

# KnoBAB: a Knowledge Base for Querying Temporal Models

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## Abstract

State of the art approaches for declarative temporal model checking over trace logs with data payloads exploit straightforward solutions requiring computationally intensive query plans. While current approaches exploiting relational databases are neither using efficient column-stored representations, nor considering multiple declarative model clauses contemporaneously, nor considering join condition between events happening in different times, recent research suggests that that is possible via sub-query identification. On the other hand, solutions also considering data correlation condition do not efficiently exploit knowledge bases. In this paper we show that we can rewrite declarative temporal models via an adequate representation of Linear Temporal Logic for Finite Traces, which can be then exploited for determining the query plan definition. As the resulting query plan can be parallelized, we show that our solution outperforms the state of the art solutions for model checking for trace logs with data.

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**Keywords and phrases** Dummy keyword

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► **Lemma 1** (Lorem ipsum). *Vestibulum sodales dolor et dui cursus iaculis. Nullam ullamcorper purus vel turpis lobortis eu tempus lorem semper. Proin facilisis gravida rutrum. Etiam sed sollicitudin lorem. Proin pellentesque risus at elit hendrerit pharetra. Integer at turpis varius libero rhoncus fermentum vitae vitae metus.*

**Proof.** Cras purus lorem, pulvinar et fermentum sagittis, suscipit quis magna.

**Just some paragraph within the proof.** Nam liber tempor cum soluta nobis eleifend option congue nihil imperdiet doming id quod mazim placerat facer possim assum. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat.

▷ **Claim 2.** content...

Proof. content...

1. abc abc abc

► **Corollary 3** (Curabitur pulvinar, [2]). *Nam liber tempor cum soluta nobis eleifend option congue nihil imperdiet doming id quod mazim placerat facer possim assum. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat.*

► **Proposition 4.** *This is a proposition*

Proposition 4 and Proposition 4 ...

### 2.1 Curabitur dictum felis id sapien

Curabitur dictum Corollary 3 felis id sapien Corollary 3 mollis ut venenatis tortor feugiat. Curabitur sed velit diam. Integer aliquam, nunc ac egestas lacinia, nibh est vehicula nibh, ac auctor velit tellus non arcu. Vestibulum lacinia ipsum vitae nisi ultrices eget gravida turpis laoreet. Duis rutrum dapibus ornare. Nulla vehicula vulputate iaculis. Proin a consequat neque. Donec ut rutrum urna. Morbi scelerisque turpis sed elit sagittis eu scelerisque quam condimentum. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Aenean nec faucibus leo. Cras ut nisl odio, non tincidunt lorem. Integer purus ligula, venenatis et convallis lacinia, scelerisque at erat. Fusce risus libero, convallis at fermentum in, dignissim sed sem. Ut dapibus orci vitae nisl viverra nec adipiscing tortor condimentum [1]. Donec non suscipit lorem. Nam sit amet enim vitae nisl accumsan pretium.

■ **Listing 1** Useless code.

```
for i:=maxint to 0 do
begin
  j:=square(root(i));
end;
```

## 125 2.2 Proin ac fermentum augue

126 Proin ac fermentum augue. Nullam bibendum enim sollicitudin tellus egestas lacinia euismod  
 127 orci mollis. Nulla facilisi. Vivamus volutpat venenatis sapien, vitae feugiat arcu fringilla ac.  
 128 Mauris sapien tortor, sagittis eget auctor at, vulputate pharetra magna. Sed congue, dui  
 129 nec vulputate convallis, sem nunc adipiscing dui, vel venenatis mauris sem in dui. Praesent  
 130 a pretium quam. Mauris non mauris sit amet eros rutrum aliquam id ut sapien. Nulla  
 131 aliquet fringilla sagittis. Pellentesque eu metus posuere nunc tincidunt dignissim in tempor  
 132 dolor. Nulla cursus aliquet enim. Cras sapien risus, accumsan eu cursus ut, commodo vel  
 133 velit. Praesent aliquet consectetur ligula, vitae iaculis ligula interdum vel. Integer faucibus  
 134 faucibus felis.

- 135 ■ Ut vitae diam augue.
- 136 ■ Integer lacus ante, pellentesque sed sollicitudin et, pulvinar adipiscing sem.
- 137 ■ Maecenas facilisis, leo quis tincidunt egestas, magna ipsum condimentum orci, vitae  
 138 facilisis nibh turpis et elit.

139 ► Remark 5. content...

## 140 3 Pellentesque quis tortor

141 Nec urna malesuada sollicitudin. Nulla facilisi. Vivamus aliquam tempus ligula eget ornare.  
 142 Praesent eget magna ut turpis mattis cursus. Aliquam vel condimentum orci. Nunc congue,  
 143 libero in gravida convallis [3], orci nibh sodales quam, id egestas felis mi nec nisi. Suspendisse  
 144 tincidunt, est ac vestibulum posuere, justo odio bibendum urna, rutrum bibendum dolor sem  
 145 nec tellus.

146 ► **Lemma 6** (Quisque blandit tempus nunc). *Sed interdum nisl pretium non. Mauris sodales  
 147 consequat risus vel consectetur. Aliquam erat volutpat. Nunc sed sapien ligula. Proin faucibus  
 148 sapien luctus nisl feugiat convallis faucibus elit cursus. Nunc vestibulum nunc ac massa  
 149 pretium pharetra. Nulla facilisis turpis id augue venenatis blandit. Cum sociis natoque  
 150 penatibus et magnis dis parturient montes, nascetur ridiculus mus.*

151 Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam  
 152 vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit  
 153 amet neque.

## 154 4 Morbi eros magna

155 Morbi eros magna, vestibulum non posuere non, porta eu quam. Maecenas vitae orci risus,  
 156 eget imperdiet mauris. Donec massa mauris, pellentesque vel lobortis eu, molestie ac turpis.  
 157 Sed condimentum convallis dolor, a dignissim est ultrices eu. Donec consectetur volutpat  
 158 eros, et ornare dui ultricies id. Vivamus eu augue eget dolor euismod ultrices et sit amet nisi.  
 159 Vivamus malesuada leo ac leo ullamcorper tempor. Donec justo mi, tempor vitae aliquet non,

160 faucibus eu lacus. Donec dictum gravida neque, non porta turpis imperdiet eget. Curabitur  
 161 quis euismod ligula.

## 162 ——— References ———

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## 173 **A** Styles of lists, enumerations, and descriptions

174 List of different predefined enumeration styles:

175 ■ \begin{itemize}...\end{itemize}

176 ■ ...

177 ■ ...

178 1. \begin{enumerate}...\end{enumerate}

179 2. ...

180 3. ...

181 (a) \begin{alphaenumerate}...\end{alphaenumerate}

182 (b) ...

183 (c) ...

184 (i) \begin{romanenumerate}...\end{romanenumerate}

185 (ii) ...

186 (iii) ...

187 (1) \begin{bracketenumerate}...\end{bracketenumerate}

188 (2) ...

189 (3) ...

190 **Description 1** \begin{description} \item[Description 1] ... \end{description}

191 **Description 2** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.  
 192 Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus  
 193 massa sit amet neque.

194 **Description 3** ...

195 Proposition 10 and Proposition 10 ...

## 196 **B** Theorem-like environments

197 List of different predefined enumeration styles:

198 ► **Theorem 7.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 199 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 200 *sit amet neque.*

201 ► **Lemma 8.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 202 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 203 *sit amet neque.*

204 ► **Corollary 9.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 205 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 206 *sit amet neque.*

207 ► **Proposition 10.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo*  
 208 *dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 209 *massa sit amet neque.*

210 ► **Conjecture 11.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo*  
 211 *dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 212 *massa sit amet neque.*

213 ► **Observation 12.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et*  
 214 *leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 215 *massa sit amet neque.*

216 ► **Exercise 13.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo*  
 217 *dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 218 *massa sit amet neque.*

219 ► **Definition 14.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo*  
 220 *dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 221 *massa sit amet neque.*

222 ► **Example 15.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo*  
 223 *dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus*  
 224 *massa sit amet neque.*

225 ► **Note 16.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 226 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 227 *sit amet neque.*

228 ► **Note.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam*  
 229 *vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit*  
 230 *amet neque.*

231 ► **Remark 17.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 232 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 233 *sit amet neque.*

234 ► **Remark.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.*  
 235 *Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa*  
 236 *sit amet neque.*

237 ▷ **Claim 18.** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.  
238 Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa  
239 sit amet neque.

240 ▷ **Claim.** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui.  
241 Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa  
242 sit amet neque.

243 **Proof.** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam  
244 vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit  
245 amet neque. ◀

246 **Proof.** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam  
247 vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit  
248 amet neque. ◀