# Understanding the comorbidity of multiple chronic diseases using a network approach

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# Motivations

- Chronic diseases are the leading causes of death.
- Become more expensive and bring several health risks for the people with more than one chronic disease.
- About half of all Australian have a chronic disease, and around 20% have at least two chronic disease.
- Could lead to the development of several prediction procedures.

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# Background Study

- Rule-based scoring models including Charlson Comorbidity Index (Charlson et al., 1987)
  - to predict the 10-year mortality for a patient.
- A collaborative filtering method – CARE (Davis et al., 2010 )
  - the future disease prediction model.
  - and it raises many false alarms to predict the future disease risks.
- Network-based approaches – (Khan et al., 2018)
  - To understand and represent the progression of T2D using SNA.
  - Multiple chronic disease progression is not tested.

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# Research Goal

- To understand the health trajectory of chronic disease patients from healthcare data.
- To represent the health trajectory (after diagnosis of 1st chronic disease and before diagnosis of 2nd chronic disease) of chronic disease patients into a baseline disease network using network analytics.
- To develop a research framework using social network analysis and graph theory to understand the comorbidity of two chronic diseases (i.e., type 2 diabetes (T2D) leading to the development of cardiovascular disease).

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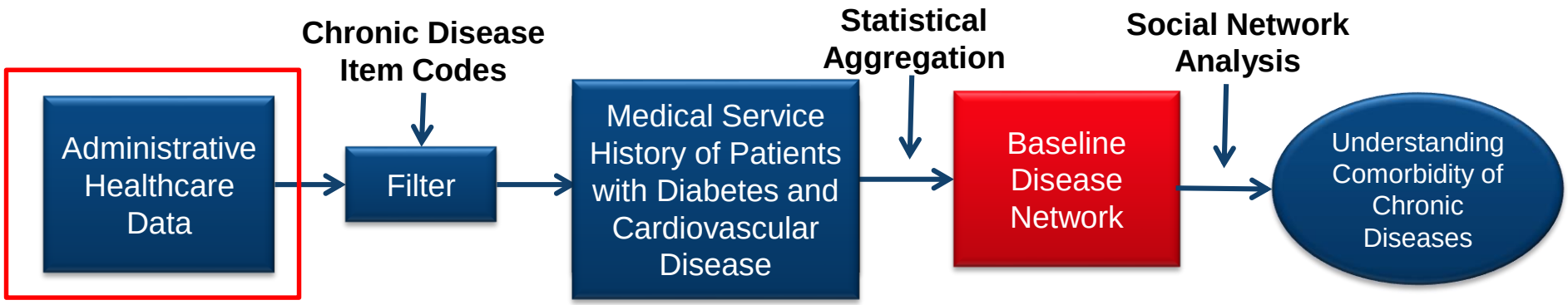
# Methodology



# Administrative Dataset

- Data Source: Australian's Universal Healthcare System (Medicare)

- Medicare Benefits Schedule (MBS)
  - Generated by financial reimbursement claims from GP, Specialists and Hospitals.
  - Contains 10% data of patients from 2008 to 2014.
  - Including information about Patient ID, Date of Services, MBS Item Code.

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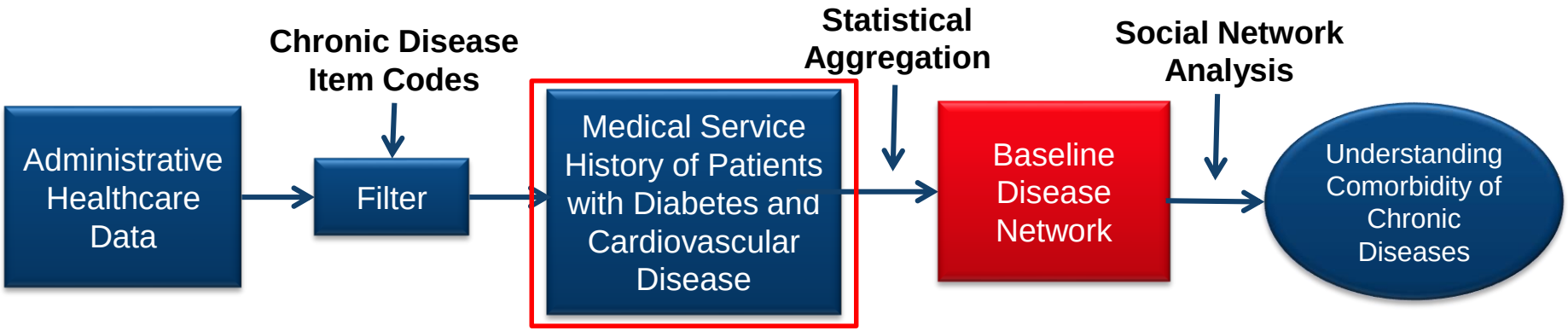
# Methodology



# Why Diabetes and Cardiovascular?

- Choose type 2 diabetes as first chronic disease risk and cardiovascular disease as second chronic disease risk.
- Explores the progression of cardiovascular disease for all patients who are already diagnosed with T2D.
- Comorbid nature of diabetes and cardiovascular disease.
- Over two-thirds of Australian people (68%) with diabetes also had cardiovascular disease (AIHW, 2015).

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# Data Filtering Process

- Item code is used to filter the patients with disease information.
- Search for patients who have both item codes for diabetes and cardiovascular disease
- Resulted only those patients who were diagnosed with diabetes first and with cardiovascular disease at a later stage.
- Between these two services are to be inspected to understand the nature of comorbidity for those chronic diseases.

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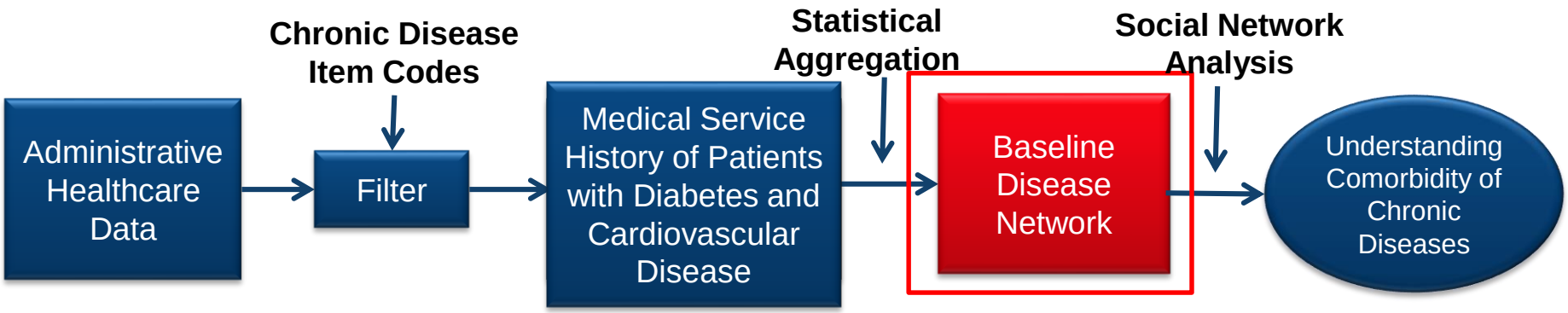
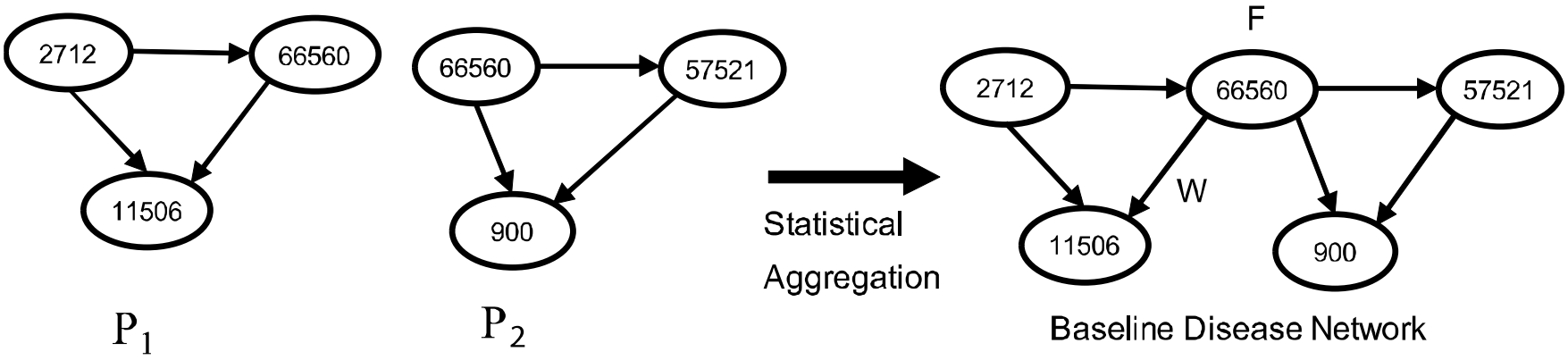
# Methodology

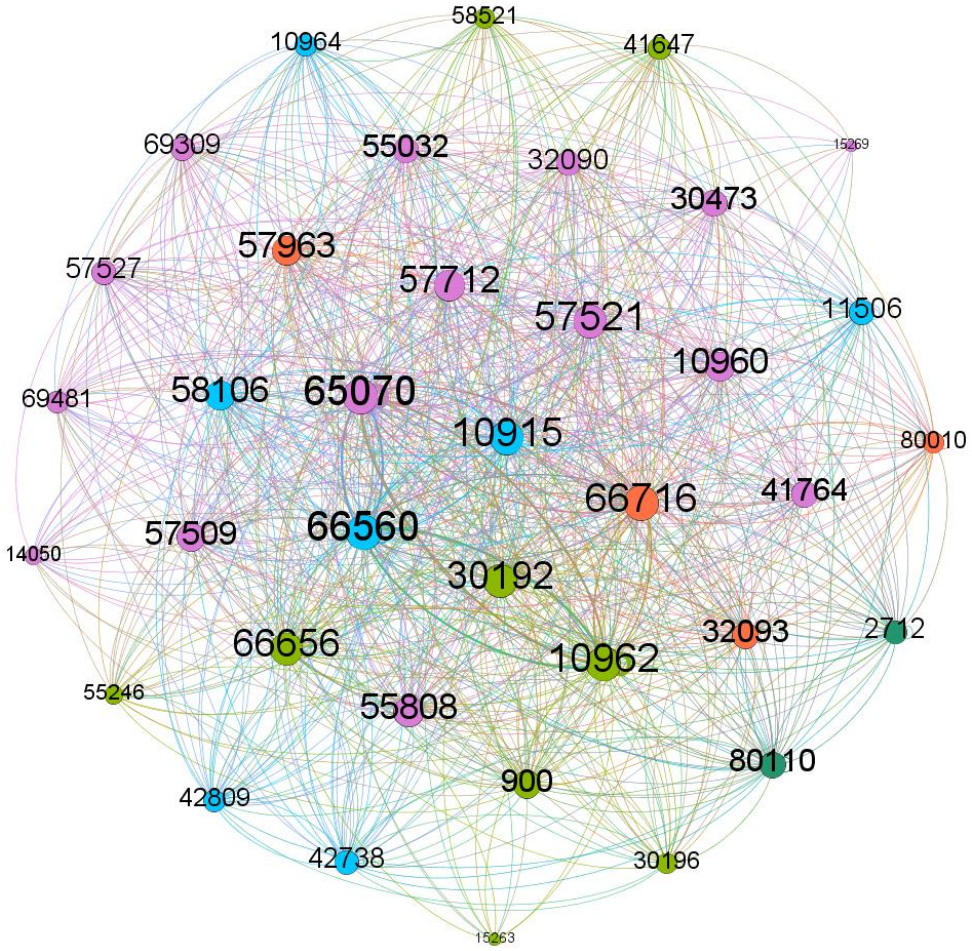


# Baseline Disease Network




The baseline disease network represents the overall health trajectory of a large number of patients.

# Results: Understanding the Comorbidity of Chronic Diseases




Baseline Disease Network

## Graph Representation of Baseline Disease Network

- Nodes are MBS item codes
- Edges between nodes indicating transition between item codes in consecutive medical services.
- Visualized the item codes in subsequent or same medical service to understand the health trajectory of patients suffering from multiple chronic diseases.

# Results: Understanding the Comorbidity of Chronic Diseases

## Clustering the item codes with major diagnosis

| Cluster | % of item codes belonging to this cluster | Major Diagnosis |
|---|---|---|
| 0 | 10.81 | Thyroid disease, Colon cancer |
| 1 | 18.92 | Spine lumbosacral, Kidney disease, Respiratory problem, Eye related disease, Acute closed-angle glaucoma |
| 2 | 40.54 | Cutaneous disease, Neck problem, Gullet problem, HIP joint, Chronic hepatitis, Skin disease |
| 3 | 24.32 | Bowen's disease, Feet problem, Prostatic disease |
| 4 | 5.41 | Mental disorder |

- It might be useful to understand the more frequently occurring disease groups

# Results: Understanding the Comorbidity of Chronic Diseases

Top 10 most prevalent diseases for patients with diabetes and cardiovascular disease

| Comorbidity Conditions | Prevalence |
|---|---|
| Disease related to blood | 11656 |
| Disorder of foot, ankle and lower extremity | 9523 |
| Kidney disease | 8260 |
| Thyroid disease | 4372 |
| Eye related diseases | 1598 |
| Mental disease | 696 |
| HIP joint | 531 |
| Shoulder or upper arm | 455 |
| Spine lumbosacral | 393 |
| Disease of Teeth | 381 |

# Results: Understanding the Comorbidity of Chronic Diseases

Top 10 most prevalent transitions between comorbidities

| Initial Condition | Next Condition |
|---|---|
| **Diseases related to blood** | Disorder of foot, ankle and knee |
| **Kidney disease** | Disorder of foot, ankle and knee |
| **Diseases related to blood** | Kidney disease |
| **Disorder of foot, ankle and knee** | Kidney disease |
| **Diseases related to blood** | Thyroid disease |
| **Thyroid disease** | Disorder of foot, ankle and knee |
| **Kidney disease** | Thyroid disease |
| **Eye related diseases** | Kidney disease |
| **Eye related diseases** | Diseases related to blood |
| **Kidney disease** | Prostatic disease |

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# Conclusions

- Can potentially help to visualise the health trajectory of multiple chronic disease patients

- Understand the progression from one chronic disease to another for a chronic disease patient.

- The analysis of baseline disease network and its attributes could help healthcare providers to understand high-risk diseases and progression pattern between recurrence of diabetes and cardiovascular disease.

# Thank you.