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Perspectives on cross-domain visual analysis of cyber-physical-social big data

Key words: Visual analysis; Big data; Cyber-physical-social (CPS) space; Cross-domain

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Motivation

1. Existing visual analytics methods still lack intelligence. Intelligent visual analysis of cyber-physical-social (CPS) big data should overcome the stereotype of data intelligence, the inefficiency of automatic visualization, and the unavailability of human–machine collaboration.

2. CPS big data is cross-domain in nature. There are multiple domains in the CPS space, such as space, data, task, application scenario, and analysis subject.

Main idea

1. We propose an innovation in the visual analytics mode to address the aforementioned challenges posed by exploiting the cross-domain nature of CPS big data.

2. We focus on critical challenges of CPS big data in the cross-data domain, cross-subject domain, and cross-task domain.

3. We build a new cross-domain visual analytics theory and methods to overcome the shortcomings of existing visual analytics methods, which are applicable only to a single domain.

Method

1. Cross-data representation constructs a unified data representation model for cross-subject collaborative visual analysis and cross-task guided visual analysis; cross-subject collaborative visual analysis realizes efficient integration of different subjects' intelligence; cross-task guided visual analysis realizes cross-domain migration of analysis tasks.

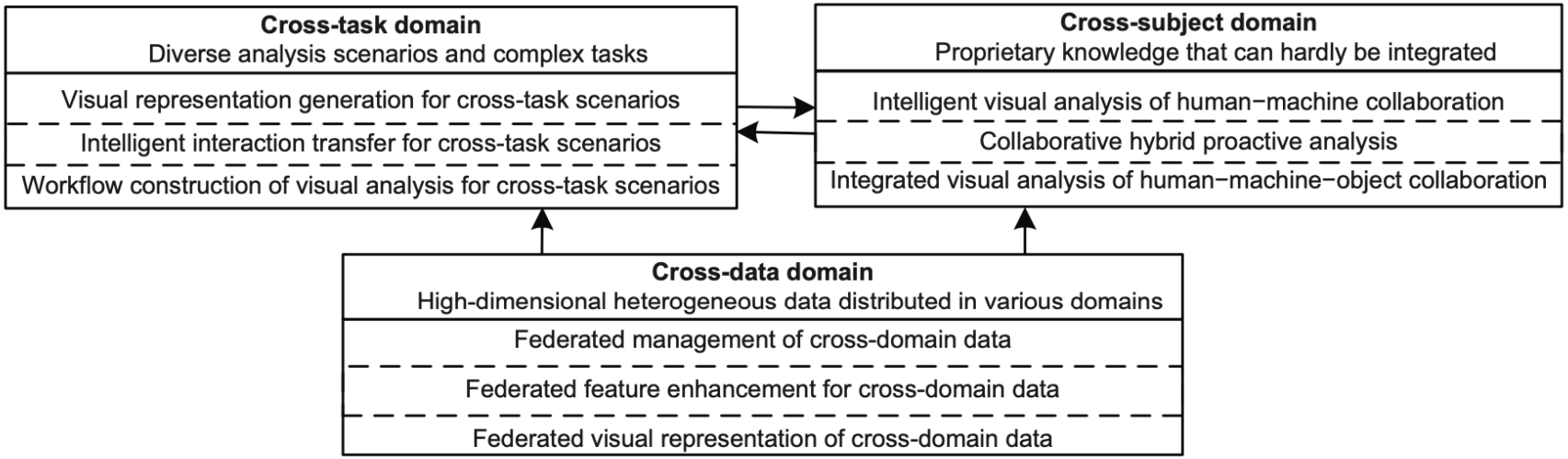


Fig. 1 The pipeline of cross-domain visual analysis of CPS big data

Method (cross-data domain)

2. We design a new mechanism of federated data representation that supports visual analysis. This new mechanism considers different data application scenarios, different modalities, and different sources.

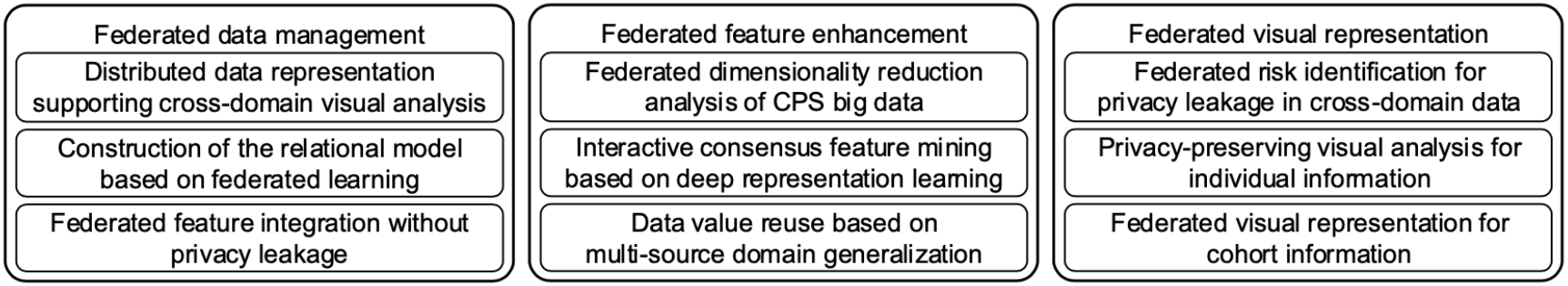


Fig. 2 The pipeline of federated representation of cross-domain data

Method (cross-task domain)

3. We study the automatic generation of visual expressions and intelligent transfer of visual interactions across tasks. This helps knowledge generation, reasoning, and method reuse, so that visual analytics methods for CPS big data can be standardized and generalized.

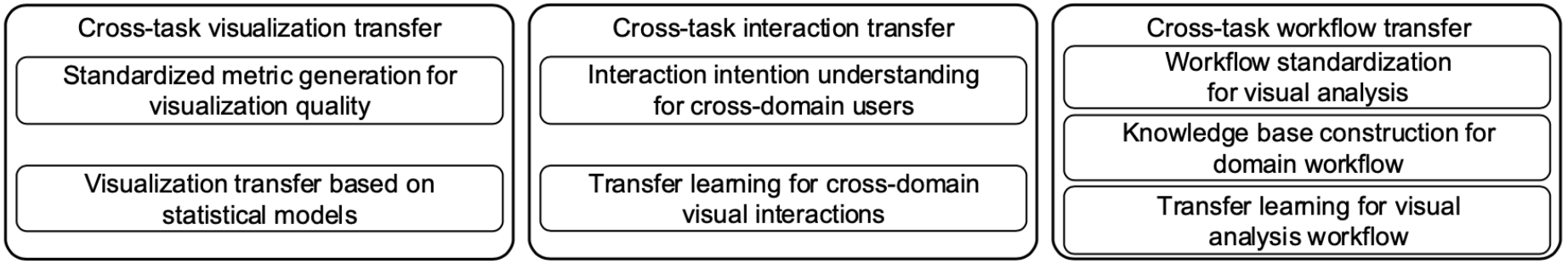


Fig. 3 The pipeline of cross-task visual analysis

Method (cross-subject domain)

4. We establish a new workflow across human and machine intelligence, which reduces human cognitive costs and intervention. We explore the new cross-subject (human, machine, and object) visual interaction theory, which helps form a human–machine–object collaborative agent.

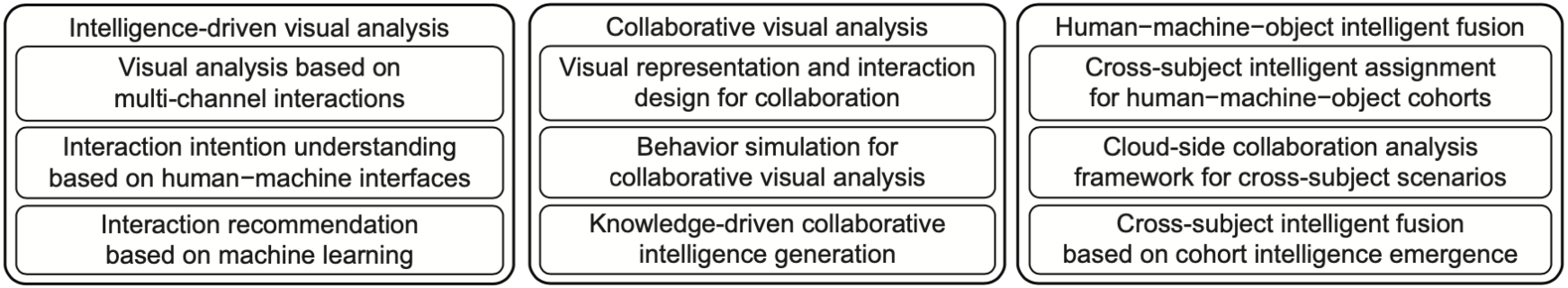


Fig. 4 The pipeline of collaborative visual analysis across subject domains

Conclusions

1. We propose a new model for cross-domain visual analysis of CPS big data.

2. This will enable efficient integration and presentation of cross-domain data, distillation of knowledge, and human–machine collaboration, which will lead to the development of the fundamental theory of visual analytics.

3. We believe that our theory and methods can be applied in multiple application scenarios (for example, medical insurance analysis), and that our theory can effectively support cross-domain visual analytics by reducing human intervention and improving analysis accuracy.