Dilemmas of an Astro-PhD and Real-Life Applications of Research Methodology

Kiyoaki Christopher Omori (JSPS DC2 Fellow), Nagoya University

Co-Learnium, CSIRO, September 12, 2023

Overview of Talk

- About me (brief)
  - General Intro
  - Research Intro
- The Challenges of an Astro-PhD Student
- What can we do and how?

About Me

- Born in **London, Ontario, Canada**

Arku et al. (2011)

About Me

- Born in London, Ontario, Canada
- Graduated **London Central Secondary School**

https://en.wikipedia.org/wiki/London_Central_Secondary_School#/media/File:Central_Secondary,_London.jpg

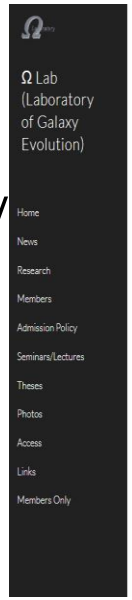
About Me

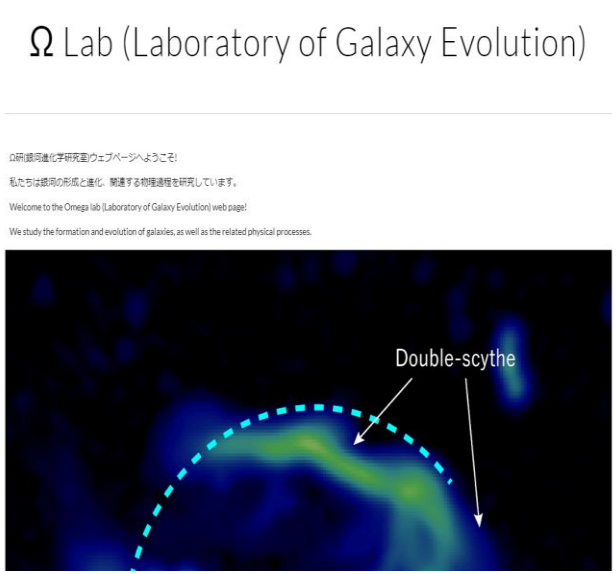
- Born in London, Ontario, Canada
- Graduated London Central Secondary School
- Undergraduate – **Nagoya University G30 Program**
- Master's Degree – **Nagoya University**

NAGOYA UNIVERSITY GLOBAL 30 INTERNATIONAL PROGRAMS

About Me

- Born in London, Ontario, Canada
- Graduated London Central Secondary School
- Undergraduate – Nagoya University G30 Program
- Master's Degree – Nagoya University
- Currently in 3rd year of Doctoral Program @ **Nagoya University Laboratory of Galaxy Evolution** (Supervisor: Tsutomu T. Takeuchi) (JSPS DC2 Fellow)
  - Research Interests: Everything about Galaxy Mergers, Galaxy Evolution with Machine Learning





Recent Research

- Galaxy Merger Identification in the HSC-SSP using Machine Learning Techniques

- Galaxy merger incidence and their dependence on environment

- Current projects:
  - Further investigation on machine learning architecture – what features is our AI sensitive to?

  - Mergers, AGNs, and environment

Galaxy mergers in Subaru HSC-SSP: a deep representation learning approach for identification and the role of environment on merger incidence

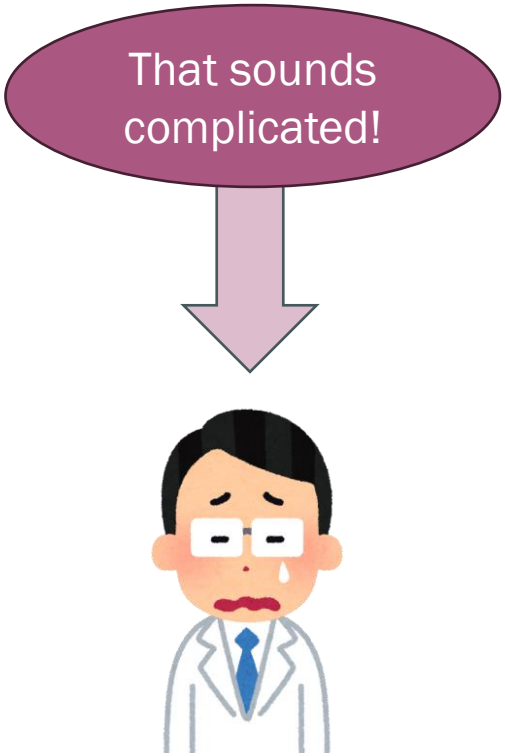
Kiyoaki Christopher Omori[1], Connor Bottrell[3], Mike Walmsley[4], Hassen M. Yesuf[3,5], Andy D. Goulding[6], Xuheng Ding[3], Gergö Popping[11], John D. Silverman[3,7], Tsutomu T. Takeuchi[1,2], and Yoshiki Toba[8,9,10]

[1]Division of Particle and Astrophysical Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464–8602, Japan
[2]The Research Centre for Statistical Machine Learning, the Institute of Statistical Mathematics, 10–3 Midori-cho, Tachikawa, Tokyo 190–8562, Japan
[3]Kavli Institute for the Physics and Mathematics of the Universe (WPI), UTIAS, University of Tokyo, Kashiwa, Chiba 277-8583, Japan
[4]Jodrell Bank Centre for Astrophysics, Department of Physics & Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, UK
[5]Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing 100871, People's Republic of China
[6]Department of Astrophysical Sciences, Princeton University,Princeton, NJ 08544, USA
[7]Department of Astronomy, School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
[8]National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan
[9]Academia Sinica Institute of Astronomy and Astrophysics, 11F of Astronomy-Mathematics Building, AS/NTU, No.1, Section 4, Roosevelt Road, Taipei 10617, Taiwan
[10]Research Center for Space and Cosmic Evolution, Ehime University, 2-5 Bunkyo-cho, Matsuyama, Ehime 790-8577, Japan
[11]European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748, Garching, Germany

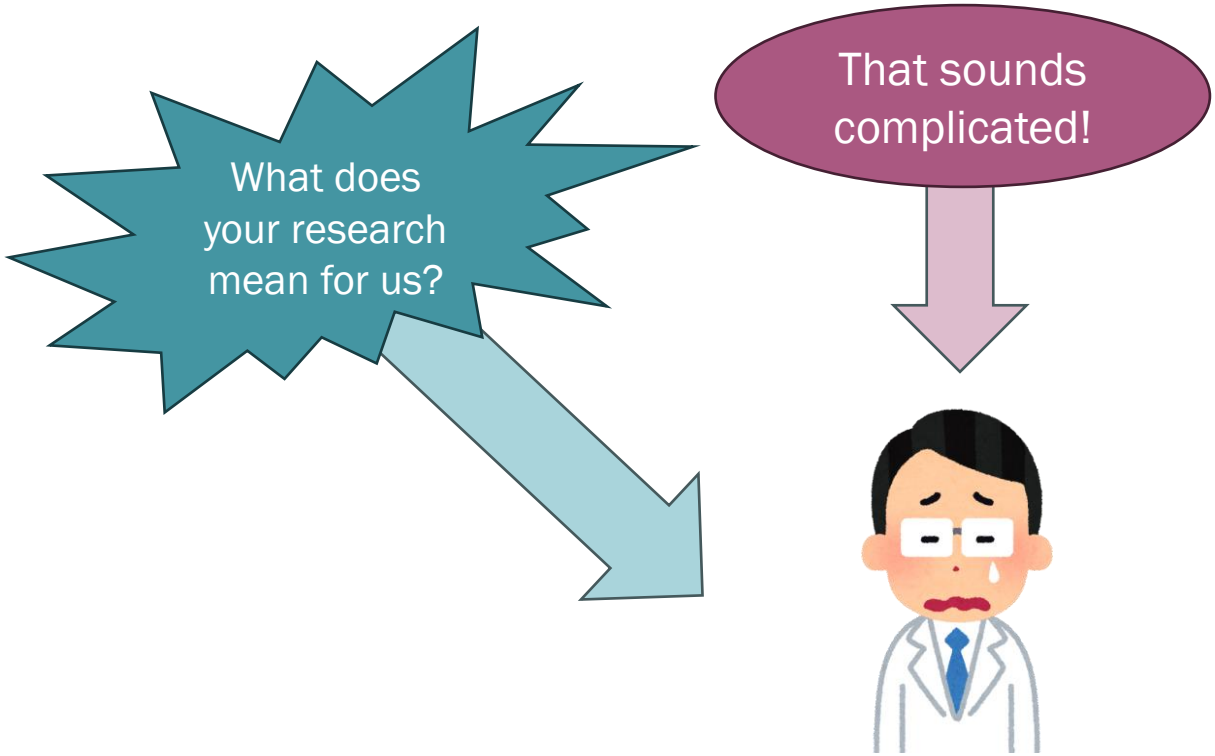
Received September , 2023; accepted September, 2023

The Challenges of an Astro-PhD Student

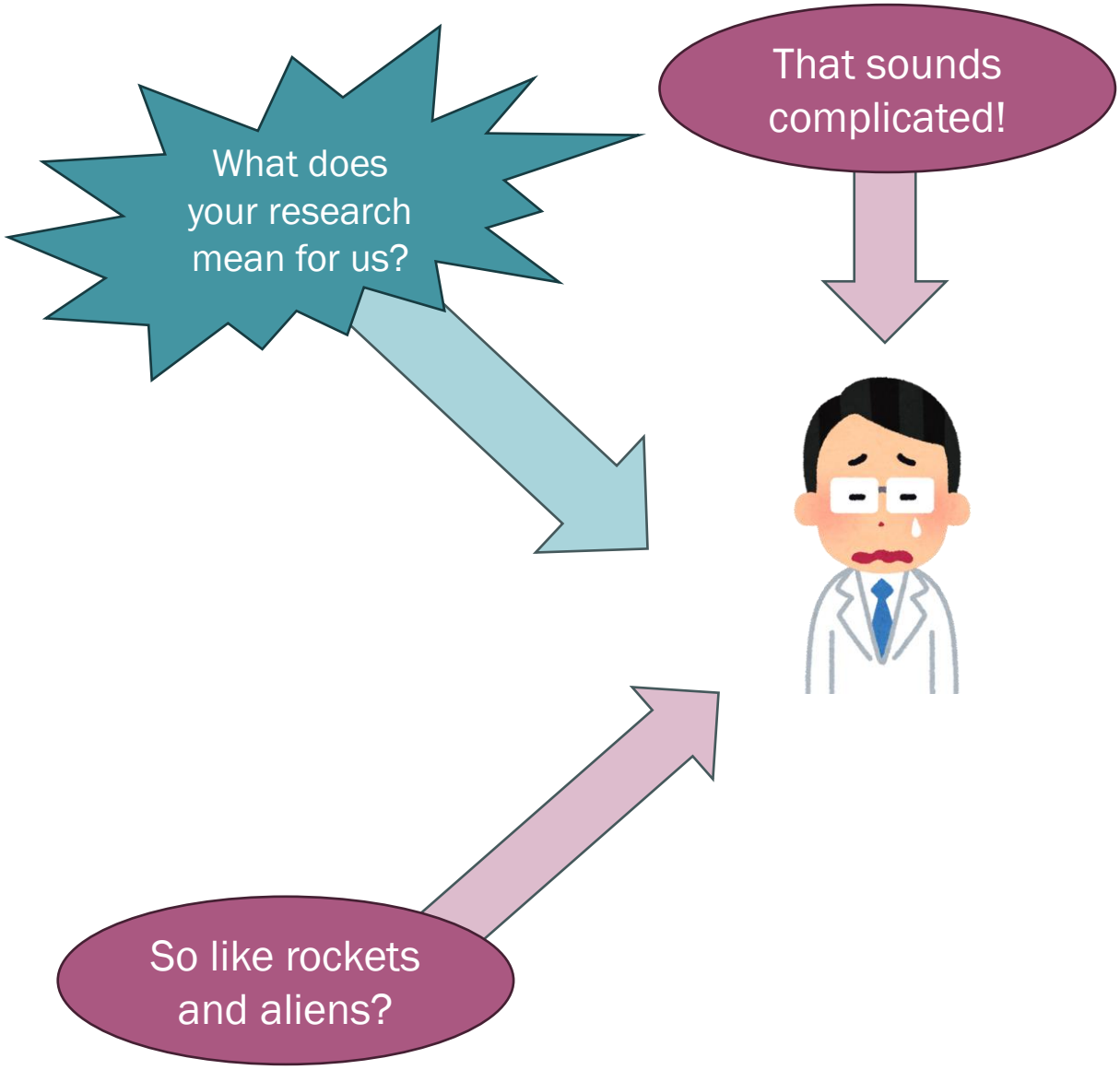
The Challenges of an Astro-PhD Student



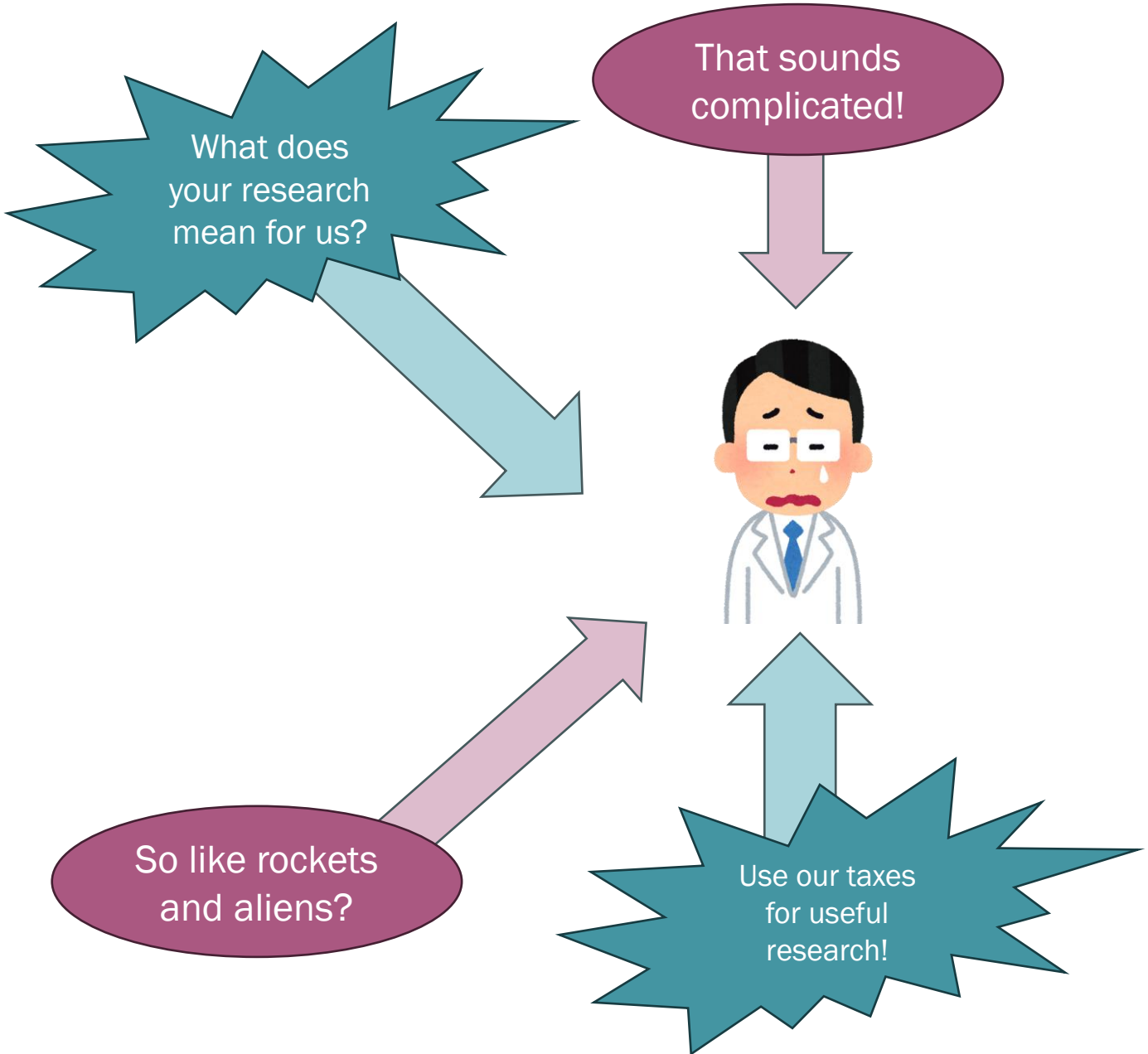
The Challenges of an Astro-PhD Student



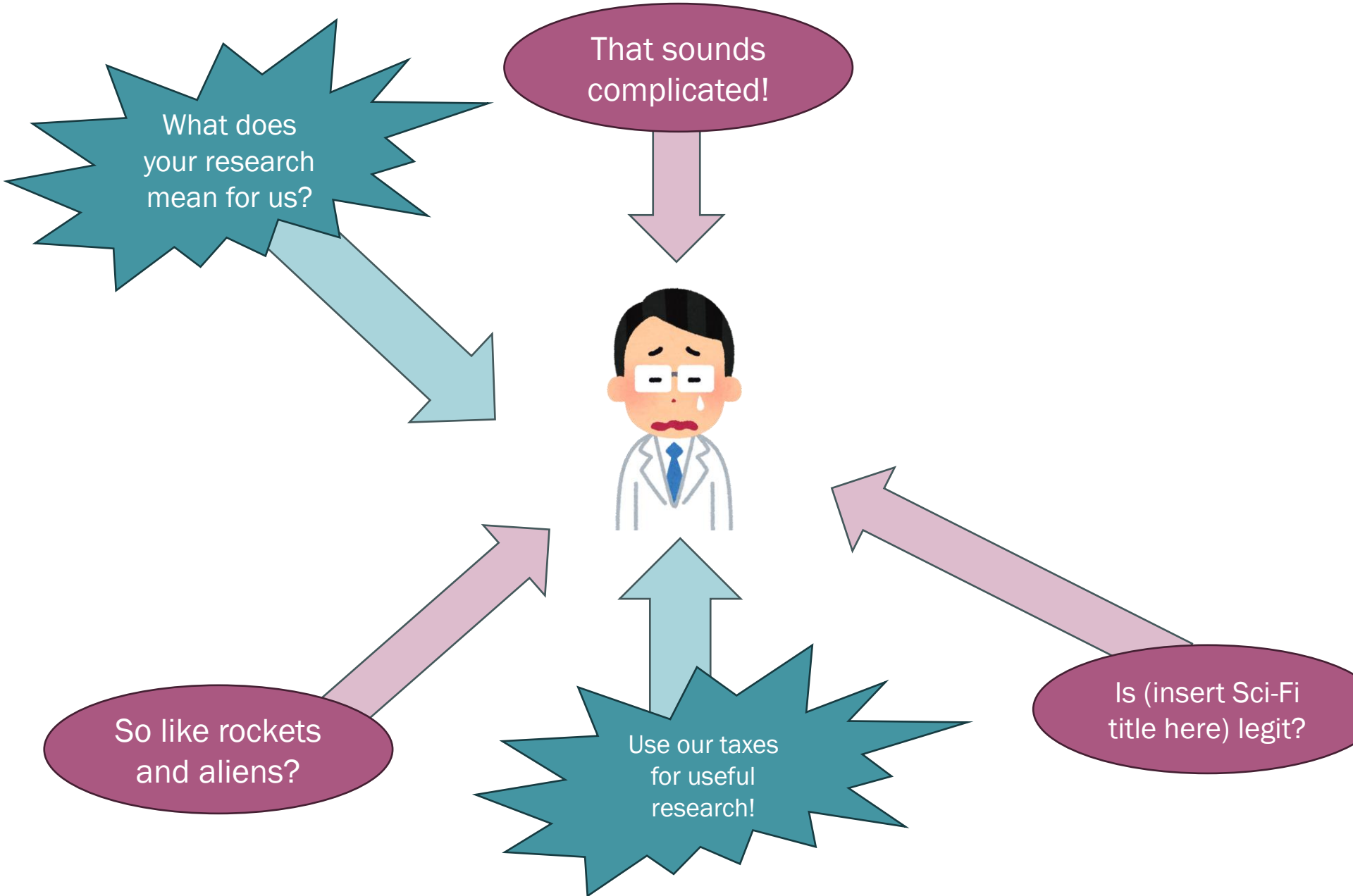
The Challenges of an Astro-PhD Student



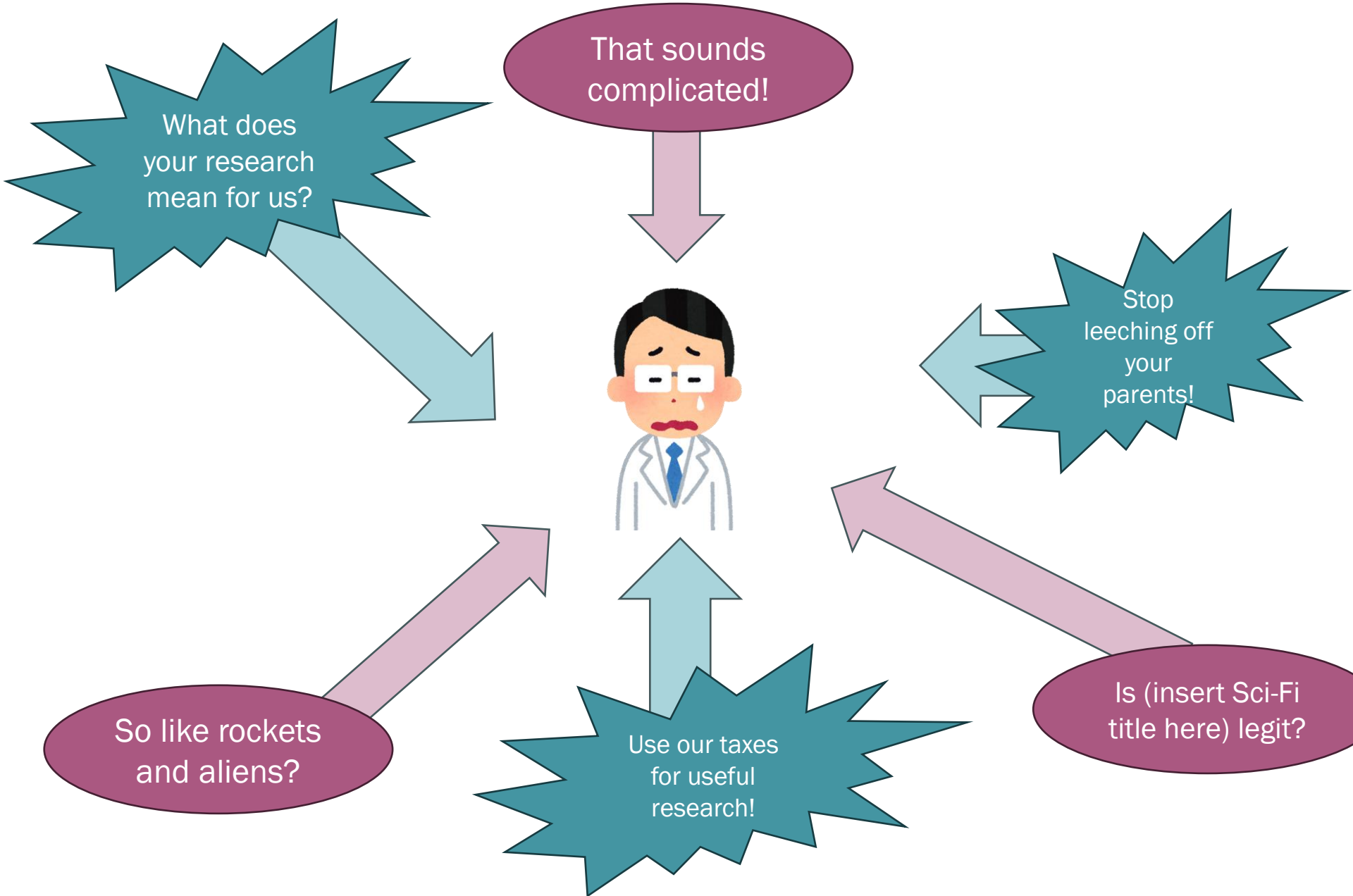
The Challenges of an Astro-PhD Student



The Challenges of an Astro-PhD Student



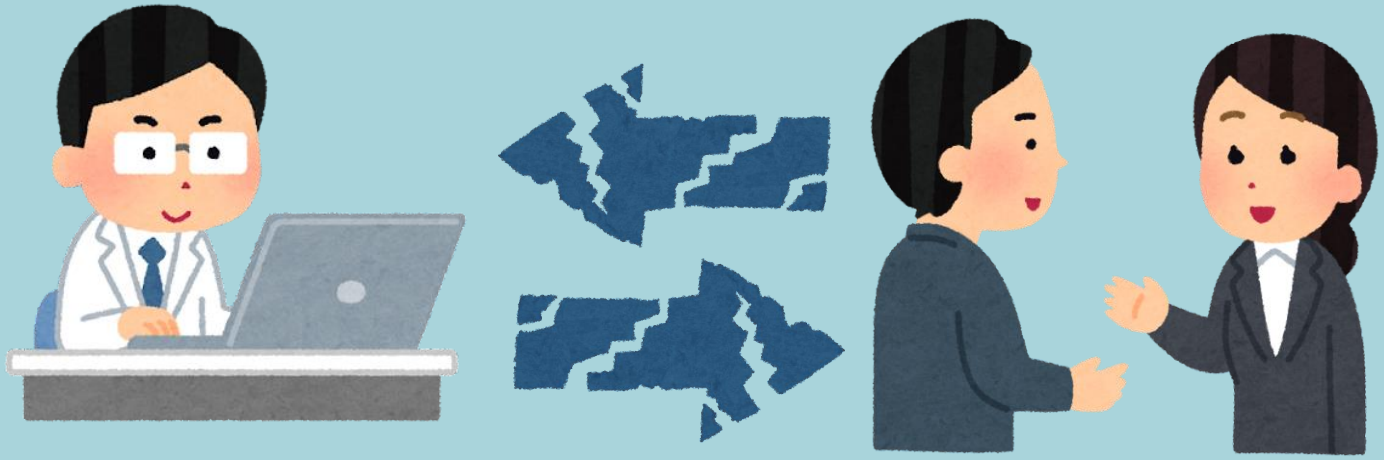
The Challenges of an Astro-PhD Student



The Challenges of an Astro-PhD Student

That sounds

Disconnect with non-academia



and aliens?

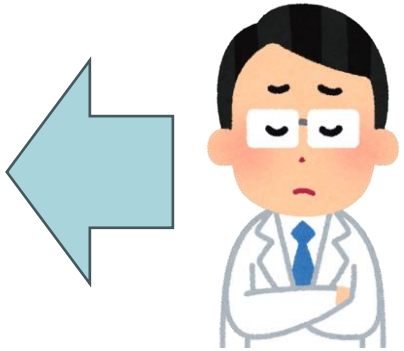
use our taxes
for useful
research!

ci-Fi
e) legit?

What can we do?

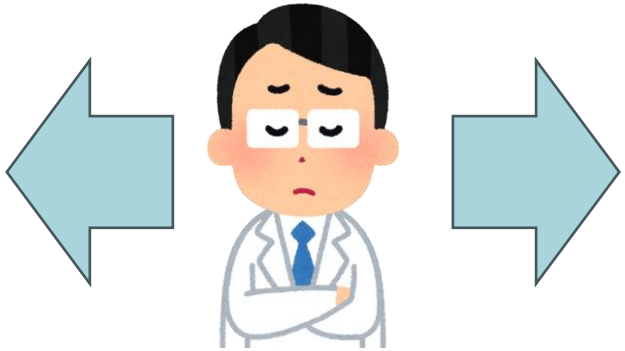
What can we do?

Outreach



What can we do?

Outreach



Real-Life Applications

Outreach - IGNIMUS

- Founded in 2023 by Sena Matsui (Nagoya University), with the motivation of providing a platform where students interested in education and outreach activities can access useful information
- Conducting activities with the goal of becoming a group which motivates students interested in conducting outreach
- Main Activities
  - Sharing information related to education and outreach
  - Outreach events
  - Interdisciplinary networking

Find us on twitter:
@nu_stu_outreach

IGNIMUS Activities

- “月替わりサイエンス食堂” (Monthly Science Lunch)
  - Held monthly at Nagoya University
  - A student “chef” interested in outreach presents their research
  - Students of all disciplines are welcome to attend

IGNIMUS Activities

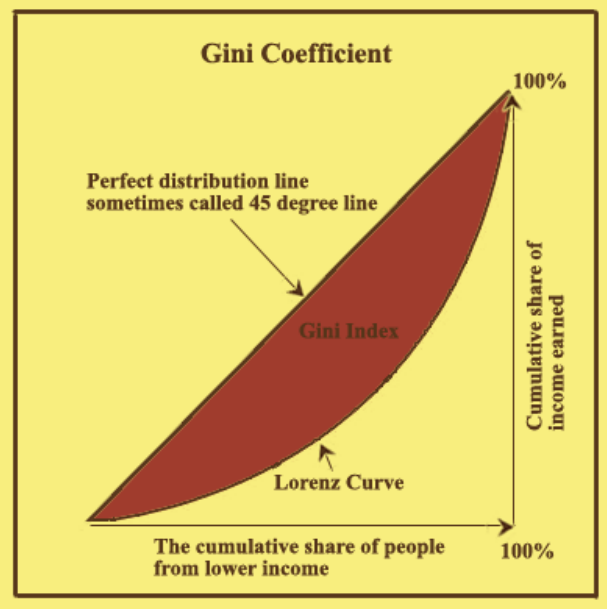
- Local events
  - Workshops @ Nagoya University and other locations
  - Booths at local events (pictured: Toyohashi Space Event)
  - Collaborations with other local organizations

IRL Applications

- A lot of items we use come from other disciplines!

IRL Applications

- A lot of items we use come from other disciplines!



https://www.laits.utexas.edu/lawdem/unit03/reading2/Gini_definition.jpg

Gini Coefficient for Galaxy Morphologies - **Economics**

https://tile.loc.gov/storage-services/service/pnp/cph/3c10000/3c10000/3c10400/3c10447_150px.jpg

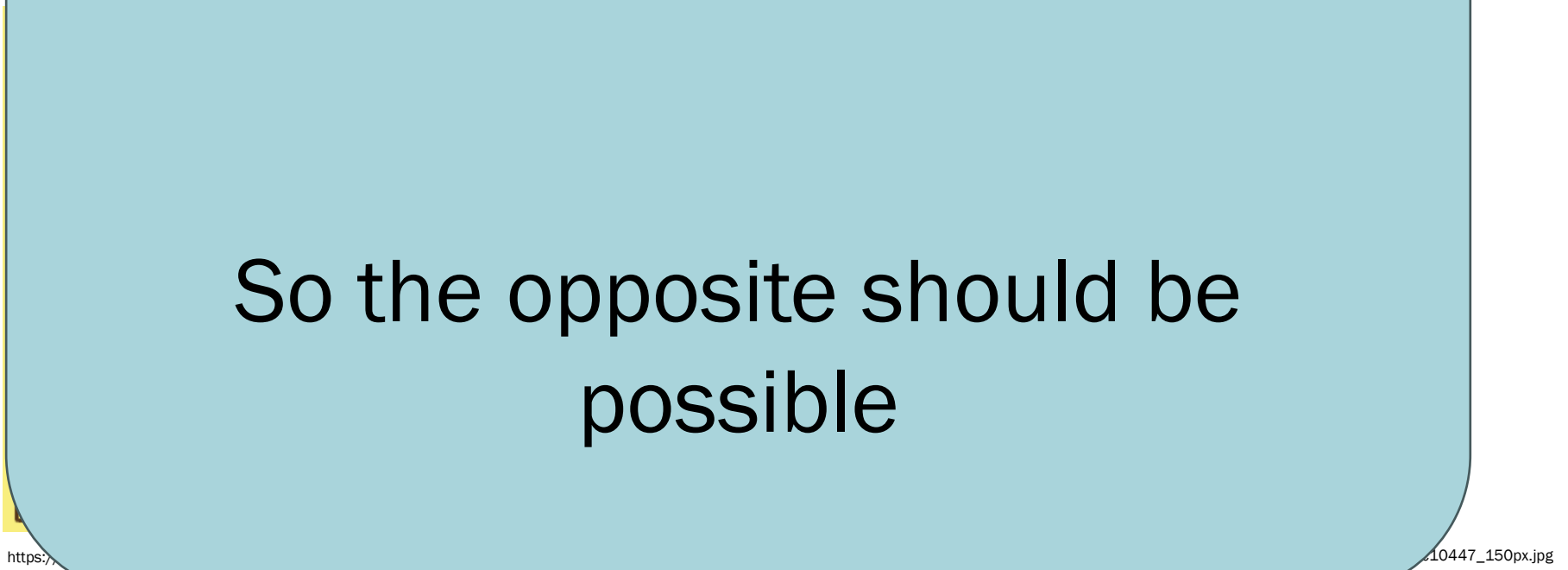
First telescopes - **Military Use**

IRL Applications

- A lot of items we use come from other di

Other disciplines→Astro exists...

So the opposite should be possible



https:/ 10447_150px.jpg

Gini Coefficient for Galaxy Morphologies - **Economics**

First telescopes - **Military Use**

IRL Applications

- Research Overview
  - Galaxy Mergers in HSC-SSP
    - What are mergers?
  - AGN Studies
    - What are AGNs?
  - Machine-Learning and Data Science in Astro
    - There must be something here…

IRL Applications

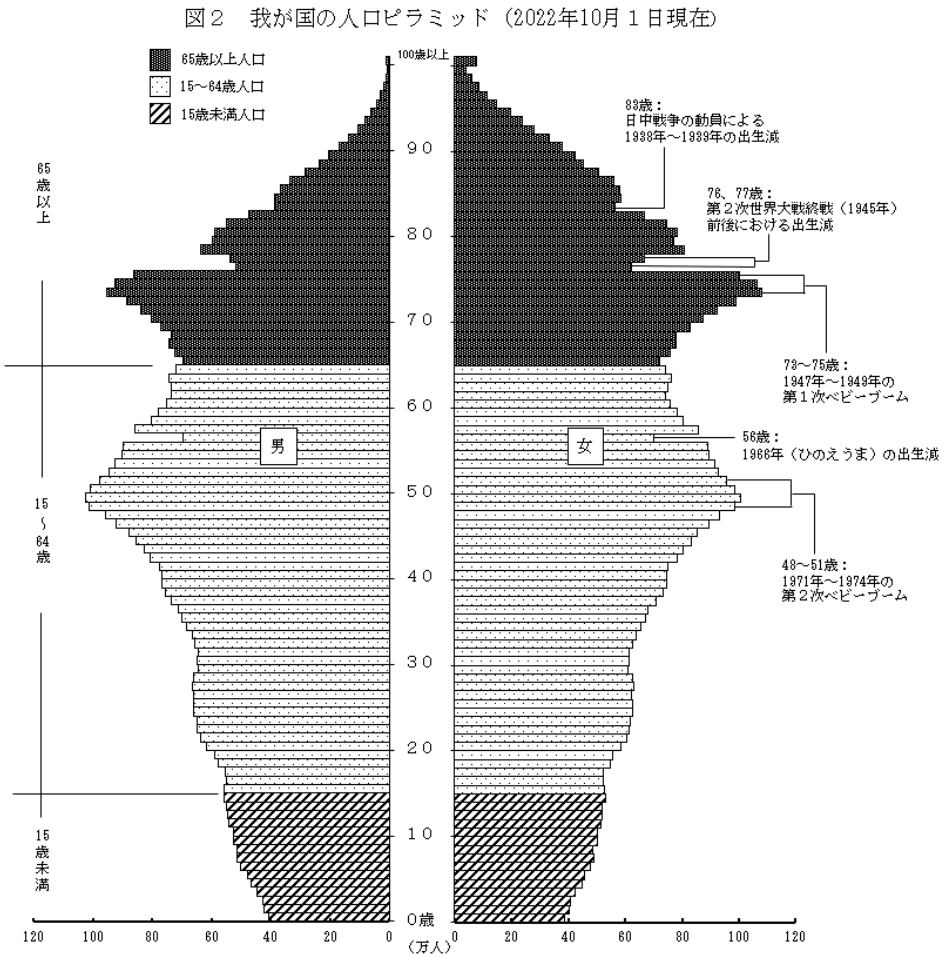
- Machine-Learning/Data Science
  - Galaxy merger identification using ML
    - Random forests
    - CNNs
    - Multi-Input Neural Networks
    - AI
  - Big-data approaches to galaxy evolution
    - Several hundred thousand ~ million data points
    - Quantitative and qualitative trends

ML and DS Applications in an Aging Society

Loosely based on 実践データサイエンティスト育成プログラム
Project @ Nagoya University
(limited by NDAs)

Japan – Aging

- Increase in aging population/decrease in youth(少子高齢化)
  - 40%+ over 65, projected to increase
  - Less than 15% under 15, projected to decrease
  - Increase in average age

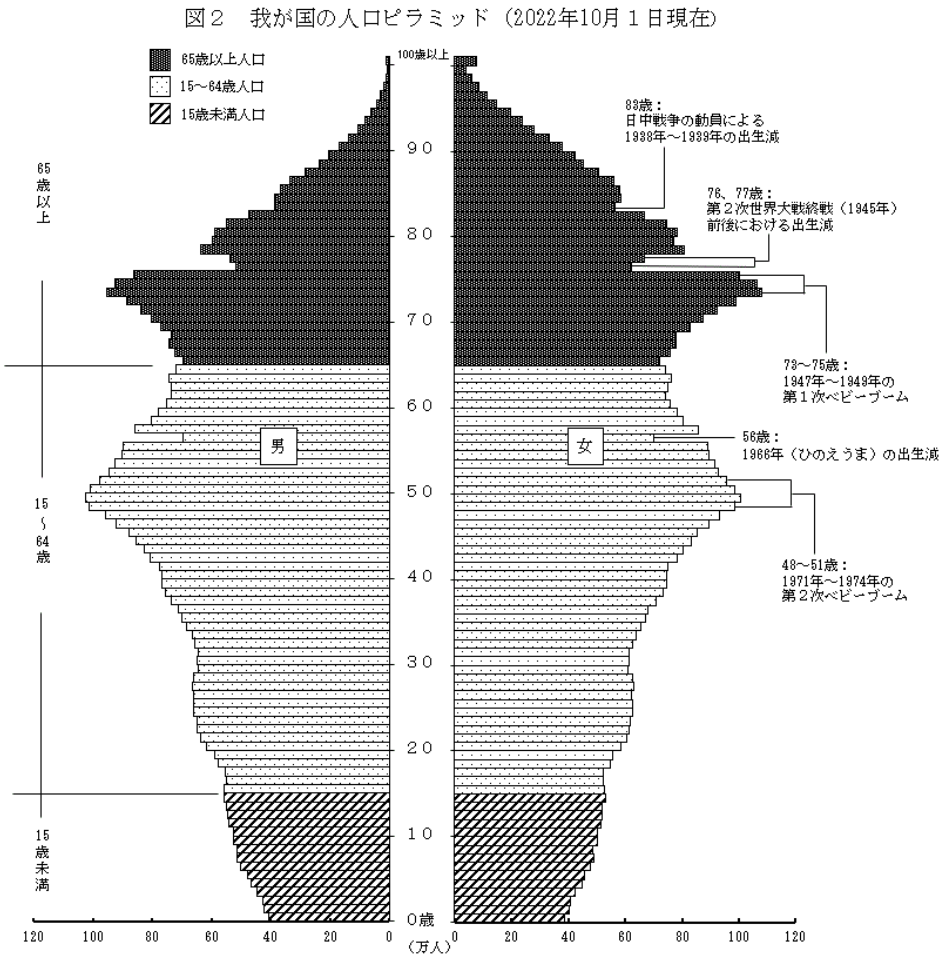


https://www.stat.go.jp/data/jinsui/2022np/index.html

Japan – Aging

- Increase in aging population/decrease in youth(少子高齢化)
  - 40%+ over 65, projected to increase
  - Less than 15% under 15, projected to decrease
  - Increase in average age

Many Issues Arise!

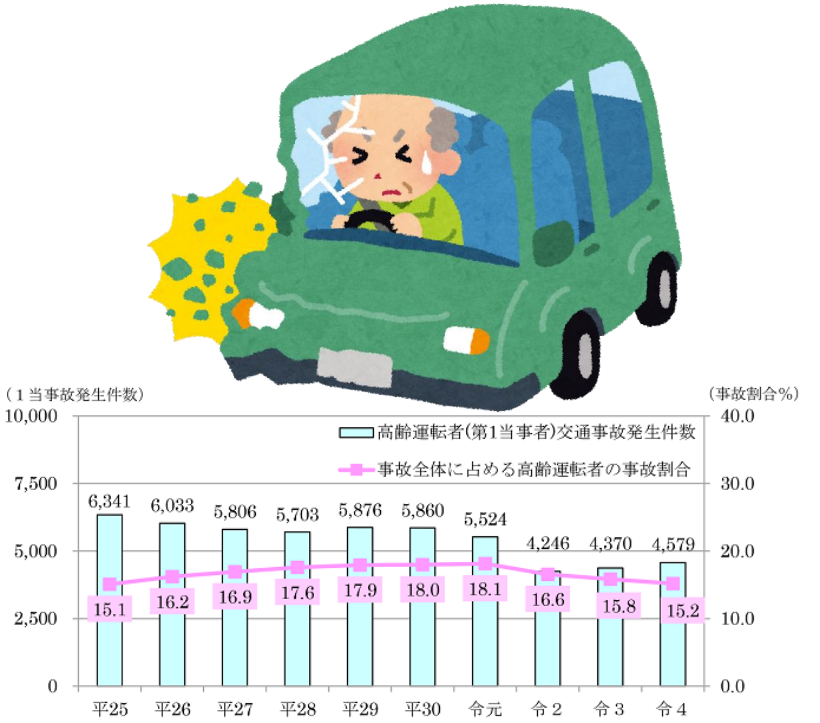


https://www.stat.go.jp/data/jinsui/2022np/index.html

Issues in an Aging Society

https://www.city.kuwana.lg.jp/kanko/filmcommission/spot/machinami/spot6.html

Desolate Cities



https://www.keishicho.metro.tokyo.lg.jp/kotsu/jikoboshi/koreisha/koreijiko.html

Traffic Accidents

What can we do?

https://www.city.kuwana.lg.jp/documents/9604/midokorokuwana01.jpg

Tourism

https://www.city.kuwana.lg.jp/images/684/community_bus01.jpg

Public Transport

What can we do?

https://www.city.kuwana.lg.jp/documents/9604/midokorokuwana01.jpg

https://www.city.kuwana.lg.jp/images/684/community_bus01.jpg

Tourism

Public Transport

Machine Learning/Data Science?

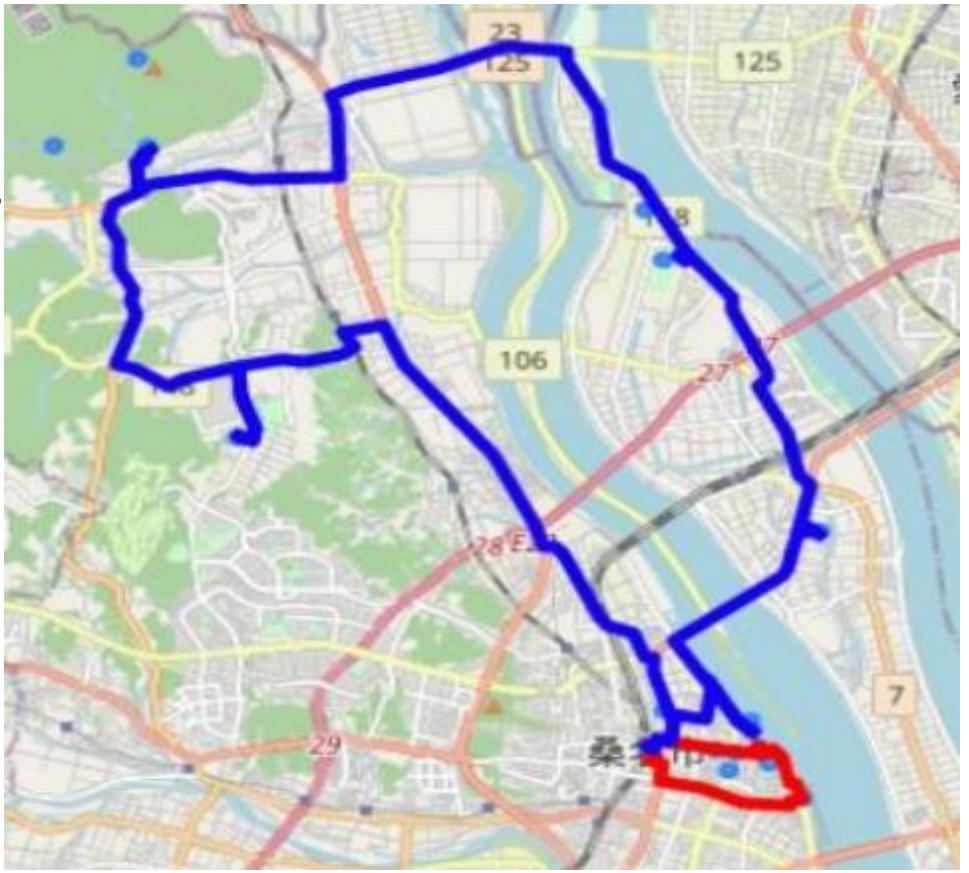
ML/DS Approaches to aid an Aging Society

1. Use of machine-learning in public transport route optimization

In the current society, many regional communities are facing a need of reform of public transport. For example, there is a need to re-think routing that allows for easier access between train stations, commercial facilities, and hospitals. In addition, newer plans for tourism are required to liven up these communities. We can use machine-learning methods for route optimization to tackle these issues.

2. Multi-input neural networks to identify danger zones

The neural network techniques we use in our galaxy studies are not limited to use in astrophysics - we can combine imaging data and numerical information (such as accidents) of roads in a neural network to identify safe and dangerous zones in a city.



An example of route optimization for tourism sites in the city of Kuwana

Take-Home Message

- Our research methodology and tools are NOT limited to our discipline – it is up to us to find ways to apply them

- We can find and create ways for the public to understand and apply our research