

Pancreapp:

innovative approach to computational individualization of nutritional therapy in chronic gastrointestinal disorders.

www.pancreapp.pl

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Nutrition therapy has a meaningful role in various gastrointestinal disorders such as chronic pancreatitis, inflammatory bowel diseases (Leśniowski-Crohn's disease and ulcerative colitis) or irritable bowel syndrome. [1]



Unquestionably, the dietary regime can soothe inconveniences and thus **self-control is as crucial as clarity of recommendations. [2]**

[1] Balliet WE, Edwards-Hampton S, Borckardt JJ, Morgan K, Adams D, Owczarski S, Madan A, Galloway SK, Serber ER, Malcolm R. Depressive Symptoms, Pain, and Quality of Life among Patients with Nonalcohol-Related Chronic Pancreatitis. *Pain Res Treat*. 2012;2012:978646.

[2] Grant JP. Nutritional support in acute and chronic pancreatitis. *Surg Clin North Am*. 2011 Aug;91(4):805-20, viii.

Guidelines may not be appropriate for every individual, thus personalization is needed.

= personalized medicine

Lack of the individualization can **affect directly the compliance**, as guidelines are usually complex and **can be misinterpreted by patients**.

Personalized therapy applied in other scenarios, has recently shown positive results. [3, 4, 5]

[3] Laserra N, Alesanco A, Guillén S, García J. A three stage ontology-driven solution to provide personalized care to chronic patients at home. J Biomed Inform. 2013 Jun;46(3):516-29.

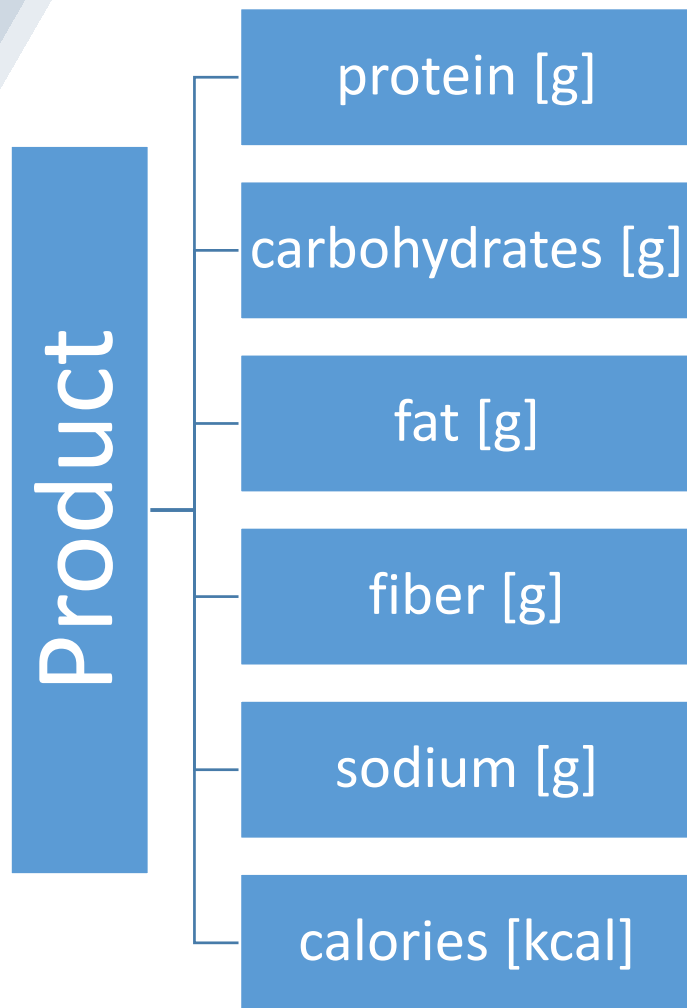
[4] van der Heijden M, Lucas PJ, Lijnse B, Heijdra YF, Schermer TR. An autonomous mobile system for the management of COPD. J Biomed Inform. 2013 Jun;46(3):458-69.

[5] Spat S, Höll B, Petritsch G, Schaupp L, Beck P, Pieber TR. Automatic system testing of a decision support system for insulin dosing using Google Android. Stud Health Technol Inform. 2013;186:187-91.

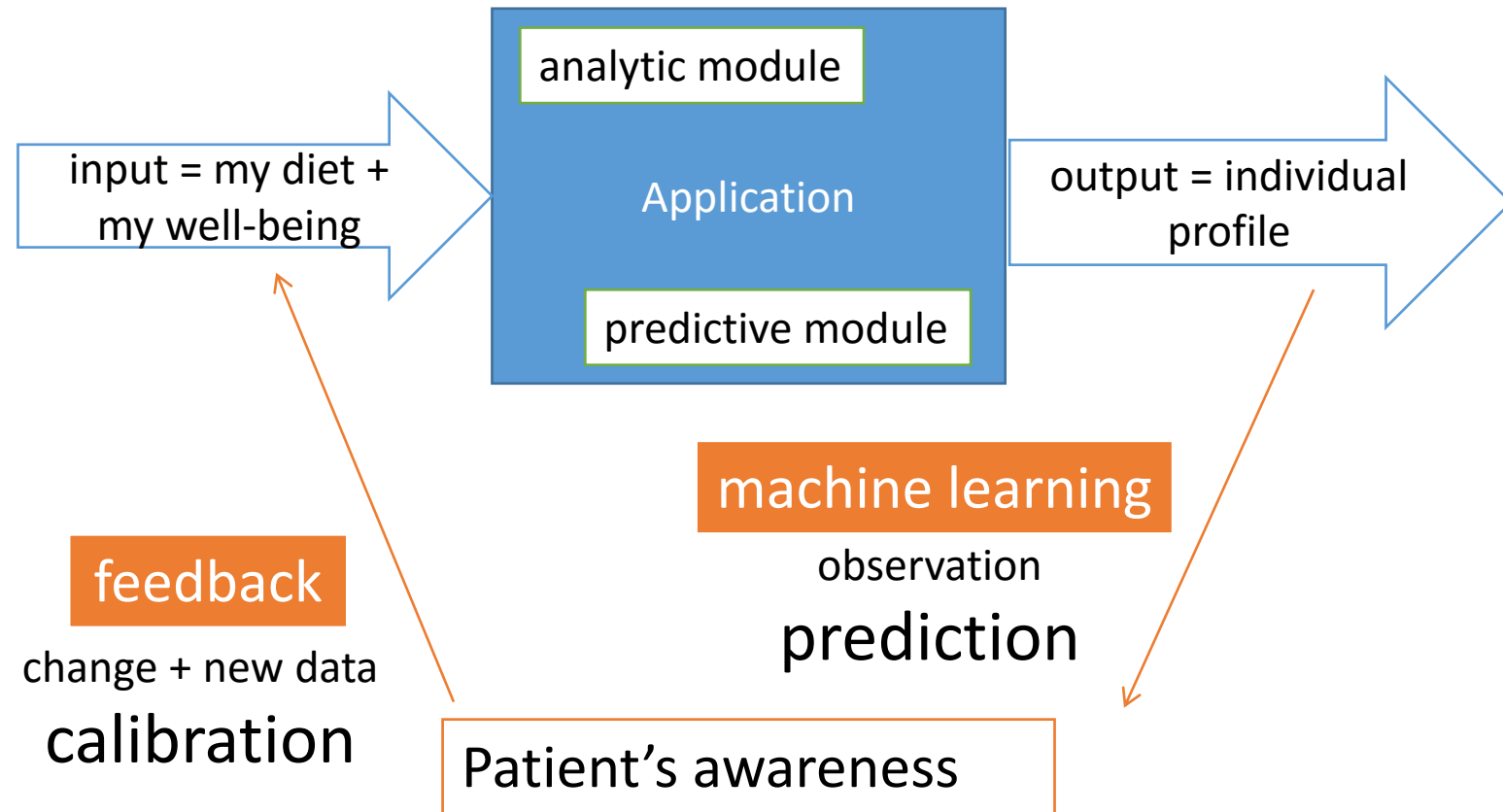


The aim of this study is to develop and evaluate a solution which purpose is to support patients' self-control and adjust diet to the best possible fettle based on individualized machine learning model.

The proposed solution has been called – PancreApp.



Food products available on the market are almost always described quantitative, based on basic ingredients content.

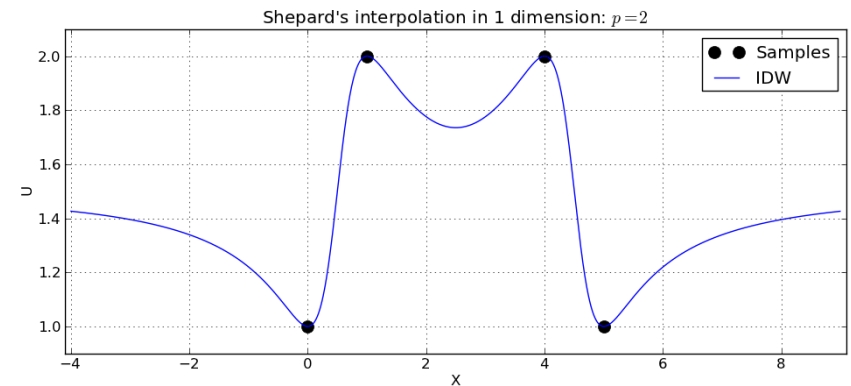


The aim of the following data processing is to **provide patients with individually computed profile** of their disease that can be applied in the estimation of fettle for next meals. In this model, continuous acquisition of new data enables constant calibration of prediction, being in general a concept of machine learning algorithms.

When the diet is known, users can define their fettle (associated with a particular meal). The **fettle can be determined by the user on the scale from 1 to 10** (where 10 is the best) and should reflect the severity of symptoms.

Dataset consisting of:

1. Gramms of protein in the meal
2. Gramms of carbohydrates in the meal
3. Gramms of fat in the meal
4. Gramms of fiber in the meal
5. Gramms of sodium in the meal
6. Calories in the meal
7. Time of the meal *subsetting filtering variable*
8. Fettle after the meal



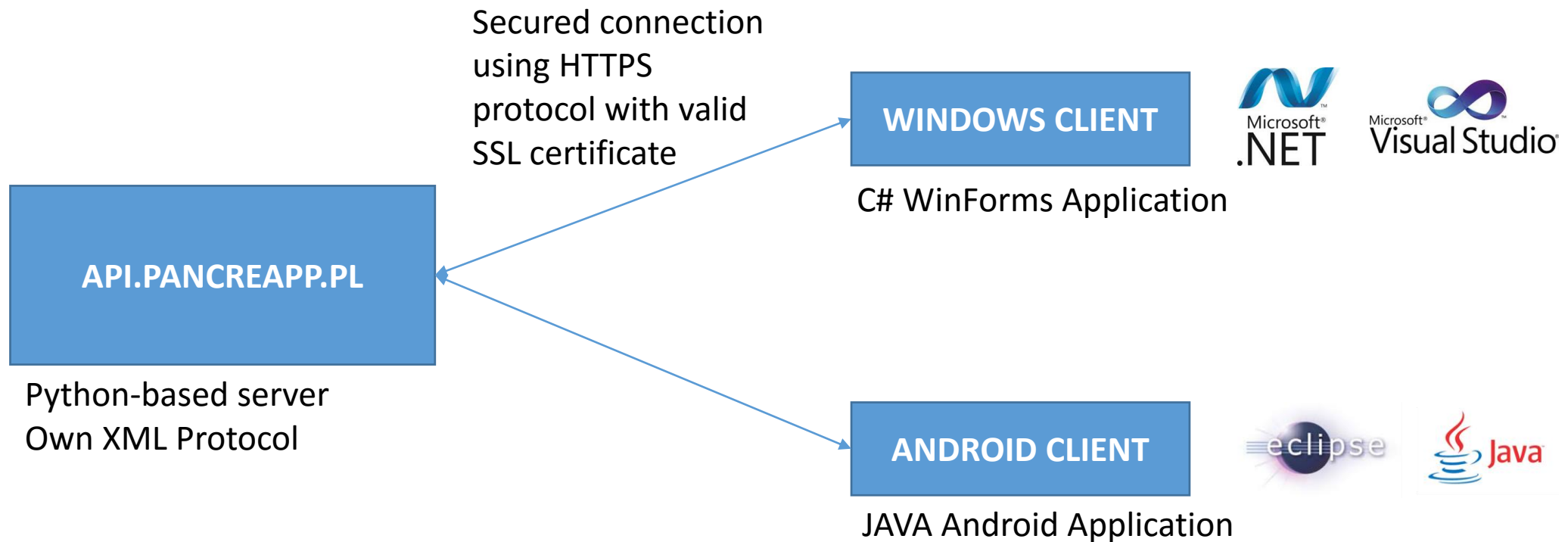
Shepard's method of Inverse Distance Weighting (IDW)

multivariate interpolation

- 6-dimensional model
- usage of euclidian distance
- rationale: we needed a fast method that could be applied on low-end devices

Idea development and application design

PancreApp is designed as a multiplatform, cloud-based digital diet diary.



GUI: Input → Output

creating input = **my diet** + my well-being

The screenshot displays a web application for managing a diet. It is divided into several sections:

- Twoja dieta:** A calendar view for March 2014. The 14th is selected. Below the calendar, it shows the date "15.4.2013" and the meal type "Śniadanie".
- Choose a day:** A calendar for March 2014 with the 14th selected. A text box prompts the user to "Choose a day. Please enter the details about your diet, and then progress to setup accompanying fettle."
- Features of the product:** A form with input fields for various nutritional values:
 - Elementary unit = 100 ml
 - Energy [kcal] = 44
 - Protein [g] = 3
 - Carbohydrates [g] = 4,7
 - Fat [g] = 1,5
 - Roughage [g] = 0
 - Sodium [g] = 0,04
 - Weight per one unit [g] = 1000,00
- Your diet during 14.3.2014 r.:** A section for logging a meal. It includes a dropdown for "Breakfast", a text input "I ate...", a "product" dropdown showing "Musli owocowe [firma]", a "< search" button, an "in an amount of" input with "0,2", and an "I ate this!" button.
- Product Details:** A tree view showing the meal breakdown:
 - Breakfast
 - Mleko Pulos 1,5% (0,33)
 - Musli owocowe [firma] (0,2)
 - II Breakfast
 - Lunch
 - Dinner
 - Supper
- Footer:** A "View:" dropdown set to "drzewo", a "I didn't eat this!" button, and a "Setup accompanying fettle for the same day!" button.

At the bottom left, there is a section for "Jovi Duet o smaku jabłkowo-gruszkowym (2 [jogurt])" with nutritional data: węglowodany: 91.6 [g], sól: 0.0 [g], białko: 119.0 [g], tłuszcz: 5.6 [g], błonnik: 0.0 [g], masa: 700.0 [g], wartość energetyczna: 464.0 [kcal]. Below this is a button "Weryfikuj posiłek z profilem żywieniowym" and a row of buttons "Dodaj", "Edytuj", and "Usuń".

Our products database contains **over 2200 products** that are available on Polish market.

GUI: Input → Output

creating input = my diet + **my well-being (fettle)**

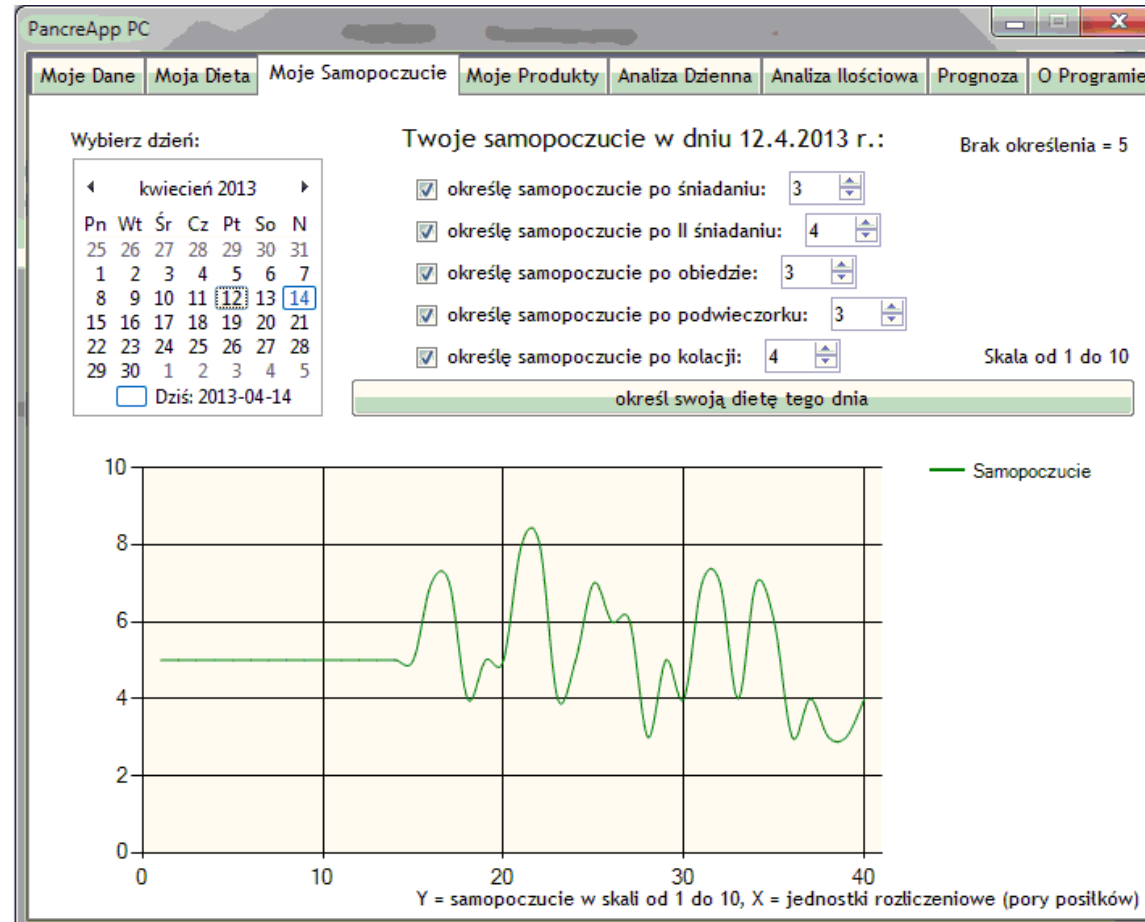
Samopoczucie:

		S	M	T	W	T	F	S	
Mar	14	14	31	1	2	3	4	5	6
Apr	15	15	7	8	9	10	11	12	13
May	16	16	14	15	16	17	18	19	20
	17	21	22	23	24	25	26	27	
	18	28	29	30	1	2	3	4	

Twoje samopoczucie w dniu: 15.4.2013

- ☒ Po śniadaniu: 5
- ☒ Po drugim śniadaniu: 5
- ☒ Po obiedzie: 5
- ☒ Po podwieczorku: 5
- ☒ Po kolacji: 5

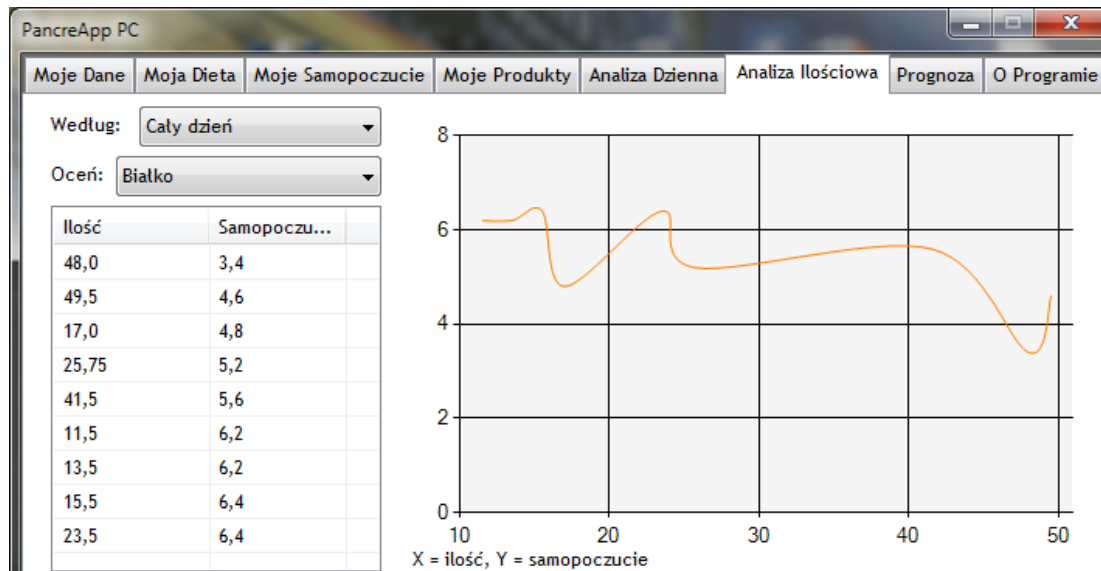
Zapisz



10 = the best
5 = average
1 = the worst

$$fettle \sim \frac{1}{\text{relative severity of symptoms}}$$

GUI: Input → Output



PancreApp PC (ImagineCup edition)

My Profile | My Diet | My Fettle | My Products | Daily analysis | Quantitative analysis | Prognosis & Prediction | About App

What would you like to eat? This feature will allow you to predict the fettle after a meal.

During I would like to eat

product in amount of

Product	Amount [elementary units]
Mleko Piłs 1,5%	0,2
Musli owocowe [firma]	0,2

You would eat

Weight [g] =

Sodium [g] =

Energy [kcal] =

Protein [g] =

Carbohydrates [g] =

Fat [g] =

Roughage [g] =

Aproximative prediction

Prediction of fettle: 6,33

Żywnościowy

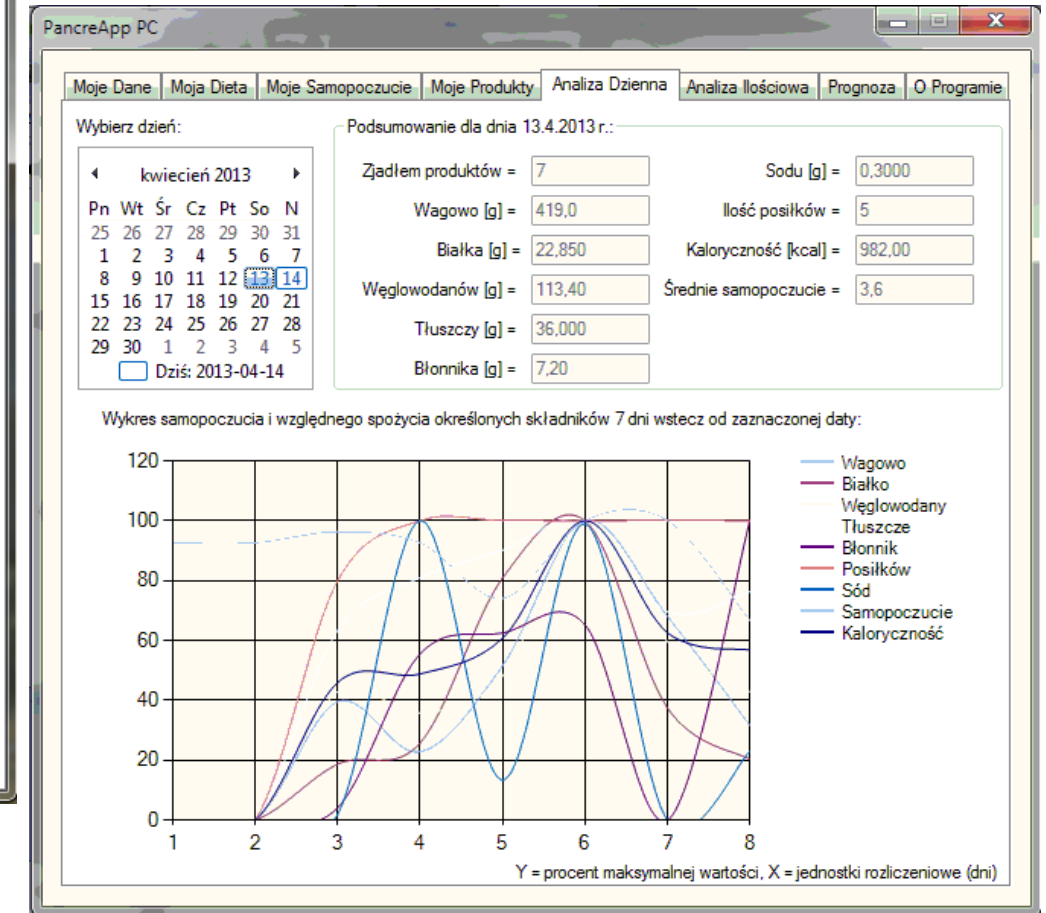
y [g] =

z [g] =

k [g] =

analiza profilu.

Wygeneruj nowy najlepszy profil żywieniowy dla zaktualizowanych danych!



Analytics: descriptive statistics, charts, predict fettle for future meals using multidimensional Shepard's method.

Step 1: Preliminary evaluation

6 healthy individuals that were using software on a daily basis for 2 weeks

- Related-Samples Wilcoxon Signed Rank test showed that **median difference between the well-being (fettle) value described by the tester and the well-being value predicted using Shepard's algorithm** (based on all data except for tested; n-fold cross-validation) **was not statistically significant** ($p=1.00$).
- The absolute error of prediction was equal to 0.6454, while the relative error of prediction equalled 7.59% of fettle value.

phone survey on 9 patients to assess if proposed idea reflects the needs of the target group

- Food-specific intolerance has been noted by 8 out of 9 surveyed patients.
- All surveyees were interested in participation.
- Only one of surveyed patients had a phone with Android OS. The rest of the patients would prefer using PC with Windows OS.

Step 2: Trial

Since October 2014 this project has been financed by the Polish Ministry of Science and Education as a grant for student researchers.



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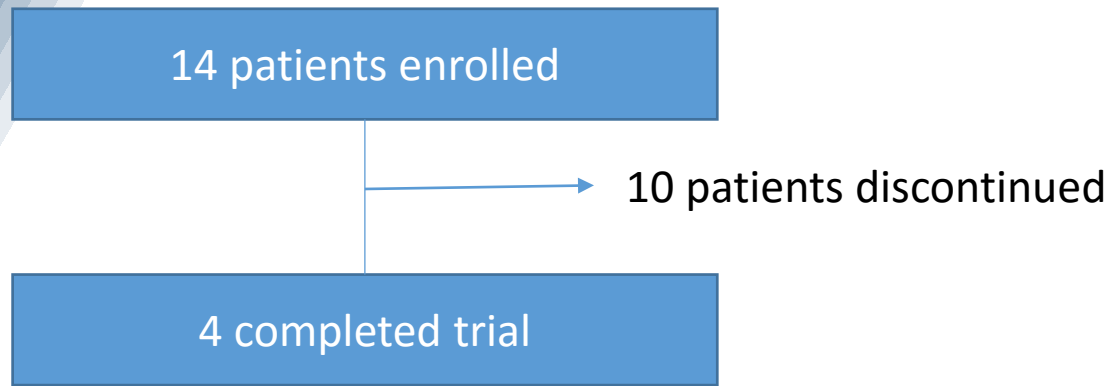
**Adult patients-volunteers
with chronic pancreatitis,
inflammatory bowel diseases
(Leśniowski-Crohn's disease
and ulcerative colitis) or
irritable bowel syndrome**

control group = just another diet diary

experimental group = prediction available

3 weeks

Early results (may 2015)

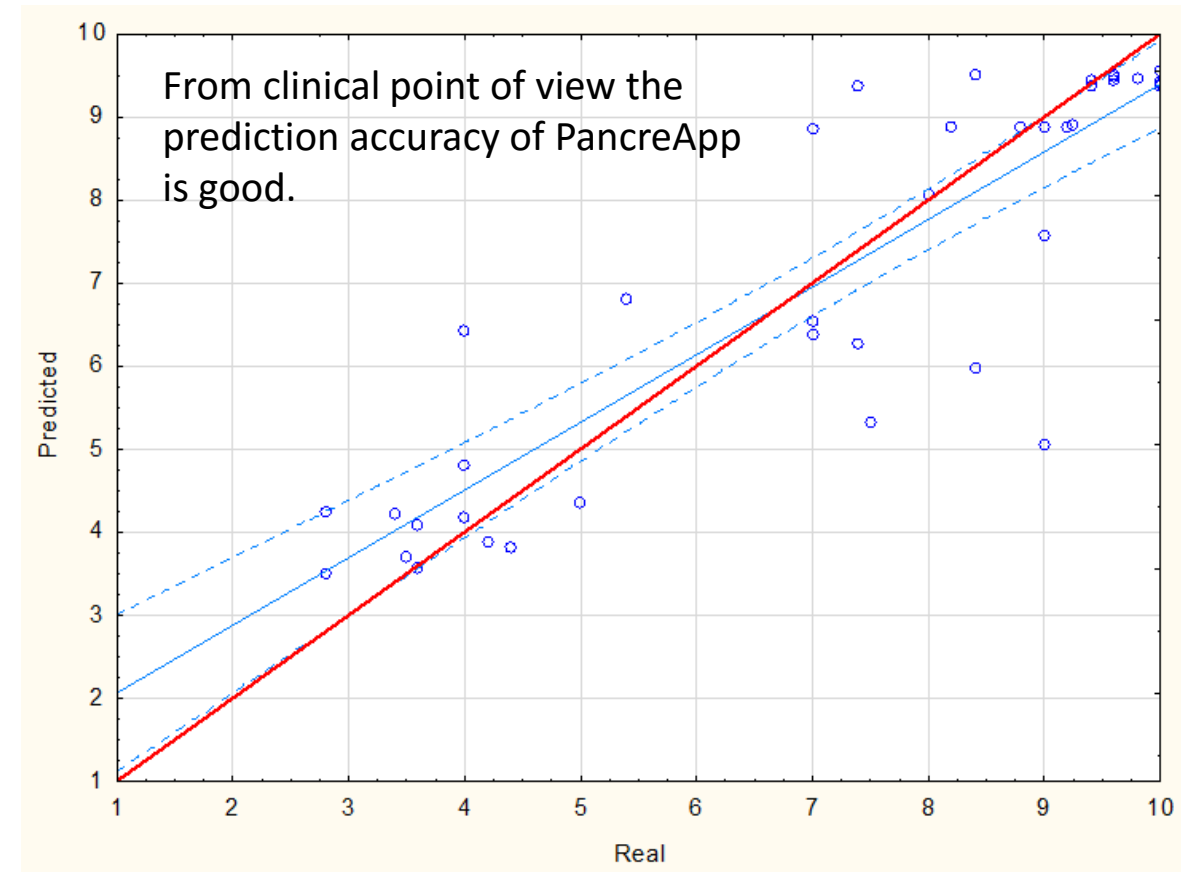


It is also remarkable that not even one patient has chosen an Android device.

Two of those patients have Crohn's disease, one has ulcerative colitis and one - irritable bowel syndrome.

Dataset limited – simulation performed.
Evaluation: leave-one-out cross-validation (LOOCV)

1. 95% confidence interval of regression almost contains the line of ideal prediction.
2. root mean squared error was equal to 0.80, while Spearman's correlation coefficient between predicted and real values was equal to 0.87 ($p=0.000$).



Lack of faith in treatment is one of the factors predisposing to reduced compliance [6]

PANCREAPP

Therapeutic effect may be strictly dependent on feedback from a patient.

Current compliance is in the expected range, as all patients (qualified so far) are in a remission state.

Usage of fettle as a self-assessment of clinical state is disputable, however, modern medicine is going to be focused rather on the quality of life than on a simple survival.

Hawthorne effect, selection and technology bias cannot be excluded, as convenient sample is being enrolled.

Machine learning and data-mining techniques are very promising and widely used in various aspects of science.

Algorithm applied here is one of the simplest, however, can be quickly deployed in everyday scenario (on low-end devices).

We must also notice the need to test and compare different regression methods on data harvested from this study (retrospectively).

1. Early results of evaluation have shown that applied approach has a potential to predict the fettle accurately and with low error.
2. Possible broad spectrum of application (pancreatitis, obesity, kidney and liver disorders) encourages us not only to finish current trail, but also to check whether PancreApp could be applied in different scenarios (diseases).
3. Furthermore, PancreApp can be used in evidence based medicine – as an easy available data-gathering service. The main advantage is flexibility achieved by individualized models.
4. Data collected by this tool could also be used in retrospective analysis of studied disorders, being a source of valuable inferences.

Thank you.

visit www.pancreapp.pl for details