



University of Antwerp
Operations Research Group
ANT/OR



EPS2016
Lorient, France - April 20-28

The school bus routing problem

Lab sessions

Daniel Palhazi Cuervo and Kenneth Sörensen
April, 2016 – Lorient

Description of EPS2016

*“...During one week, participants will explore the challenging domain of **Matheuristics** along with its application to the **Vehicle Routing Problem (VRP)**. Additionally, participants will learn how to make their algorithms available to the research community by means of **web services**...”*

EPS2016 website

Main objectives

To get familiar with:

- Web services
- Matheuristics
 - Metaheuristics
 - Mathematical/exact solvers
- Application to a VRP

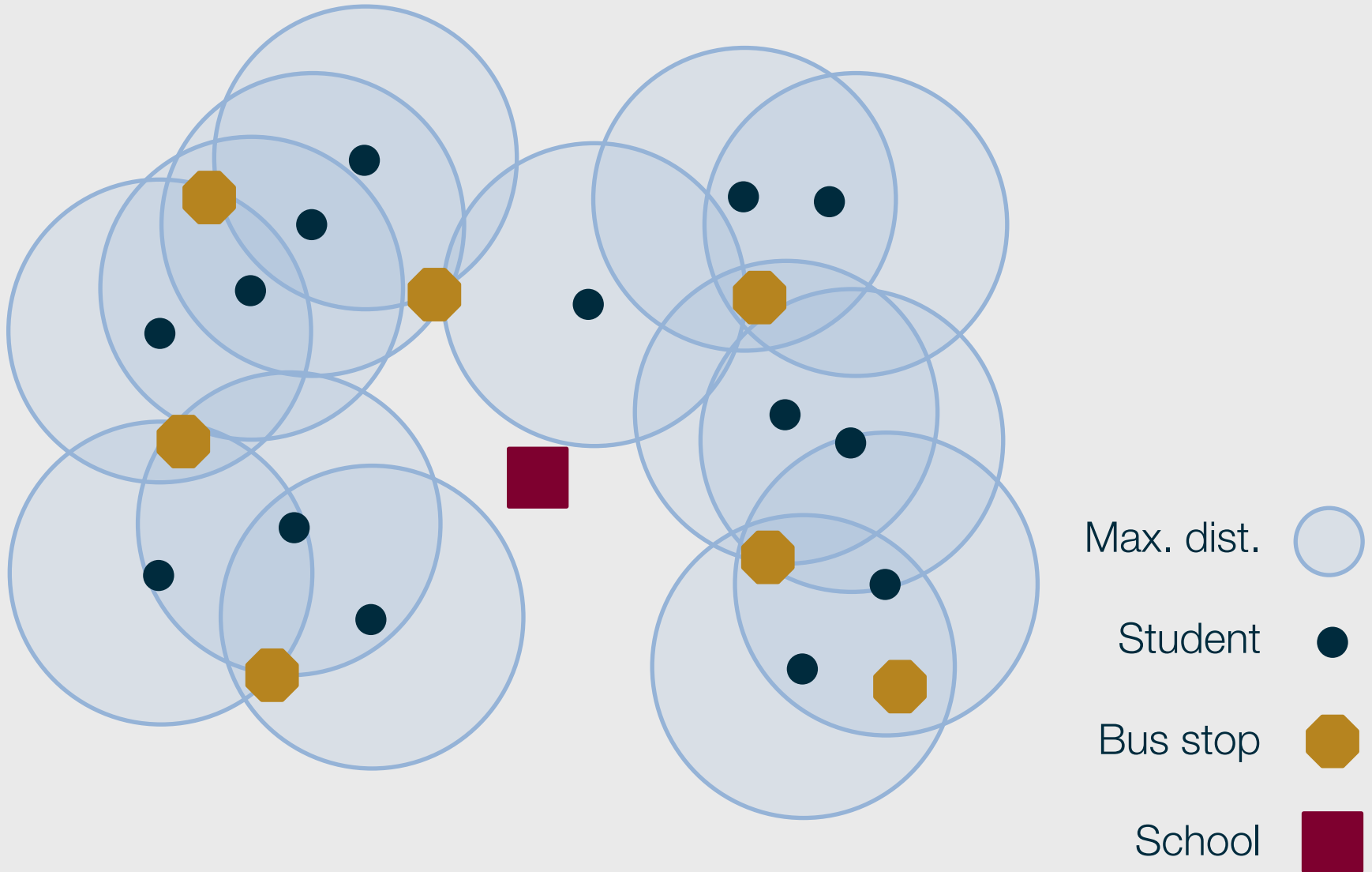


The School Bus Routing Problem (SBRP)

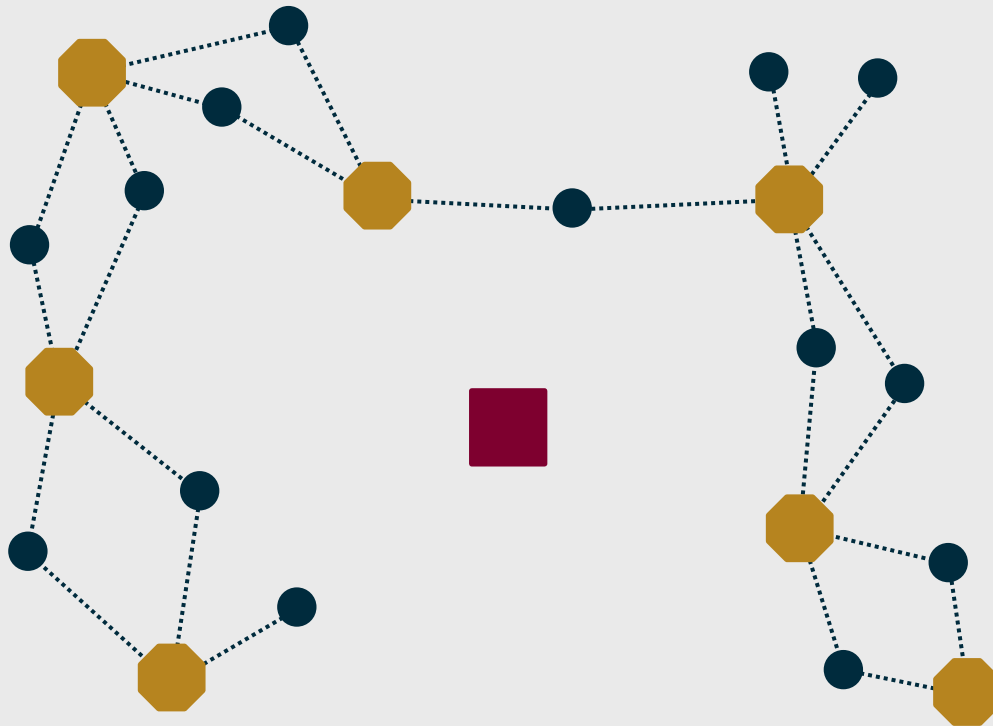
The School Bus Routing Problem (SBRP)



The School Bus Routing Problem (SBRP)

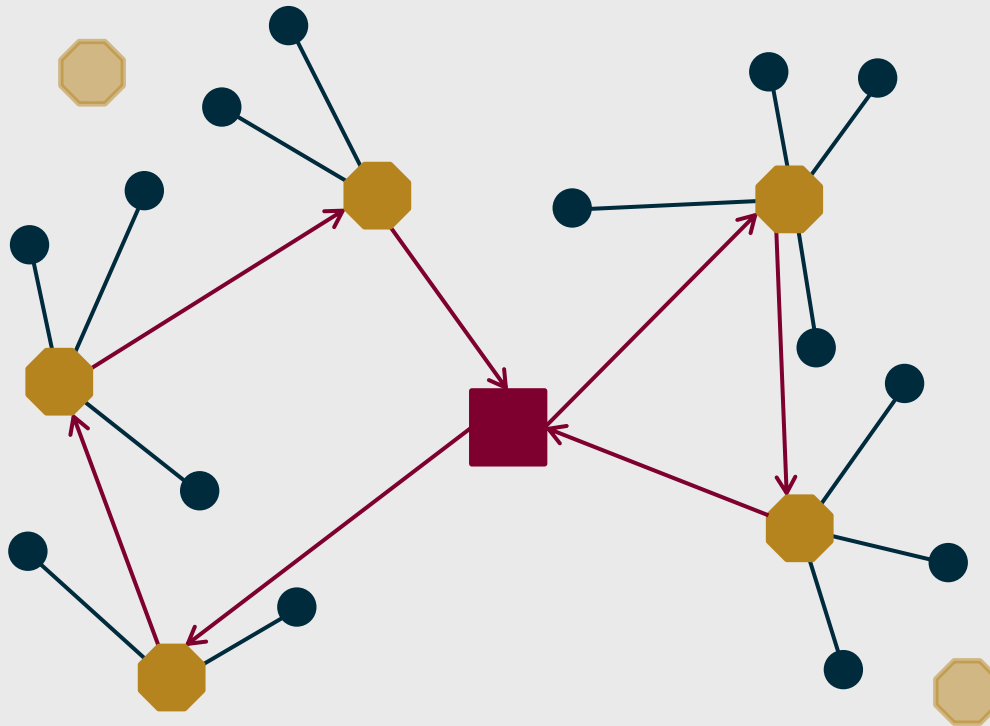


The School Bus Routing Problem (SBRP)



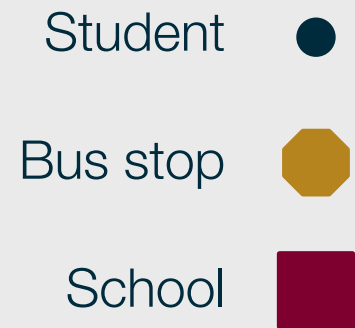
- Student ●
- Bus stop ○
- School ■

The School Bus Routing Problem (SBRP)



Minimize the total distance travelled

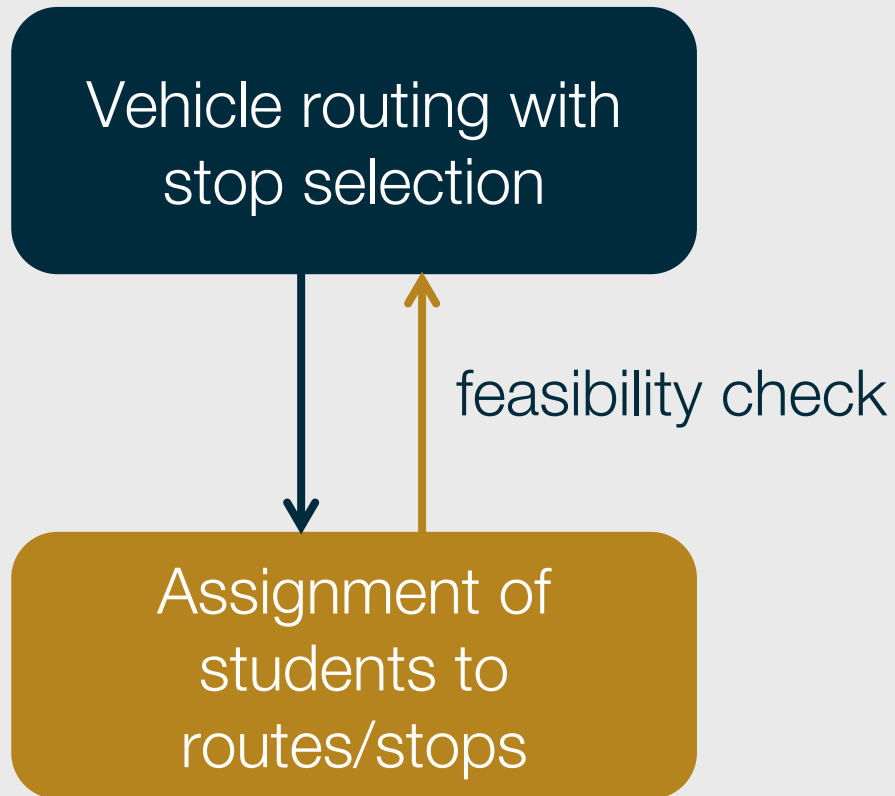
* No restrictions on the number of buses/routes



Possible variants of the SBRP

- Basic version
- Varying number of students
- Alternative objective function
- Time limit
- Heterogeneous fleet of buses
- Multiple schools (end of the routes) – buses departure from a common depot

Decision levels



Metaheuristics

**Exact/mathematical
solver**

Connection to the web-service platform

Web-service platform



- **Objective #1:** interface between the web-service platform and the optimization algorithm
 - Adapt the input/output format to your variant

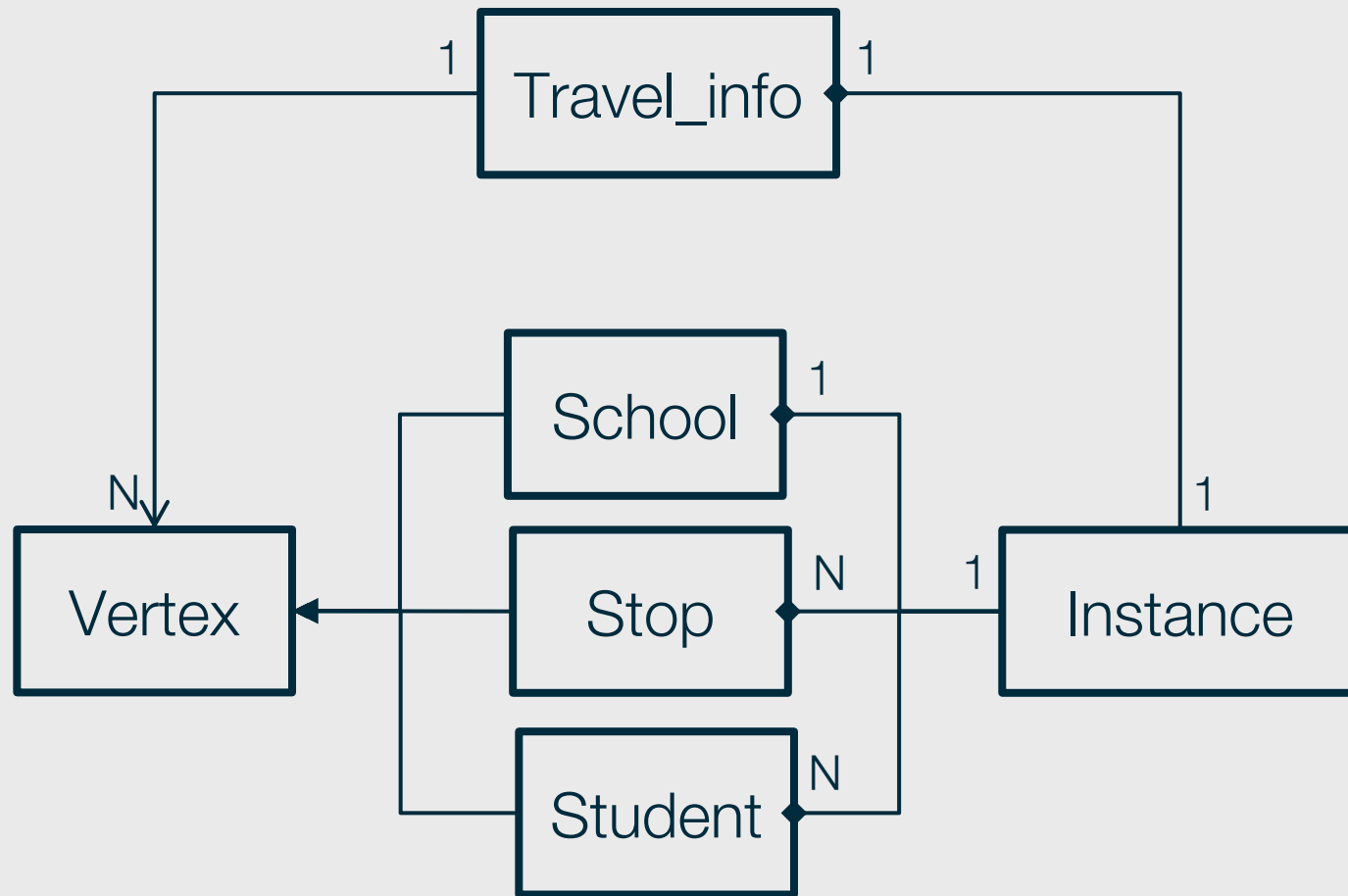
SBRP library

SBRP library

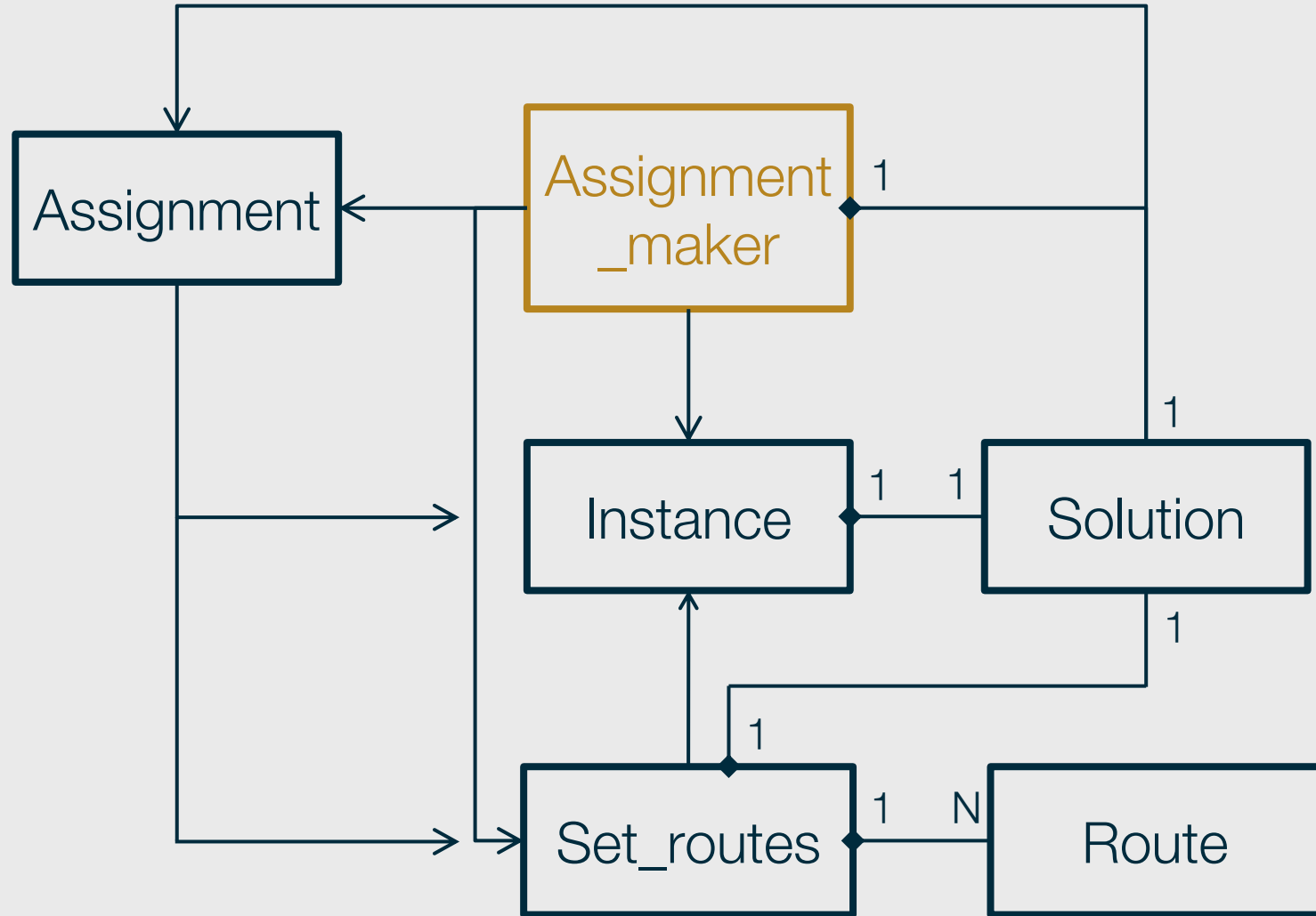
- Optimized for readability and modularity (at the expense of efficiency)
- Plenty of assertions (identify bugs asap)
- Documentation available in HTML format

- **Objective #2:** get familiar with the SBRP library
- **Alternative:** write your own library from scratch

Class diagram #1



Class diagram #2



Input/Output

- Input: info.txt, distances.txt, times.txt
- Output: solution.txt
- Formatting available in the folder “files”
- **Assumption:** order of the vertices
school, stop_1, ..., stop_n, student_1, ..., student_m
- **Objective #3:** adapt the SBRP library and the input/output format to your variant

Matheuristics

Metaheuristic

- **Objective #4:** implement a metaheuristic framework to solve the routing (and stop selection) problem
 - Initial solution (Clarke and Wright, insertion heuristic,...)
 - Local search (neighborhood operators, improvement strategy,...)
 - Iterated local search (perturbation operator)
 - ALNS (destroy and repair operators)
 - ...

Exact/mathematical approach

- **Objective #5:** create and solve the mathematical model to assign students to routes/stops
 - LocalSolver
 - FICO optimization suite
 - Gurobi

Tentative schedule

Tentative schedule

	Monday	Tuesday	Wednesday
08:30 - 12:30		Adapting the library Mathematical model	Metaheuristic implementation
14:00 - 18:00	Interface web service Exploring the library	Mathematical model Metaheuristic implementation	Metaheuristic implementation



**COFFEE
AND
CODE**