GraphNEx

Graph Neural Networks for Explainable Artificial Intelligence

graphnex.eecs.qmul.ac.uk
Graph construction & refinement
Concepts & rules discovery
Attention-driven concept selection

Personalisation, gamification & user feedback
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Concepts & rules discovery
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Systems genetics

Privacy protection

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Systems Genetics

The problem
Classic systems genetics approaches
• focus on *pairwise comparisons* between individual biological data layers
• fail to capture *complex patterns of interactions* across many biological data layers

The objective
To capture complex patterns across multiple biological *data layers*
To highlight the *key elements* of the patterns

Privacy Protection

AI systems capture *secondary information* that
• is *irrelevant* for the intended purpose
• but may *bias* the prediction and
• may *infringe* upon the privacy of users

The objective
To discover complex and/or hidden *relationships* between similar, hierarchical or correlated (private) concepts in audio and video data

Personalisation, gamification & user feedback
The video does not disclose personal / protected / confidential information

Private
The video discloses personal / protected / confidential information
Adapted from:

Genome

Transcriptome

Proteome

Metabolome

Phenome

**Disease**
- *GeneY* associated with disease
- AND High expression in Liver
- AND High blood pressure

**No disease**
- *GeneX* associated with no disease
- AND Low expression in Liver
- AND Normal blood pressure
90 strains

Phenotyping tests
- Activity
- Cognition
- Fitness
- Vision
- Metabolism
- Body composition
- Glucose tolerance

Birth

Bio-molecular assays
- 1-35 tissues
- 25,000 genes transcripts
- 2,622 proteins
- 979 metabolites
- ~200 lipids

20 months
On which inputs do the predictions depend?

Multiple sources of information

Networks

Biological network
Entities in images/audio/videos

Learn

Graph Machine Learning

Explain

On which inputs do the predictions depend?
Graph Machine Learning

Learning from several sources of information on one or multiple graphs

- Prior knowledge: curated databases, biological ontologies, privacy laws and regulations
- Experimentally derived information (co-expression graph, protein-protein interactions, entity co-occurrence)
- Graph coarsening for explanations to emerge
  - private concepts: hierarchy of general concepts
  - list of genes: larger groups of genes with high co-expression or with similar functions

Challenges
- Heterogeneous viewpoints on genes / on people captured in videos
- Strong interdependencies only sparsely known
- Missing data or explicit concepts
Explanations: visualize, evaluate, interact

• User-guided explainability in GraphNEx:
  • Investigating evaluation strategies for different stakeholders
  • Gamification interfaces for users with different levels of expertise
  • Stakeholder-based adaptation of the graph structure

• Post-hoc explainability in GraphNEx:
  • Diagnostic graph for probing non-explainable AI systems
  • Quantifying how responses correlate with the concepts in the (explainable) concept graph
  • Assessing the reliability and robustness of explanations
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