Knowledge Visualized

MCS Portfolio Report Brief

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I. Foundation

Every day, we perceive, process, and traverse a multidimensional matrix of data. From an AI perspective, this raises many questions such as: How do we make meaningful decisions amid potentially irrelevant or erroneous information? What are the hallmarks of useful and trustworthy knowledge? Are efficient searches possible? How do we filter multiple answers intelligently? Should we rely on automated conclusions? How can we know that the decisions a machine makes are correct?

On the following pages are two applied studies in specific areas of computer science: knowledge representation and reasoning *and* data visualization. The aim of the former is to automatically solve complex problems, while the goal of the latter is to graphically represent information and transform data into actionable knowledge.

II. Automated Inference

In the first paper, knowledge representation and reasoning solves a path planning problem for autonomous robots in a warehouse environment. To begin, an array models the floor plan of the warehouse. Next, symbols represent robots and shelving units. The low-profile robots are able to move under, lift, and transport the units. A logic programming language encodes a set of rules and scenarios. The rules determine behavior such as how robots move and their positional constraints. The scenarios define example maps of the warehouse, robot and shelving arrangements, products in the shelving units, and orders which require fulfillment.

The modeling and planning solution evolves in phases. The first phase implements the simplest task of moving a robot under a shelf, lifting it, navigating to a specified location, and putting it down. Stepwise, the development process continues to build an automated method of fulfilling product orders by computing the optimal pathways such that multiple robots make only necessary moves and do not collide.

The paper presents and discusses six scenario results, each providing a slightly different challenge. Visualization of the results captured for the final scenario can be viewed at the following link: vimeo.com/516442641

Finally, the study illuminates the need for understanding the fundamentals of expressing concepts in a declarative programming language, describing the "*what*" rather than the "*how*" of the problem.

III. Visual Artifact

The second paper focuses on data visualization; seeking meaningful and statistically significant information within a given dataset and graphically communicating the results. The study discusses several statistical predictors discovered and visualized in the US census source data. The discovery process involves data exploration, transformation, and analysis; which are also an important part of machine learning and data mining. Both manual analysis and automated analytical tools assist in revealing patterns, insights, relationships, and anomalies to locate averages, trends, quartiles, and clusters. When a pattern can statistically predict something like an event or a logical conclusion, then it can be graphically diagrammed to convey the findings.

Predictors translate into data visualizations to communicate results through standard charts, maps, and graphs. The visualizations provide resolution to principal questions, and support the discovery of new pathways for inquiry. Each statistical predictor requires an appropriate method of visualization such as donut chart, line graph, box-and-whisker, or scatter plot. Careful consideration of visual variables like size, position, color, and shape enhance the readability of the data. In addition, developing an overarching graphic design consistency and information hierarchy for the final deliverables provides a more unified, aesthetically-pleasing user experience.

The study points out the challenges with discovering insights in the data and understanding complex software. New users might feel lost like the little robot, not knowing what tool to use or which way to go amid all the choices of data analytics tools and options. Similar to the path produced for the robot, perhaps a plan can be generated from gathered knowledge to help guide the beginner with advice on what to explore next.

IV. Reflective Integration

The study topics share common concerns of search, filtering, analysis, efficiency, trust, ethics, legal explain-ability, bias, privacy, security, and accessibility. Is there a relationship between knowledge and visualization? Are they two views of the same thing? Is it a cycle where knowledge is made visible, which ultimately leads to more knowledge? Can machine learning assist in recommending which types of visualizations are best for various sets of data? Can we improve search engines to better understand not just the meta-data, but the content of data visualizations? These questions invite further research into teaching intelligent agents to learn like humans.