

# MTECH KE-4102 (ISBA) PROJECT REPORT

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BABY FOOD & TIPS RECOMMENDATION SYSTEM

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## 1.0 EXECUTIVE SUMMARY

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This report outlines the development process of the rule-based **Baby Food & Tips Recommendation System**. It is an intelligent system for mothers with a child between 4 and 24 months to get a recommendation for baby food recipes along with some childcare tips. These recommendations are customized to the condition of the baby and the other preferences of the mother.

First, the report details the **knowledge acquisition and modelling** process. 2 domain experts were interviewed and further knowledge about the domain was obtained from documented sources. The acquired knowledge was then modelled into multiple decision trees to capture the baby food selection process for various baby conditions. These trees include one to check if the baby is ready for the first solid food, another to infer the reasons the child is underweight or overweight and one to check the symptoms and severity of 3 common illnesses which are common cold, constipation and diarrhea. These knowledge are linked up in a dependency diagram to capture all the factors dependencies in deciding what recipes to recommend.

Next, the report details the solution outline which shows the **inference structure diagram**, how the input from the user is processed, the **certainty factors assignment**, the scope and the **high-level architecture of the system**. In particular, the system checks the weight of the child against their age to infer whether the child is underweight, normal weight or overweight. In addition, the system allows the user to indicate if the child has any allergies, checks the symptoms and severity of the illnesses and asks the user for preferences in recipe selection in terms of meal type, preparation time, dietary preferences and preparation complexity. Also, the report details how the certainty factors are used for scoring the recipes and the rationale behind the values assigned.

Currently, the system has 80 recipes in its database and it is a web-based and mobile-friendly system. Some future enhancements and developments include increasing the recipes database from the current 80 recipes, increasing the number of common illnesses covered from the current 3 illnesses and allow for the user to feedback which recipes are suitable for the various conditions and these will be fed back into the system to improve the recommendations.

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## 2.0 PROBLEM DESCRIPTION & PROJECT OBJECTIVE

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### 2.1 PROBLEM DESCRIPTION

“What should I cook today?” is the question that goes into the mother’s mind every day when she has a young child. The mother also does not have the choice to buy takeaway or resort to “fast-food” for the baby, especially when the child is below 24 months old. Time constraint from being a working mother does not allow many mothers to have much time for shopping for food and cooking for the child. This is even more critical when a child is unwell and cranky, where a mother may find that the child does not have much appetite to eat anything at all or even lack the knowledge of what kind of nutritious food should be prepared during this time. Another example would be another mother having a child who is underweight because the child such a picky eater that almost nothing goes into the mouth of the child during meal time.

These situations are not uncommon in our society nowadays as young parents tend to live on their own, away from their older-age parents, thus lack the childcare support from their own parents who are more experienced with childcare. As every situation with a child is different, many times, these mothers find themselves searching the internet for blogs to find if any mothers out there experience the same situation before. Or they may even need to call their own mothers for advice.

Most knowledge about what to cook for certain condition and what to do when a child is sick comes from experience and some motherly instincts that sometimes are not available in documented sources out there. Hence, in this project, we aim to model this knowledge from mothers and provide a baby food and tips recommendation for other new mothers out there needing help.

### 2.2 PROJECT OBJECTIVE

This project aims to:

1. Develop a recommendation system for baby food recipes that a mother can prepare based on the attributes and conditions of the child and preferences of the mother.
2. Model and document the knowledge from mothers on what to cook and how to provide some basic care for a child below 24 months old.
3. Provide a system that is easy to use, web-based and mobile friendly with no installation required that mother can access to anywhere anytime to find baby food recipes and tips recommendation.

The user of the system can expect to:

1. Have a systematic way to get recommendations for recipes for the baby according to the child’s conditions and her own preferences.
2. Obtain some child care tips together with recipes recommendation based on the child’s weight, conditions and other preferences.

### 2.3 TARGET USERS

Our target users are mothers with a child or children between 4 to 24 months old.

### 3.0 KNOWLEDGE MODELING

Our knowledge of the domain comes from 2 sources, namely our domain experts as well as published documented sources.

#### 3.1 DOMAIN EXPERTS

To better understand the domain of baby food preparation and other childcare tips, we have interviewed 2 domain experts who are mothers of young children.

1. Nyon Yan Zheng, 32, a mother of a 3-year old child. She is also our project member.

Interview date: 30 January 2018

Interview time: 7.00 pm

Focus: Recipes selection for the child, food for a child with diarrhea, the importance of menu rotation

2. Maggy Anastasia Suryanto, 33, who is a full-time working mother of a 1-year old child.

Interview date: 1 Feb 2018

Interview time: 8.00 pm

Focus: Food for younger babies, the readiness of a child for solid food, allergies, food for a child with constipation and other common illness.

#### 3.2 KNOWLEDGE FROM DOMAIN EXPERTS

The knowledge that we obtained from both our domain experts are summarized below:

1. The first solid food to feed a child is usually store bought cereal with milk, preferably organic with no sugar added and is high in iron. A mother can check if the child is ready for solid food when the child is between 4 to 6 months old based on the following signs:
  - The child can sit upright independently;
  - Start to pick things up and put in their mouth;
  - Able to swallow and no longer push food out of their mouth;
  - Start to look intently at the food that the adults are eating;
2. Child younger than 4 months old do not take any solid food and depends solely on breast milk or formula milk as their main source of energy.
3. Subsequently, for a child between 6 to 9 months, mothers can prepare pureed food for the child. The first and easiest to prepare purees are such as avocado and banana purees.
4. Phases of child's eating pattern are before 12 months, 12 – 24 months and above 24 months. Before 12 months old, food is all pureed or mashed. After 12 months old, a child can start to eat food in their original form such as rice, mee suah, noodle or baby pasta, fish, chicken.
5. The main considerations when choosing baby food are age-appropriateness, nutritional content, organic (if budget permits), the weight of baby and condition of the baby.
6. Certain foods such as egg white, cow's milk, shellfish, sea fish, dairy, peanut may cause allergies in children under 1-year-old and generally are not recommended to be given to them.
7. Some common illnesses that a child suffers from are common cold, fever, cough and constipation. Other conditions are such as sensitive skin, sensitive nose, teething and asthma.
  - For a child with diarrhea, it is advised to stop giving food that contains lactose as lactose tends to prolong diarrhea.
  - For a child with constipation, mothers can consider giving more fibre, prune juice and ensure that the child drinks a lot of fluid. Food with high iron tends to cause constipation.
  - A child's appetite tends to reduced significantly during fever. During fever, parents can consider feeding plain food such as plain porridge, soup and bread.
8. A child has a tendency to get bored with the same type of food every day. There is a need to vary the food so that they are excited about eating, hence menu rotation is important.

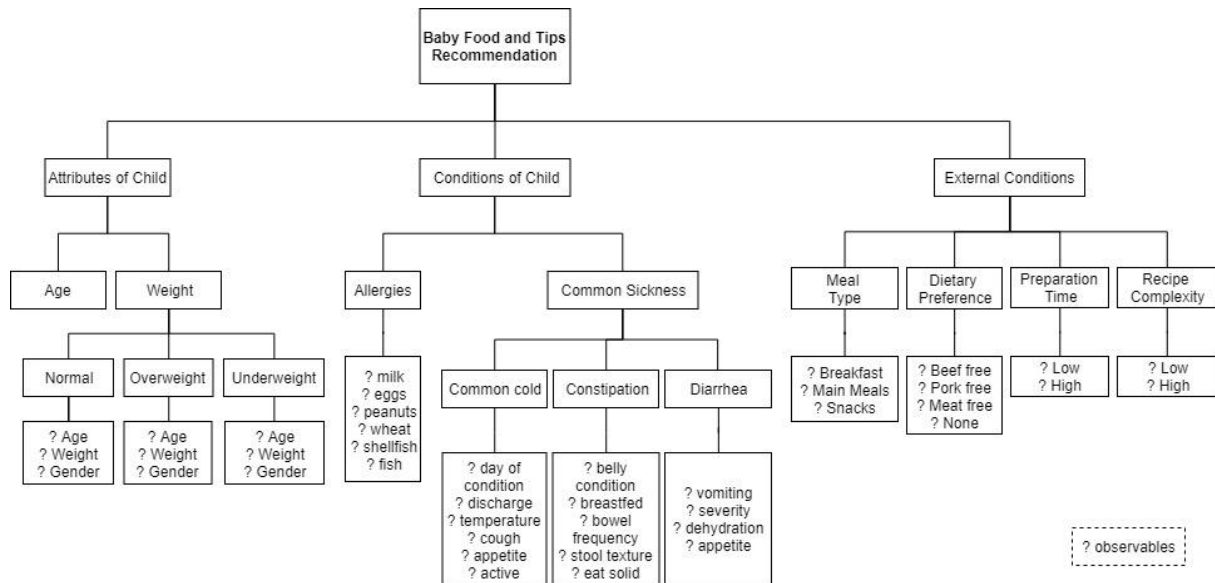
9. It is recommended for mothers with young children, particularly children below 24 months to home cook the child food. Preferably, child's food should not be processed food, no additional sugar and salt added, and wherever possible, not deep fried.

### 3.3 KNOWLEDGE MODELLING

With the knowledge obtained from the domain experts and other documented sources, we have modelled some of the child's conditions in the following decision trees.

#### Dependency Diagram

The following dependency diagram has been drawn up to show all the factors dependent on deciding what type of baby food recipes and tips to recommend to a mother.



The first level nodes in figure above split the decision making into 3 main components:

- a. the attributes of the child – referring to the child's age and weight;
- b. the conditions of the child – referring to the child's well-being;
- c. other external conditions – referring to meal type, dietary preference, preparation time and complexity of recipe.

Underweight and overweight: The decision trees below model the possible reasons why a child is underweight or overweight so that appropriate recipes and tips could be recommended.

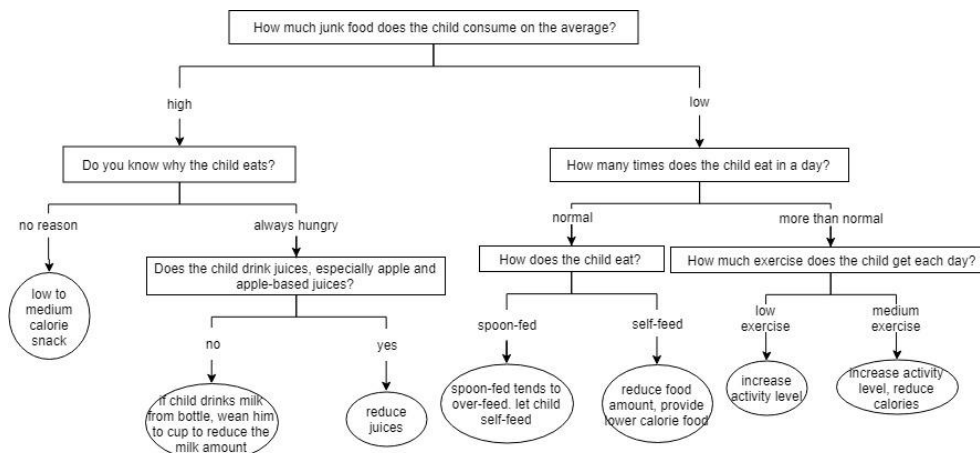


Figure 1: Decision tree to check why a child is overweight

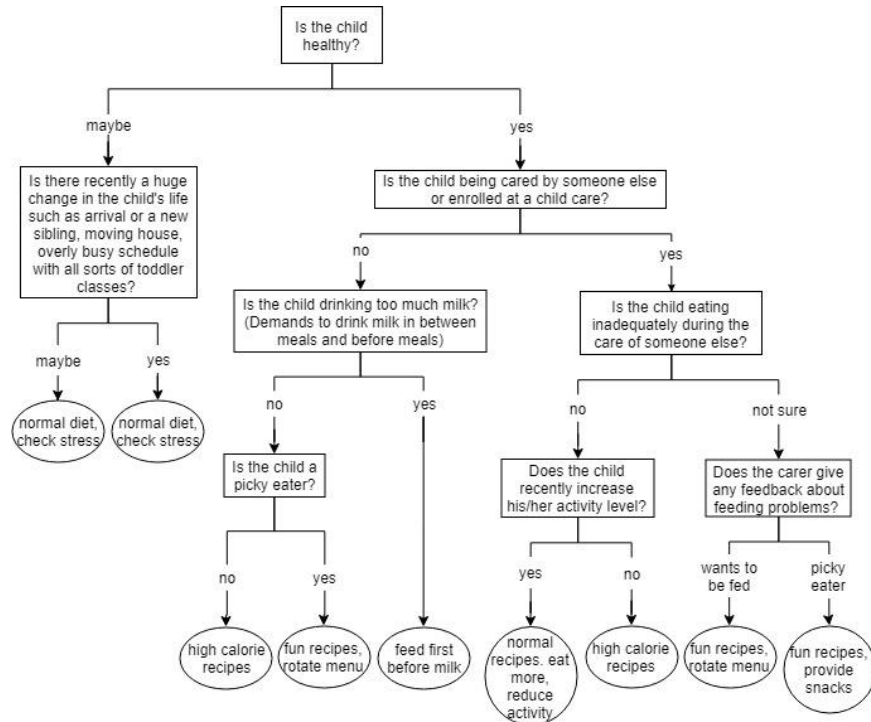


Figure 2: Decision tree to check why a child is underweight

Common cold, constipation and diarrhea: The decision tree models the common illnesses based on the symptoms and severity of the conditions.

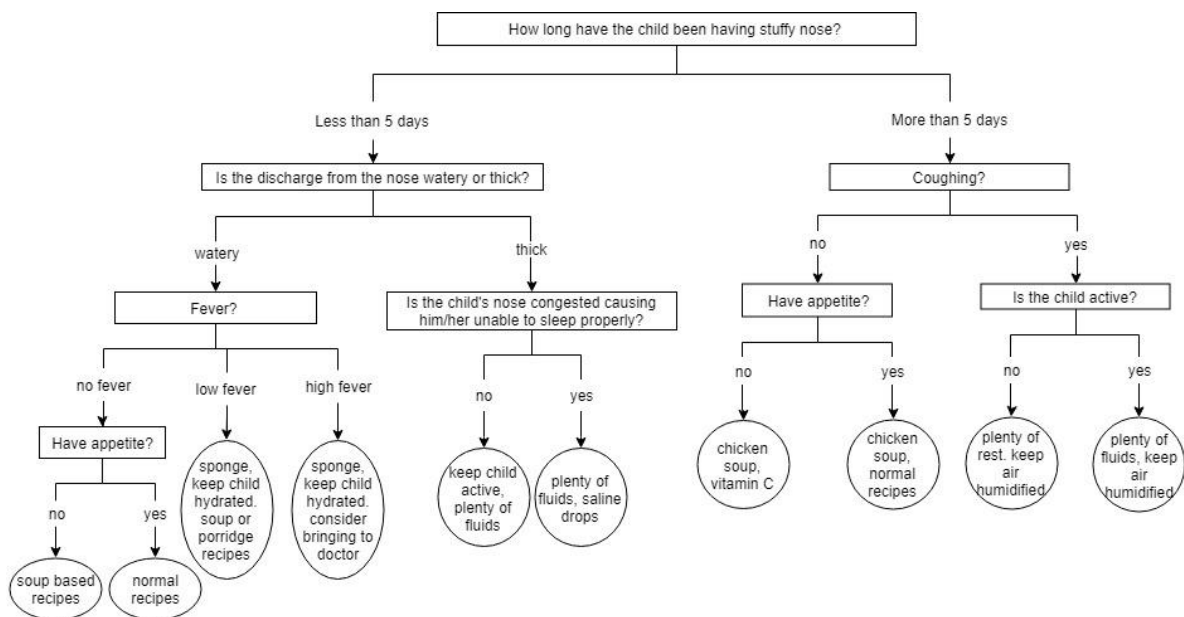


Figure 3: Decision tree to check the symptoms and severity of the common cold

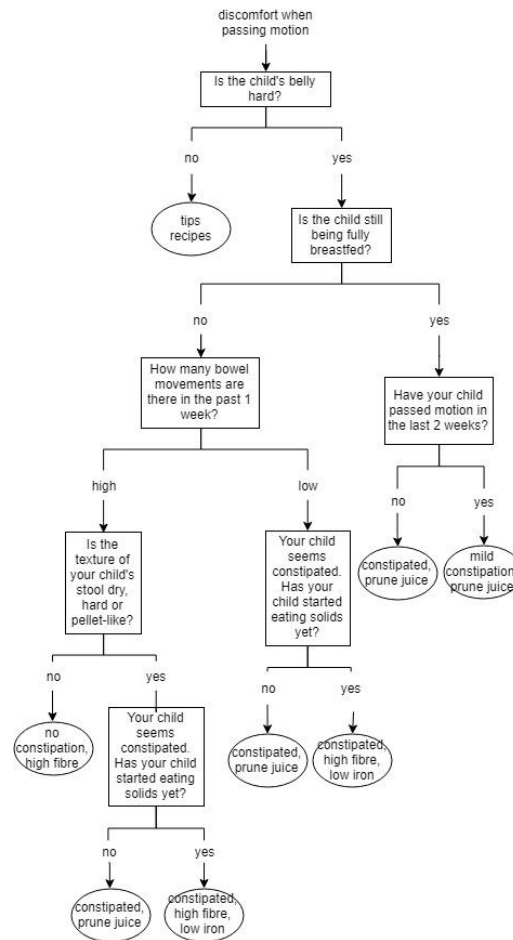


Figure 4: Decision tree to check the symptoms and severity of constipation

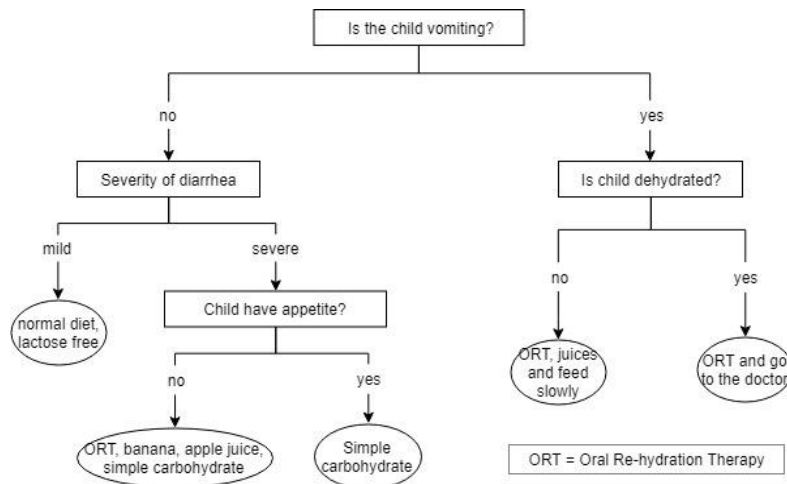


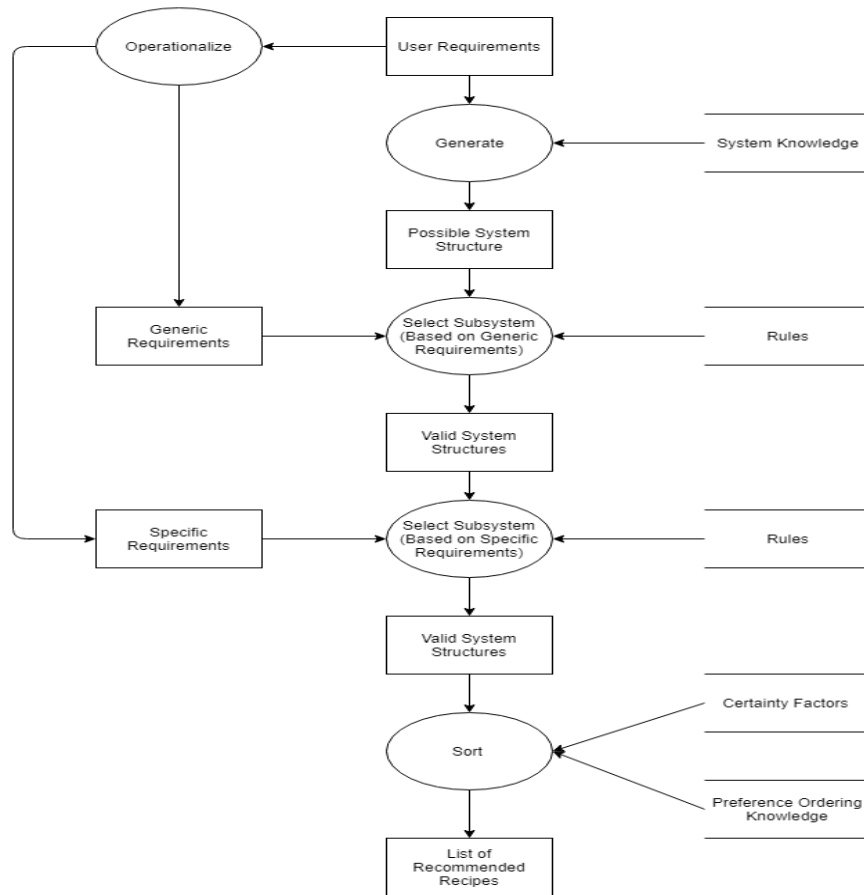
Figure 5: Decision tree to check the symptoms and severity of a child with diarrhea

### 3.4 CONCEPT DICTIONARY

The concept dictionary is provided in Appendix C showing a list of terms that are used in the system with their descriptions.

## 4.0 SOLUTION OUTLINE

### 4.1 INFERENCE STRUCTURE DIAGRAM



#### Control Method for Inference Structure

Operationalize (User Requirements → Generic Requirements + Specific Requirements);

Generate (User Requirements → Possible System Structures)

Select Subsystem (Possible System Structure + Generic Requirements → Valid System Structures);

Select Subsystem (Valid System Structure + Specific Requirements → Valid System Structure);

Sort (Valid System structures → List of Recommended Recipes);

The clips rule-based system has the inference structure as described above. System Knowledge is expressed in the system in form of rules. User Requirements are divided into two parts: Generic Requirements and Specific Requirements. Generic Requirements are requirements such as age, weight, etc., that are required to infer the attributes of child, condition of child and external conditions from the dependency diagram. Specific Requirements are requirements such as whether child has fever, whether child is vomiting, etc., that are required to go deep down the different decision trees. In the end, all possible recipe solutions are sorted on the basis of certainty factors and recipes with higher score of certainty factors are reported as output of the system.

#### Attributes of Child: Age

From the age input, the system will categorise the input into one of the 4 main age groups in table below and assign a certainty factor to the recipes in the age group.

Age Groups	Action
Age < 4 months	Inform user that there is no suitable recommendation and exit the system.
Age [4 months, 6 months]	Proceed to check if the child is ready for solid food, based on the readiness signs.



Age (6 months, 12 months]	Automatically assigns a negative certainty factor to all food that contains all types of allergic food items.
Age > 12 months	Proceed to the next section of the system.

### Attributes of Child: Weight

From the age, weight and gender, the system will check if the child is underweight, normal weight or overweight based on the weight graph from the *Health Booklet by the Health Promotion Board*. The weight graph of a child in this document is a curve function with age.

For a small age range, we find that it is sufficient to assume that the weight is a straight line function of the age. Hence, to simplify the computation in the system, we have derived a formula to determine the child's weight condition for each age group. These formulas assume a straight line function between the weight and age of the child and are shown in tables below.

Weight condition formulas for Boys

(weight = w, age = x)

Age	Underweight	Normal weight	Overweight
[4 months, 6 months]	$(w - 5.1)/x < 0.25$	$(w - 5.1)/x \geq 0.25$ and $(w - 6.5)/x \leq 0.4$	$(w - 6.5)/x > 0.4$
(6 months, 12 months]	$(w - 5.7)/x < 0.20$	$(w - 5.7)/x \geq 0.20$ and $(w - 7.58)/x \leq 0.26$	$(w - 7.58)/x > 0.26$
(12 months, 24 months]	$(w - 5.9)/x < 0.183$	$(w - 5.9)/x \geq 0.183$ and $(w - 7.7)/x \leq 0.25$	$(w - 7.7)/x > 0.25$

Weight condition formulas for Girls

(weight = w, age = x)

Age	Underweight	Normal weight	Overweight
[4 months, 6 months]	$(w - 4.0)/age < 0.35$	$(w - 4.0)/x \geq 0.35$ and $(w - 5.2)/x \leq 0.50$	$(w - 5.2)/age > 0.5$
(6 months, 12 months]	$(w - 5.1)/age < 0.20$	$(w - 5.1)/x \geq 0.20$ and $(w - 6.26)/x \leq 0.32$	$(w - 6.26)/age > 0.32$
(12 months, 24 months]	$(w - 5.3)/age < 0.183$	$(w - 5.3)/x \geq 0.183$ and $(w - 7.7)/x \leq 0.25$	$(w - 7.1)/age > 0.25$

The 10<sup>th</sup> and 90<sup>th</sup> percentile curves for both genders in the *Health Booklet* have been used as the reference to derive the underweight and overweight formulas respectively. This means, if the child's weight is below the 10<sup>th</sup> percentile, we categorise the child as underweight and if it is above the 90<sup>th</sup> percentile, the child is overweight. Otherwise, the child has a normal weight. We have also assumed that height plays a less significant role in determining a child's weight condition, hence, not taken into consideration in the formulas.

Once the system determines the child is underweight or overweight, the system proceeds to go through the decision tree questions related to underweight or overweight to infer the reason the child has such weight condition. The decision trees are shown in Figure 1 and 2 in Section 3.3 above.

For example, an underweight child could be due to him/her being a picky eater and thus, the system will assign a certainty factor to the "fun food" recipes to entice the child to eat more. At the end of each node, a customised childcare tips related to that situation will also be printed together with the recipes.

### Conditions of Child: Allergies

The system also asks for the user to indicate the type of allergies that the child has. We have selected the common allergies that a child usually has and included them in the system. The list of allergic food items is milk, egg, peanuts, wheat, shellfish and fish. Depending on the allergies inputted, the system will assign a large negative certainty factor to all the recipes containing the food item that cause allergies.

### Conditions of Child: Common Sickness

The system prompts the user by asking if the child is feeling well. If the child is unwell, the user will be asked if the child is having any of the following 3 symptoms or conditions:

- stuffy nose and irritated – to infer common cold and proceed to check the symptom and severity according to the decision tree in Figure 3;
- discomfort when passing motion – to infer whether the child has constipation and proceed to check the symptoms to see if the child indeed is constipated based on the decision tree in Figure 4;
- diarrhea – the system proceeds to check the severity of diarrhea based on the decision tree in Figure 5.

## External Condition

Finally, the system asks the user input for other external conditions related to mother's preferences such as meal time, dietary preference, preparation time and preparation complexity.

## 4.2 CERTAINTY FACTORS

To account for the various input combinations in our system, we have assigned certainty factors shown in table below. The **certainty factors are summed linearly** so that each recipe in the database has a final score in terms of relevance to the user input. The recipes with the top 12 highest scores will be printed out as the output.

Variable	CF	Description and example
Age	+20	The CF value is assigned to all recipes that are suitable for the age selected. For example, if the user indicates the child is 9 months old, all recipes that are suitable for that age will be added with +20.
Underweight, normal weight or overweight	+3	The CF value is assigned to all recipes that are suitable for the respective weight conditions. For example, if the system computes that the child is overweight, all low-fat recipes will be added +3.
Sickness	+5	The CF value is assigned to recipes that are suitable for the particular sickness. For example, if the user selects that child is sick with common cold with fever and no appetite, all recipes that are suitable for this condition will be added with +5.
Allergy & Lactose Intolerance	-100	The CF value is assigned to recipes containing the ingredient that may cause allergies and lactose intolerance. For example, if the user selects "nut-free", all recipes containing nuts will be added with -100.
Dietary Preference	-50	The CF value is assigned to recipes that do not meet the dietary preference. For example, if the user selects "pork-free", all recipes containing pork will be added with -50.
Meal Type	+3	The CF value is assigned to all recipes that are suitable for the meal type selected. For example, if the user selects "breakfast", all breakfast recipes will be added with +3.
Preparation Time	+1	The CF value is assigned to all recipes that meet the preparation time selected by the user. For example, if the user selects "low" preparation time, all recipes that require less than 15 minutes to prepare will be added with +1.
Preparation Complexity	+1	The CF value is assigned to all recipes that meet the preparation complexity selected by the user. For example, if the user selects "low" complexity, all recipes that only require basic cooking skills will be added with +1.
Other selected nodes	+3	These are added only at selected nodes for special conditions such as if the system concludes that the child is a "picky eater" and there is a need to recommend "fun recipes", we assign this +3 value to relevant recipes that meet this condition.

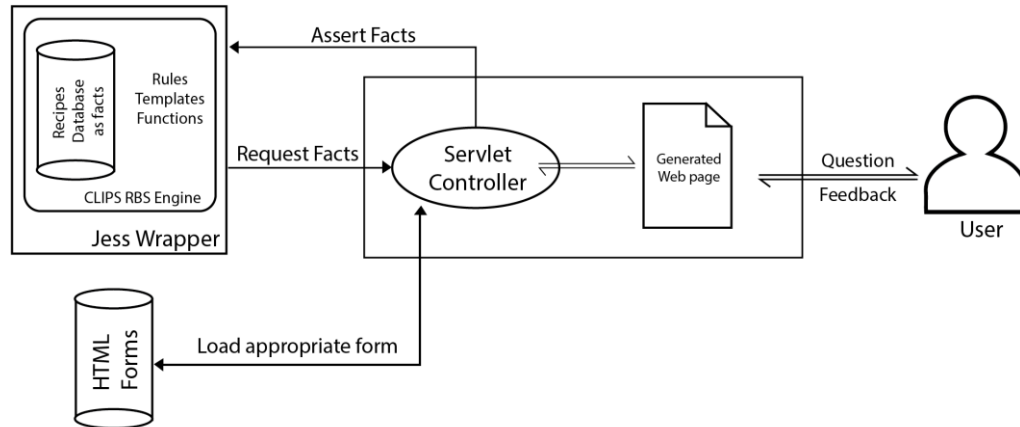
### The rationale for assigning the current levels of certainty factors

- We assign a large negative value to the allergy and lactose intolerance conditions because these are serious conditions that require "elimination" of the recipes containing the allergic food items. Hence, we want these recipes to rank the lowest in the list.
- Similarly, dietary preference such as "beef-free", "pork-free", "meat-free" are given high priority in recipes elimination, thus given a high negative score.
- A recipe that is age-appropriate is also highly important as young babies will not be able to consume older child's food. Hence, we have chosen to add +20 to recipes that meet the age criteria. With this in place, all recipes suitable for that particular age group will be given a high priority in the database.
- A larger positive figure is added to recipes that meet the sickness condition as compared to the weight condition because illness condition should take precedence over weight conditions.
- For preparation time and complexity, only +1 is added each to ensure that when both of these conditions are added up, the resulting certainty factor would not exceed those from illness or weight conditions.
- Lastly, the CF value that we have chosen for age appropriateness recipe is high enough such even when all the CF factors added from the weight condition, illness, preparation time, complexity and any special condition, will not exceed 20, such that none of these factors will take precedence of the age factor.

### 4.3 SCOPE OF SYSTEM

The system only caters for a child or children from age 4 to 24 months who do not have serious illnesses or chronic conditions. The system is unable to provide medical advice to chronic illnesses.

### 4.4 HIGH-LEVEL ARCHITECTURE OF THE SOLUTION



For each web browser session

The Java-based web application uses Jess as RBS engine backend, Java servlets as controller and HTML/JSP as views. Each web browser session is granted a session-local Jess runtime instance. Once initiated Jess runtime requests the servlet for a fact. If there are no more facts required, the recommendation page is displayed. The servlets load the corresponding HTML form and display it to the user. The user fills the form and posts it back to the servlet. The servlet converts the input into a fact and asserts it to the runtime instance, and waits for it to respond. If the instances does not responds, servlet assumes that no more fact are required and loads the recommendation page using the current recipes in working memory of the runtime instance.

### 4.5 SIGNIFICANT AND UNIQUE FEATURES

The system has the following significant and unique features:

- For babies between 4 to 6 months where the mother wants to start giving solid food but not sure if the child is ready for solid food, the system will bring the user through the steps to check if the child shows all the signs that he/she is ready for solid food;
- There is a collection of 80 recipes in our system, each being classified into the appropriate age categories, suitability for feeding during the 3 common illnesses, suitability for weight conditions by their calories content, existence of any contents that may cause allergies, meal type, dietary preference, preparation time and complexity to prepare the food;
- Besides the food recommendation, the system also provides tips for under and overweight child by inferring the possible reasons why the child may be under or overweight.
- The system also checks for symptoms and severity of the common illness and provides the appropriate advice and tips to the mother.
- The system provides not just 1 recipe recommendation, but a list of 12 recipes that have the best match in the entire database.
- The system is web-based and mobile friendly and no installation is required.

### 4.6 LIMITATIONS

- Currently, the system only includes 3 common child illnesses: common cold, constipation and diarrhea.
- The system also does not consider the child's preferences for food, such as the child's like and dislikes for certain food item.

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## 5.0 CONCLUSION & REFERENCES

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### 5.1 LEARNING

- a. Understanding of forward chaining rules-based system

Through the project, we have gained a thorough understanding of the forward chaining rule-based system and rule-based programming through the CLIPS shell. From this exercise, we had a chance to go through the development cycle of an expert system from the knowledge acquisition and modelling, task and design modelling, coding and development, verification and validation.

- b. Understanding of domain and requirements engineering

We learned that we need to have a good understanding of the domain that we are working on in order to model the knowledge acquired. We also faced challenges while conducting interviews with the domain expert and acknowledged that interview questions design is important in order to effectively extract relevant and useful knowledge from them. We recognized that knowledge acquisition and modelling have been a challenging but crucial process in this project.

- c. CLIPS programming and user interface

After which, we also had to learn the CLIPS language from scratch to be able to transform the knowledge into codes and program and finally, we had to squeeze our creativity while designing the user interface.

- d. Teamwork and friendships

Lastly, we also appreciate the opportunity to work with project mates from various nationalities and professional background. We tapped on each other's strengths and cover one's weaknesses, tolerated with each other's habits, at the same time build strong friendship bonds and had lots of fun while working on the project.

### 5.2 IMPROVEMENT AND ENHANCEMENT TO THE SYSTEM

There is huge potential for further improvement and enhancement of the current system and these are including, but not limited to:

- a. increasing the food recipes database from the current 80 recipes;
- b. capturing more child's conditions and child care tips;
- c. allowing the user to feedback which recipes are suitable for the different kinds of conditions and the certainty factors will be adjusted accordingly.

### 5.3 REFERENCES

Heidi Murkoff, Sharon Mazel, *What to Expect the Toddler Years 2<sup>nd</sup> Edition*, Chapter 18 & 20 (Simon & Schuster, 2009).

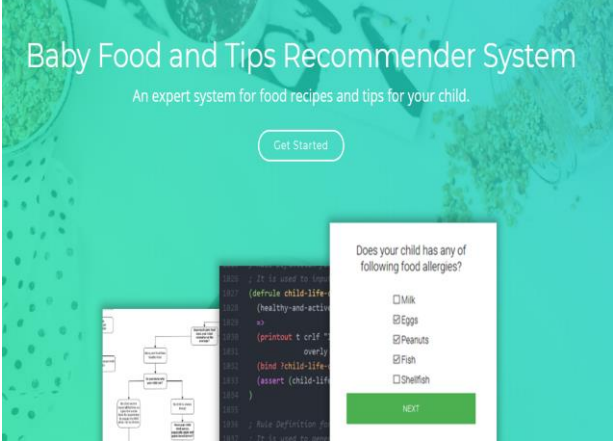

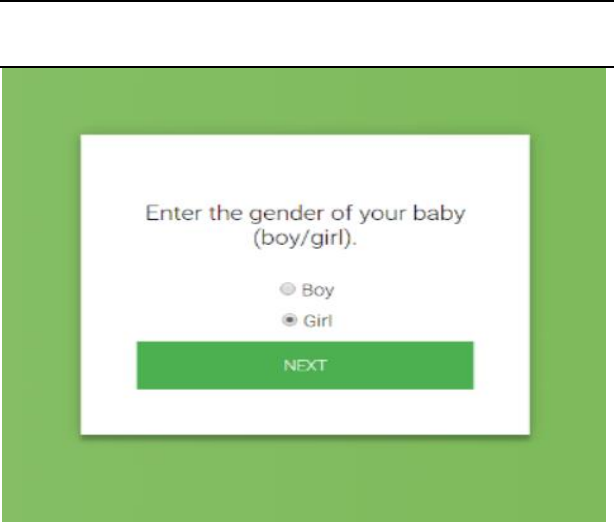
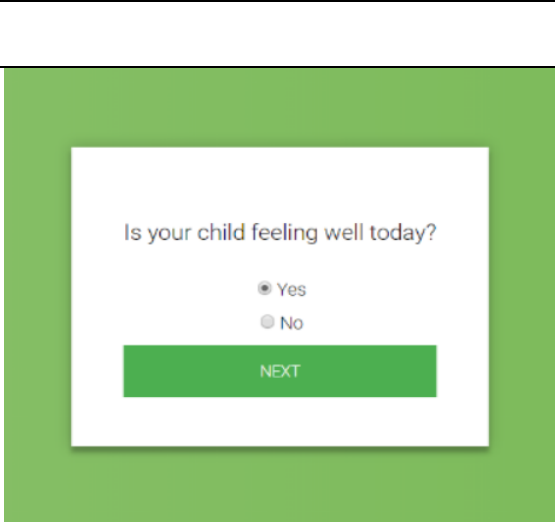
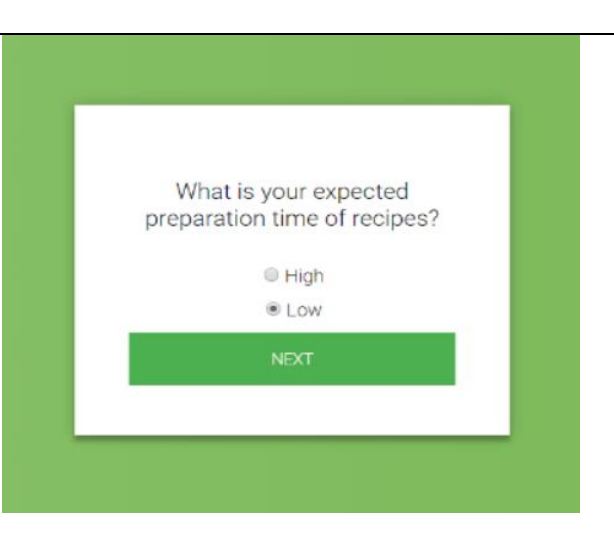
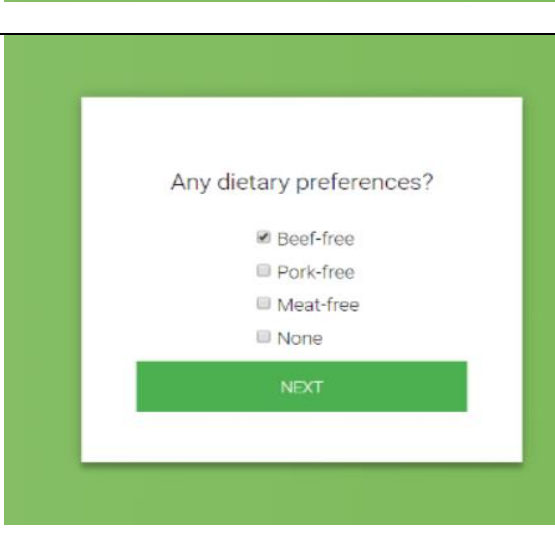
Annabel Karmel, Recipes, Baby Food, Books & Products for Baby and Children, assessed February 28, 2018, <https://www.annabelkarmel.com/>.

Health Booklet, Health Promotion Board, Ministry of Health, page 30 and 31, downloaded on February 28, 2018, <https://www.healthhub.sg/sites/assets/Assets/Programs/screening/pdf/health-booklet-2014.pdf>.

## APPENDIX A: SAMPLE INPUT & SYSTEM OUTPUT

### Sample Input and Output Screen Captures

The following are sample screen captures that follow the Case 1: Standard Case of execution, which is mentioned below.

<p>What is the complexity of recipes your are expecting?</p> <p> <input type="radio"/> High  <input checked="" type="radio"/> Low         </p> <p>NEXT</p>	<p>What kind of meal type are you looking for?</p> <p> <input type="checkbox"/> Breakfast  <input checked="" type="checkbox"/> Main  <input checked="" type="checkbox"/> Snacks         </p> <p>NEXT</p>
<p>Enter the weight of your baby.</p> <p>7.3</p> <p>NEXT</p>	<p>Is your child healthy and active?</p> <p>I believe so. My child is just a little timid. I think he/she is just shy. (Maybe)</p> <p>My child is just a little skinny. Otherwise she is quite healthy. (Yes)</p> <p> <input type="radio"/> Maybe  <input checked="" type="radio"/> Yes         </p> <p>NEXT</p>
<p>Is your child being cared by someone else or enrolled at the child care?</p> <p> <input checked="" type="radio"/> Yes  <input type="radio"/> No         </p> <p>NEXT</p>	<p>Is your child eating inadequately during the care of someone else?</p> <p>My carer says my child always finishes his/her food.(No)</p> <p>I am not sure.(Maybe)</p> <p> <input type="radio"/> No  <input checked="" type="radio"/> Maybe         </p> <p>NEXT</p>

Does your carer give you any feedback about feeding problems?

(Does not eat) Carer feedback that my child does not want to eat if not fed

(Wants junk food) Carer feedback that my child is a picky eater and only wants to eat junk foods

☒ Does not eat  
☐ Wants junk food

NEXT

Does your child has any food allergies?

☒ Yes  
☐ No


NEXT

Does your child has any of following food allergies?


☐ Milk  
☐ Eggs  
☒ Peanuts  
☐ Fish  
☒ Shellfish

NEXT


Recipe Recommendations




[Pasta with Veggi Sauce](#)




[Polenta Fries and Ketchup](#)




[Peanut Butter Banana Roll Up](#)



[Asparagus and Gruyere Pizza](#)




[Apple & Pear with Cinnamon Puree](#)




[Cheese & Cherry Tomato Muffins](#)




[Sweet Pork & Apple](#)




[Prune Juice](#)



[Apple Juice](#)



[Peach Juice](#)



[White Grape Juice](#)



[Pancakes](#)

Tips

"Your child is underweight. Try to make food fun because for many child, eating can be something of a bore. Try adding a pinch of merriment the next time you prepare your food such as cutting the food into intriguing shapes, or sculp a dish with decorations, or cut food into tiny squares, create some sauce and dip food."

Follow the steps below and insert input as per the table below.

#### CASE 1: STANDARD CASE

Question	Input Type	Input Value
What is the age of your child?	Text	13
Enter the gender of your baby	Radio Button	Girl
Is your child feeling well today?	Radio Button	Yes
What is your expected preparation time of recipes?	Radio Button	Low
Any dietary preferences?	Checkboxes	Beef-free
What is the complexity of recipes your are expecting?	Radio Button	Low
What kind of meal type are you looking for?	Checkboxes	Main, Snacks
Enter the weight of your baby.	Text	7.3



Is your child healthy and active?	Radio Button	Yes
Is your child being cared by someone else or enrolled at the child care?	Radio Button	Yes
Is your child eating inadequately during the care of someone else?	Radio Button	Maybe
Does your carer give you any feedback about feeding problems?	Radio Button	Does not eat
Does your child has any food allergies?	Radio Button	Yes
Does your child has any of following food allergies?	Checkboxes	Peanuts, Shellfish

Output	
<b>Recommendation</b>	Pasta with Veggie Sauce, Polenta Fries and Ketchup, Peanut Butter Banana Roll Up, Asparagus and Gruyere Pizza, Apple & Pear with Cinnamon Puree, Cheese & Cherry Tomato Muffins, Sweet Pork & Apple, Prune Juice, Apple Juice, Peach Juice, White Grape Juice, Pancakes
<b>Tips</b>	"Your child is underweight. Try to make food fun because for many child, eating can be something of a bore. Try adding a pinch of merriment the next time you prepare your food such as cutting the food into intriguing shapes, or sculpt a dish with decorations, or cut food into tiny squares, create some sauce and dip food."

## CASE 2: CHALLENGING CASE

Question	Input Type	Input Value
What is the age of your child?	Text	9
Enter the gender of your baby	Radio Button	Boy
Is your child feeling well today?	Radio Button	No
Select those which describe the condition of your child?	Checkboxes	Child is irritated and his/her nose is stuffy, Child is having diarrhea
How long has your child been experiencing these symptoms of common cold?	Text	2
Is the discharge from the nose watery or thick?	Radio Button	Watery
What is your child's temperature?	Text	37.3
Is your child vomiting?	Radio Button	No
Watery bowel movements every 2 hours or more often?	Radio Button	Yes
Does your child have appetite?	Radio Button	Yes
What is your expected preparation time of recipes?	Radio Button	High
What kind of meal type are you looking for?	Checkboxes	Main
Any dietary preferences?	Checkboxes	None
What is the complexity of recipes you are expecting?	Radio Button	High
Enter the weight of your baby.	Text	10.1
How much junk food does your child consume on an average?	Radio Button	Low
How many times does your child eat in a day?	Radio Button	Normal
How does your toddler eat? Does he/she eat on its own?	Radio Button	No

Output
--------



Recommendation	Chicken Avocado Pasta, Braised Beef with Sweet Potato Puree, Minced Beef with Kale & Butternut Squash, Mushroom Cabbage and Rice Soup, Beans Pork Peppers, Chicken Congee, Apple-Walnut Baby Puree, Curry Green Leaf Soup, Chicken Soup, Carrot Soup, Lemon Honey and Garlic Soup, Thai Ginger Soup
Tips	<p>"We recommended to give your child ORT (Oral Rehydration Therapy) using a commercially available electrolyte solution for 24 to 48 hours, followed by a bland diet. Increase fluid intake (at least 75ml an hour, while the child is awake)."</p> <p>"Your child is overweight. Children who are still being spoon-fed often consume more than they want or need. Give your child plenty of opportunity to self-feed and when he/she loses interest in the meal, end it."</p>

### CASE 3

Question	Input Type	Input Value
What is the age of your child?	Text	6
Has the baby started eating solids?	Radio Button	No
Would you like to start giving solid food to your baby?	Radio Button	Yes
Can your baby sit up well without support and has good head control?	Radio Button	Yes
Has your baby lost the tongue-thrust reflex and does not automatically push solids out of his/her mouth with his/her tongue?	Radio Button	Yes
Is your baby eager to participate in mealtime and tries to grab food and put it in his/her mouth?	Radio Button	Yes
Is your child feeling well today?	Radio Button	No
Select those which describe the condition of your child?	Checkboxes	Child shows some sign of discomfort when passing motion.
Is the child's belly hard?	Radio Button	Yes
Is the child still being fully breastfed?	Radio Button	No
How many bowel movements are there in the past week?	Radio Button	More than or equal to 3 times.
Is the texture of your child's stool dry, hard or pellet-like?	Radio Button	Yes

Output	
Recommendation	Prune Juice, Carrot Puree, Broccoli Puree, Pear Puree, Apple Puree, Spinach Puree, Squash Puree, Mango Puree, Banana Puree, Cauliflower Puree, Pea Puree, Blueberry Puree
Tips	<p>"It seems like your baby is ready for solids. Try giving him rice cereal as a start."</p> <p>"Your child seems constipated. Be sure that your child is drinking sufficient fluids. We also recommend prune juice to help with it. Daubing a bit of petroleum jelly at the anal opening may help the movement slip out more easily."</p>

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## APPENDIX B: USERS MANUAL

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### General Information

#### System Overview

An intelligent rule-based recommendation system for a parent to help them decide a recipe for

- A web application recommendation system
- Supports all major web browsers: Firefox, Safari, Chrome
- Interaction with the user is done using web forms
- Recommends food recipes and tips for babies

#### Authorized Use Permission

This is an academic project for course KE4102 ISBA by M.Tech KE Students of NUS ISS. It should not be used for commercial purposes. Any software used in this system is either open source (like CLIPS) or trial version of commercial software (such as JESS).

The information of the user and the baby taken during the execution of the system is used only for recommending recipes and tips for the baby. The system doesn't store any of the user's information for any future use. Once the user exits the system, all the information stored about the user or characteristics of the baby is destroyed as the session is closed on the web application.

For the recommendation of recipes, we provide the user with a list of recipes with recipe names and image. For detailed description of the recipe, the user can click on the link over the recipe name. Once clicked, user is directed to a new tab containing the detailed description of the recipe. The contents of the description of the recipe are not part of our system and refer to independent websites.

Please take note that the system only caters for child from age 4 to 24 months who does not have serious illnesses or chronic conditions. The system is unable to provide medical advice to chronic illnesses.

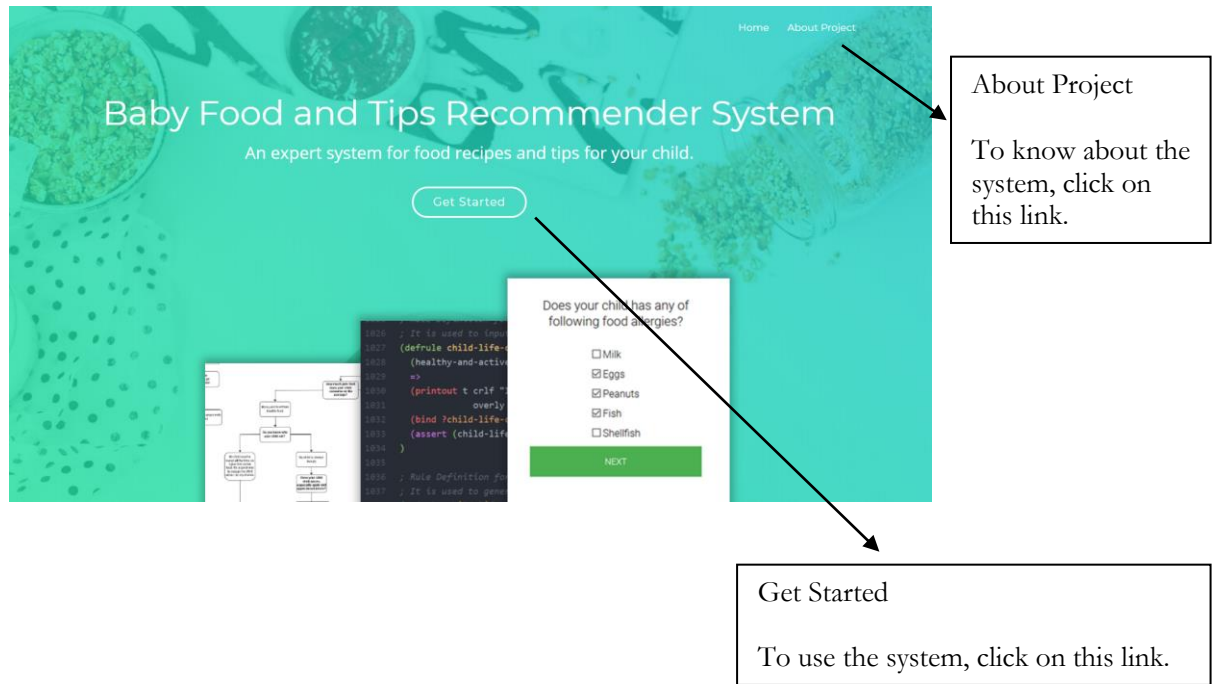
#### User Access Levels

Any user can access the system as the system doesn't require any login authentication.

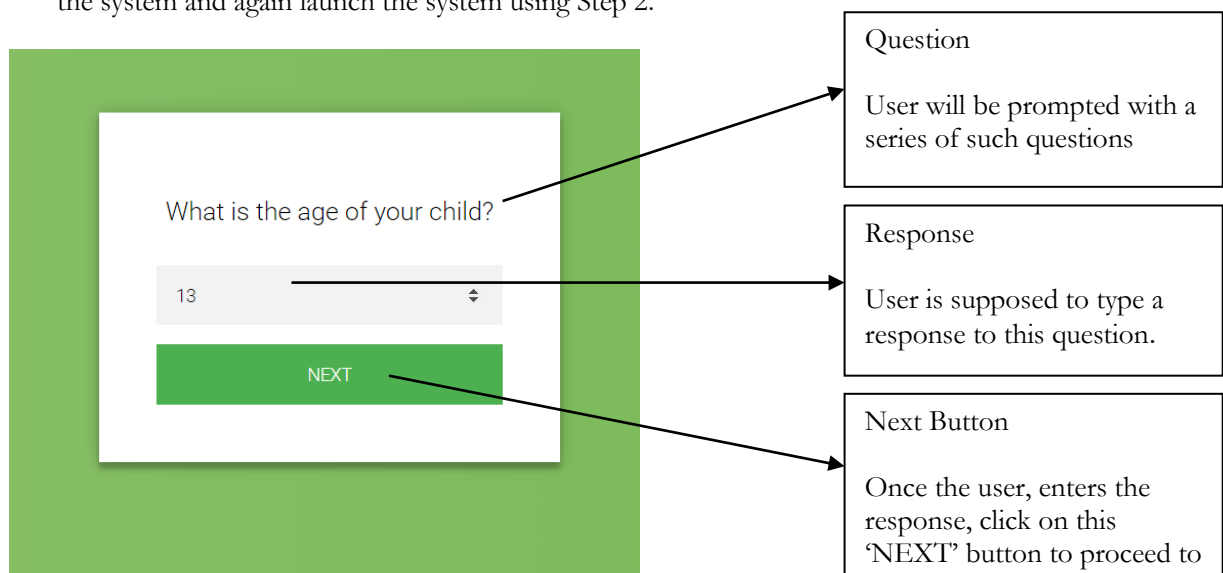
### Getting Started

#### How to use the system?

- 1) Make sure that the device (laptop/personal computer/mobile) has an internet connection.
- 2) Open a web browser, can be any of the popular web browsers, Chrome, Firefox, Safari etc.
- 3) Enter this URL in the address bar: **foodnplay.herokuapp.com**
- 4) Once the web page gets loaded, you should be able to view the home page of the system.



- 5) To know more about the project, click on 'About Project'.
- 6) To get started using the system, click on 'Get Started'.
- 7) The user will be asked a series of questions before recommending any recipe for the baby. Each question is on a new web page. Once the user enters the response to the question, click on the 'NEXT' button, to proceed to next web page.
- 8) The user can't go back to edit its previous response using the back button of the browser. This will break the web application. If the user wanted to edit some previous response, then the user should exit the system and again launch the system using Step 2.



- 9) Different questions have different input types to interact with the user. There are three different input types used in the system, text input, radio button and checkboxes.

- a. Text Input: User needs to type a response using the keyboard.

- b. Radio Button: User can select only one of the given list of options. To select a given option, click the radio button corresponding to that option. To change the selection, click the radio button corresponding to that option.
- c. Checkboxes: User can select multiple options from the given list of options. To select a given option, click on the checkbox corresponding to that option. To unselect a given option, click on the checked checkbox corresponding to that option.

What is the age of your child?

13

NEXT

Text Input

Type your response here

Does your child has any food allergies?

☒ Yes

☐ No

NEXT

Radio Button

Select any one of the choices. The presence of black dot, indicates the current selection

Does your child has any of following food allergies?

☐ Milk

☐ Eggs

☒ Peanuts

☐ Fish

☒ Shellfish

NEXT

Checkboxes

Select multiple responses form the given list of choices. The check in the checkbox indicates the current selections

- 10) Once the required user information is gathered by the system, the recommendation recipes and tips are displayed.

Recipe Recommendations

 <a href="#"><u>Apple &amp; Pear with Cinnamon Puree</u></a>	 <a href="#"><u>Sweet Pork &amp; Apple</u></a>	 <a href="#"><u>Pasta with Veggi Sauce</u></a>	 <a href="#"><u>Polenta Fries and Ketchup</u></a>
 Prune Juice	 Apple Juice	 Peach Juice	 White Grape Juice
 <a href="#"><u>Pancakes</u></a>	 <a href="#"><u>Peanut Butter Banana Roll Up</u></a>	 Orange Juice	 Papaya Juice

Click on this link to get a detailed description about the recipe

Tips

No advise for your baby. Your child seems to be living a healthy life.

- 11) To get a detailed description of the preparation of given recipe, click on the link associated with the recipe name. The user will be directed to a new tab displaying a detailed description of the recipe.
- 12) For simple recipes, such as puree and juices, there is no link associated with the recipe name. If the user wants to know more about such recipes, then the user needs to search themselves.
- 13) Once the user is satisfied with the recommended recipes, the user should exit the system.

### How to exit the system?

To exit the system at any point, the user needs to close the browser window in which the web application was opened.

### How to reuse the system?

The web application stores no information about the user for future use. So, if a user wants to reuse the system in future, they have to enter all the details once again. If the user wants to reuse the system due to some error in the previous execution of the system, the user should first close the browser window of previous erroneous execution of system and start the execution in a new browser window.

## Error Messages

- 1) 500 Internal Server Error: This error occurs when a user tries to open the web application in two windows of the same browsers or when the previous application is executing and the user starts a new execution of application without exiting the previous execution of the application.

### HTTP Status 500 – Internal Server Error

**Type** Exception Report

**Message** null

**Description** The server encountered an unexpected condition that prevented it from fulfilling the request.

**Exception**

```
java.lang.NumberFormatException: null
    java.lang.Integer.parseInt(Integer.java:542)
    java.lang.Integer.parseInt(Integer.java:615)
    jesstry.engine.input.AgeInput$1.get(AgeInput.java:17)
    jesstry.controller.ClipsServlet.doGet(ClipsServlet.java:63)
    javax.servlet.http.HttpServlet.service(HttpServlet.java:635)
    javax.servlet.http.HttpServlet.service(HttpServlet.java:742)
```

**Note** The full stack trace of the root cause is available in the server logs.

Apache Tomcat/8.5.23

## APPENDIX C: CONCEPT DICTIONARY

Term	Description
Baby or child	Baby or child is used interchangeably to refer to any child under age of 24 months for which the recommendation system is designed
Baby food	Any recipe fit for baby to consume
Recommended Baby Food	Baby food recommended by our system. Typically, a set of recipes recommended to the mother based on input parameters and statistical findings
Food item	An individual edible item like chicken chunks, carrot
Recipe	A dish comprising <i>food item(s)</i> with an associated procedure explaining preparation steps.
Preparation complexity	Used to describe how complex/easy the recipe is to follow
Preparation time	Describes time taken to prepare the recipe.
Food Allergy	A condition of showing allergic symptoms to specific kind of food item
Allergic food item	A food item triggering a food allergy
Lactose Intolerance	The inability of a baby to digest lactose enzyme causing symptoms such as abdominal gas, diarrhea or abdominal cramps, often temporary.
Milk allergy	An allergic reaction is triggered when exposed to cow milk-based formulas
Eggs allergy	An allergic reaction is triggered when exposed to egg-based baby food items. Mostly due to proteins present in the egg.
Peanuts allergy	An allergic reaction is triggered when food item containing peanut is consumed.
Fish allergy	Allergic to consumption of fish like tuna, salmon.
Shellfish allergy	Allergic to consumption of shellfish like lobsters, clams, shrimp, crab.
Wheat allergy	Allergic to consumption of food items made from wheat. Triggered mostly due to the presence of Gluten, a type of wheat protein.
Commercial baby food	Food items which are ready to be consumed directly or with some minor preparation like infant cereals
Porridge	Porridge is a food made by boiling ground, crushed or chopped starchy plants—typically grain—in water or milk
Puree	A purée is cooked food, usually, vegetables or legumes that have been ground, pressed, blended or sieved to the consistency of a creamy paste or liquid
Picky Eater	A set containing food items which are disliked by the baby. Not to be confused with an allergic food item
Underweight	A child having a weight below the 10 <sup>th</sup> percentile
Overweight	A child having a weight above the 90 <sup>th</sup> percentile
Liquid food item	A baby food with a liquid base like soups
Solid food item	Solid food chunks