MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

Introduction to Research! (How to Read Research Papers)

2/25/2025

Session Agenda

- P3 Announcements
- ARC Introduction (3:45~4:45)
- Introduction to Research

P3 Announcements

- Check for anomalous imports
- Training Faster_CNN may fail alone, retrain

ARC Introduction

- Several services require VPN access to use from off-campus
- VPN clients and setup information is available:

https://its.umich.edu/enterprise/wifi-networks/vpn/getting-started

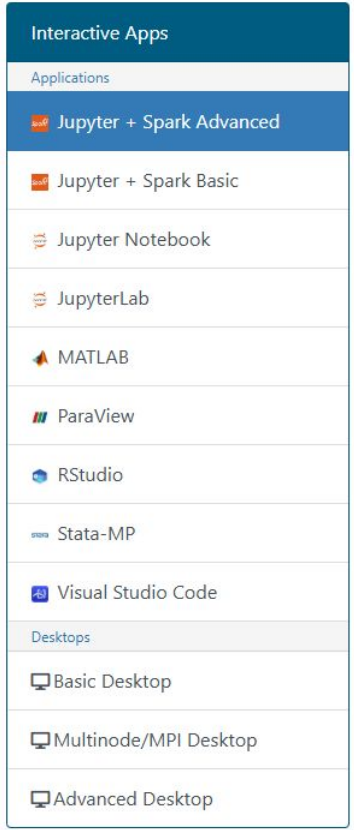
ARC Introduction

- Some forms of data are **SENSITIVE**
- Examples of sensitive data (health, etc)
- Sensitive Data Guides are available from here:

https://safecomputing.umich.edu/dataguide?check_logged_in=1

ARC Introduction

Class staffs' goal is to provide larger compute resources to the class. Available platforms shown to right:



ARC Interlude

Guest Speaker from ARC

Break

~5 Minutes

Learning Objectives

- Understand purpose of research
- Understand how research papers fit into the paradigm
- Identify economics of research operations

Purpose of Research

- Why bother?
- What are the different forms research can take?
- How do the results of research get communicated?

Why bother?

Why bother?

- Advance human knowledge
- Takes place in the private and public realms
- Public is primarily academia
- Private is corporate R&D

How is public research created?

- Research Labs (national labs, etc)
- Universities
- Government agencies

Research Labs

Government Agencies

DARPA

NIH National Institutes of Health
Turning Discovery Into Health

USDA U.S. Department of Agriculture

How is research communicated?

- Conferences (Posters and Presentations)
- Workshops
- Professional Orgs (IEEE)
- **Papers! (Will return to shortly)**

Understanding the economics

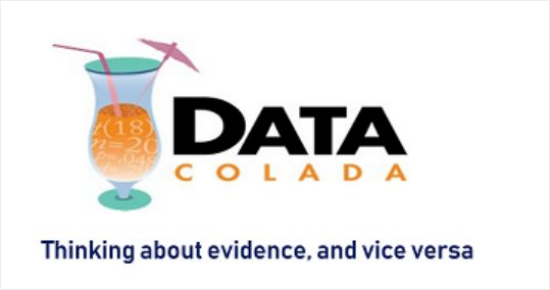
- Money comes in through grants (and tuition)
- Money is spent in several buckets:
  - Equipment
  - Personnel
  - Space

Understanding the economics

- Principal Investigators (PIs) publish to get grants
- Better publishing means more grants
- Better publishing means better recruits
- Better publishing means more prestige
- Better publishing means appointments
- **But also any adverse incentives!**

Adverse Incentives

- Many famous cases
- Recommend listening to authors of Data Colada



Case Study

Any Guesses?

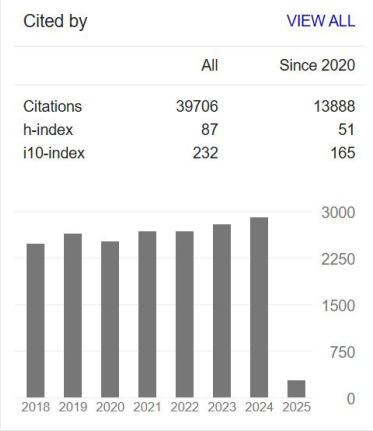
Case Study

John Leonard

Professor of Mechanical and Ocean Engineering, MIT
Verified email at mit.edu - Homepage

Robotics SLAM Marine Robotics

https://robotics.umich.edu/people/advisory-board/



What does “Better” mean?

- Surface level - Citations
- More impactful
- Helps move the needle of subsequent papers

How to identify advancement (and read papers)

- First, what is claimed?
- Second, how is it supported?
- Third, how does it support moving forward?

Case Study - GraphCast

GraphCast: AI model for faster and more accurate global weather forecasting

Learning skillful medium-range global weather forecasting 919 2023
R Lam, A Sanchez-Gonzalez, M Willson, P Wirnsberger, M Fortunato, ...
Science, eadi2336

What is claimed?

- Generally, the main idea is in the abstract
  - New model
  - Predicts weather
  - Performs well
  - Is novel
  - *By what metrics?*

Abstract

Global medium-range weather forecasting is critical to decision-making across many social and economic domains. Traditional numerical weather prediction uses increased compute resources to improve forecast accuracy but does not directly use historical weather data to improve the underlying model. Here, we introduce GraphCast, a machine learning–based method trained directly from reanalysis data. It predicts hundreds of weather variables for the next 10 days at 0.25° resolution globally in under 1 minute. GraphCast significantly outperforms the most accurate operational deterministic systems on 90% of 1380 verification targets, and its forecasts support better severe event prediction, including tropical cyclone tracking, atmospheric rivers, and extreme temperatures. GraphCast is a key advance in accurate and efficient weather forecasting and helps realize the promise of machine learning for modeling complex dynamical systems.

What is claimed?

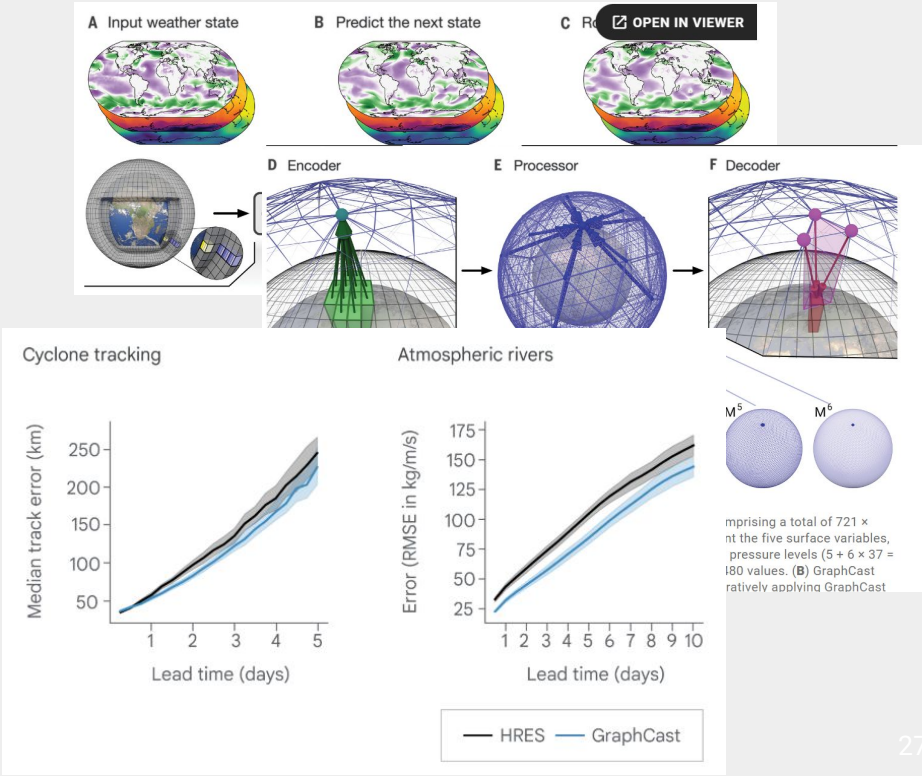
- Abstract is a good place to gather vocabulary
- What vocabulary haven't you seen before?

Abstract

Global medium-range weather forecasting is critical to decision-making across many social and economic domains. Traditional numerical weather prediction uses increased compute resources to improve forecast accuracy but does not directly use historical weather data to improve the underlying model. Here, we introduce GraphCast, a machine learning–based method trained directly from reanalysis data. It predicts hundreds of weather variables for the next 10 days at 0.25° resolution globally in under 1 minute. GraphCast significantly outperforms the most accurate operational deterministic systems on 90% of 1380 verification targets, and its forecasts support better severe event prediction, including tropical cyclone tracking, atmospheric rivers, and extreme temperatures. GraphCast is a key advance in accurate and efficient weather forecasting and helps realize the promise of machine learning for modeling complex dynamical systems.

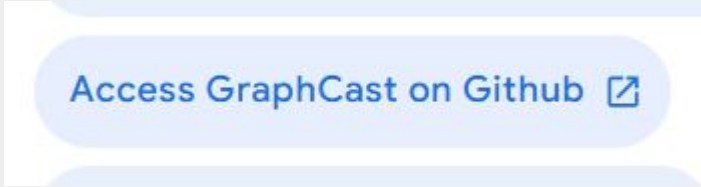
How is it supported?

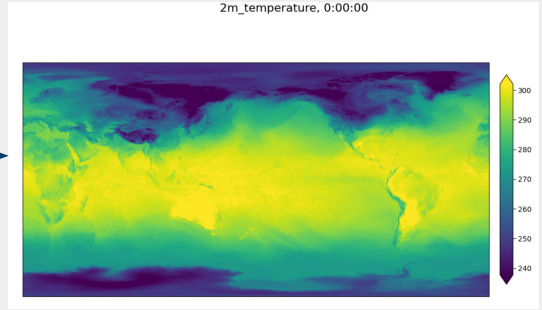
- Implementation details
- Useful graphics
- Open datasets



How is it supported?

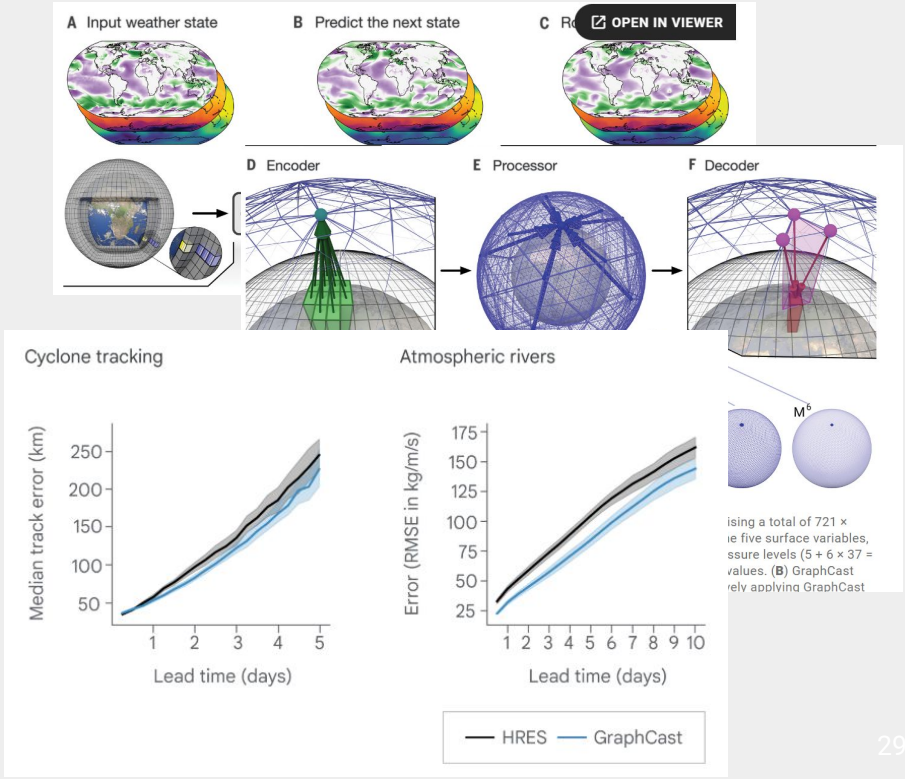
- CODE!!!





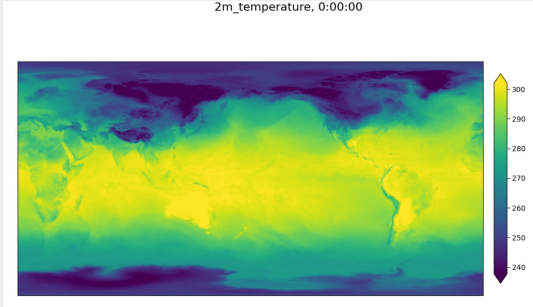
Questions to ask

- Does the data relate to the claims?
- Do the figures convey the data?
- Is the data relevant?



How does it support moving forward?

- Does the research help subsequent projects?
- Is the data made available or indications on availability made?



Closing Remarks

- Questions?
- When reading papers, consider what makes it easier on your readers

Have a wonderful break!