ICRAR & ICRAR-Pawsey Summer Studentships 2018-2019
Project Proposal

Project Details

Project Title	**Hunting for fossils of ancient galaxy merging with deep learning**
Primary Supervisor	**Kenji Bekki**
Primary Supervisor Availability	**Between Nov 2018 and March 2019**
Contact Details	kenji.bekki@uwa.edu.au
Additional Supervisors & Contact Details	No others
Additional Resources Required	Students will be able to use my own GPU clusters (Magellan and Pleiades). Only laptop PC from students is required for data analysis.
Pawsey Centre Hardware Use	N/A
Software Required	Student Desktop Requirements: • Data analysis software (e.g., Mathmatica, Matlab) Pawsey Centre software installations required: • N/A.
Student Location for project	ICRAR-UWA
Project Description	Galaxy merging is a fundamentally important physical process of galaxy formation and evolution. The signature of such merging can be imprinted on the physical properties of outer parts of galaxies (e.g., stellar halos and globular cluster systems around galaxies). However, it is a formidable task for astronomers to detect such faint signals of ancient merger events of galaxies. In this project, students will try to ``hunt for'' fossil records of ancient galaxy merging in stellar structures and kinematics of galaxies by applying deep convolutional neural networks (CNNs) to the 2D images of galaxies. First, students will create a large number of 2D images of galaxies for isolated and merging galaxies for training CNNs based on the results of computer simulations. Using new data sets from simulations, students then will investigate whether a (new) simulated galaxy can be correctly classified as an isolated galaxy or a merging galaxy. The main purpose of this project is to develop a CNN for such classification.

Student Attributes

Academic Background	Basic knowledge of astronomy or computer science. Some skills to use software for data analysis. It would be great, if students know some basic things about deep learning. Students with computer science background is OK.
Computing Skills	This is not essential, but, if students are familiar with any programming with either C, Fortran, or python, it would be great.
Training Requirement	Basic physical processes of galaxy formation and evolution will be learned by students. Classification of galaxies using Keras or Tensorflow will be learned.

Project Timeline

Week 1	**Pawsey training (or inductions and project introduction)**
Week 2	Using a test (Keras) code for simple galaxy classification
Week 3	Performance of computer simulations of isolated and galaxies (stellar halos and globular cluster systems)
Week 4	The same above Week 3
Week 5	Data analysis from the simulations from Week 3-4 (structures of outer halos). Training a CNN for classification of isolated and merging galaxies.
Week 6	The same as Week 5.
Week 7	Testing isolated vs merging models using the CNN developed in Week 6
Week 8	Discussion of the results from Week 6-7
Week 9	Writing a report (if possible for a paper)
Week 10	**Final Presentation and Reporting**

Can a convolutional neural network (CNN) classify isolated vs merging galaxies ?

Simulated galaxy

CNN
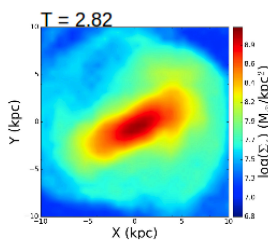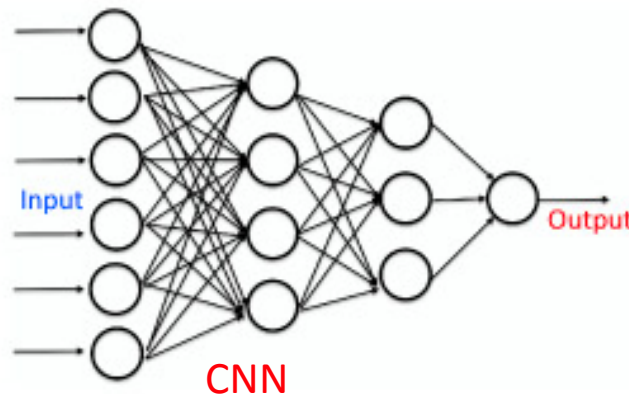
1. Isolated ?

2. Merger ?

If it is classified as a merger, then what is the mass-ratio of two merging galaxies (regression problem) ?