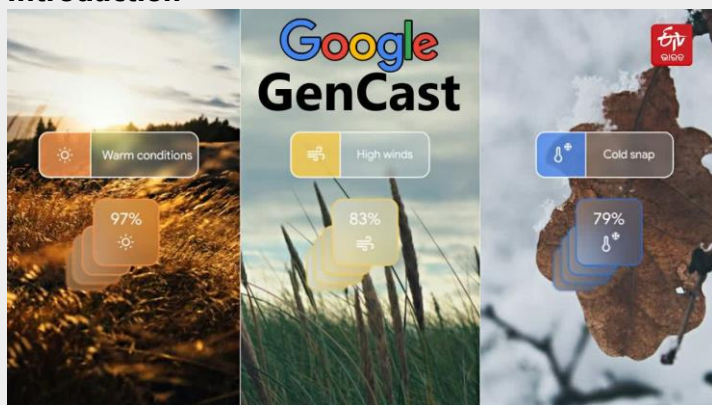
On December 4, Google DeepMind introduced GenCast, an advanced AI model that significantly improves weather forecasting. GenCast not only surpasses traditional tools in accuracy but can also predict weather events further into the future. Its capabilities signal a potential shift in how meteorological data is analyzed and utilized globally.

How Does Traditional Weather Forecasting Work?

Traditional Weather Forecasting relies on Numerical Weather Prediction (NWP), which uses simulations of atmospheric behavior based on physical laws. High-quality data and powerful supercomputers are essential for these predictions, which typically provide accurate results up to a week in advance. Since the 1990s, ensemble forecasting has enhanced NWP by producing multiple predictions with slightly different starting conditions, offering a range of possible outcomes.

GenCast's Training and Performance

GenCast employs ensemble forecasting but replaces traditional simulations with an AI model. Trained on 40 years of reanalysis data from 1979 to 2019, the AI leverages a comprehensive blend of past weather observations and modern forecasting techniques. This training was accomplished in just five days using Google's advanced TPU v5 processors, demonstrating remarkable efficiency. GenCast has shown superiority over ECMWF's ENS model, outperforming it on 97.2% of evaluated targets and offering better accuracy on predictions beyond 36 hours in 99.8% of cases. It excels in predicting extreme weather events, tropical cyclone tracks, and wind power production.

How GenCast Works

The technology behind GenCast relies on a neural network with over 41,000 nodes and 240,000 edges. It uses a diffusion-based AI model that refines noisy input data through iterative processes to generate precise weather predictions. By completing 30 refinements per forecast, GenCast produces 50 probabilistic forecasts simultaneously. These forecasts cover 15 days

with high spatial and temporal resolution, achieving results in just eight minutes using a single TPU v5 processor—a dramatic improvement over the hours required by traditional supercomputers.

Probabilistic Forecasts: A New Approach
GenCast's forecasts are probabilistic, providing probabilities like "25% chance of rain," rather than deterministic predictions, such as "5 mm of rain." Experts view probabilistic forecasts as more useful for identifying extreme weather risks, as they allow for better preparation. However, GenCast depends on high-quality reanalysis data, which is sourced from traditional NWP models, underscoring the importance of these systems in training and validating AI models.

Future of AI in Weather Forecasting
Looking ahead, GenCast is part of a broader wave of AI advancements in weather forecasting. Google is developing other models like GraphCast for deterministic forecasts and NeuralGCM for hybrid AI-NWP approaches. Meanwhile, companies like Huawei and Nvidia are also creating AI models that rival NWP in speed and accuracy.

Conclusion
In conclusion, GenCast represents a breakthrough in weather forecasting, combining speed, accuracy, and the ability to predict extreme events. While it complements rather than replaces traditional NWP, its development marks a significant step toward more efficient and comprehensive meteorological tools.

Relevance: GS Prelims & Mains Paper III; Science & Technology

2. Why Trump wants to buy Greenland, and why he is not alone in this

Introduction

US President-elect Donald Trump has once again expressed interest in buying Greenland, and Greenland has again stated it is not for sale.

In recent weeks, Trump has threatened to take over the Panama Canal and said Canada should be the USA's 51st state. While his claims have earned flak for displaying "territorial ambitions", Trump is not the first US president to want Greenland, nor is buying new territories unheard of for the US.

Why is the huge Arctic island important for the US? When did the US last buy territories, and what efforts has it made in the past to acquire Greenland? We explain in three points.

1. Why does Greenland matter to the US?
Broadly, there are three reasons, related to geostrategy and geography.

Greenland was once a Danish colony and is now an autonomous province of Denmark. It is located in the North Atlantic Ocean, between Europe and North America, across the Baffin Bay from Canada. Its strategic importance rose during the Cold War, and the US has a large air base there, the Pituffik Space Base, earlier the Thule Air Base. From Greenland, the US can monitor and prevent any missile coming towards it from Russia, China, or even North Korea. Similarly, it can launch missiles and ships towards Asia or Europe more easily from Greenland. Second, Greenland is rich in rare earth minerals, which are used in mobile phones, electric vehicles and other consumer electronics, but also in bombs and other weapons. At present, China is a major supplier of these minerals. In 2021, Greenland passed a law banning uranium mining.

Third, as global warming leads to melting of ice, new waterways can open in the Arctic region, and all major powers are keen to boost their presence here. The US would want to pre-empt a larger Russian or Chinese role in Greenland and its neighbourhood.

2. When did the US last try to acquire Greenland?
Trump in his last term had proposed buying Greenland, terming his proposal a "large real estate deal". When the Danish PM, Mette Frederiksen, called the idea absurd, Trump cancelled a scheduled visit to Denmark.

Before that, in 1946, just after the end of World War II, President Harry S Truman offered $100 million to Denmark for Greenland. Truman had earlier considered exchanging some portions of Alaska for certain parts of Greenland. The proposal did not progress.

In 1867, the US State Department pointed to the fact that Greenland's strategic location and abundant natural resources make it ideal for acquisition. However, no formal effort was made to move on the suggestion.

3. And when has US bought territories before this?
One famous example is the purchase of Alaska, which the Russian empire transferred to the US in 1867 when Andrew Johnson was President, for $7.2 million. The purchase added about 1.5 million sq km of land to the US. In 1959, the modern state of Alaska was created.

Earlier, in 1803, the US bought more than 2 million sq km of land from France in what is known as the Louisiana Purchase. The acquisition of Louisiana happened when Thomas Jefferson was President, and the US paid $ 15 million for the deal.

In 1917, the US bought the Danish West Indies, a group of islands in the Caribbean, and called them the US Virgin Islands.

Relevance: GS Prelims & Mains Paper II; International Relations

3. Why India Doesn't Have to Extradite Sheikh Hasina to Bangladesh

Introduction

CAN BE A LONG PROCESS UNDER '13 PACT

➤ Hasina (pic) is in India since her Aug 5 ouster. A B'desh tribunal has issued arrest warrants against her for **'crimes against humanity, genocide'**

➤ Monday's **request to India made through a 'note verbale'** (formal diplomatic note)

➤ B'desh home adviser Jahangir Alam claims she can be extradited under 2013 pact with India

➤ But it can be a lengthy and complex affair, given that **Hasina will most certainly challenge it in court**

➤ Also, **India needs to balance its legal commitments with geopolitical considerations**

➤ According to Article 8 of treaty, **extradition may be refused** if Hasina can convince India that charges against her not 'made in good faith in interests of justice'

India and Bangladesh signed an extradition treaty in 2013 to address the issue of fugitives operating between the two countries. However, the existence of this treaty does not obligate India to hand over Sheikh Hasina to Bangladesh. Several provisions in the treaty, along with political considerations, play a crucial role in such decisions.

Provisions for Refusal in the Extradition Treaty
The treaty includes a clause allowing refusal of extradition for offences of a "political nature". While this exception excludes crimes such as murder, enforced disappearance, and torture—charges Sheikh Hasina faces—the option to deny extradition still exists.

Additionally, Article 8 of the treaty provides grounds for refusal, such as:
• Accusations not made "in good faith in the interests of justice."
• Cases involving military offences not recognized as crimes under general criminal law.
India could leverage these provisions to deny the request, though it might strain diplomatic ties with Bangladesh.

Amendments Simplifying Extradition
In 2016, an amendment to Article 10(3) simplified the extradition process by removing the need for evidence of the offence. Now, an arrest warrant issued by a competent court is sufficient for processing extradition. Sheikh Hasina has multiple such warrants against her in Bangladesh.

Despite this, the treaty still provides discretionary grounds for India to reject an extradition request.

Political Considerations in Extradition Decisions

Ultimately, the decision to extradite Sheikh Hasina is not solely a legal matter but a political one. India's critical interests and bilateral relations with Bangladesh will weigh heavily on this decision. As a former Research and Analysis Wing (R&AW) officer noted, "The legalese of the treaty does not matter."

A former diplomat emphasized that healthy relations between nations can persist even with unresolved extradition requests, highlighting the broader context of bilateral ties over isolated legal cases.

Previous Extradition Successes

India and Bangladesh's extradition treaty has facilitated cooperation in the past. For instance, in 2015, India successfully extradited Anup Chetia, a top leader of the United Liberation Front of Assam (ULFA). This demonstrates the treaty's functionality when political and mutual interests align.

Conclusion

While the 2013 extradition treaty and its 2016 amendments streamline the extradition process, they do not mandate India to hand over Sheikh Hasina. Legal provisions and political considerations give India the flexibility to refuse the request if it serves its broader strategic interests, preserving the balance in its relationship with Bangladesh.

Relevance: GS Prelims & Mains Paper II; Bilateral Relations