From Food to Wellness

The Tangle of Knowledge Graph and Artificial Intelligence

Ming Zhaoyan 明朝燕
National University of Singapore
1. Motivations: the rise and rise of chronic diseases

2. Current App and Platform
   - DietLens personal lifestyle AI assistant app
   - DietShare food and nutrition social network
   - DietMed Lifestyle factor medical research platform

3. Knowledge and Food Recognition

4. Future Work: Scale up from Singapore
Motivations: the rise and rise of chronic diseases
The Cost of Diabetes in Singapore

Poor control of diabetes can lead to serious complications:

- **2 in 5** stroke victims were diabetic
- **1 in 2** heart attack victims were diabetic
- **2 in 3** new kidney failure cases were diabetes-related

The impact of diabetes on healthcare costs and productivity losses is set to increase:

- **2010**: $1.02 billion
- **2050**: $2.5 billion
The Excess Lifetime Cost of Diabetes

Diabetes Lifetime Medical Cost

<table>
<thead>
<tr>
<th>Age Diagnosed</th>
<th>USD Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>211,400</td>
</tr>
<tr>
<td>50</td>
<td>135,600</td>
</tr>
<tr>
<td>60</td>
<td>70,200</td>
</tr>
<tr>
<td>65</td>
<td>43,900</td>
</tr>
</tbody>
</table>

The Lifetime Cost of Diabetes and Its Implications for Diabetes Prevention. Xiaohui Zhuo, etc. Diabetes Care 2014 Sep; 37(9): 2557-2564.
Lifestyle + Environment > Medicine

From World Health Organization

- 30% - 50% lifestyle
- 20% genetics
- 10% medical healthcare
- 20% environment

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Current App and Platform

- DietLens personal lifestyle AI assistant app
- DietShare food and nutrition social network
- DietMed  Lifestyle factor medical research platform
Prospective Wellness Ecosystem

Primary care doctor

Knowledge Graph

User community

Recommendation

Diet
Activity
Health condition
Dietlens: Personal Lifestyle AI Assistant

**FEATURES:**

- **Food Recognition:** Snap and identify food on your camera instantly.
- **Food Diary:** Keep track of your daily diets with calories and nutrients.
- **Food & Nutrition:** Automatically log nutrients such as carbohydrate, protein, fat.
- **Exercise & Fitness:** Daily steps counts that track distance and calories burned.

**Example:**

- Breakfast: Salmon Pasta 480 kcal
- Lunch: Bibimbap 320 kcal
- Dinner: Shrimp Rice 520 kcal
- Snack: Spaghetti And Rice 528 kcal

**Nutrition Information:**

- Protein: 17g (25%)
- Carbohydrates: 9.1g (25%)
- Fat: 40g (50%)

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Research Platform: Lifestyle as risk factors

**Dietmed**

**Patient**

**Alan Chong**

- **Age**: 27
- **Gender**: F
- **BMI**: 31.2
- **Weight**: 78 kg
- **Height**: 175 cm

**Calorie**

- **Actual**
- **Standard**

**Nutrition distribution**

- 65%

**Step**

- 15790 steps

**Food dairy**

13 March, 2018

- **Breakfast**: Omelette
  - Calories: 154 kcal
  - Carbohydrates: 0.5 g
  - Protein: 11.0 g
  - Fat: 12.0 g
Self-Management: Most Frequent & Successful

The Chronic Care Model

- **Community**
  - Resource and Policies: 0.6%
  - Self-Management support: 45.8%

- **Health System**
  - Organization of health care: 1.9%
  - Delivery system Design: 22.6%
  - Clinical Information System: 21.3%
  - Decision Support: 8.9%

**Improved Outcome**

- **Productive Interaction**

- **Informed, Activated Patient**
- **Prepared, Proactive Practice Team**

Demo

Build on around 300k food images and growing

900+
Now support 900+ food recognition Adding more as we progress
Knowledge and Food Recognition
Tangle of AI and Knowledge

Convenience

01 Accuracy

02 Coverage

Multi-task DCNN
Deep-based Dish/Ingredient Recognition

Accuracy:
Top 1: 0.61, Top 5: 0.89, Top 25: 0.93
Tangle of AI and Knowledge

Convenience

01 Accuracy

02 Coverage

Input

Multi-task DCNN

Output
Tangle of AI and Knowledge Output: The Coverage

01 Sources
02 Depth in knowledge taxonomy
03 Visual Differentiability
Tangle of AI and Knowledge Output: The Coverage

01 Sources

- Common Sense
- Availability of Training Data
- Professional Knowledge (Static)
- Professional Knowledge (Dynamic)
- Data + Knowledge
Define AI Output: Knowledge from Common Sense

- Yellow Mee
- Mee Kia
- Kway Teow
- Bee Hoon
- Mee Pok
AI Output: Knowledge from Static Domain Structure
### Define AI Output: Food Composition Tables

```
SELECT food_name, 'Protein (g)', 'Fat (g)', 'Carbohydrate (g)', 'Energy (kcal) (kcal)'
FROM "NCFoodlist"
WHERE Food_Group = 'MCA'
LIMIT 0, 30
```

<table>
<thead>
<tr>
<th>food_name</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrate (g)</th>
<th>Energy (kcal) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burger, chicken/turkey, coated, retail, grilled</td>
<td>14.20</td>
<td>15.00</td>
<td>16.70</td>
<td>206.00</td>
</tr>
<tr>
<td>Chicken breasts/steak, baked</td>
<td>17.70</td>
<td>11.60</td>
<td>15.80</td>
<td>254.00</td>
</tr>
<tr>
<td>Chicken pieces, coated, takeaway</td>
<td>19.90</td>
<td>14.10</td>
<td>17.60</td>
<td>267.00</td>
</tr>
<tr>
<td>Chicken portions, bread, deep fried, takeaway</td>
<td>24.90</td>
<td>12.50</td>
<td>4.80</td>
<td>223.00</td>
</tr>
<tr>
<td>Chicken, breast, casseroled, meat and skin</td>
<td>26.90</td>
<td>8.00</td>
<td>0.00</td>
<td>164.00</td>
</tr>
<tr>
<td>Chicken, breast, casseroled, meat and skin, weighed</td>
<td>24.20</td>
<td>7.60</td>
<td>0.00</td>
<td>165.00</td>
</tr>
<tr>
<td>Chicken, breast, casseroled, meat only</td>
<td>28.40</td>
<td>5.20</td>
<td>0.00</td>
<td>160.00</td>
</tr>
<tr>
<td>Chicken, breast, grilled with skin, meat only</td>
<td>29.60</td>
<td>3.10</td>
<td>0.00</td>
<td>147.00</td>
</tr>
<tr>
<td>Chicken, breast, grilled without skin, meat only</td>
<td>32.00</td>
<td>2.20</td>
<td>0.00</td>
<td>148.00</td>
</tr>
<tr>
<td>Chicken, breast, grilled, meat and skin</td>
<td>28.50</td>
<td>6.40</td>
<td>0.00</td>
<td>173.00</td>
</tr>
<tr>
<td>Chicken, breast, strips, stir-fried in corn oil</td>
<td>29.70</td>
<td>4.60</td>
<td>0.00</td>
<td>161.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, raw, dark meat only</td>
<td>19.50</td>
<td>7.20</td>
<td>0.00</td>
<td>143.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, raw, light meat only</td>
<td>23.00</td>
<td>2.80</td>
<td>0.00</td>
<td>118.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, raw, meat only</td>
<td>21.40</td>
<td>4.00</td>
<td>0.00</td>
<td>129.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, raw, skin only</td>
<td>10.10</td>
<td>52.70</td>
<td>0.00</td>
<td>514.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, roasted, dark meat only</td>
<td>24.00</td>
<td>9.50</td>
<td>0.00</td>
<td>160.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, roasted, light meat only</td>
<td>25.80</td>
<td>4.20</td>
<td>0.00</td>
<td>141.00</td>
</tr>
<tr>
<td>Chicken, corn-fed, roasted, meat only</td>
<td>24.90</td>
<td>7.20</td>
<td>0.00</td>
<td>164.00</td>
</tr>
<tr>
<td>Chicken, dark meat, raw</td>
<td>20.90</td>
<td>2.80</td>
<td>0.00</td>
<td>109.00</td>
</tr>
<tr>
<td>Chicken, dark meat, roasted</td>
<td>24.40</td>
<td>10.90</td>
<td>0.00</td>
<td>196.00</td>
</tr>
<tr>
<td>Chicken, drumsticks, casseroled, meat and skin</td>
<td>22.30</td>
<td>14.20</td>
<td>0.00</td>
<td>217.00</td>
</tr>
<tr>
<td>Chicken, drumsticks, casseroled, meat and skin, weighed</td>
<td>13.50</td>
<td>9.20</td>
<td>0.00</td>
<td>141.00</td>
</tr>
<tr>
<td>Chicken, drumsticks, casseroled, meat only</td>
<td>24.30</td>
<td>9.70</td>
<td>0.00</td>
<td>185.00</td>
</tr>
<tr>
<td>Chicken, drumsticks, roasted, meat and skin</td>
<td>25.00</td>
<td>9.10</td>
<td>0.00</td>
<td>165.00</td>
</tr>
<tr>
<td>Chicken, drumsticks, roasted, meat and skin, weighed</td>
<td>10.20</td>
<td>5.70</td>
<td>0.00</td>
<td>116.00</td>
</tr>
<tr>
<td>Chicken, drumssticks, roasted, meat only</td>
<td>26.60</td>
<td>5.10</td>
<td>0.00</td>
<td>152.00</td>
</tr>
<tr>
<td>Chicken, leg quarter, casseroled, meat and skin</td>
<td>22.90</td>
<td>13.90</td>
<td>0.00</td>
<td>217.00</td>
</tr>
<tr>
<td>Chicken, leg quarter, casseroled, meat and skin, weighed</td>
<td>14.40</td>
<td>8.00</td>
<td>0.00</td>
<td>137.00</td>
</tr>
<tr>
<td>Chicken, leg quarter, casseroled, meat only</td>
<td>25.00</td>
<td>8.40</td>
<td>0.00</td>
<td>176.00</td>
</tr>
<tr>
<td>Chicken, leg quarter, raw, meat and skin</td>
<td>19.30</td>
<td>15.35</td>
<td>0.00</td>
<td>195.00</td>
</tr>
</tbody>
</table>
Define AI Output:
Knowledge from Dynamic Professional Sources

<table>
<thead>
<tr>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee_with_condensed_milk</td>
<td>36</td>
</tr>
<tr>
<td>3in1_coffee_powder</td>
<td>34</td>
</tr>
<tr>
<td>Coffee_with_sugar</td>
<td>20</td>
</tr>
<tr>
<td>Coffee_with_whole_milk</td>
<td>16</td>
</tr>
<tr>
<td>Coffee_powder_instant</td>
<td>15</td>
</tr>
<tr>
<td>Coffee_with_whole_milk_and_sugar</td>
<td>10</td>
</tr>
</tbody>
</table>
02 Depth in knowledge taxonomy

- Chicken
  - Chicken Breast
  - Chicken leg
  - Chicken Wing
    - Baked Chicken Wing
    - BBQ Chicken Wing
    - Deep Fried Chicken Wing
    - Grilled Chicken Wing
    - Braised Chicken Wing
    - Coco-Cola Chicken Wing
      - Mexican Chicken Wing
      - Har cheong gai
      - Spicy Baked Chicken Wing
Define AI Output: Visual Differentiability

03 Visual Differentiability
Define AI Output: Visual Differentiability from Data and Knowledge

Blueberry

Bilberry
Tangle of AI and Knowledge

Convenience
01 Accuracy
02 Coverage

Input
Multi-task DCNN

Output

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Train AI Model: Knowledge Define the AI Input
Train AI Model: Knowledge Define the AI Input
Tangle of AI and Knowledge
Future Work: Scale up from Singapore
Food Recognition Scalability
Food Recognition Scalability
Food Recognition Scalability

Globalization of Culinary Tradition

Global Influence
- Japanese
- Korean
- Vietnamese
- Thai
- Western

Chinese
Malay
Indian
Eurasian

Fusion
Otak-otak Burger
Food Recognition Scalability

Globalization of Ingredients and Cooking Method

Examples of countries Singapore imports food from:

- **United States**: Beef, Chicken, Fruits, Milk, Pork, Rice, and Vegetables
- **China**: Fish, Fruits, Vegetables, and Cooking Oil
- **Vietnam**: Fish, Fruits, Rice, Vegetables, and Sugar
- **Philippines**: Fruits
- **Australia**: Beef, Cooking Oil, Fruits, Milk, Mutton, Pork, Sugar, Vegetables, and Fish
- **New Zealand**: Beef, Fruits, Milk, and Mutton
- **Thailand**: Fish, Fruits, Milk, Rice, Sugar, and Vegetables
- **Indonesia**: Cooking Oil, Fish, Milk, Pork, and Vegetables
- **South Africa**: Fruits

Based on 2015 and 2016 figures from AVA.

Cooking Methods:
- Stir-fry
- Fry
- Deep-fry
- Soups
- BBQ
- Bake
- Steam
- Grill

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Future Work

Scale up from Singapore

Start with Globalized Coverage

End with Personalized Treatment
Thank You

Data-Driven AI for Personal Wellness

www.dietlens.com