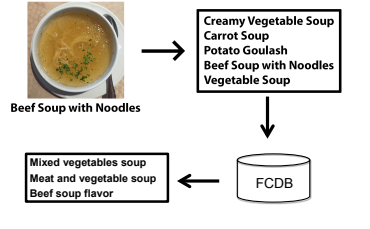**Mixed *Deep Learning* &**
***Natural Language Processing* Approach**
for food image detection, recognition &
analysis to estimate nutritional values

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Problem definition

Beef Soup with Noodles

Creamy Vegetable Soup
Carrot Soup
Potato Goulash
Beef Soup with Noodles
Vegetable Soup

Mixed vegetables soup
Meat and vegetable soup
Beef soup flavor

FCDB

Food & Drink Image Datasets

Tea or soup?

What is hiding in there?

What kind of meat was used to prepare this?

Deep Learning Models

- Food & drink image detection and recognition is performed by applying **deep convolutional neural networks**
  - NutriNet : a new architecture, based on AlexNet
  - Extra convolutional layer, faster training and higher accuracy on our datasets
  - **Results** - recognition accuracy of 86.72% and a detection accuracy of 94.47%:
    - Comparable accuracy to current research works.
    - Able to recognize a much larger number of foods.
    - First to recognize drink images.
- Automatic online training is implemented to continually improve the recognition model.

StandFood: Standardization of Foods according to FoodEx2

- FoodEx2 standardized food classification & description system (developed by EFSA):

  - Four food categories: raw (r), derivatives (d), simple (s) and aggregated (c) composite foods

  - FoodEx2 code example:

    - A03BG#F09.A0EXH$F10.A077L$F21.A07SE
    - nectar, orange (A03BG), FORTIFICATION AGENT = 53 Calcium (F09.A0EXH), QUALITATIVE INFO = Sugar free (F10.A077L), PRODUCTION METHOD = 54 Organic production (F21.A07SE)

StandFood classification, description, and post-processing part

Classification part

Description part

Post-processing part
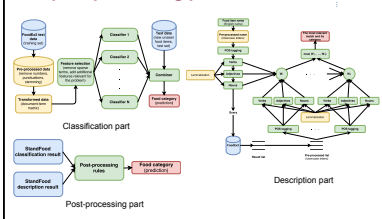
StandFood results

- 532 instances from Slovenian dataset
- 89% accuracy of the **classification** part and 79% accuracy of the **description** part

Food Item	StandFood FoodEx2 Code	StandFood Relevant FoodEx1 Item	Manual FoodEx2 Code
Mushroom soup	A041R	Mushroom soup	A041R
Prepared green salad	A042C	Mixed green salad	A04EC
Meat burger	A03XF	Meat burger no sandwich	A03XF
Yeast	A049A	Baking yeast	A049A
Brown sauce (gravy, byrtráin sauce)	A04IZ	Continental European brown cooked sauce gravy	A04IZ
Cow milk, c1% fat (skimmed milk)	A02MA	Cow milk skimmed low fat	A02MA
Supplements containing special fatty acids (e.g., omega-3, essential fatty acids)	A02SX	Formulations containing special fatty acids (e.g., omega-3 essential fatty acids)	A02SX
Durum wheat flour (semola)	A04MC	Wheat flour durum	A04MF
Gingerbread	A0KCT	Gingerbread	A0PQ$F14.$PGX
Cherry, fresh	A0LGG	Cherries and similar	A01GK
	A01GH	Sour cherries	
	A0LGK	Cherries sweet	
	A0DVN	Nanking cherries	
	A0DVP	Cornelian cherries	
	A0DVR	Black cherries	

Conclusion

- The results are encouraging as the DL model has a high classification accuracy and is able to recognize the largest selection of foods and drinks so far (520).

- The DL model is being used in practice as part of a mobile app for dietary assessment of Parkinson's Disease patients.

- The benefit of using the approach for food matching is that the whole process is made automatically, compared to several other techniques used in Europe that are based on manual matching.

Questions

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