Australian Government

Jobs and Skills Australia

Occupation Mobility Graph

Methodology Paper

July 2026

Contents

1. Methodology

1.1 Source Data and Preprocessing

The sample used to construct the Occupation Mobility Graph are occupation headcounts and transition counts that were sourced from Jobs and Skills Australia's (JSA) data showing how workers move between occupations across years (known as Data on Occupation Mobility (DOM)). DOM was created in the ABS DataLab environment, using data from their Person Level Integrated Data Asset (PLIDA; ABS, 2023; Biddle *et al*, 2019). DOM's occupation series were derived from a single module in PLIDA, the Australian Tax Office's (ATO) Personal Income Tax (PIT) data, specifically their Individual Tax Return (ITR) records. The DOM data utilised for the Occupation Mobility Graph comprises annual—by financial year (FY)—headcount and transition count values, covering the FYs 2010-11 through 2022-23, inclusive. This report uses data from FY 2021-22 and FY 2022-2023. Occupations in DOM are resolved at the six-digit level, converted from ATO's occupation encodings to version 1.3 of the Australian and New Zealand Standard Classification of Occupations (ANZSCO).

This analysis utilises the FY 2022-23 inflow data to construct the Occupation Mobility Graph. Flows are defined as coming from the FY 2021-22 occupation into the FY 2022-23 occupation and are used to create the nodes, edges, and edge weights in the mobility graph.

Inflows comprise over 500,000 rows of data, with each FY having between 40,000 and 50,000 rows. Each row in the data defines a connection between a FY 2021-22 occupation and a FY 2022-23 occupation.

The process of identifying occupation clusters corresponds to a well-known computational problem, graph partitioning (Bui, 2001; Erciyes, 2018). Graph partitioning is computationally intensive. Given this, steps were taken to achieve a feasible solution with the available resources. Outlined below are the steps that were followed to clean the data and reduce the complexity of the clustering analysis:

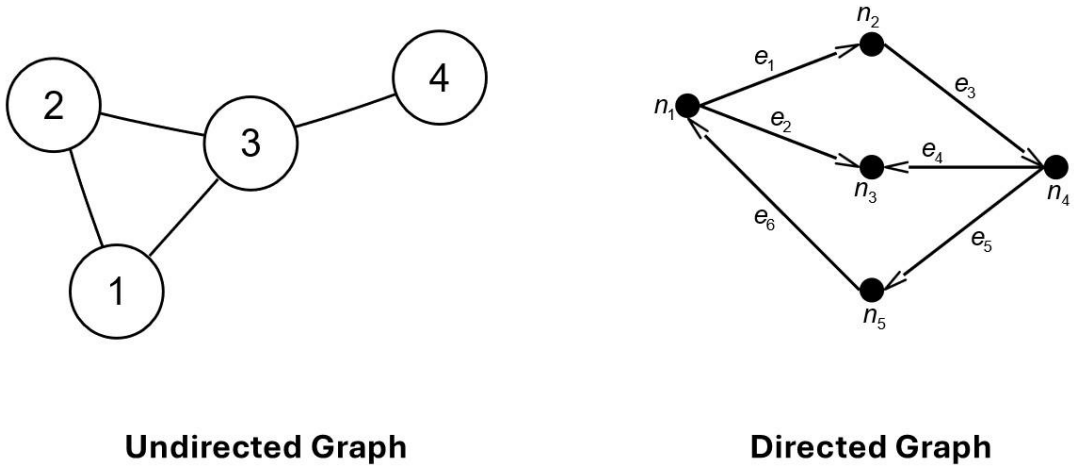
- Truncate occupations from six-digit ANZSCO to four-digit unit group resolution and aggregate flow counts to the unit group level.
- Remove observations for which FY 2021-22 occupations are not ANZSCO codes but aggregate classes that resulted from the hierarchical keep-and-sweep data suppression scheme employed to aggregate small counts for inclusion in DOM; e.g., aggregate classes such as " Other Minor Group 621", " Other Sub-major Group 22", " Other Major Group 1", et cetera. Such nodes cannot be mapped to a single unit group and cannot be used in the analysis.
- Remove observations for which any occupation in a FY has a fill value. Fill values are associated with records for which an individual did not file a tax return ("NO_ITR"), the occupation was not supplied by the individual ("UNKNOWN"), or there was no reliable mapping between the ATO occupation code and ANZSCO 1.3 ("UNMAPPED"). None of these values correspond to ANZSCO unit groups and are irrelevant to the analysis.
- For each unit group in FY 2022-23, retain only the ten largest remaining inflows from the 2022-23 unit groups and with a flow larger than 10. This measure is taken to reduce the

complexity of the resulting Occupation Mobility Graph and results in lower computational complexity for the partitioning process.

1.2 Derivation of the Occupation Mobility Graph

A graph is a set of nodes that are connected to each other by a set of edges (Figure 1). An edge connects two nodes and can be either directed (an arrow pointing from a node to the other node) or undirected. Edges can have attributes, for example a weight that indicates the strength of the connection between the nodes that the edge connects. Graphs that have directed edges are called directed graphs, while nodes that have undirected edges are called undirected graphs. The sample resulting from the preprocessing described in the previous section can be instantiated as a weighted, directed graph, with ANZSCO unit groups corresponding to nodes and the inflows as weighted (by the number of people changing occupations) directed edges pointing from the FY 2021-22 unit groups to the FY 2022-23 unit groups.

Figure 1: Examples of undirected (left) and directed (right) graphs.



This approach builds on earlier research that models labour flows as networks, including Guerrero and Axtell (2013) and Schmutte (2014), who identified distinct mobility segments between which movement is constrained.

Once the Occupation Mobility Graph is constructed, deriving insights involves navigating edges and nodes to discover and understand relationships. For this analysis, graph partitioning is utilised to understand the different clusters that exist within the network.

1.3 Graph Partitioning to Identify Occupation Clusters

Given the high computational burden of graph partitioning, one further simplification was made to the Occupation Mobility Graph to convert it from a directed to undirected graph. This choice can also be justified by the reasoning that if we only want to analyse the affinity between occupations, no directional information is required. For each pair of nodes that are connected, the Occupation Mobility Graph may have either a single edge pointing from one

node to the other, or a pair of nodes pointing in each direction between them. For the single connection case, the directional information is removed but the weight is retained. For the dual connection case, the edges are combined into an undirected edge and assigned the sum of the directed edges' weights.

Graph partitioning is the division of the set of nodes in a graph into non-overlapping groups of nodes, sometimes called groups, clusters, modules, or communities. For the Occupation Mobility Graph, this means clustering nodes by occupation. Eight clusters have been developed as part of the Occupation Mobility Graph (see Appendix A). There exist many approaches to graph partitioning and software implementations (Buluc et al., 2016). The selected approach aimed to maximise a quantity called modularity, which measures the strengths of connections within modules versus the connectivity between modules. The modularity Q is defined as:

$$\mathrm{Q} = \frac{1}{2\mathrm{m}} \sum_{\mathrm{i}=1}^{\mathrm{N}} \sum_{\mathrm{j}=1}^{\mathrm{N}} \left[\mathrm{A}_{\mathrm{ij}} - \frac{\mathrm{k}_{\mathrm{i}} \mathrm{k}_{\mathrm{j}}}{2\mathrm{m}} \right] \delta(\mathrm{c}_{\mathrm{i}}, \mathrm{c}_{\mathrm{j}}),$$

A_{ij} is the weight of the edge connecting node i to node j; N is the total number of nodes; k_{i} and k_{j} are the sums of the weights of the edges attached to nodes i and j, respectively; m is the sum of all of the edge weights; c_{i} and c_{j} are the modules to which nodes i and j belong, respectively; and $\delta(\mathrm{c}_{\mathrm{i}}, \mathrm{c}_{\mathrm{j}})$ is the Kronecker delta function, which is 1 if $\mathrm{c}_{\mathrm{i}} = \mathrm{c}_{\mathrm{j}}$ and 0 otherwise.

For a weighted graph, values of the modularity Q for a partitioning range from -1 to 1. Strongly negative Q-values indicate links between resulting clusters are more dominant than links within the clusters. Strongly positive Q-values ($Q > 0.3$) indicate robust community structure and intra-cluster links are dominant over inter-cluster links. Values of Q near 0 indicate that the partitioning is indistinguishable from what might occur by chance and any clusters identified may be random.

The graph partitioning scheme is called “Louvain” partitioning (Blondel et al., 2008). We used a software implementation of this scheme from the R igraph package (igraph Core Team, 2025). The clustering results presented were generated using this method and the partitioning scheme’s modularity score was $Q = 0.43$, which indicates significant cluster structure was determined.

In terms of a methodological improvement, currently the complexity of the analysis is reduced by looking at the 10 most significant connections between different occupations. A future improvement can be to use the flow size as weights across all occupations when computing the clustering algorithm, which will provide a more detailed view of the movements between occupations. In addition, clustering can be performed at the six-digit occupation level, although this dramatically increases the complexity.

2. References

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3. Appendix A – Cluster Composition

Professional and Clerical

- Chief Executives and Managing Directors
- General Managers
- Legislators
- Corporate Services Managers
- Finance Managers
- Human Resource Managers
- Policy and Planning Managers
- Research and Development Managers
- Importers, Exporters and Wholesalers
- Supply, Distribution and Procurement Managers
- Health and Welfare Services Managers
- Other Specialist Managers
- Amusement, Fitness and Sports Centre Managers
- Call or Contact Centre and Customer Service Managers
- Other Hospitality, Retail and Service Managers
- Accountants
- Auditors, Company Secretaries and Corporate Treasurers
- Financial Brokers
- Financial Dealers
- Financial Investment Advisers and Managers
- Human Resource Professionals
- Training and Development Professionals
- Archivists, Curators and Records Managers
- Economists
- Intelligence and Policy Analysts
- Land Economists and Valuers
- Management and Organisation Analysts
- Other Information and Organisation Professionals
- Architects and Landscape Architects
- Interior Designers
- Urban and Regional Planners
- Occupational and Environmental Health Professionals
- Real Estate Sales Agents
- Other Health Diagnostic and Promotion Professionals
- Judicial and Other Legal Professionals
- Solicitors
- Primary Products Inspectors
- Safety Inspectors
- Florists
- Indigenous Health Workers
- Tourism and Travel Advisers
- Contract, Program and Project Administrators
- Office Managers
- Practice Managers
- Personal Assistants
- Secretaries
- General Clerks nfd
- General Clerks
- Keyboard Operators
- Call or Contact Centre Workers
- Information Officers
- Receptionists
- Accounting Clerks
- Bookkeepers
- Payroll Clerks
- Bank Workers
- Credit and Loans Officers (Aus) \ Finance Clerks (NZ)
- Insurance, Money Market and Statistical Clerks
- Clerical and Office Support Workers nfd
- Conveyancers and Legal Executives
- Court and Legal Clerks
- Debt Collectors
- Human Resource Clerks
- Inspectors and Regulatory Officers
- Insurance Investigators, Loss Adjusters and Risk Surveyors
- Other Miscellaneous Clerical and Administrative Workers
- Insurance Agents

Ticket Salespersons

Arts

Advertising, Public Relations and Sales Managers
Conference and Event Organisers
Photographers
Visual Arts and Crafts Professionals
Artistic Directors, and Media Producers and Presenters
Authors, and Book and Script Editors
Film, Television, Radio and Stage Directors
Journalists and Other Writers
Advertising and Marketing Professionals
ICT Sales Professionals
Public Relations Professionals
Graphic and Web Designers, and Illustrators
Printers
Signwriters

Engineering and ICT

Actuaries, Mathematicians and Statisticians
Air Transport Professionals
Aircraft Maintenance Engineers
Architectural, Building and Surveying Technicians
Civil Engineering Draftspersons and Technicians
Civil Engineering Professionals
Commissioned Officers (Management)
Computer Network Professionals
Construction Managers
Database and Systems Administrators, and ICT Security Specialists
Deck and Fishing Hands
Defence Force Members - Other Ranks
Dental Hygienists, Technicians and Therapists
Electrical Distribution Trades Workers
ICT Business and Systems Analysts
ICT Managers
ICT Support and Test Engineers
ICT Support Technicians
ICT Trainers
Industrial, Mechanical and Production Engineers
Marine Transport Professionals
Mechanical Engineering Draftspersons and Technicians
Mining Engineers
Multimedia Specialists and Web Developers
Optometrists and Orthoptists
Other Engineering Professionals
Other Miscellaneous Technicians and Trades Workers
Police
Prison Officers

Electrical Engineering Draftspersons and Technicians
Electrical Engineers
Electricians
Electronic Engineering Draftspersons and Technicians
Electronics Engineers
Electronics Trades Workers
Engineering Managers
Fire and Emergency Workers
Geologists, Geophysicists and Hydrogeologists
Security Officers and Guards
Senior Non-commissioned Defence Force Members
Software and Applications Programmers
Surveyors and Spatial Scientists
Telecommunications Engineering Professionals
Telecommunications Technical Specialists
Telecommunications Trades Workers

Nursing and Caring

Cafe and Restaurant Managers
Hotel and Motel Managers
Licensed Club Managers
Retail Managers
Actors, Dancers and Other Entertainers
Technical Sales Representatives
Fashion, Industrial and Jewellery Designers
Veterinarians
Nutrition Professionals
Medical Imaging Professionals
Pharmacists
Complementary Health Therapists
Occupational Therapists
Physiotherapists
Midwives
Nurse Educators and Researchers
Nurse Managers
Registered Nurses
Barristers
Social Workers
Welfare, Recreation and Community Arts Workers
Medical Technicians
Bakers and Pastrycooks
Chefs
Cooks
Animal Attendants and Trainers
Veterinary Nurses
Hairdressers
Massage Therapists
Welfare Support Workers
Aged and Disabled Carers
Dental Assistants
Nursing Support and Personal Care Workers
Hospitality Workers nfd
Bar Attendants and Baristas
Cafe Workers
Gaming Workers
Hotel Service Managers
Waiters
Other Hospitality Workers
Beauty Therapists
Funeral Workers
Gallery, Museum and Tour Guides
Personal Care Consultants
Travel Attendants
Other Personal Service Workers
Fitness Instructors
Outdoor Adventure Guides
Sports Coaches, Instructors and Officials
Sportspersons
Other Clerical and Office Support Workers
Sales Representatives
ICT Sales Assistants
Motor Vehicle and Vehicle Parts Salespersons
Pharmacy Sales Assistants

- Performing Arts Technicians
- Ambulance Officers and Paramedics
- Diversional Therapists
- Enrolled and Mothercraft Nurses
- Housekeepers
- Laundry Workers
- Other Cleaners
- Fast Food Cooks
- Food Trades Assistants
- Kitchenhands
- Shelf Fillers
- Vending Machine Attendants
- Retail Supervisors
- Service Station Attendants
- Other Sales Assistants and Salespersons
- Checkout Operators and Office Cashiers
- Models and Sales Demonstrators
- Retail and Wool Buyers
- Telemarketers
- Cleaners and Laundry Workers nfd
- Commercial Cleaners
- Domestic Cleaners

Social, Education and Service

- Audiologists and Speech Pathologists \ Therapists
- Child Care Centre Managers
- Child Carers
- Chiropractors and Osteopaths
- Counsellors
- Early Childhood (Pre-primary School) Teachers
- Education Advisers and Reviewers
- Education Aides
- Gallery, Library and Museum Technicians
- Librarians
- Library Assistants
- Middle School Teachers \ Intermediate School Teachers
- Ministers of Religion
- Music Professionals
- Numerical Clerks nfd
- Office Managers and Program Administrators nfd
- Other Education Managers
- Personal Carers and Assistants nfd
- Primary School Teachers
- Private Tutors and Teachers
- Sales Assistants (General)
- Sales Assistants and Salespersons nfd
- School Principals
- School Teachers nfd
- Secondary School Teachers
- Social Professionals
- Special Care Workers
- Special Education Teachers
- Street Vendors and Related Salespersons
- Survey Interviewers
- Teachers of English to Speakers of Other Languages
- Vocational Education Teachers \ Polytechnic Teachers
- Wood Trades Workers nfd

Agricultural

- Aquaculture Farmers
- Crop Farmers
- Livestock Farmers
- Mixed Crop and Livestock Farmers
- Caravan Park and Camping Ground Managers
- Agricultural and Forestry Scientists
- Environmental Scientists
- Agricultural Technicians
- Shearers
- Greenkeepers
- Nurserypersons
- Other Farm, Forestry and Garden Workers
- Auctioneers, and Stock and Station Agents
- Agricultural, Forestry and Horticultural Plant Operators
- Food Process Workers nfd
- Product Quality Controllers
- Farm, Forestry and Garden Workers nfd
- Aquaculture Workers
- Crop Farm Workers
- Forestry and Logging Workers
- Garden and Nursery Labourers
- Livestock Farm Workers
- Mixed Crop and Livestock Farm Workers

Manufacturing

- Manufacturers
- Production Managers
- Transport Services Managers
- Other Building and Engineering Technicians
- Automotive Electricians and Mechanics nfd
- Automotive Electricians
- Motor Mechanics
- Fabrication Engineering Trades Workers nfd
- Sheetmetal Trades Workers
- Structural Steel and Welding Trades Workers
- Mechanical Engineering Trades Workers nfd
- Metal Fitters and Machinists
- Panelbeaters
- Vehicle Painters
- Bricklayers and Stonemasons
- Carpenters and Joiners
- Floor Finishers
- Painting Trades Workers
- Glaziers
- Plasterers
- Roof Tilers
- Wall and Floor Tilers
- Storepersons
- Car Detailers
- Building and Plumbing Labourers
- Concreters
- Fencers
- Insulation and Home Improvement Installers
- Paving and Surfacing Labourers
- Railway Track Workers
- Structural Steel Construction Workers
- Other Construction and Mining Labourers
- Food and Drink Factory Workers
- Meat Boners and Slicers, and Slaughterers
- Meat, Poultry and Seafood Process Workers
- Packers
- Product Assemblers
- Metal Engineering Process Workers
- Plastics and Rubber Factory Workers
- Timber and Wood Process Workers
- Other Factory Process Workers
- Freight and Furniture Handlers
- Caretakers
- Handypersons
- Motor Vehicle Parts and Accessories Fitters
- Recycling and Rubbish Collectors

- Plumbers
- Airconditioning and Refrigeration Mechanics
- Butchers and Smallgoods Makers
- Gardeners
- Cabinetmakers
- Wood Machinists and Other Wood Trades Workers
- Chemical, Gas, Petroleum and Power Generation Plant Operators
- Driving Instructors
- Couriers and Postal Deliverers
- Mail Sorters
- Purchasing and Supply Logistics Clerks
- Transport and Despatch Clerks
- Clay, Concrete, Glass and Stone Processing Machine Operators
- Industrial Spraypainters
- Paper and Wood Processing Machine Operators
- Other Miscellaneous Labourers
- Other Machine Operators
- Crane, Hoist and Lift Operators
- Drillers, Miners and Shot Firers
- Engineering Production Workers
- Other Stationary Plant Operators
- Earthmoving Plant Operators
- Forklift Drivers
- Other Mobile Plant Operators
- Road and Rail Drivers nfd
- Automobile Drivers
- Bus and Coach Drivers
- Train and Tram Drivers
- Delivery Drivers
- Truck Drivers

Health, Science and Research

- Anaesthetists
- Chemical and Materials Engineers
- Chemists, and Food and Wine Scientists
- General Practitioners and Resident Medical Officers
- Life Scientists
- Medical Laboratory Scientists
- Other Medical Practitioners
- Other Natural and Physical Science Professionals
- Psychiatrists
- Psychologists
- Science Technicians
- Specialist Physicians
- Surgeons
- University Lecturers and Tutors