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Temporal logic and its applications to information sciense

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1   Introduction

Temporal logic in which ew can deal with notion of time is applied to several field of information science such as verification of specification of parallel programming, design of VLSI, natural language processing, artifical intelligence,etc.The basic system is propositional logic with some temporal operators.Complicated systems such as many sorted predicate logic shich real time can be expressed may be used in some case.But many cases need not use so complicated logical systems.

   By this research, it argues about the logic which meant improvement in the description power and power of expression, and combined temporal logic and other modal logic, holding the desirable character which fundamental temporal logic has. It argues about combination with the operation which considers epistemic logic as logic to combine, especially is called logic of knowledge.

2   Temporal Logic and Epistemic Logic

Both of them are studied in the framewark of modal logic and are formulated as multimodal logic with some modal operators.

Temporal Logic K_t

    axioms
      (a) **CL**
      (b) $G(p \to q) \to (Gp \to Gq)$ $H(p \to q) \to (Hp \to Hq)$
      (c) $q \to GPq$ $q \to HFq$
      (d) $Gp \to GGp$ $Hp \to HHp$

    rules
      (e) $\dfrac{A}{GA}, \dfrac{A}{HA}$ (f) $\dfrac{A \quad A \to B}{B}$

Epistemic Logic K_K

    axioms

    CL

    $K_\alpha(p \to q) \to (K_\alpha p \to K_\alpha q)$

    $K_\alpha p \to p$

    $K_\alpha p \to K_\alpha K_\alpha p$

    $\neg K_\alpha p \to K_\alpha \neg K_\alpha p$

    rules

    Generalization $\dfrac{A}{K_\alpha A}$

    Modus ponens $\dfrac{A \quad A \to B}{B}$

3   Epistemic Temporal Logic

Epistemic temporal logic $K_t K_\alpha$ is defined as the minimum modal logic containing temporal logic K_t and epistemic logic K_K. This does not have a dependency mutually between aspect operations. Consideration of an actual application side considers automatically giving a dependency among each agent, or giving correlation between time operation and epistemic operation.

   Then, the logic which gave the dependency among agents, and the logic which gave the dependency between time and epistemic operation are considered.

1) $K_\alpha p \to K_\beta p$
2) $K_\alpha p \to GK_\alpha p$

The logic which added the axiom 1) to the epistemic temporal logic $K_t K_\alpha$ is expressed as $K_t K_{\alpha\beta}$.

The logic which added the axiom 2) to the epistemic temporal logic $K_t K_\alpha$ is expressed as $K_t K_\alpha I_2$.

In this paper, completeness and finite model property are proved about epistemic temporal logic $K_t K_\alpha$ of these, $K_t K_{\alpha\beta}$, and $K_t K_\alpha I_2$, respectively.

theorem (completeness and finite model property)
(1) Epistemic temporal logic $\mathbf{L}$ is perfect about the class of the whole frame of epistemic temporal logic $\mathbf{L}$.
(2) epistemic temporal logic $\mathbf{L}$ has finite model property.

4   Conclusion

Three systems of epistemic temporal logic were able to be considered and the completeness and finite model property were able to be shown. Although this strengthens the description power and power of expression which were the original purpose, it is considered that it was realizable to hold original desirable character though it was small-scale.

Being related with the logic of a belief first of all will be thought as a direction to which it will go from now on [of this research]. Although the combination of temporal logic and the logic of knowledge was thought as important in this research, it is considering combination with the logic of a belief with continuity, and believes with what the improvement in the further description power and power of expression or the way to a possibility of having differed opens.

Moreover, in this research, probably, to extend to the system of an about will be required, when probably considering actually applying epistemic temporal logic to a certain problem n persons' agent exists, although the agent argued only about the case of one person or two persons.

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