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Using Causal Relationship Model to Prioritize Simulation Parameters 使用因果关系模型来确定模拟参数的优先级

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The World Leader in Serving Science 服务科学的世界领导者

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Titan Krios TEM

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ImmunoCAP Allergy and EliA Autoimmunity Tests

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A Mission We Are Proud Of 我们引以为傲的使命

We enable our customers to make the world **healthier**, **cleaner**, and **safer**

我们帮助客户使世界更健康、更清洁、更安全

How Thermo Fisher Could Address “City Health”赛默飞如何解决“城市健康问题”

Instruments and Data Sources that we make 我们制作的仪器和数据源

Examples of Current Use 最新示范案例

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Challenges in Simulating a City 城市仿真面临的挑战

- **Problem of Scale**
  - Time Domains from Hours…to…Years
  - Event Density from one meter to 1000 KM
- **Problem of Variable Semi-Open System**
  - People, Food, Materials, Money…
  - Fuel, Power, Water, Air, Pollution, Waste…

The sum of a set of model terms ($\delta x/\delta t$) cannot be set equal to zero as a simplifying assumption for a simulation.

$\Sigma\ (\delta x/\delta t) = 0$ will be true within some time and space domains and false within other time and space domains; and we don't know which are which or how they change.

- **时间和空间尺度问题**
  - 时间域: 从小时到……年
  - 事件密度:从1米到1000公里
- **可变半开放系统问题**
  - 人，食品，材料，钱
  - 燃料，电力，水，空气，污染，废物

作为模拟的简化假设，不能将一组模型项($\delta x/\delta t$) 的总和设置为等于零。

$\Sigma\ (\delta x/\delta t) = 0$ 在某些时域和空域中为真，在其他时域和空域内为假;我们不知道哪个为真，哪个为假，也不知道它们是如何改变的。

The Boundary of a City is Far Beyond the City 城市边界远远超越城市本身

1	Temperature ✓	温度
2	Humidity/Rain ✓	湿度
3	Ozone ✓	臭氧
4	Particles ✓	原子
5	NOx ✓	氮氧化物
6	SOx ✓	硫氧化物
7	VOC ✓	挥发性有机化合物
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11	Radioactive Metal ✓	放射性金属
12	SiOx ✓	亚氧化硅
13	Gas Use ✓	汽油的用量
14	Oil Use	油的用量
15	Coal Use	煤的用量
16	Power Use	用电量
17	Food Supply	食品供应
18	Food Quality ✓	食品质量
19	Soil Salts ✓	土壤内的盐
20	Soil Metals ✓	土壤内的金属
21	Water Usage	用水量
22	Water Waste ✓	水的浪费
23	Water Quality ✓	水的质量
24	Human Health ✓	人口
25	Population	交通

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Specific Products from Thermo Fisher Scientific 赛默飞的特定产品

Water Quality
水质测试：


Air Quality Monitoring
空气质量监测




Food Quality 食品质量

Elements, Chemicals, Radiation, Narcotics
元素，化学品，辐射，麻醉品

1	Temperature	✓	温度
2	Humidity/Rain	✓	湿度
3	Ozone	✓	臭氧
4	Particles	✓	原子
5	NOx	✓	氮氧化物
6	SOx	✓	硫氧化物
7	VOC	✓	挥发性有机化合物
8	COx	✓	氧化碳
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21	Water Usage		用水量
22	Water Waste	✓	水的浪费
23	Water Quality	✓	水的质量
24	Human Health	✓	人口
25	Population		交通

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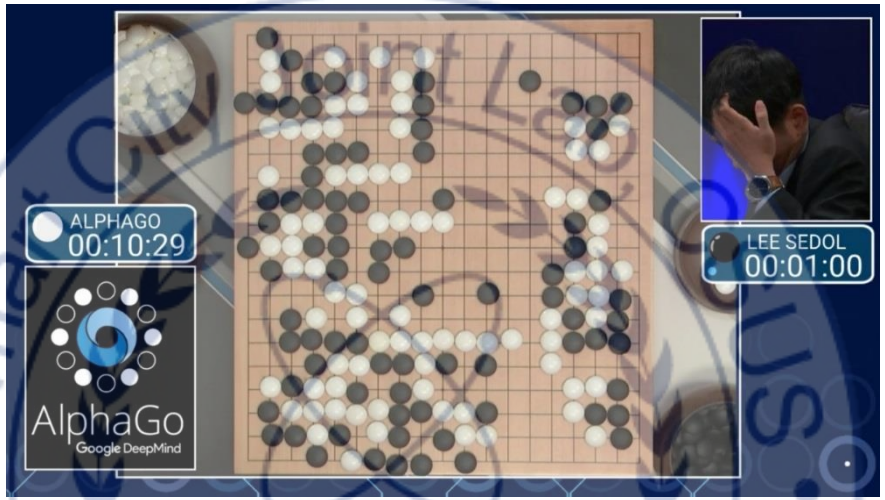
The Challenge of Full Simulation

Comparison to Google Alpha Go 与Google AlphaGo比较

Simulating Complex Grid is extremely expensive 模拟复杂网格非常昂贵

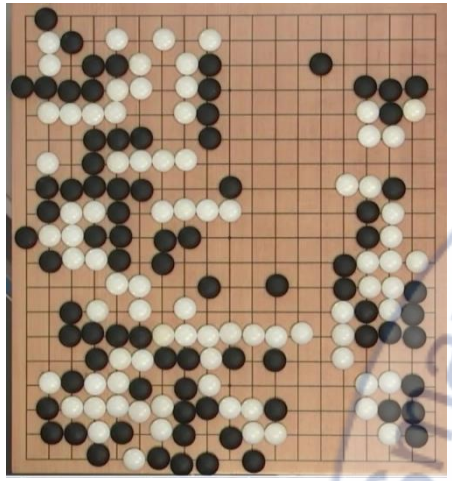
Need to Prioritize Parameters for Heuristic Modeling 需要为启发式建模确定参数的优先级

The Computational Cost of Modeling Complex Unbounded Systems
超复杂无界系统建模的计算成本



AlphaGo Google DeepMind		Lee Sedol
2000 Processing Chips 2000加工芯片	**Computer 计算机**	Human Brain 人脑
1 Mega Watt (2% of a Nuclear Power Plant) 1兆瓦（占核电厂的2%）	**Power 功率**	20 Watts 20瓦
Two Hours 两个小时	**Duration 持续时间**	Two Hours 两个小时
90	**Moves per game 每场比赛的动作**	90
245 kg Coal 245千克煤	**Fuel 燃料**	0.5 kg Lunch 1 斤午餐
Games 1, 2, 3, and 5 第1, 2, 3, 5场比赛	**Victories 胜利**	Game 4 第4场比赛

Study the Problem Without Becoming the Problem 研究问题而不成为问题制造者



Simulating Go (10^{361} Legal Games)	Simulating A City
19 x 19 Grid with edges (Monte Carlo Tree Search)	Variable Grid no edges
One Binary State (Black, White), Zero Noise	Mostly scalar states with variable noise
A move is permanent, does not change prior moves	A change is temporary, can influence prior changes
One Parameter per grid cell (Occupancy)	Perhaps 50+ Parameters per grid cell
At end of each game, the parameter is reset.	No Reset. Errors Accumulate.
Needs 2% of a Nuclear Power Plant, 2 Hours	Several Continuous Nuclear Power Plants (??)

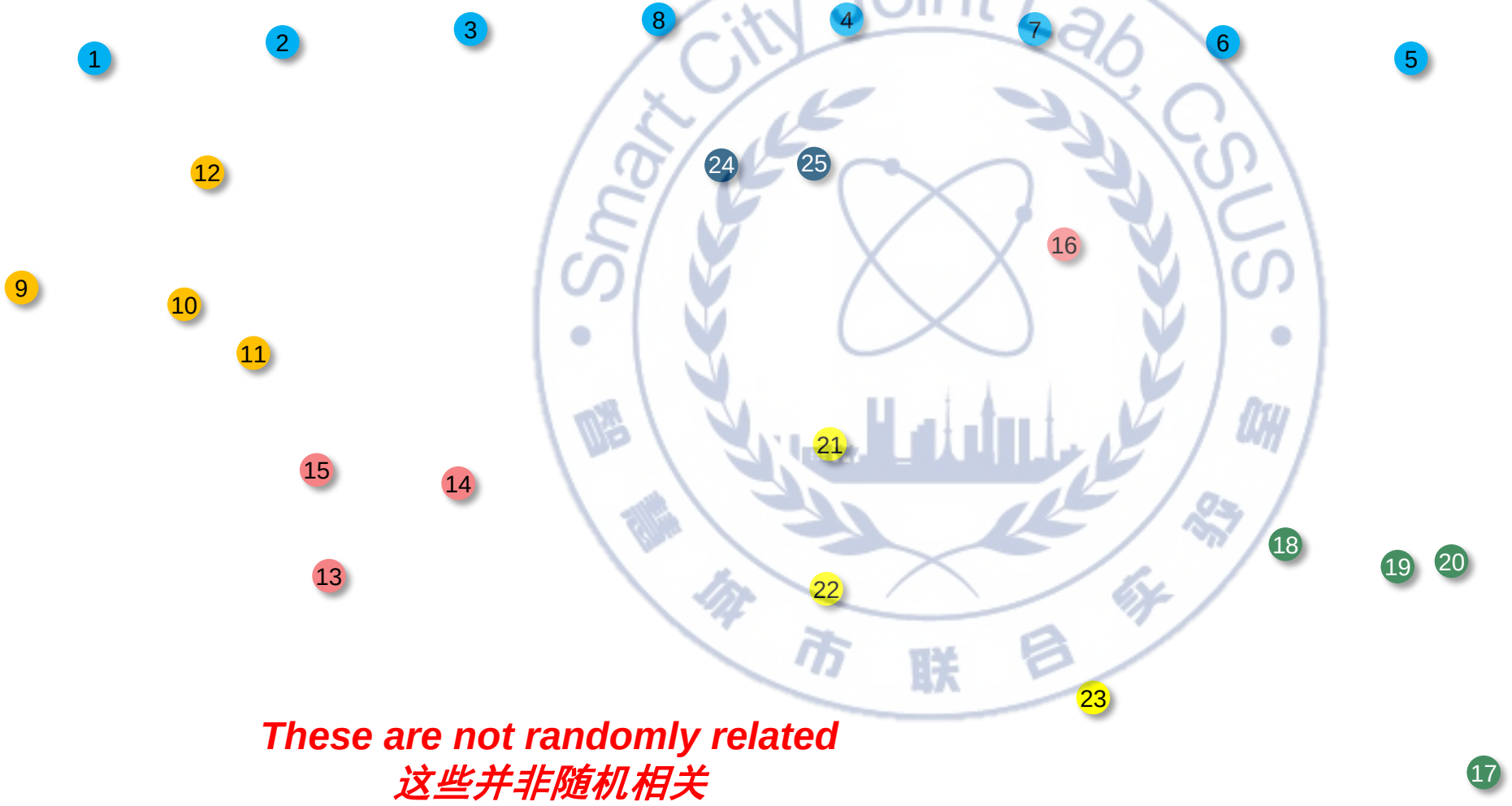
Full Simulation of a City Makes "Super-Computers" into "Femto-Computers"
城市的全面模拟使"超级计算机"成为"毫微微-计算机"

Qualitative Causal Relationships to Prioritize Data Simulation
专注于用定性因果关系来考虑数据模拟优先权

How those Data Support Model of a City 如何支持一个城市的数据模型

How the Data could be Prioritized 如何确定数据的优先顺序

The Connections That We Already Know 我们已经知道的联系



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24	Human Health	人口
25	Population	交通

These are not randomly related
这些并非随机相关

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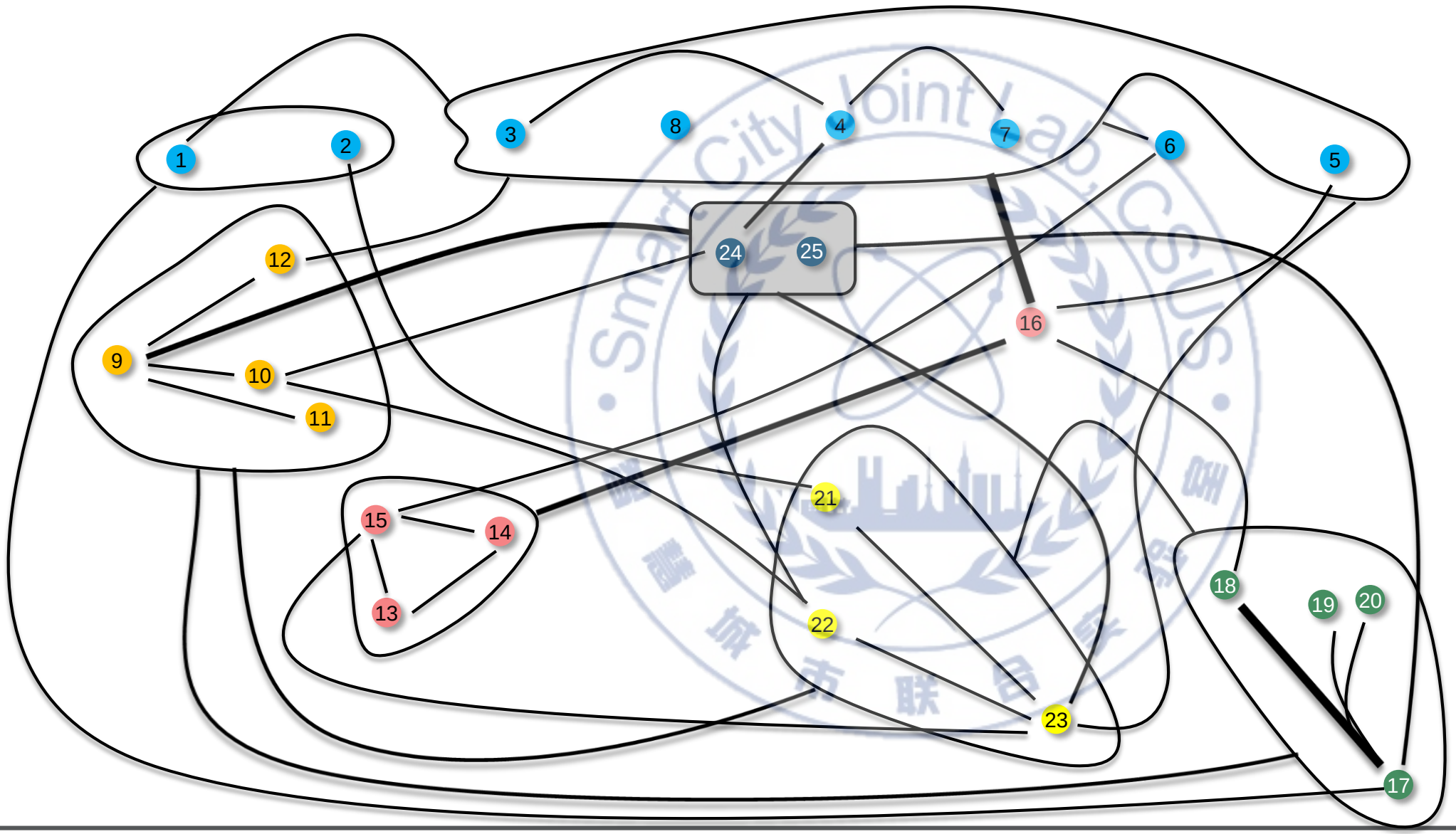
The Connections That We Already Know 我们已经知道的联系



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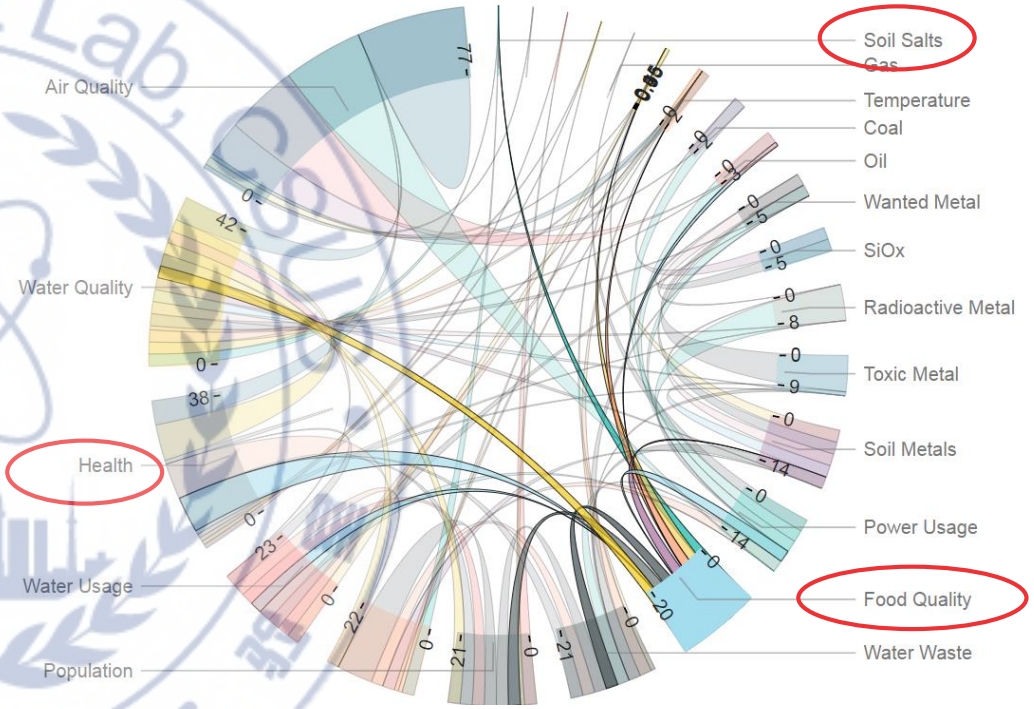
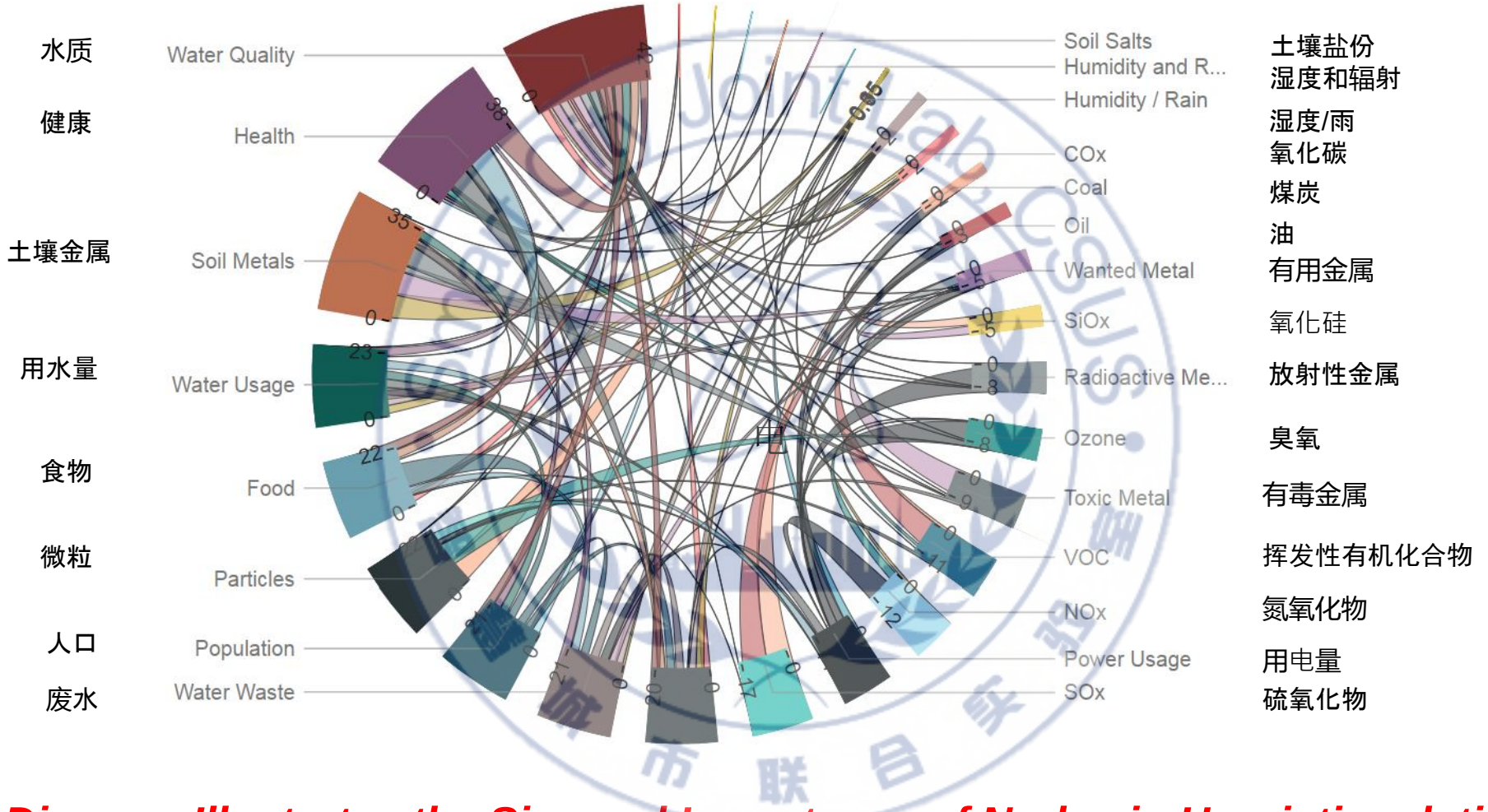
Scoring System for Causal Connections 因果关系评分系统

Score 比分	Definition 定义
1	A Influences B A 影响B
3	A Partial Cause of B A is Partial Basis of Demand for B B的部分原因是A A是B需求的部分基础
9	A Directly Causes B A is Direct Basis of Demand for B A直接导致B. A是B需求的直接基础

Example: Food Quality
示例：食品质量



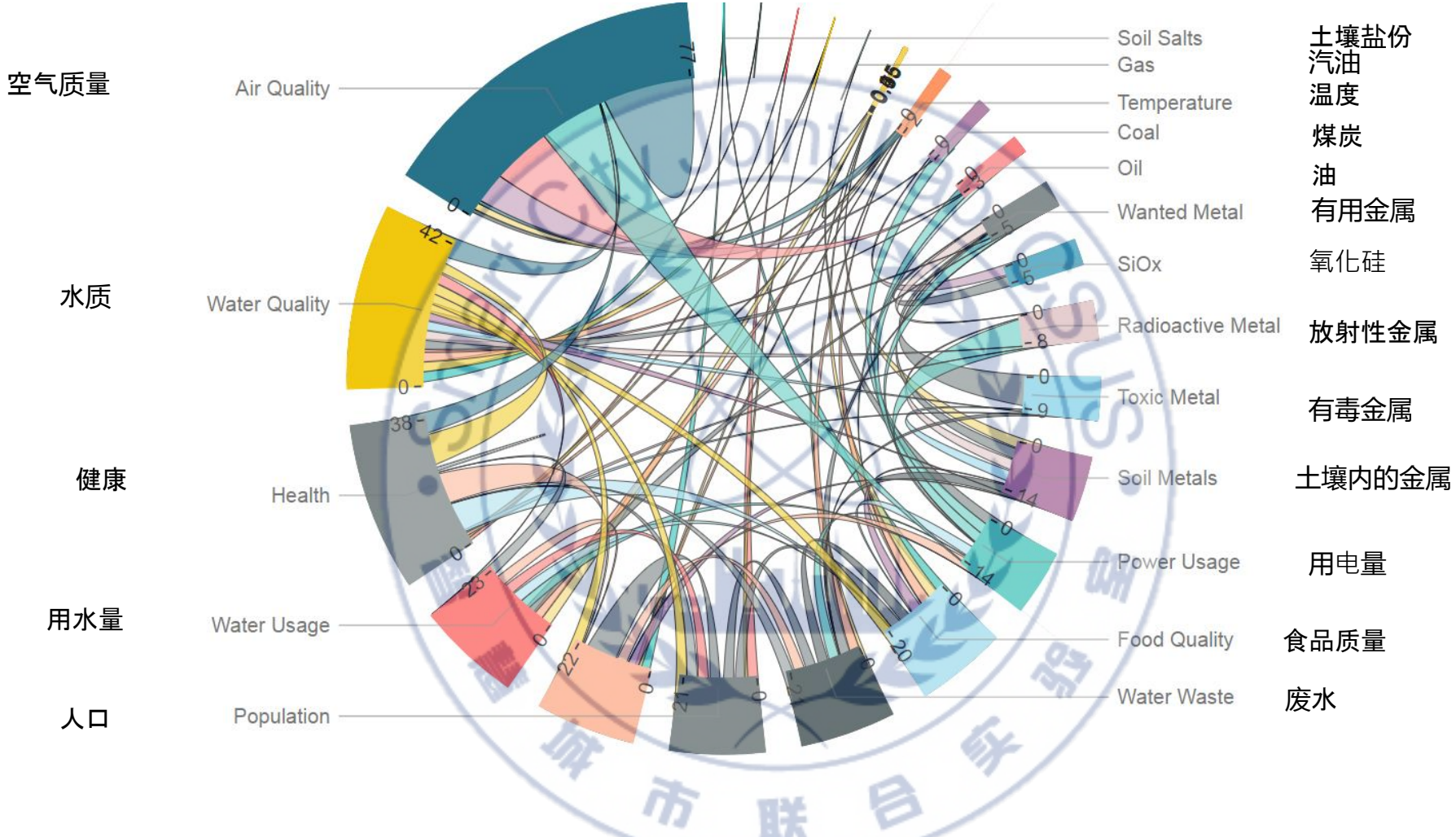
Nodes and Predictive Strength 节点和预测强度



Chord Diagram Illustrates the Size and Importance of Nodes in Heuristic relationships

(启发式关系中节点大小与重要性弦图)

Simplified Node Analysis 简化的节点分析



Water Quality and Air Quality may be Super-Predictive Nodes for Health and Population of a City

水质和空气质量可能是城市健康和人口的超级预测节点

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Summary

- Thermo Fisher has very large product offering of instruments that would generate important data for modeling parameters
- The number of relevant parameters for “City Health” is very large.
- Heuristic analysis of logical parameters in a grid would be extremely costly.
- Therefore simplifying, prioritizing, and reducing simulation parameters is necessary.
- Analysis of causal relationship are one way to simplify and prioritize parameters.
- In one scheme, water quality and air quality are highly influential for any data model.
- Thermo Fisher would be pleased to discuss potential collaboration.

- Thermo Fisher有许多仪器可以为建模参数生成重要数据
- 与“城市健康”相关的参数数量太多。
- 对网格中所有逻辑参数的启发式分析将非常昂贵。
- 因此，需要简化，优先化和减少模拟参数。
- 因果关系分析是简化和优先考虑参数的一种方法。
- 在一个方案中，水质和空气质量对任何数据模型都具有很大影响。
- Thermo Fisher很乐意讨论潜在的合作。

Thank you

谢谢