Taaable

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Introduction
&
Overviews

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Case-Based Reasoning

Process of solving new problems based on the solutions of similar past problems

- **Retrieve**
  Blueberry pancakes? Remember when you made plain pancakes
- **Reuse**
  Adapt the pancake recipe to include blueberries
- **Revise**
  Test the adapted solution and make necessary adjustments
- **Retain**
  When a satisfying solution is found, add to knowledge base

Computer Cooking Contest

- Case base: provided recipe book (xml file)
- Judges: panel of scientists and cooking experts

```
<RECIPE>
<TI>Glutinous Rice with Mangoes</TI>
<IN>3 c Glutinous rice</IN>
<IN>1 1/2 c Coconut cream</IN>
<IN>1/2 c Sugar</IN>
<IN>1 ts Salt</IN>
<IN>1 1/4 c Coconut cream</IN>
<IN>2 tb Sugar</IN>
<IN>1/4 ts Salt</IN>
<IN>6 Ripe mangoes, well chilled</IN>
<IN>2 tb Sesame seeds, toasted</IN>
<PR>SEASONINGS SAUCE GARNISH Soak the rice in cold water for 2 hours.
Drain. Line a steamer with cheesecloth, heat steamer and lay rice on the
cheesecloth. Steam for 30 minutes or until cooked through. The rice will
become glossy. Mix the SEASONINGS ingredients in a large bowl and gently
mix in the hot steamed rice. Cover tightly and let soak for 30 minutes to
absorb the coconut flavour. Blend the SAUCE ingredients in a pot and heat
until it just reaches the boiling point. Let cool. Peel the mangoes, slice
lengthwise and remove the pits. Divide the rice among 6 plates. Place
mango slices on top and cover with the sauce. Sprinkle with the sesame
seeds and serve.
</PR>
</RECIPE>
```

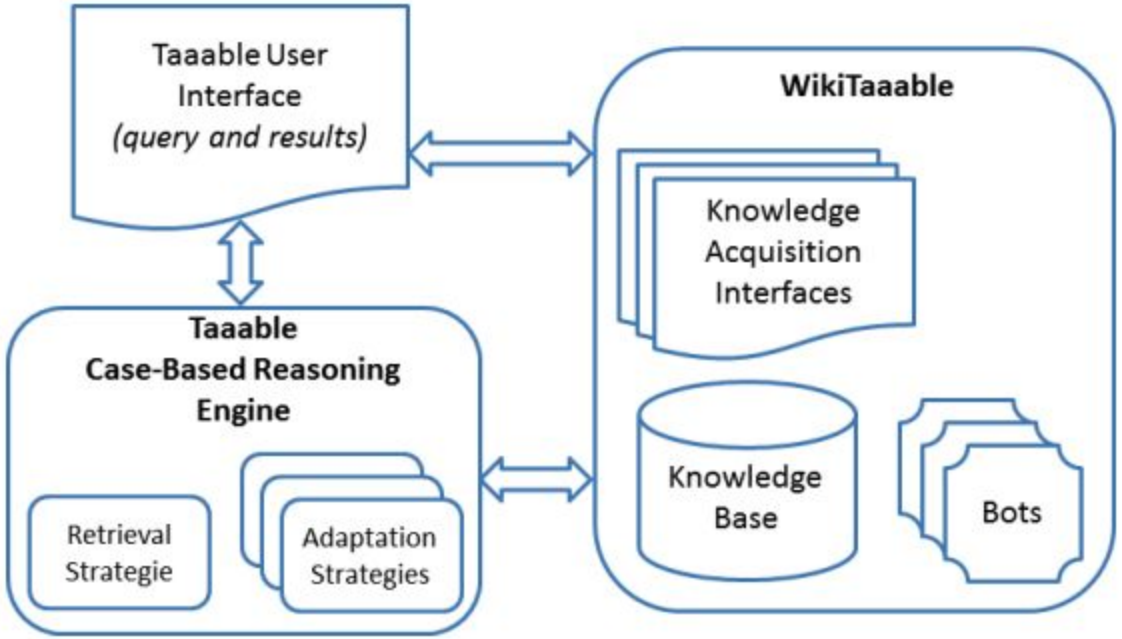
Computer Cooking Contest - Challenges

- **Main challenge**: given a query in NL, find a satisfying recipe adapted from a recipe from the book
- **Adaptation challenge**: Given a recipe and a set of constraints, provide a suitable adaptation of this recipe
- **Menu challenge**: The user gives a list of ingredients and the goal is to retrieve three recipes using these ingredients
- **Healthy challenge**: similar to main challenge but with additional constraints on special diets such as vegetarianism or a gluten-free diet
- **Open challenge**: This challenge was created in order to allow participants to investigate specific issues and demonstrate their results during the contest

Taaable

They combined their skills and knowledge of various research issues: knowledge representation and knowledge management, case base organisation and representation, development of a similarity measure, adaptation knowledge acquisition, formal representation of preparations, retrieval and adaptation strategies in cbr, etc

Taaable architecture overview



Taaable Inference Engine

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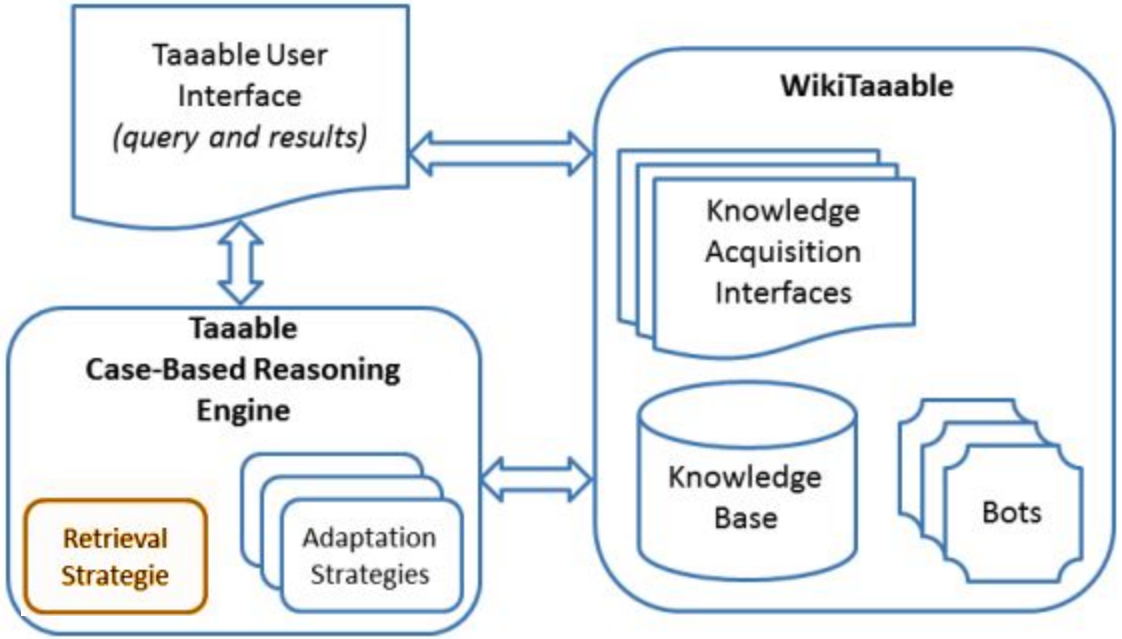
Case Retrieval

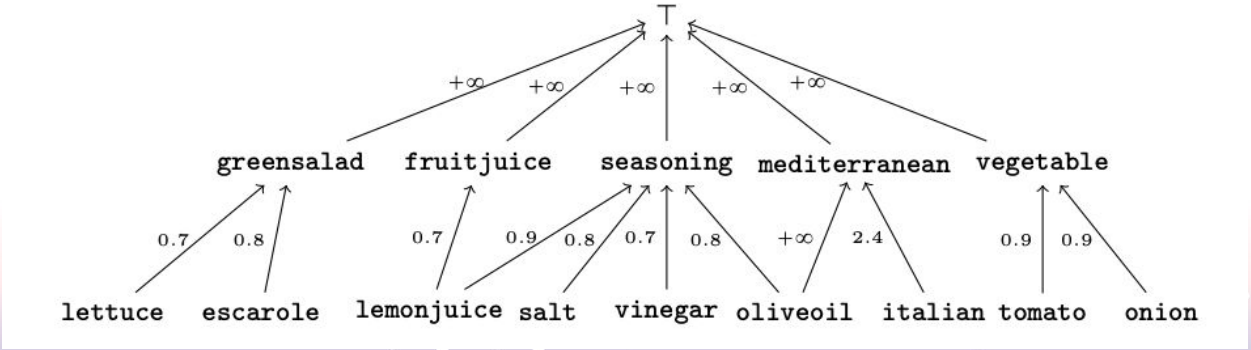


Case Retrieval

- selecting recipes **R** from the base of recipes where **R** is a best match to the query **Q**

- a generalisation **Γ(Q)**: minimal in cost and such that at least one recipe from the base matches

- Domain Knowledge (DK) as a hierarchy (DAG) of knowledge
e.g. lemon => citrusfruit



Case Retrieval - Algorithm

- **Q** is transformed in a conjunction of litterals
  Q = escarole ^ lemonjuice ^ ¬onion
  = “a recipe with escarole and lemon juice, but without onions”

- Γ <- identity function
- While no recipe match for Γ(Q)
  - Γ <- next generalisation
  - Check for matches for Γ(Q) in DK

Case Retrieval - Generalisations

One step generalisation γ:

- Generalisation of a positive litteral
  - γ = Lemon ~> citrusfruit
- Removal of a negative litteral
  - γ = ¬garlic ~> ø
- Γ is a composition of γ's

Case Retrieval - Cost Function

Cost function for each a ~> b such that a => b in DK

It is assumed that *Recipes* is homogenous so $\mu(x) = N(x) / N(T)$ is a good estimation of the proportion of recipes containing *x*

- If a => b, cost(a ~> b) = μ(b) - μ(a) (first idea)
- Adaptation cost depends of types of a and b (ingredients, location…)
  - Coefficient K depending on the type of classes a and b
  - Generalisation between different types is forbidden (e.g. oliveoil ~> mediterranean)
  - $K_{ingredient} = 1$
  - $K_{locationt} = 10$

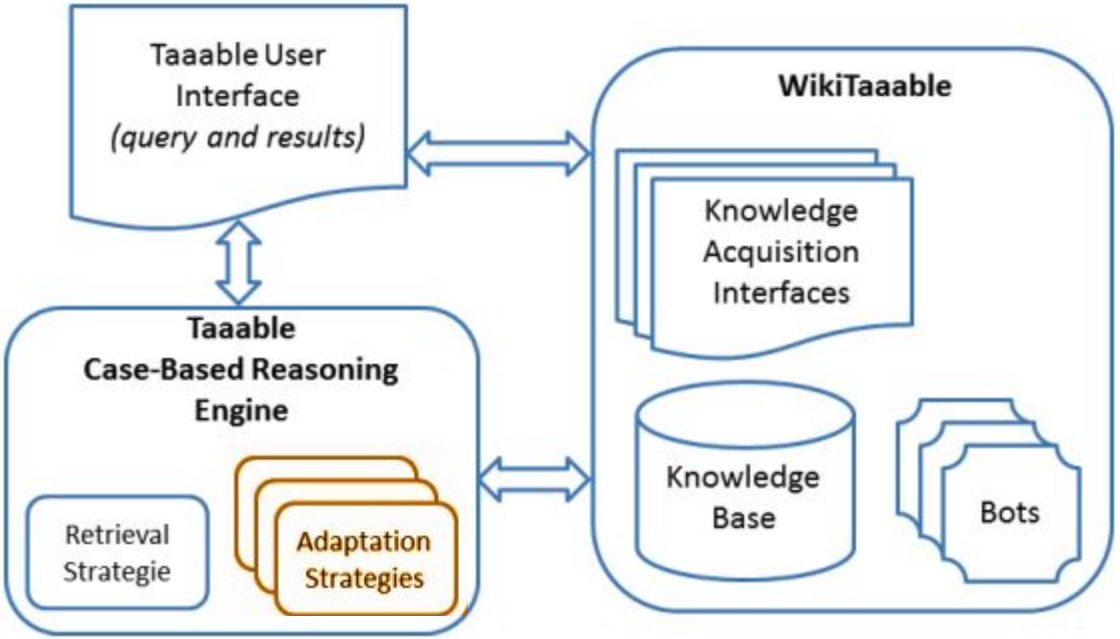
cost(a ~> b) = K (μ(b) - μ(a))

Case Retrieval - Example

Q = escarole ^ lemonjuice ^ ¬onion

- Identity function — Cost 0
- Lemonjuice ~> fruitjuice — Cost 0.7
- Escarole ~> greensalad — Cost 0.8
- Lemonjuice ~> seasoning — Cost 0.9
- Lemonjuice ~> fruitjuice && escarole ~> greensalad — Cost 1.5
- Lemonjuice ~> seasoning && escarole ~> greensalad — Cost 1.7

Case Adaptation



Case Adaptation - Basic Adaptation

- Lettuce ~> green salad
- Vinegar ~> seasoning
- Greensalad ~> escarole
- Seasoning ~> lemonjuice

Lettuce ~> escarole && vinegar ~> lemonjuice

Find a recipe R1 that shares a generalisation valid as a generalisation of Q:
The substitutions that goes from Q to R1 are the adaptation
(Basic adaptation: composition of substitutions)

Case Adaptation - Rule-based Adaptation

Adaptation knowledge in the form of adaptation rules

*“In a given context **C**, some ingredients **F** can be replaced by other ingredients **B**”* e.g. “In a recipe with green salad, vinegar can be replaced by lemon juice and salt”

- greensalad ^ vinegar ~> greensalad ^ lemonjuice ^ salt

  Lettuce ~> escarole && vinegar ~> lemonjuice ^ salt

Case Adaptation - Adaptation of ingredients quantities

- Q = banana ^ ¬chocolate
- `flour ^ milk ^ granulatedsugar ^ egg ^ apple` AND `apple ~> banana`
- Origin Recipe

  $(flour_{cup}=1)\wedge(milk_{cup}=1)\wedge(egg_{u}=4)\wedge(granulatedsugar_{cup}=1)\wedge(apple_{u}=2)\wedge(banana_{g}=0)$
- Conversion of all quantities in grams (e.g. 1 apple = 223g)
- Generalisation of the recipe
  - $(flour_{cup}=1)\wedge(milk_{cup}=1)\wedge(egg_{u}=4)\wedge(granulatedsugar_{cup}=1)\wedge(fruit_{g})$
  - $fruit_{g} = apple_{g} + banana_{g}$
- Constraints
  - No apple in adapted recipe
  - Minimalisation of distance

Case Adaptation - Textual Adaptation

Concept lattice built using formal concept analysis

	Cut	Halve	Remove	Place	Pour	Dot	Cook	Chill	Combine
Fig R1		X		X	X	X	X		
Fig R2	X								X
Mango	X		X	X				X	

We choose the preparation that minimizes the distance with the original ingredients preparation

Knowledge Management

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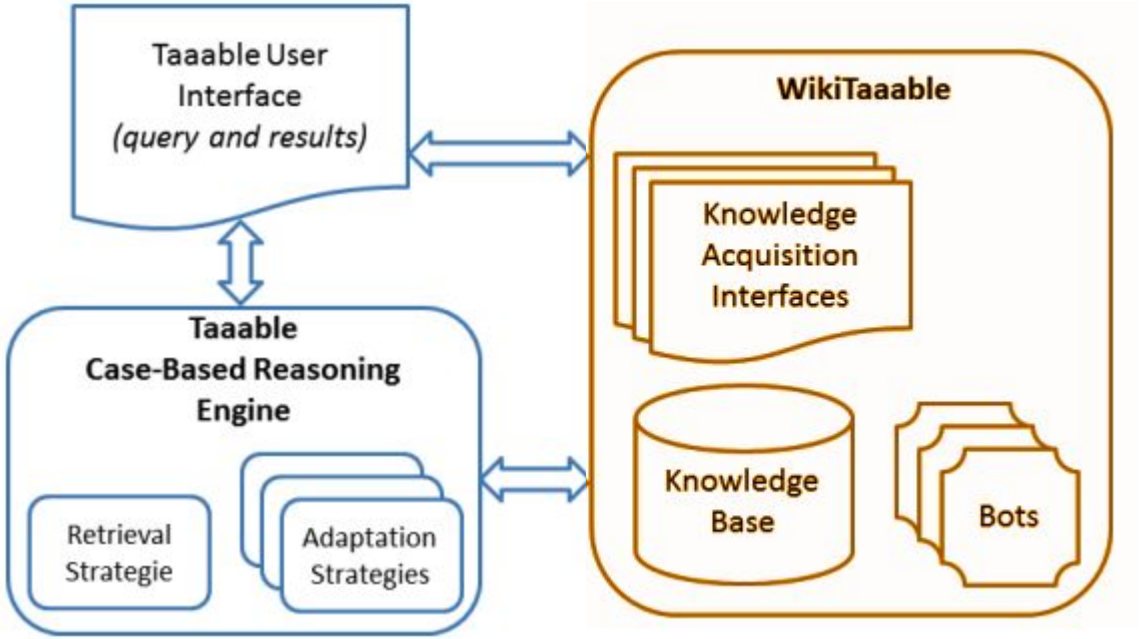
Knowledge Management



Knowledge Management

- Food (*Lemon, Garlic...*)
- Dish types (*PieDish, Salad...*)
- Dish moment (*Snack, Starter, Dessert...*)
- Location (*Mediterranean, ...*)
- Diet (*Vegetarian, NutFree...*)
- Action (*Cut, Peel...*)

Knowledge Management - Food Hierarchy

- From Cook's Thesaurus and Wikipedia
- Association to linguistically preferred form, and lexical variants

  `BokChoy` : bok choy - pak choy, chinese cabbage…
- Semi automatic process for missing ingredients
  - Retrieves ingredient lines not linked to food classes
  - Food class missing in hierarchy
  - Food class exists but lexical variant missing
  - Ingredient line contains an error
- Information automatically collected: description, lexical variants, compatibility with other diets, link to wikipedia page

Knowledge Management - Food Hierarchy

Nutritional Data:

Collected automatically from USDA Nutrient database

Nutritional values

Nutritional value per 100 g (3.5 oz)	
Energy	52 kcal (220 kJ)
Carbohydrates	13.81 g
Sugars	10.39 g
Dietary fiber	2.4 g
Fat	0.17 g
Protein	0.26 g
Water	85.56 g
Vitamin A (equiv.)	3 µg (0%)
Thiamine (Vit. B1)	0.017 mg (1%)
Riboflavin (Vit. B2)	0.026 mg (2%)
Niacin (Vit. B3)	0.091 mg (1%)
Pantothenic acid (Vit. B5)	0.061 mg (1%)
Vitamin B6	0.041 mg (3%)
Folate (Vit. B9)	3 µg (1%)
Vitamin C	4.6 mg (8%)
Calcium	6 mg (1%)
Iron	0.12 mg (1%)
Magnesium	5 mg (1%)
Phosphorus	11 mg (2%)
Potassium	107 mg (2%)
Sodium	1 mg (0%)
Zinc	0.04 mg (0%)

Nutritional data for the ingredient “apple”

Knowledge Management - Dish Type and Dish Origin

- Recipe Source Database
- Dish Origin: 41 classes, 2 levels

  European, Asian - French, German, Spanish...
- Dish Type: 69 classes, 3 levels

  BakedGood, Burger, Dessert - Bagel, Biscuit, Cookie...

Knowledge Management

- Dish moments: 8 classes, 1 level
- Diets: 7 classes, 1 level

- Actions:
  - 449 clases, 5 levels
  - Described by semantic and syntactic properties

Knowledge Management - Adaptation Knowledge

- Adaptation rules: (*context*, *replace*, *with*, *provenance*)
  e.g. (*“Chocolate and Banana Cake”*, *Banana*, *Apple*, *TAAABLE*)
- 4 sources:
  - TAAABLE
  - AK extractor (knowledge added to WikiTaaable)
  - User (editing the wiki)
  - Recipe (e.g. “100g of butter or margarine”)

Knowledge Management - WikiTaaable

Semantic Wiki used to represent, edit and maintain knowledge

- Semantic Media Wiki

  Knowledge encoded as a set of semantic wiki pages
- Import Bots

  Import knowledge once at creation (set given by CC)
- Recipe Annotation Bot

  Parses pages and add annotations and categorisation

  Triggered each time a recipe is added
- Knowledge Acquisition Interfaces

Knowledge Management - Case Acquisition

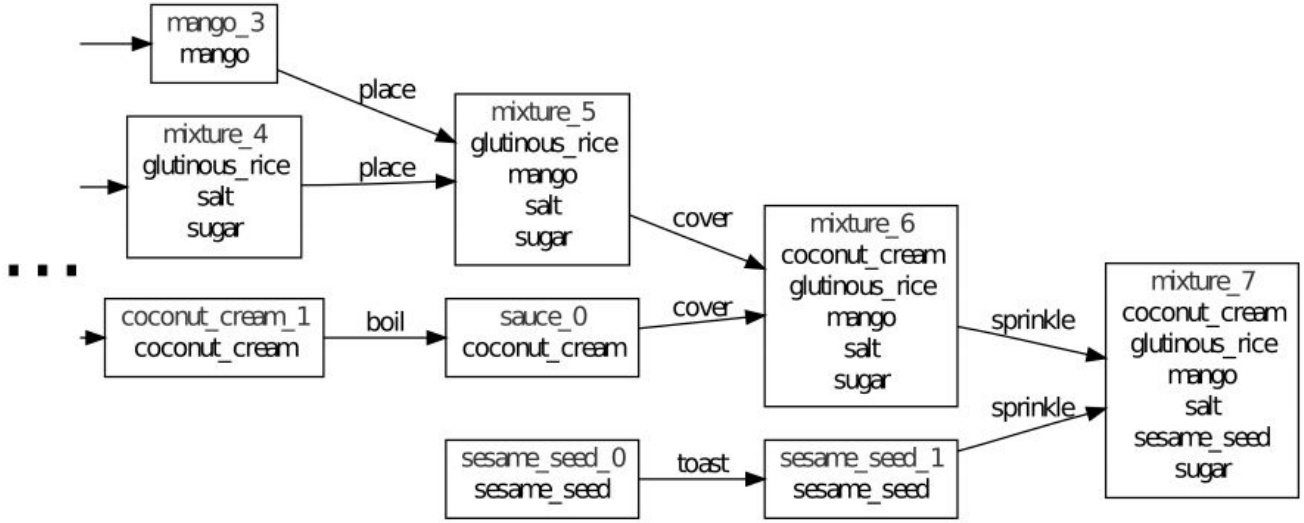
- Ingredient list parsed:

  "*1kg of sliced pak choy*" -> `(1, kg, BokChoi, sliced)`
  - Lexical variants
  - Regular expressions
- Origin and type of dish: from RecipeSource
  - There is a recipe with the same title: origin and type are kept
  - Title of recipe contains keywords corresponding to classes: assigned
  - Data mining of recipe source: set of associations

    <set of ingredients> -> <origin or dish type>

Knowledge Management - Preparation annotation

- Built iteratively verb by verb
- Only the leftmost part of the tree is replaced or used as a replacement



Extract of the representation of “Glutinous rice with mangoes”

Knowledge Management - Adaptation Knowledge Acquisition

- WikiTaaable produces an ingredient substitution
- Asks user about the substitution
  - User is **satisfied**:
    Ingredient adaptation is stored in WikiTaaable as an AK
  - User is **not satisfied**:
    Explanation of failure is identified with user interaction
    User choses a repair strategy
    A new substitution is then proposed

Knowledge Management - Adaptation Knowledge Acquisition

The user selects the problematic substitution A ~> B

- An ingredient x of B requires an ingredient y which is not in the adapted recipe
- An ingredient x of the adapted recipe requires an ingredient y of A which has just been removed
- An ingredient x of B is not compatible with an ingredient y of the adapted recipe.

Knowledge Management - Adaptation Knowledge Acquisition

“apple pancakes” with substitution *apple ~> pear*

- The user selects the substitution apple ~> pear
- Explanation selected: pear is not compatible with cinnamon
  - remove cinnamon
  - find a substitute for cinnamon
- Remove cinnamon
  - New substitution **apple ^ cinnamon ~> pear**
-

Evolutions And Conclusions

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Results

- Vice champion 2008 & 2009
- Adaptation challenge champion 2009
- World champion 2010

Evolutions

- New challenges: salad, sandwich and cocktail
- What’s in the fridge?
  Find / Create a recipe using only a given set of ingredients
- Cocktail names

Evolutions - What’s in the Fridge?

Recipe that matches a user query **according to a set of available food provided by the CCC**

Evolutions - Cocktail names

Mixology challenge: cocktail that matches a user query according to a set of available food provided by the CCC

- “Alcohol abuse is dangerous for health”: Removing alcohol: add “Virgin”
- Default Strategy: “The new”
- Turn constants into variables
  Find explanation for words in the title, draw conclusions from adaptations
  “Green Russian” + MintLiquor ~> Curacao => “Blue Russian”
- Generalization-Specialization of dependencies
  “Green Russian” + MintLiquor ~> IndianTonic
  IndianTonic has properties “sparkling” and “bitter”
  New names suggestions “Sparkling Russian” and “Bitter Russian”

Possible evolutions

- Different viewpoints
  - e.g. avocado: in France mostly starter, in Brazil often dessert
- Utensils?

Use Cases

- Adapt a recipe to a specific diet (gluten-free, vegetarian, etc)
- “Lighten” recipes
- What’s in the fridge?

THANK YOU

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Sources

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  https://hal.inria.fr/hal-01240383/document
- Adaptation of TAAABLE to the CCC'2017 Mixology and Salad Challenges, Adaptation of the Cocktail Names
  http://ceur-ws.org/Vol-2028/paper29.pdf