



Human Systems Risk Network- A Ranking Analysis of Risks

CHP-PRA

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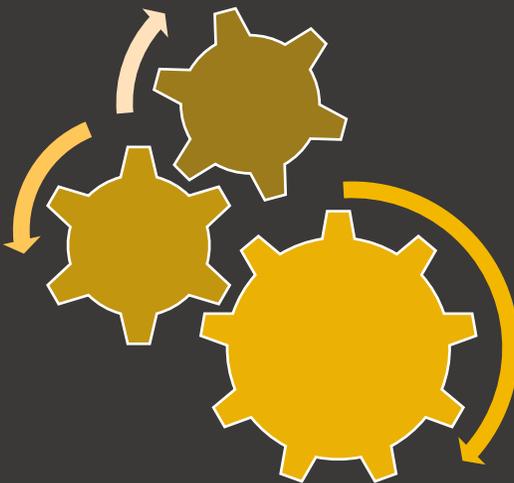
Medical Extensible Dynamic Probabilistic Risk Assessment Tool (MEDPRAT)

Input

- Medical Condition Parameters
- Treatment Info
- Crew Attributes
- Mission Parameters
- Available Resources



MEDPRAT



Output

- Risk Metrics
 - TTL
 - RTDC
 - LOCL
- Resource Consumption
- Condition Occurrence



Crew Health and Performance – Probabilistic Risk Assessment

Risks

i.e.

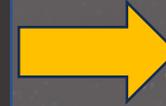
- Behavioral
- Bone Fracture
- Cardiovascular
- Sensorimotor
- Muscle
- CO₂
- SANS
- Food and Nutrition



Capabilities

i.e.

- Behavioral Capabilities
 - BHP Prevention Capabilities
 - BHP Monitoring Capabilities
 - BHP Intervention Capabilities
- Bone Fracture Capabilities
 - Ultrasound
 - MRI
 - DXA
 - QCT
- Cardiovascular
 - Exercise



Output Metrics

i.e.

- Medical Risk Model
 - TTL
 - QTL
 - RTDC
 - LOCL
- Performance Risk Model
 - Percentage of Baseline
 - Human Reliability Analysis
- Long Term Health Risk Model
 - Return to Baseline
 - Clinical Phase III Functional Impairment



Motivating Questions

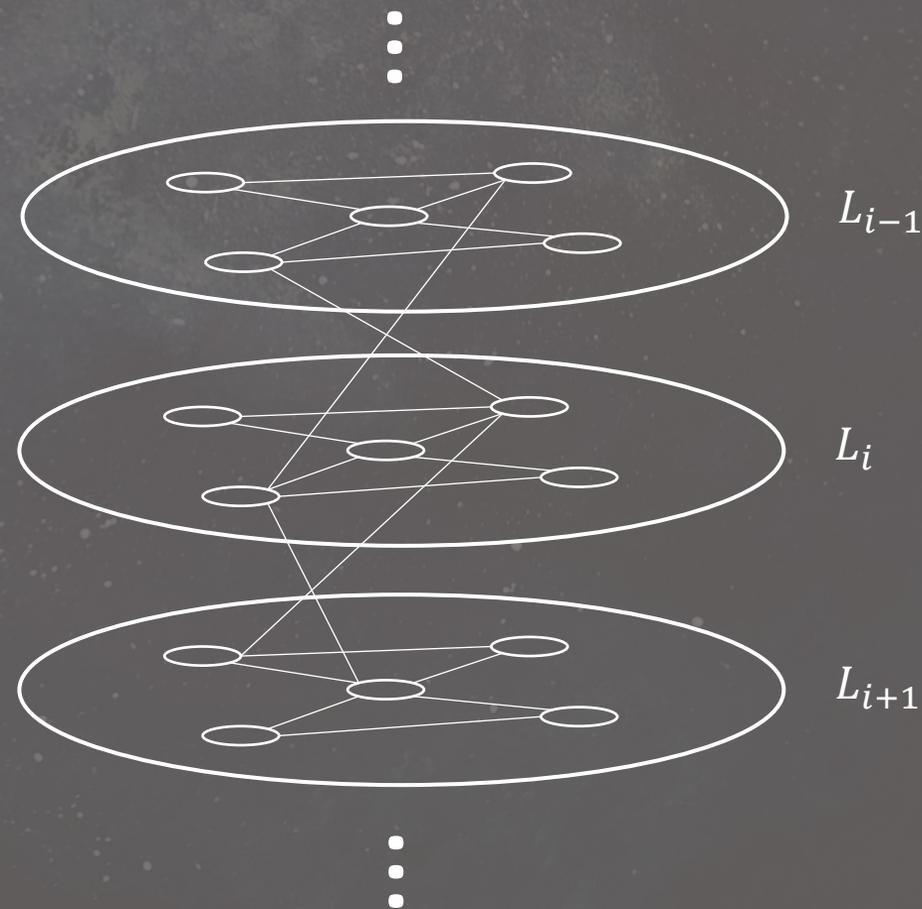
1. How many risks do we need to incorporate for an effective model?
2. Which risk do we start with?
3. What priority queue do we follow until completion?



Multilayer Network

A *multilayer network* $N = \{\mathcal{L}, V, V_i, E_i, E_{ij}\}$ is a network such that:

- $\mathcal{L} = \{L_1, L_2, \dots, L_\ell\}$ is the set of layers,
- $V = \{v_1, v_2, \dots, v_n\}$ is the set of nodes,
- $V_i \subseteq V$ is the set of nodes in layer L_i ,
- $E_i \subseteq V_i \times V_i$ is the intralayer-edges.
- $E_{ij} \subseteq V_i \times V_j$ is the interlayer-edges.

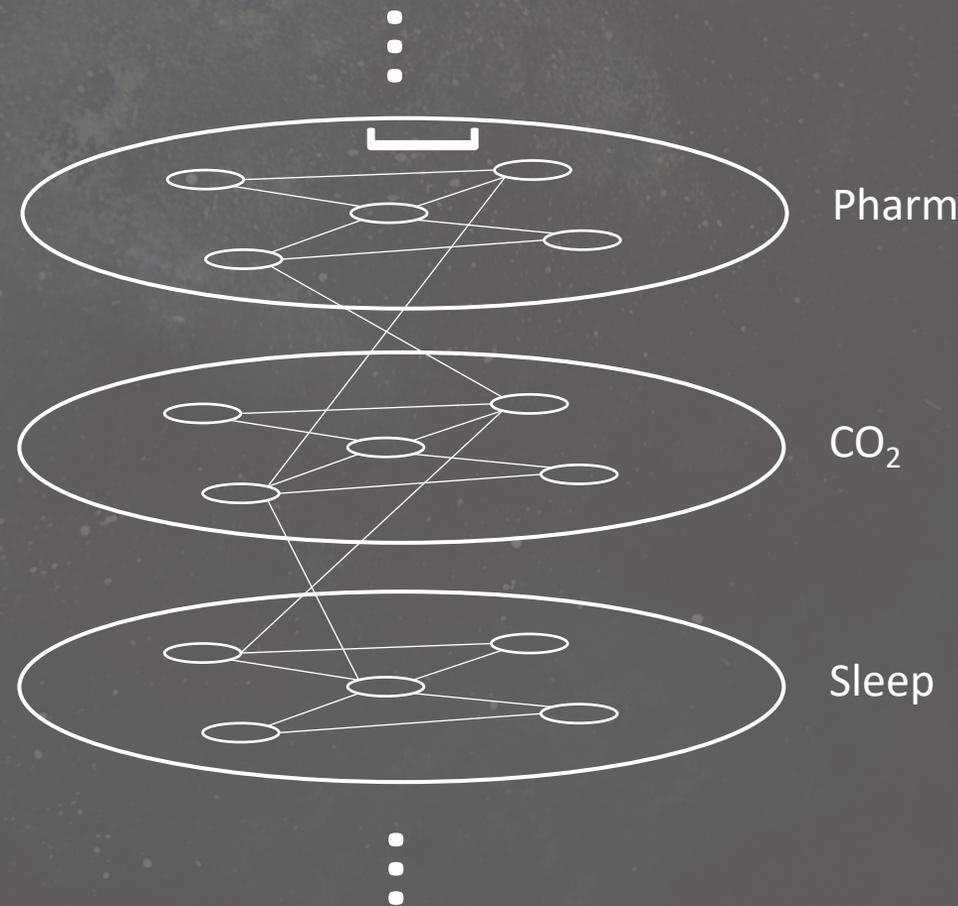




HSRB Multilayer Network

A *multilayer network* $N = \{\mathcal{L}, V, V_i, E_i, E_{ij}\}$ is a network such that:

- The Risks are the layers,
- $V = \{v_1, v_2, \dots, v_n\}$ is the set of nodes,
- $V_i \subseteq V$ is the set of nodes in layer L_i ,
- $E_i \subseteq V_i \times V_i$ is the intralayer-edges.
- $E_{ij} \subseteq V_i \times V_j$ is the interlayer-edges.

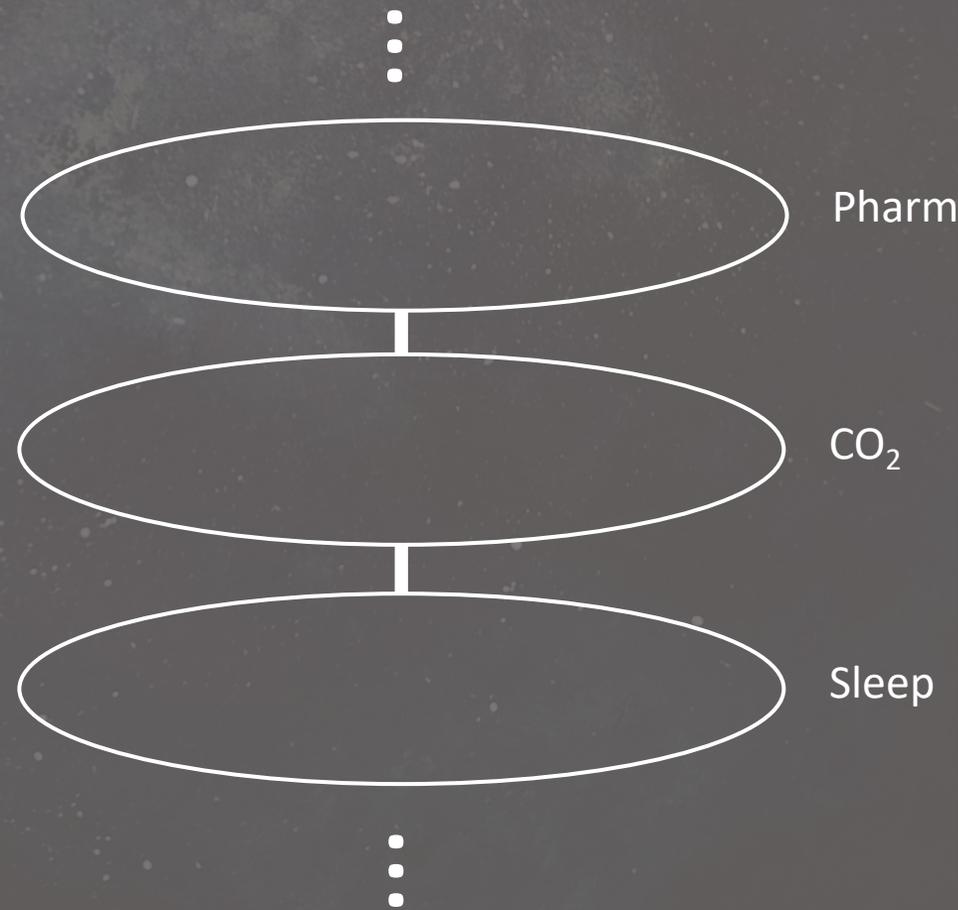


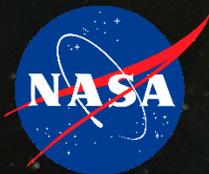


Meta Network

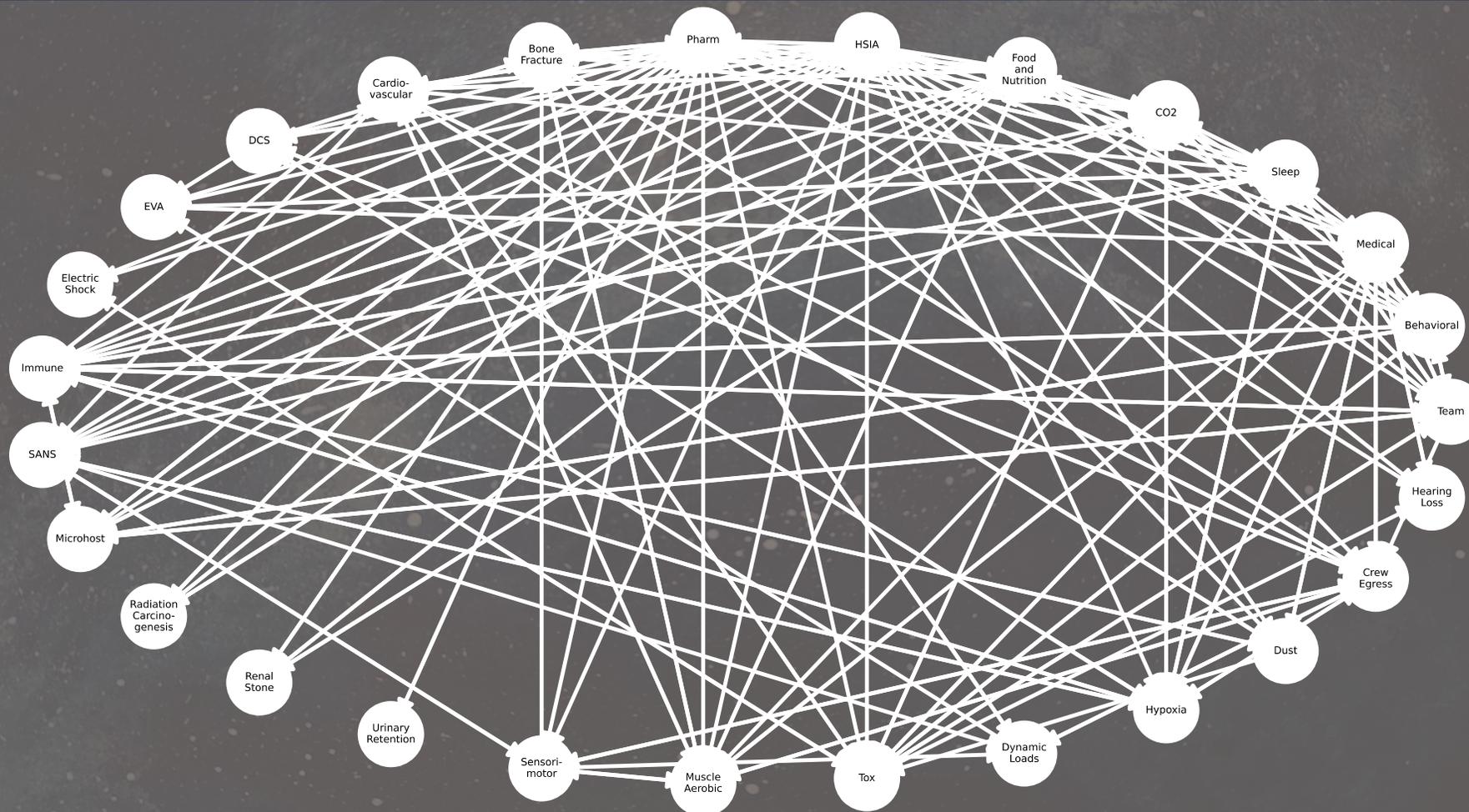
The meta network M of the multilayer network $N = \{\mathcal{L}, V, V_i, E_i, E_{ij}\}$ where there is

- a node in M for each layer in N , and
- an edge in M for any nonempty E_{ij} in N .





HSRB Meta Network



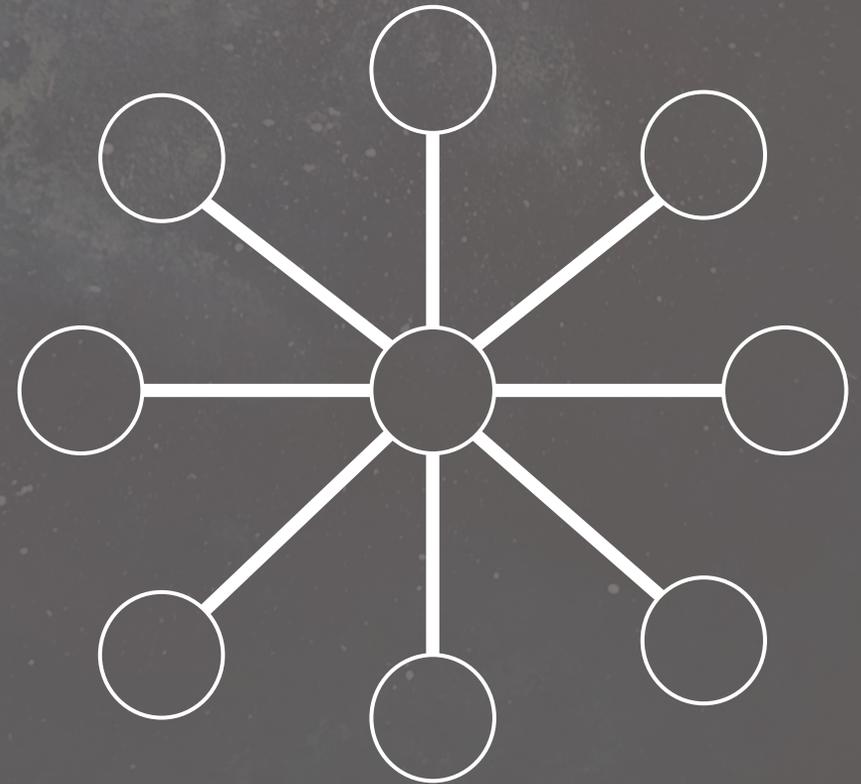


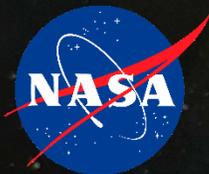
Centrality Measures

A centrality measure is a metric applied to a network, typically at the node level, used to indicate importance or influence.

Example of centrality measures:

- Degree Centrality (number of edges incident to the node)
- Betweenness Centrality (number of shortest paths the node is contained in)
- Katz Centrality (number of walks starting at the node)

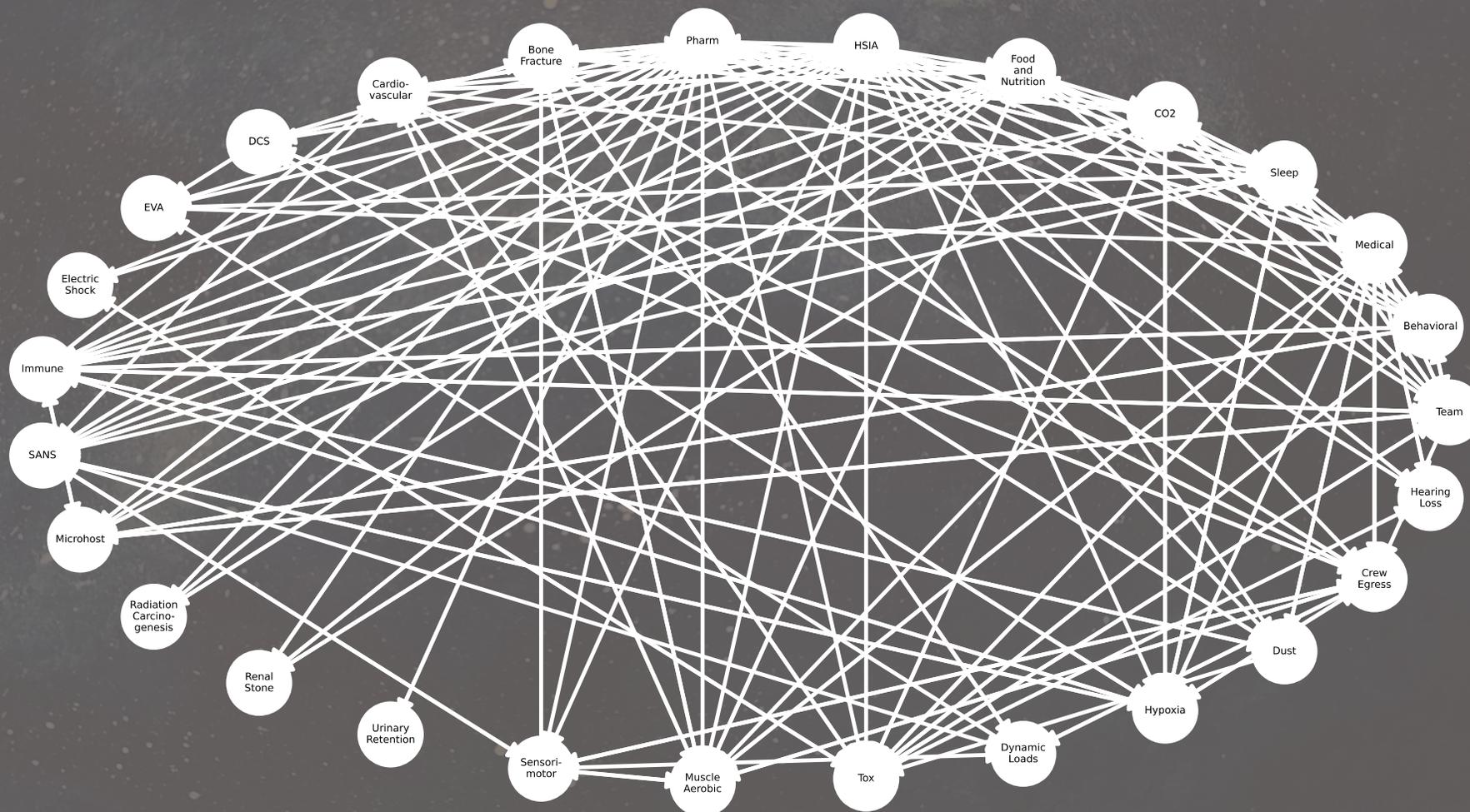




HSRB Meta Network (Rank by Katz Score)

Top Node Ranking

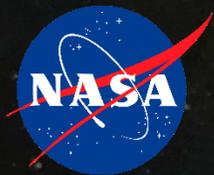
1. HSIA
2. Pharm
3. Food and Nutrition
4. Medical
5. Sleep
6. CO2
7. Behavioral
8. Team





Future Work

- Implement the DAG's into MuxViz: a tool used specifically for visualizing multilayer networks.
- Analyze each DAG from the perspective of multilayer networks (inter-vs. intra-causal inference)



Thank you!