

Unit-7: Linear Temporal Logic

B. Srivathsan

Chennai Mathematical Institute

NPTEL-course

July - November 2015

Module 3:

A Puzzle

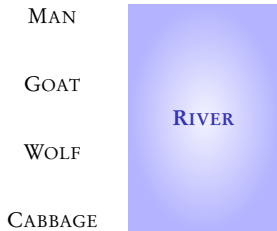
MAN

GOAT

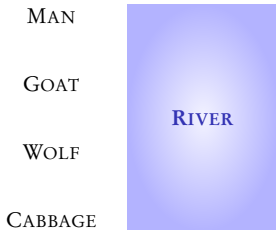
WOLF

CABBAGE

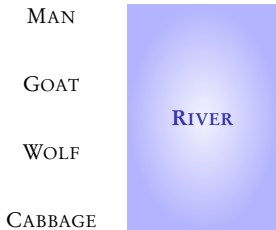




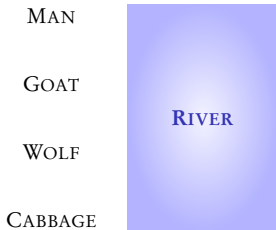
- ▶ There is a **boat** that can be driven by the man



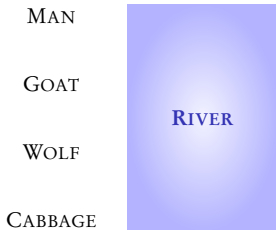
- ▶ There is a **boat** that can be driven by the man
- ▶ Man can take only **one passenger** in the boat with him at a time



- ▶ There is a **boat** that can be driven by the man
- ▶ Man can take only **one passenger** in the boat with him at a time
- ▶ **Goat and cabbage** cannot be left in the same bank if man is not there



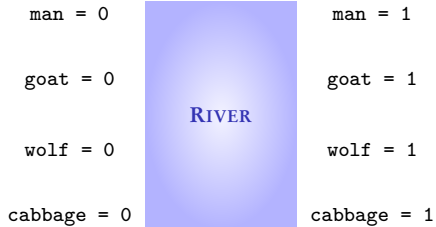
- ▶ There is a **boat** that can be driven by the man
- ▶ Man can take only **one passenger** in the boat with him at a time
- ▶ **Goat and cabbage** cannot be left in the same bank if man is not there
- ▶ **Wolf and goat** cannot be left in the same bank if man is not there

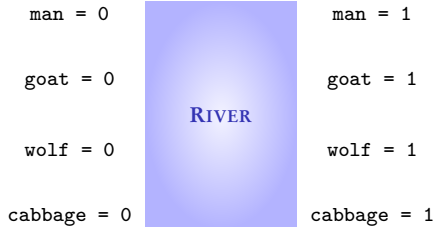


- ▶ There is a **boat** that can be driven by the man
- ▶ Man can take only **one passenger** in the boat with him at a time
- ▶ **Goat and cabbage** cannot be left in the same bank if man is not there
- ▶ **Wolf and goat** cannot be left in the same bank if man is not there

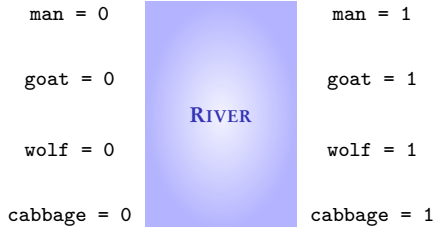
How can the man shift everyone to the right bank?

Coming next: Solution using LTL model-checking



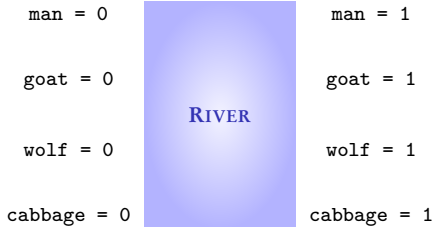


carry = {g,w,c,0}



carry = {g,w,c,0}

man can carry a passenger which has same value as him



carry = {g,w,c,0}

man can carry a passenger which has same value as him

NuSMV demo

Need a path in this transition system which satisfies:

$$\phi: ((\text{goat} = \text{cabbage} \mid \text{wolf} = \text{goat}) \rightarrow \text{man} = \text{goat}) \\ \cup (\text{man} \ \& \ \text{cabbage} \ \& \ \text{goat} \ \& \ \text{wolf})$$

Need a path in this transition system which satisfies:

$$\phi: ((\text{goat} = \text{cabbage} \mid \text{wolf} = \text{goat}) \rightarrow \text{man} = \text{goat}) \\ \cup (\text{man} \ \& \ \text{cabbage} \ \& \ \text{goat} \ \& \ \text{wolf})$$

NuSMV checks property on all paths

Need a path in this transition system which satisfies:

$$\phi: ((\text{goat} = \text{cabbage} \mid \text{wolf} = \text{goat}) \rightarrow \text{man} = \text{goat}) \\ \cup (\text{man} \ \& \ \text{cabbage} \ \& \ \text{goat} \ \& \ \text{wolf})$$

NuSMV checks property on all paths

Check $!\phi$ and look at the **counter-example!**

Summary

LTL model-checking

Use in **planning problem**

Reference

Section 3.3.2

M. Huth and M. Ryan. Logic in Computer Science
(Second Edition, Cambridge University Press)