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Identifying network visualization and analysis tools Using Knowledge Visualization Networks techniques

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Abstract— Network science is an ever-evolving field. As the research continues to evolve, new gaps are opened, and tools are created to help fill these gaps. There are a variety of network analysis tools available for research and they cover a wide range of use cases. However, there are three gaps to be addressed. First, there seems to be little discussion that network links can carry as much information (attributes) as nodes, and the important role that this information can play. Second, there is a need for multimedia data within networks, where images, video, sound and documents can be used to visually enhance the display of information in a network. Third, network partitions do not address the idea of multiple classifications, direct use of continuous data to create clusters, or clusters composed entirely of links. A Knowledge Visualization Network (KVN) is presented as an innovative approach to filling this gap.

Keywords ***Attributes, Criteria, Link Clusters, Multimedia, Multiple Classifications, Network, Network Filter, Network Partitions***

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I. INTRODUCTION

Overview There are a wide variety of network visualization and analysis tools that have been developed over the last 20-30 years. They all provide similar features and have been used for various purposes. To derive a measure of tools, Shah & Mehta used a comparative analysis that categorized social network analysis tools based on their basic functionalities, network types, graph layouts, import formats and graph attributes [1]. In their comparative analysis they concluded that of the tools they tested all had similar capabilities. Dasale compiled a list of the top 30 social network analysis software [2]. The list is mostly comprised of cross platform desktop applications with some of the applications being web based. Some of the tools have grown to become very popular with many years of software engineering and very carefully crafted architectures. The main intent of the architectures was to provide flexibility in the modeling and visualization of networks and to allow application extensibility through plugins. With such a wide variety of tools, there are a vast amount of use cases covered. However, there is still a gap that needs to be filled. This research paper will define the gap, support the gap using a brief overview of some popular network tools, and provide a solution called Knowledge Visualization Network (KVN) as a design architecture.

Problem Description & Objectives Traditionally, network science involves the analysis of complex networks, where algorithms are ran to find patterns to solve real world problems. In networks there is usually heavy emphasis on nodes and their attributes. However, there seems to be little discussion that links can carry as much information (attributes) as nodes [3], and the important role that this information can play. Attributes that describe information in a network are either quantitative (numerical/continuous) or qualitative (nonnumerical/discrete). There is a need for multimedia data within networks, where images, video, sound and documents can be used to visually enhance information in a network. Network partitioning can visually enhance the structure of a network; it is the clustering of vertices using a single classification [4]. However, network partitions do not address the idea of vertices having multiple classifications, direct use of continuous data to create clusters, or clusters composed entirely of links. This research presents an innovative approach using KVN's design architecture that supports the following: – Creation and storage of networks to a database. – Same capabilities between nodes and links. – Viewing of multimedia data within nodes and links. – Network filtering using criteria defined by attributes.

II. RELATED WORKS

With the wide variety of networks tools available, they all provide similar features and have been used for various purposes. Table I gives a summary of tools and the available features they support. The features listed are some of the most important available in network applications. The tools listed are some of the most popular network analysis applications available except for "Lullabi".

It is a tool that implements the KVN innovative approach to network representation, analysis and visualization. It is listed in the table to show its current feature set with respect to the other network applications.

Table – 1
Network Applications Feature Summary

	Features								
Tools	*Graph Layouts*	*Tables*	*Network Statistics*	*App Plugins*	*Dynamic Networks*	*Network Filters*	*Media*	*Import/ Export*	*Link Attr.*
Tulip [5]	x	x	x	x		x		x	x
Gephi [6]	x	x	x	x	x	x		x	x
Cytoscape [7]	x	x	x	x		x		x	x
Pajek [8]	x		x			x			
SocNetV [9]	x		x					x	
Meerkat [10]	x	x	x		x	x		x	x
Lullabi (KVN)				x		x	x		x

III. BACKGROUND OF STUDY KVN CONCEPTUAL DESIGN

Entity Component Model (ECM) To understand the capabilities within KVN it is important to understand the concept of its design. At the heart of KVN exists a modification of the entity component system (ECS). ECS is an architectural design pattern popularized in game development that follows composition over inheritance to allow greater flexibility in defining entities [11]. Composition is done through the addition of components which add functionality to entities. KVN's ECM is a modified ECS that allows for the building of entities where components are used to represent data and functionality. The ECM is laid out in Fig. 1. The components used in KVN are network, node, link, graphic, media, filter and attributes. An entity needs to be carefully crafted dependent on its intended purpose. For example, an entity would need a node, link or network component to define it as such, but it cannot have all three. This definition means that nodes and links can be a part of a network, but networks cannot be a part of nodes or links. However, entities defined as a node or link would require the graphics component to define how it should be visualized. Moreover, the attributes component allows for user definable data on an entity. This component could be used by nodes, links and networks. This simple example shows how components add capabilities to entities and how entities of varying types can have similar capabilities. The beauty of this model is that it can be expanded to add other components for enhanced functionality and similar capabilities between entities.

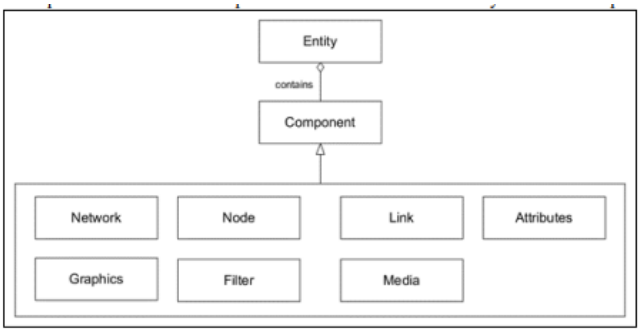

Fig. 1: Entity Component Model Serves as Heart of KVN

Attribute Component, Processing & Visualization Model KVN has an attribute system that allows for user definable data with processing and visualization. The model is based around the "attributes" component from Fig. 1. This is one of the most important components as it allows for user definable data that helps to describe an entity. Fig. 2 lays out the model in a logical format. Attributes are defined by a name, value and Multipurpose Internet Media Extensions (MIME) type. A MIME type is a "standard that indicates the nature and format of a document, file, or assortment of bytes" [12]. It is used in the World Wide Web to understand content, so it can be properly processed. In KVN, MIME types are used to classify attributes and provide appropriate functionality based on their content. Functionality is provided through the use of attribute processors that have a MIME type and process attributes of similar MIME types. For example, image processors process images, video processors process video, document processors process documents, etc. MIME types can be custom with appropriate processors to provide other forms of functionality with in a KVN. The attribute view and media view are the final parts to the model. The attribute view ties the entire model together. It allows for the addition, editing and visualization of attributes in a list format. It also has a list of attribute processors. A user would add text, image, video, document, and other types of attributes to an entity using the attribute view. The attribute view would display the attribute and send it to the appropriate processor. The processor would then build a media object according to its MIME type and send it to the media view. The media view provides a place for the visualization of media and allows a user to cycle through available media and optionally popup the media for a larger view. The media is not just for images, video and documents. It can also support sound and other forms of media such as maps, which is determined by the attribute processors provided

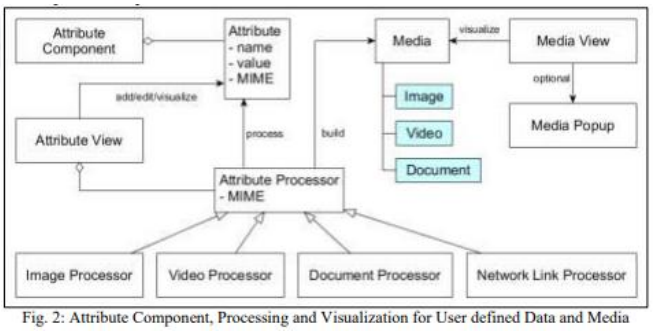

Fig. 2: Attribute Component, Processing and Visualization for User defined Data and Media

Network Link Model KVN allows for the representation of sub-networks and other forms of links between networks using an attribute, a custom MIME type and an associated processor. The functionality is provided in KVN's network link model which is laid out in Fig. 3. The attribute is a network link belonging to an entity and links to another network. The MIME type allows for the identification of the attribute as a network link and serves as an identifier that it has to be processed by the network link processor. The

network link processor provides the functionality to both create the link and initiate when and how the transition occurs. Fig. 3 shows network "A" containing an entity, that has a network link attribute contained through its "attributes" component, that is linked to network "B". The network link processor helps to create the network link, and allows the transition from network "A" to network "B".

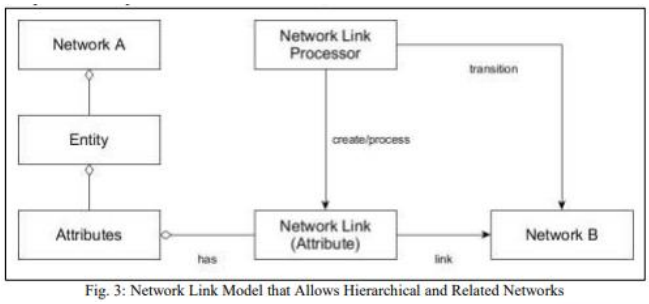

Fig. 3: Network Link Model that Allows Hierarchical and Related Networks

Network Database Model KVN must be able to represent, persist and provide query capabilities for networks. This functionality is provided in KVN's network database model as laid out in Fig. 4. Networks are composed of entities that are stored in a database. As information in entities change, persistent storage ensures its state will be persisted for later use. Since attributes can also represent media, the database must provide appropriate storage for multimedia. The query processor allows a user of the system to query the database. The main focus of network queries is to search the "attributes" component for user defined data. Other parts of an entity can be searched if so desired. The results produced by queries are either attributes or entities which can then be used for specific purposes. Searching can be done for a specific entity, extensibly with in an entity, or the entire network for a range of entities.

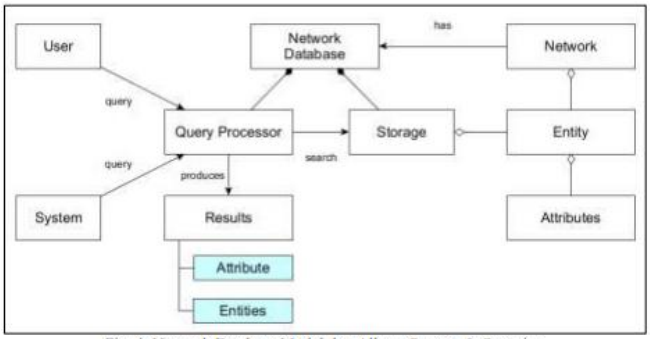

Fig. 4: Network Database Model that Allows Storage & Querying

Network Filtering Model Network filtering is the process of separating a network using a criteria to query the network database, and mixing it with visualization data to give an enhanced view of the network. It allows one to show how information within an entity is related and how entities within a network are related. The entire process is laid out in Fig. 5. A filter is composed of multiple criteria. A criteria is composed of a query string made up using both discrete and continuous values, along with visualization data for how the criteria should be visualized. The query string serves as input to query the network database for entities. The results along with the criteria visualization data servers as input to a renderer, which are used to produce a filtered network. The filtered network can contain nodes and links visualized in such a way that allows them to have multiple classifications. Multiple classifications are a way to show how information is related to each other within an entity by through proper visualization. For example, a network filter can be used to show male entities one color, female's entities using another color, and entities defined as both male and female using another and both colors. This requires the rendering of nodes using pie charts and links using multiple line segments.

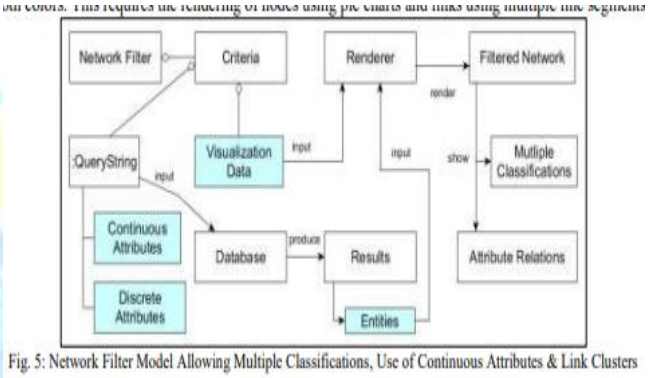

Fig. 5: Network Filter Model Allowing Multiple Classifications, Use of Continuous Attributes & Link Clusters

IV. CONCLUSION

This functionality is provided in KVN's network database model as laid out in Fig. 4. Networks are composed of entities that are stored in a database. As information in entities change, persistent storage ensures its state will be persisted for later use. Since attributes can also represent media, the database must provide appropriate storage for multimedia. The query processor allows a user of the system to query the database. The main focus of network queries is to search the "attributes" component for user defined data. Other parts of an entity can be searched if so desired.

REFERENCES

[1]. P. Nirmala, T. Manimegalai, J. R. Arunkumar, S. Vimala, G. Vinoth Rajkumar, Raja Raju, "A Mechanism for Detecting the Intruder in the Network through a Stacking Dilated CNN Model", Wireless Communications and Mobile Computing, vol. 2022, Article ID 1955009, 13 pages, 2022. https://doi.org/10.1155/2022/1955009.

[2]. D. Sathyanarayanan, T. S. Reddy, A. Sathish, P. Geetha, J. R. Arunkumar and S. P. K. Deepak, "American Sign Language Recognition System for Numerical and Alphabets," 2023 International Conference on Research Methodologies in Knowledge Management, Artificial Intelligence and Telecommunication Engineering (RMKMATE), Chennai,

India, 2023, pp. 1-6, doi: 10.1109/RMKMATE59243.2023.10369455.

[3]. J. R. Arunkumar, Tagele berihun Mengist, 2020" Developing Ethiopian Yirgacheffe Coffee Grading Model using a Deep Learning Classifier" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-4, February 2020. DOI: 10.35940/ijitee.D1823.029420.

[4]. Ashwini, S., Arunkumar, J.R., Prabu, R.T. et al. Diagnosis and multi-classification of lung diseases in CXR images using optimized deep convolutional neural network. Soft Comput (2023). https://doi.org/10.1007/s00500-023-09480-3

[5]. J.R.Arunkumar, Dr.E.Muthukumar," A Novel Method to Improve AODV Protocol for WSN" in Journal of Engineering Sciences" ISSN NO: 0377-9254Volume 3, Issue 1, Jul 2012.

[6]. R. K, A. Shameem, P. Biswas, B. T. Geetha, J. R. Arunkumar and P. K. Lakineni, "Supply Chain Management Using Blockchain: Opportunities, Challenges, and Future Directions," 2023 Second International Conference on Informatics (ICI), Noida, India, 2023, pp. 1-6, doi: 10.1109/ICI60088.2023.10421633.

[7]. Arunkumar, J. R. "Study Analysis of Cloud Security Chanllenges and Issues in Cloud Computing Technologies." Journal of Science, Computing and Engineering Research 6.8 (2023): 06-10.

[8]. J. R. Arunkumar, R. Raman, S. Sivakumar and R. Pavithra, "Wearable Devices for Patient Monitoring System using IoT," 2023 8th International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2023, pp. 381-385, doi: 10.1109/ICCES57224.2023.10192741.

[9]. S. Sugumaran, C. Geetha, S. S, P. C. Bharath Kumar, T. D. Subha and J. R. Arunkumar, "Energy Efficient Routing Algorithm with Mobile Sink Assistance in Wireless Sensor Networks," 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2023, pp. 1-7, doi: 10.1109/ACCAI58221.2023.10201142.

[10]. R. S. Vignesh, V. Chinnammal, Gururaj.D, A. K. Kumar, K. V. Karthikeyan and J. R. Arunkumar, "Secured Data Access and Control Abilities Management over Cloud Environment using Novel Cryptographic Principles," 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2023, pp. 1-8, doi: 10.1109/ACCAI58221.2023.10199616.

[11]. Syamala, M., Anusuya, R., Sonkar, S.K. et al. Big data analytics for dynamic network slicing in 5G and beyond with dynamic user preferences. Opt Quant Electron 56, 61 (2024). https://doi.org/10.1007/s11082-023-05663-2

[12]. Krishna Veni, S. R., and R. Anusuya. "Design and Study Analysis Automated Recognition system of Fake Currency Notes." Journal of Science, Computing and Engineering Research 6.6 (2023): 16-20.

[13]. V. RamKumar, S. Shanthi, K. S. Kumar, S. Kanageswari, S. Mahalakshmi and R. Anusuya, "Internet of Things Assisted Remote Health and Safety Monitoring Scheme Using Intelligent Sensors," 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2023, pp. 1-8, doi: 10.1109/ACCAI58221.2023.10199766.

[14]. R. S. Vignesh, R. Sankar, A. Balaji, K. S. Kumar, V. Sharmila Bhargavi and R. Anusuya, "IoT Assisted Drunk and Drive People Identification to Avoid Accidents and Ensure Road Safety Measures," 2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI), Chennai, India, 2023, pp. 1-7, doi: 10.1109/ACCAI58221.2023.10200809.

[15]. I. Chandra, G. Sowmiya, G. Charulatha, S. D, S. Gomathi and R. Anusuya, "An efficient Intelligent Systems for Low-Power Consumption Zigbee-Based Wearable Device for Voice Data Transmission," 2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF), Chennai, India, 2023, pp. 1-7, doi: 10.1109/ICECONF57129.2023.10083856.

[16]. G. Karthikeyan, D. T. G, R. Anusuya, K. K. G, J. T and R. T. Prabu, "Real-Time Sidewalk Crack Identification and Classification based on Convolutional Neural Network using Thermal Images," 2022 International Conference on Automation, Computing and Renewable Systems (ICACRS), Pudukkottai, India, 2022, pp. 1266-1274, doi: 10.1109/ICACRS55517.2022.10029202.

[17]. R. Meena, T. Kavitha, A. K. S, D. M. Mathew, R. Anusuya and G. Karthik, "Extracting Behavioral Characteristics of College Students Using Data Mining on Big Data," 2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF), Chennai, India, 2023, pp. 1-7, doi: 10.1109/ICECONF57129.2023.10084276.

[18]. S. Bharathi, A. Balaji, D. Irene. J, C. Kalaivanan and R. Anusuya, "An Efficient Liver Disease Prediction based on Deep Convolutional Neural Network using Biopsy Images," 2022 3rd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, 2022, pp. 1141-1147, doi: 10.1109/ICOSEC54921.2022.9951870.

[19]. I. Chandra, G. Sowmiya, G. Charulatha, S. D, S. Gomathi and R. Anusuya, "An efficient Intelligent Systems for Low-Power Consumption Zigbee-Based Wearable Device for Voice Data Transmission," 2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF), Chennai, India, 2023, pp. 1-7, doi: 10.1109/ICECONF57129.2023.10083856.

[20]. Revathi, S., et al. "Developing an Infant Monitoring System using IoT (INMOS)." International Scientific Journal of Contemporary Research in Engineering Science and Management 6.1 (2021): 111-115.