

Computational Gastronomy



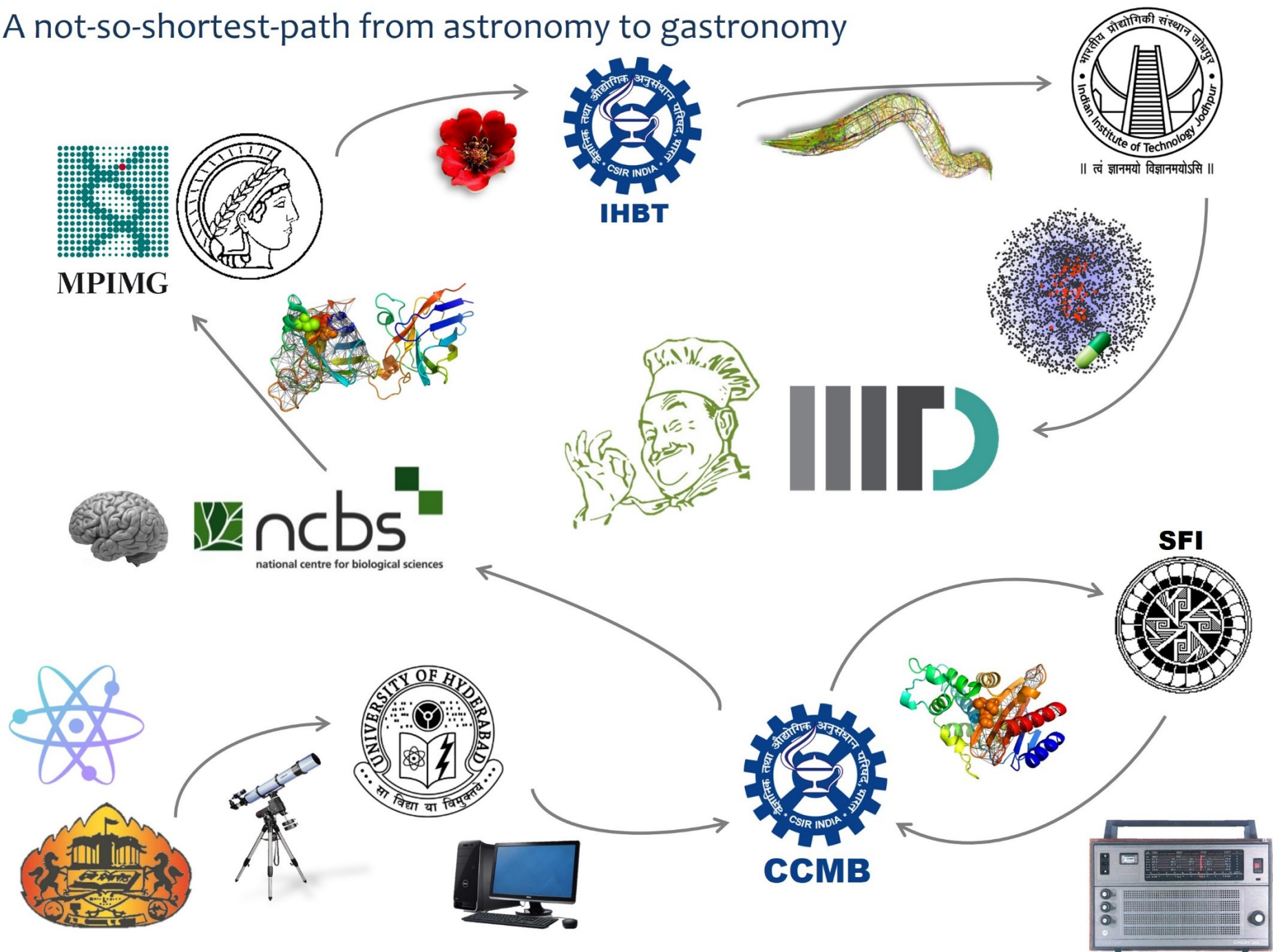
GANESH BAGLER




<http://cosylab.iiitd.edu.in>

Leveraging food for better health through data-driven investigations

A not-so-shortest-path from astronomy to gastronomy





IIT-Delhi turns 1010 years!

"There are 10 types of people in this world. Those who understand binary and those who don't." ☺

"There are 10 types of people in this world. Those who understand binary and those who don't." ☺

Complex Systems Lab

Our research focus is on study of complex systems, primarily of biological origin. We are exploring systems architecture of complex diseases, drug-target networks and brain networks. Broad areas that we study include computational & systems biology, bioinformatics, mathematical modeling, network biology, *in silico* drug discovery and biomedical data analysis. Apart from modeling and analysis of complex systems, we aim to probe for their control mechanisms and design principles.

I am associated with the [Center for Computational Biology](#) at IIIT-Delhi. ★ [Internship/Thesis Opportunities](#) ★

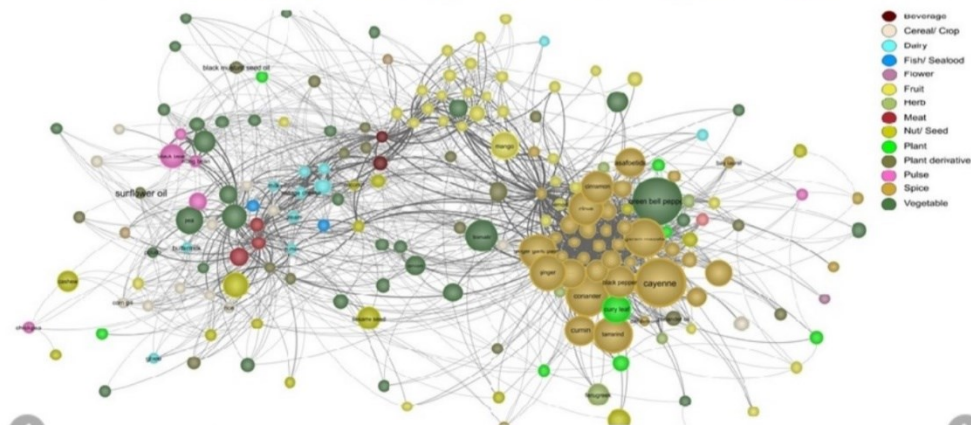
Discovery of a new food pairing phenomenon

[pe: Creating novel recipe blends](#) | [A model for *C. elegans* brain r](#)

[Dr. Ganesh Bagler's Page](#)

[Google Scholar Profile](#)

Featured as an **Emerging Technology** in **MIT Technology Review**, 25 Feb 2015



"Spices form the basis of food pairing in Indian cuisine", Anupam Jain, Rakhi N K, Ganesh Bagler*, arXiv:1502.03815 (2015)

[Spices form the basis of food pairing in Indian cuisine.](#) India is known to have culinary history of health-centric dietary practices aimed at disease prevention and promotion of health. We investigated the molecular basis of food composition in the Indian cuisine with rigorous mathematical and computational analysis. We find that the cuisine is characterized with an exceptional food pairing pattern and spices occupy an unique position in rendering this unique food pairing pattern. We are focussing on various ways we could use the knowledge of such culinary patterns.

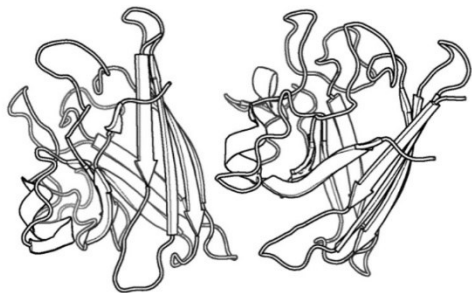
[Featured as an Emerging Technology & Best of 2015 in MIT Technology Review.](#)



Complex Systems

A system comprising of large number of sophisticated functional elements, intricately connected with each other to perform specific tasks, which otherwise can not be executed by subsets of the system.

SUM OF PARTS
– IS NOT THE SAME AS –
THE WHOLE



Biological Complex Systems



• Interdisciplinary Research •

Application of Network Modeling for Biology and Medicine

Knowledge



Hypothesis-Driven Questions

Data



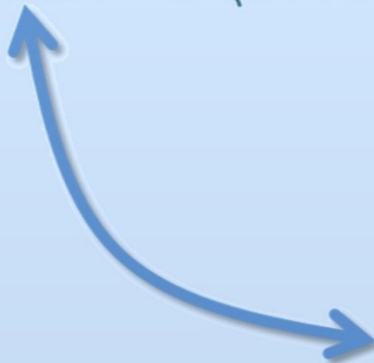
Structured Databases



Applications



Methods, Tools



Computational Gastronomy

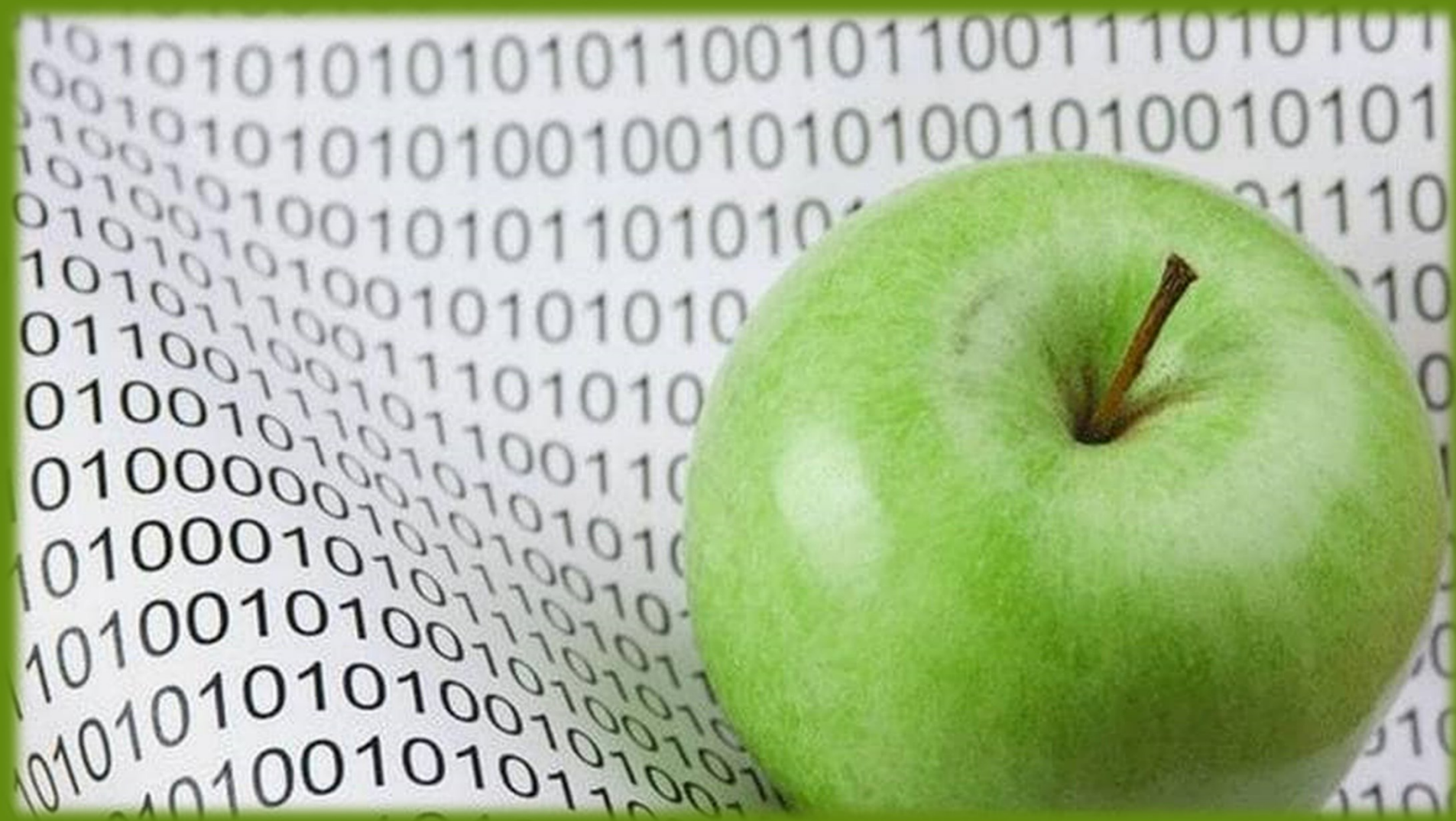


GANESH BAGLER

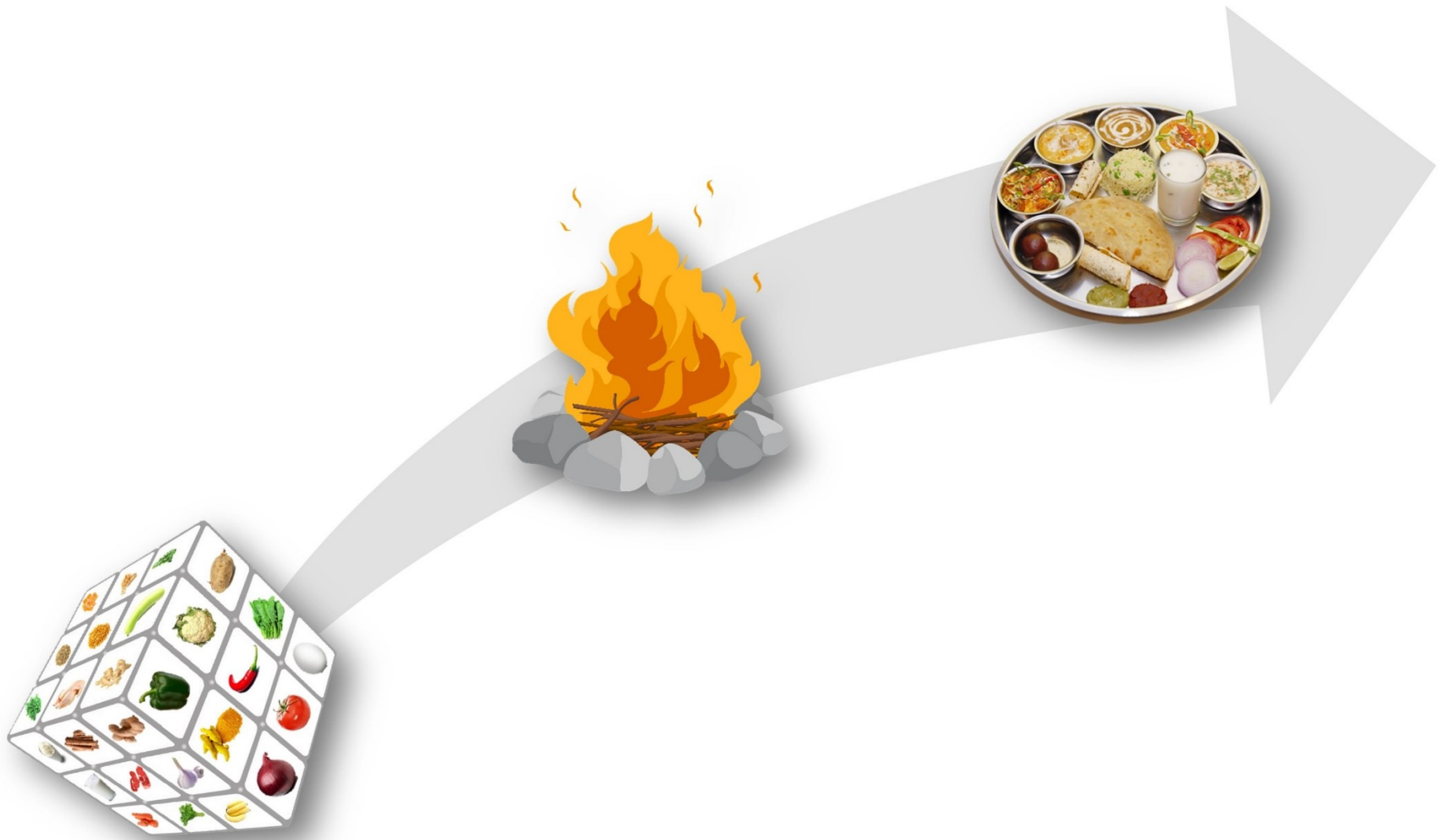


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Leveraging food for better health through data-driven investigations



Computational Gastronomy is a data science
that blends food, data, and computation for
data-driven food innovations



Cooking is alchemy

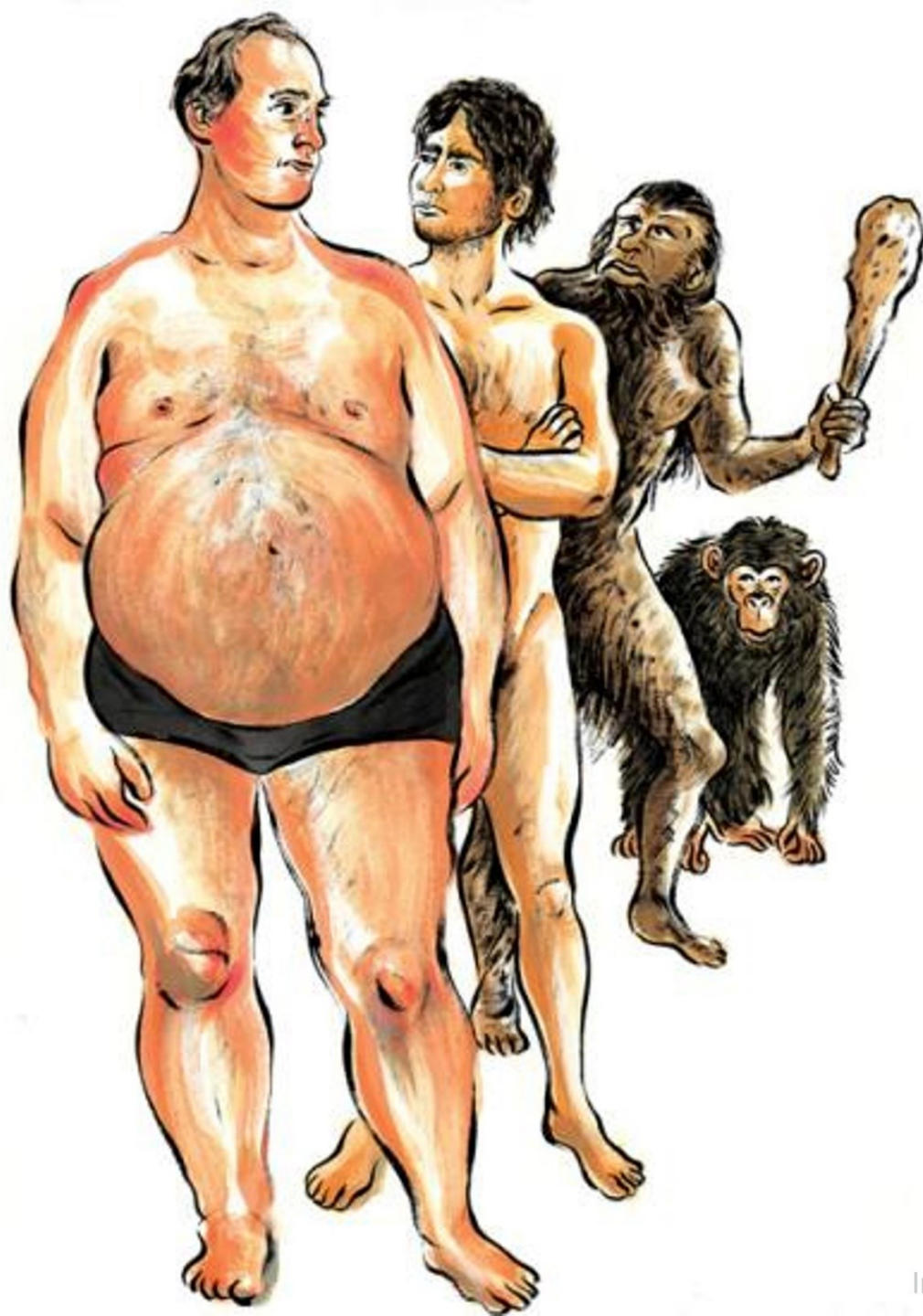


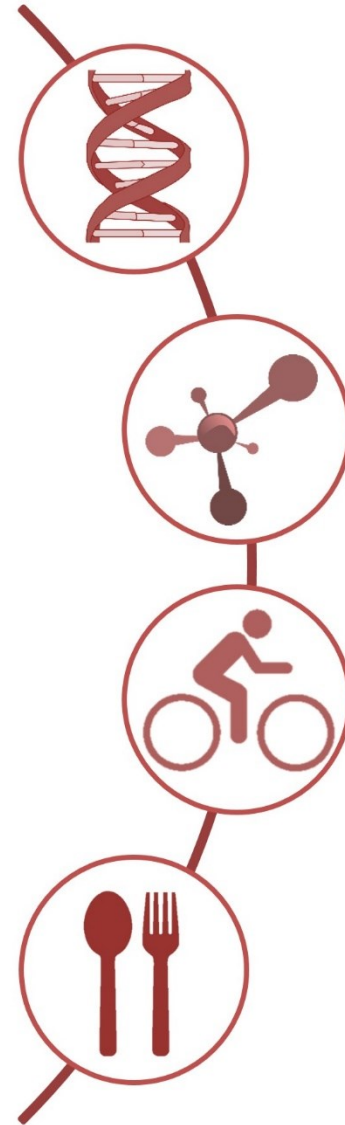
Cooking: Central to evolution of human brain

Cooking is the essence of being human



'Catching Fire—How cooking made us human' by Richard Wrangham





HEALTH IN THE SDG ERA



World Health Organization

WWW.WHO.INT/SDGS



Organization
World Health

WWW.WHO.INT/SDGS



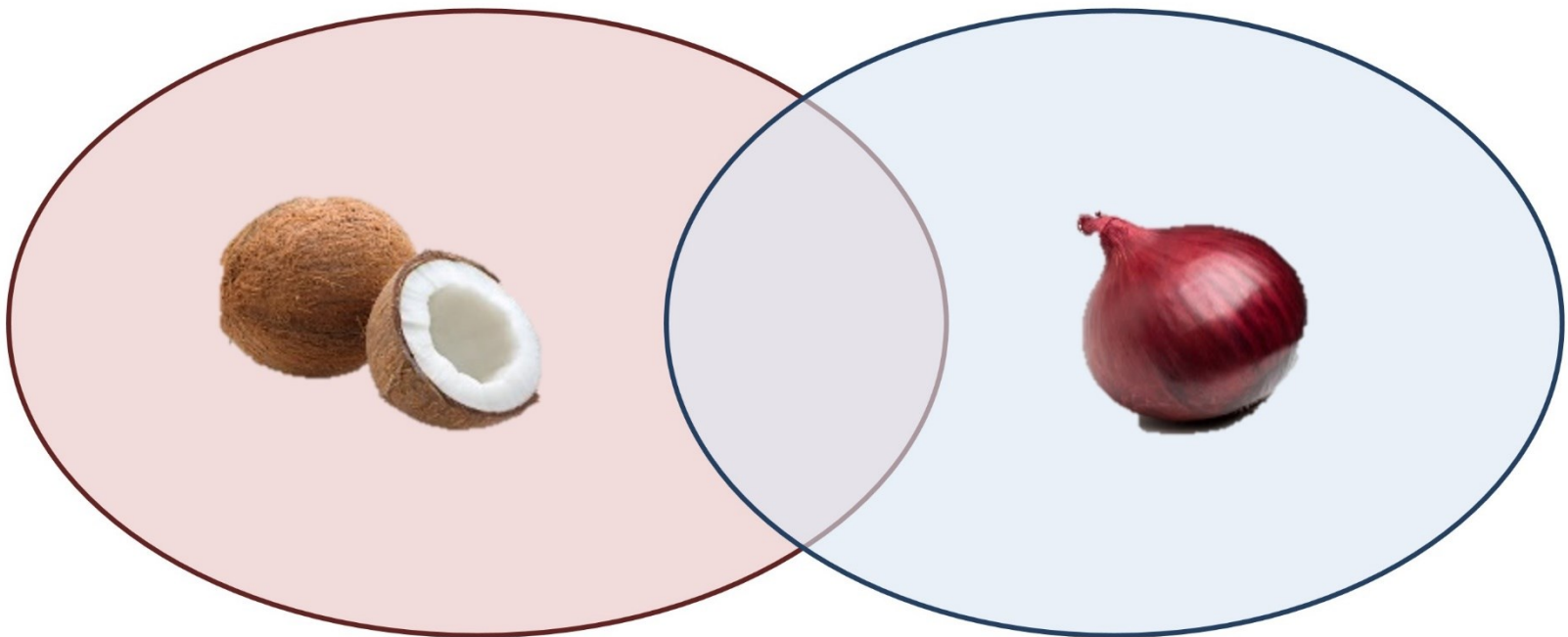
Why do we eat what we eat?

Why do we combine ingredients
in our recipes the way we do?



Food Pairing Hypothesis

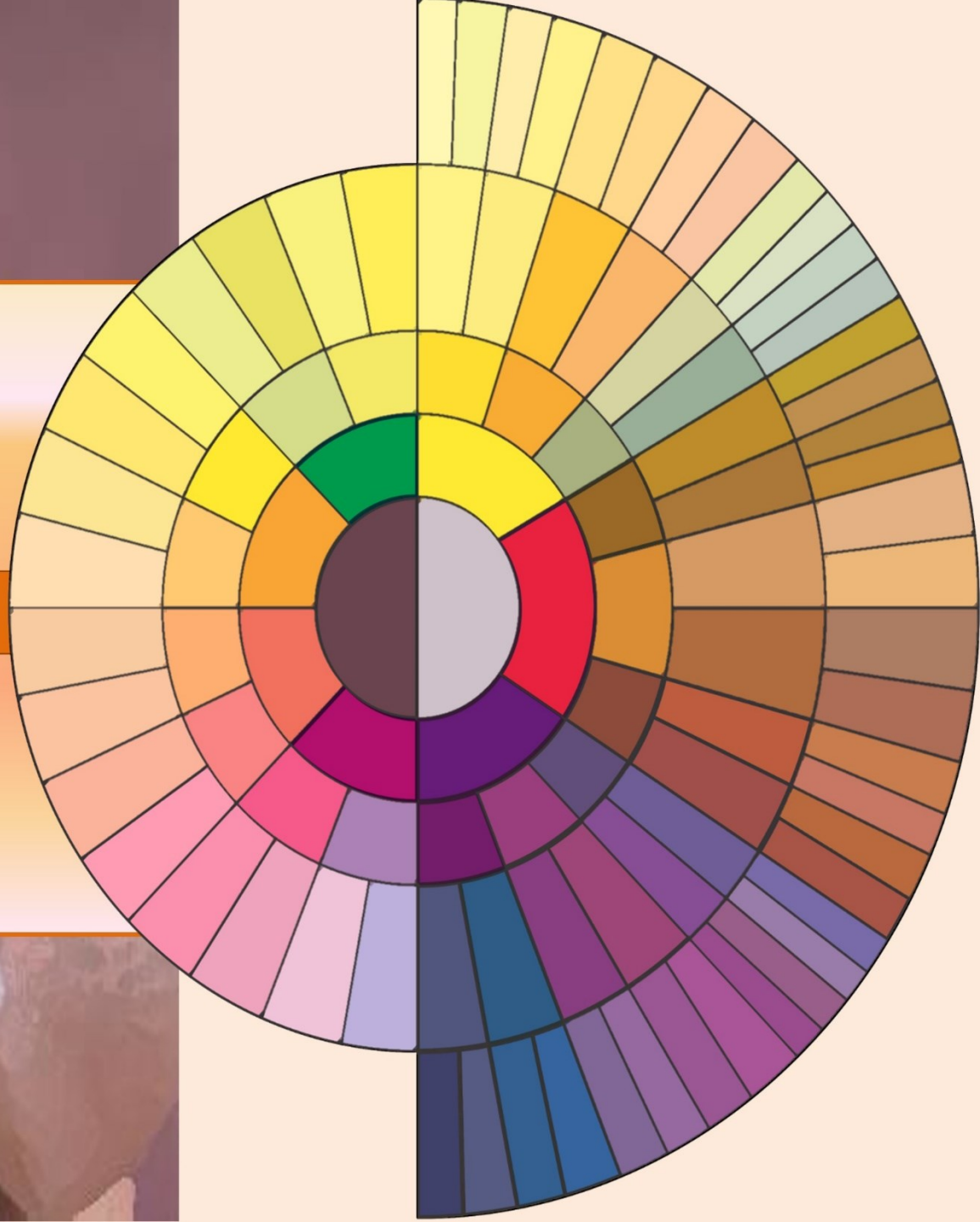
Ingredients that **taste similar** tend to be **used together** in traditional recipes

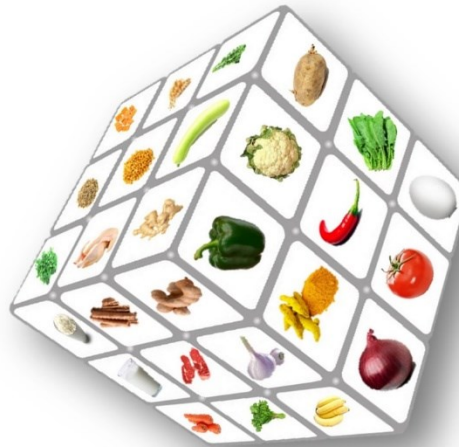


Olfactory

fla • vor = smell + taste

Gustatory

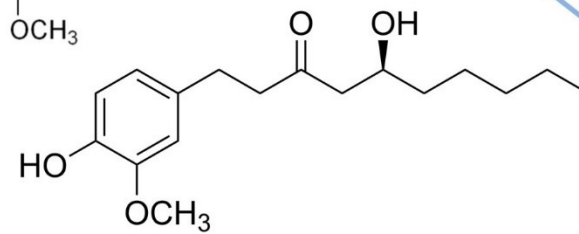
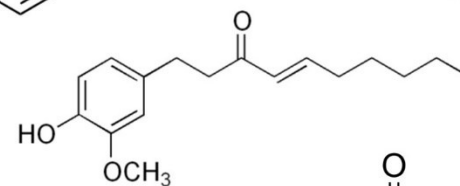
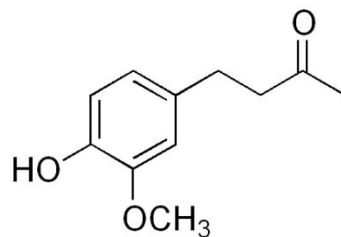
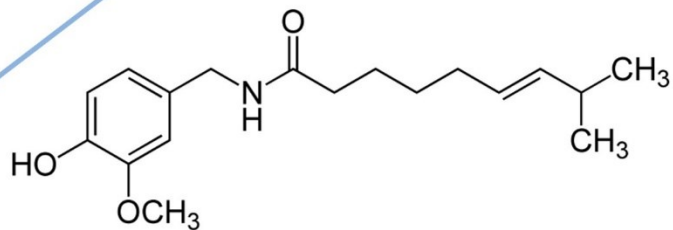
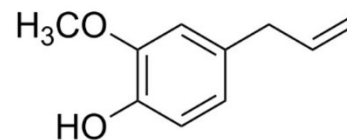
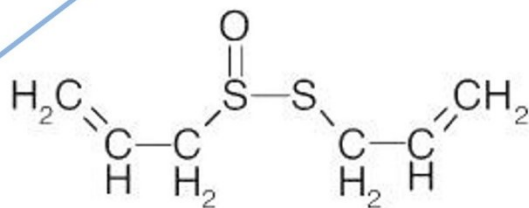
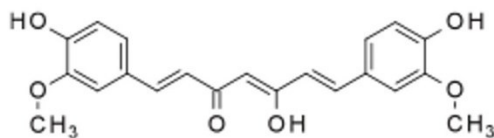




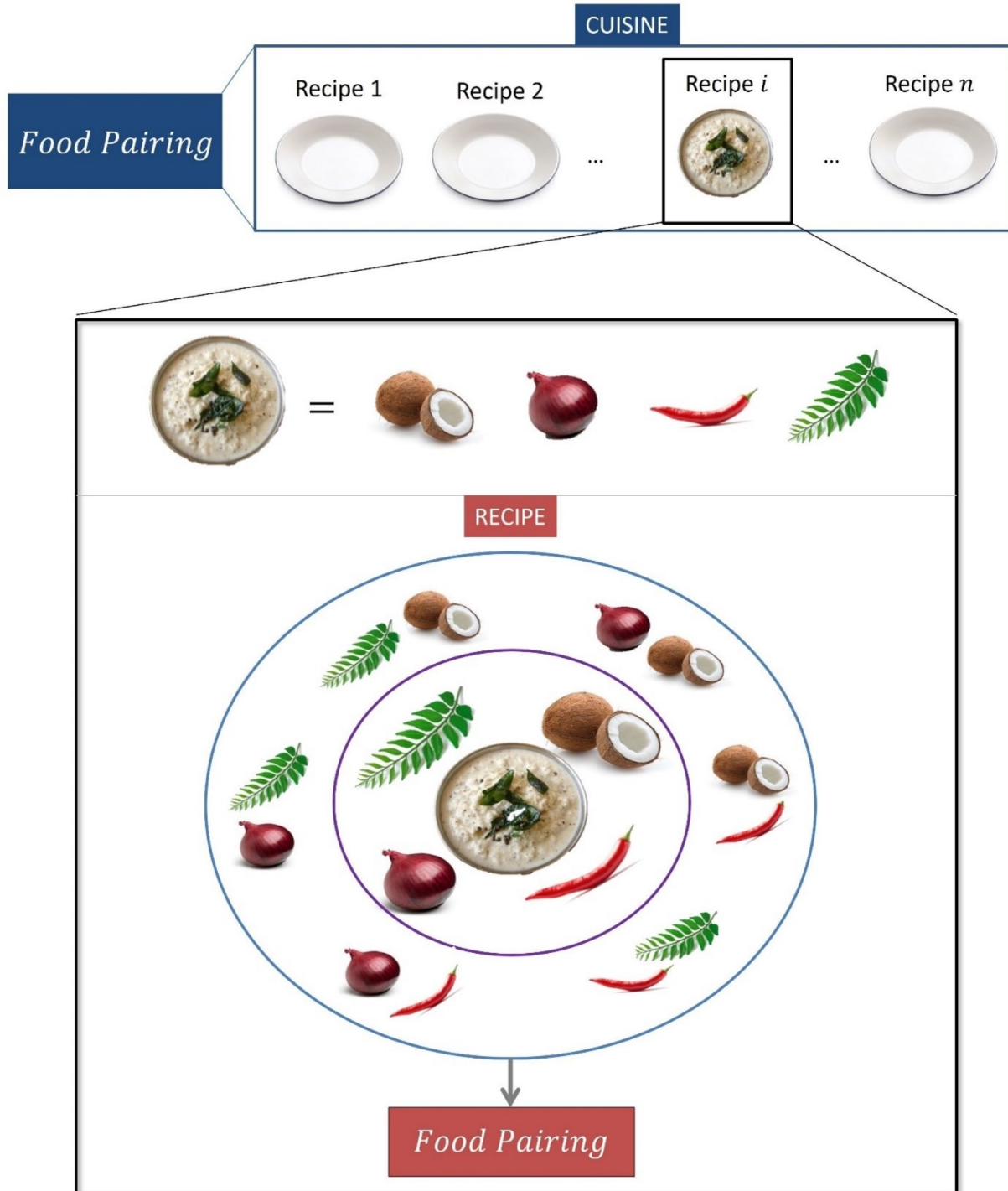
PubMed

PubChem


Fenaroli's Handbook



Food Pairing



Uniform Food Pairing

Western  Cuisines

Random  *Cuisine*

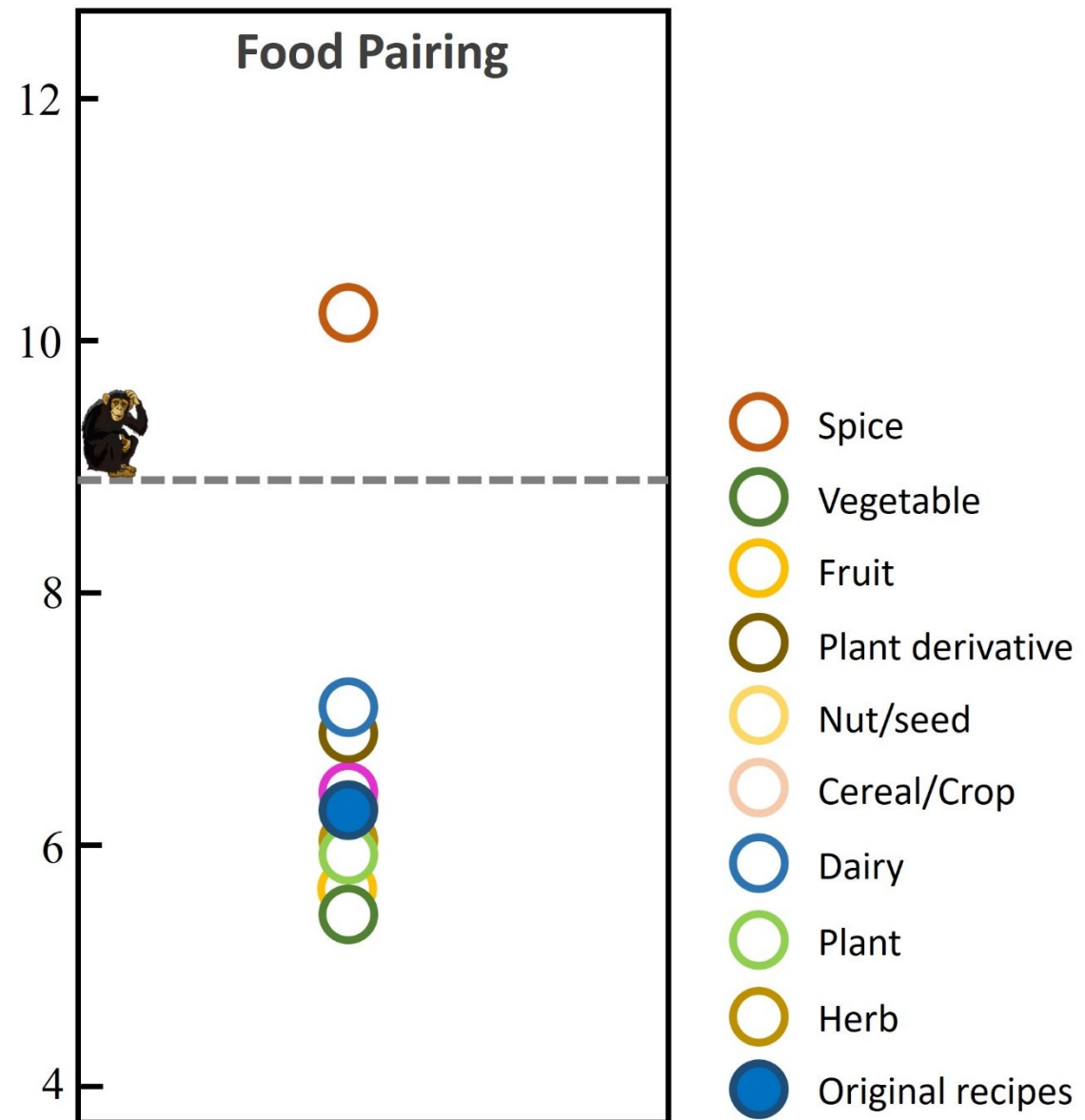
Indian  Cuisine

Contrasting Food Pairing

**Western cuisines have a
uniform blend of ingredients.**

**Indian cuisine has a
contrasting blend of ingredients.**

Spices are key to the food pairing in Indian cuisine



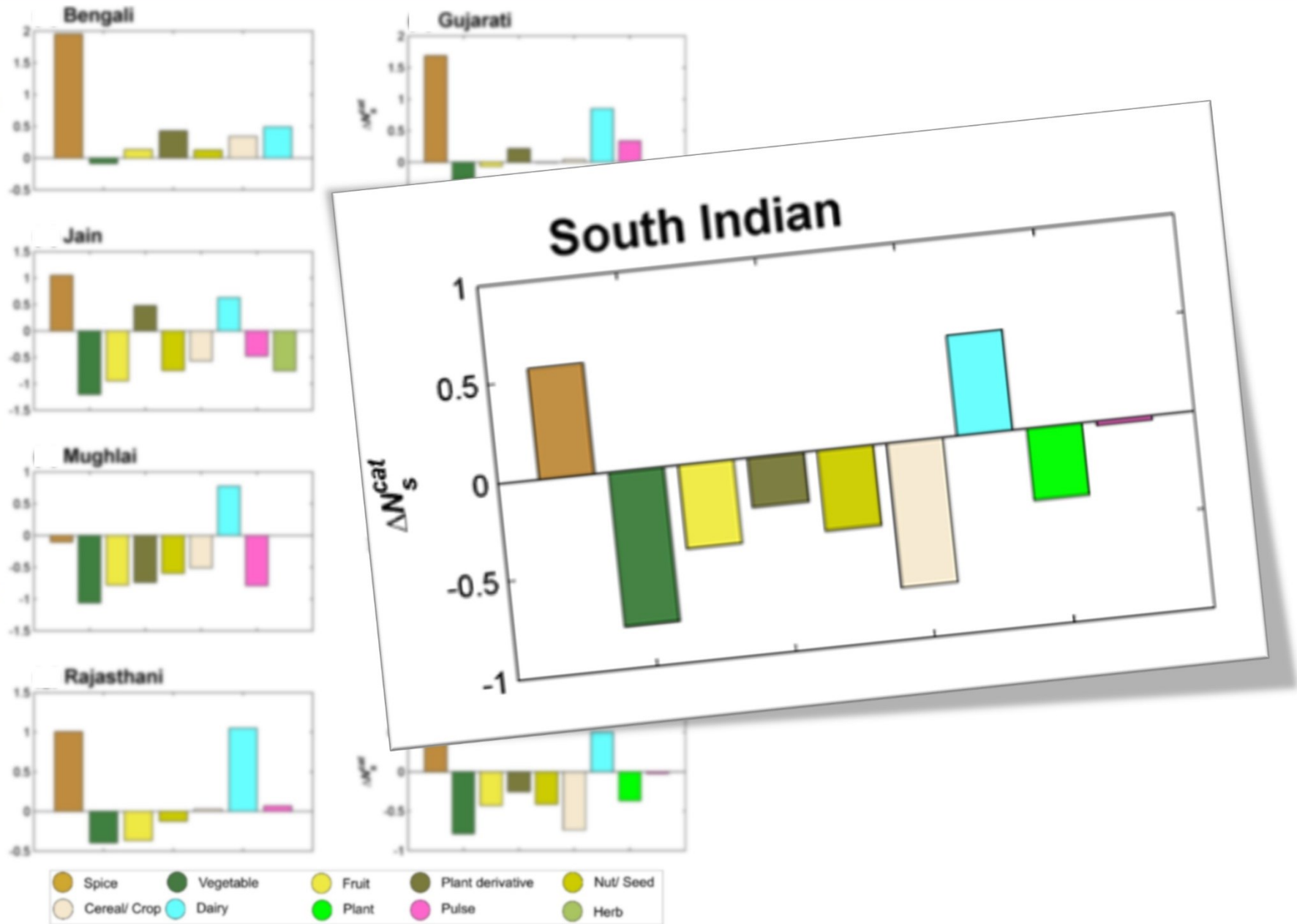


Spice

The Taste of India

Culinary Fingerprints of Regional Cuisines of India

Contribution of ingredient category towards food pairing bias



Culinary Fingerprints



A View from **Emerging Technology** from the arXiv

Best of 2015: Data Mining Indian Recipes Reveals New Food Pairing Phenomenon

By studying the network of links between Indian recipes, computer scientists have discovered that the presence of certain spices makes a meal much less likely to contain ingredients with flavors in common. From February ...

December 30, 2015

**MIT
Technology
Review**

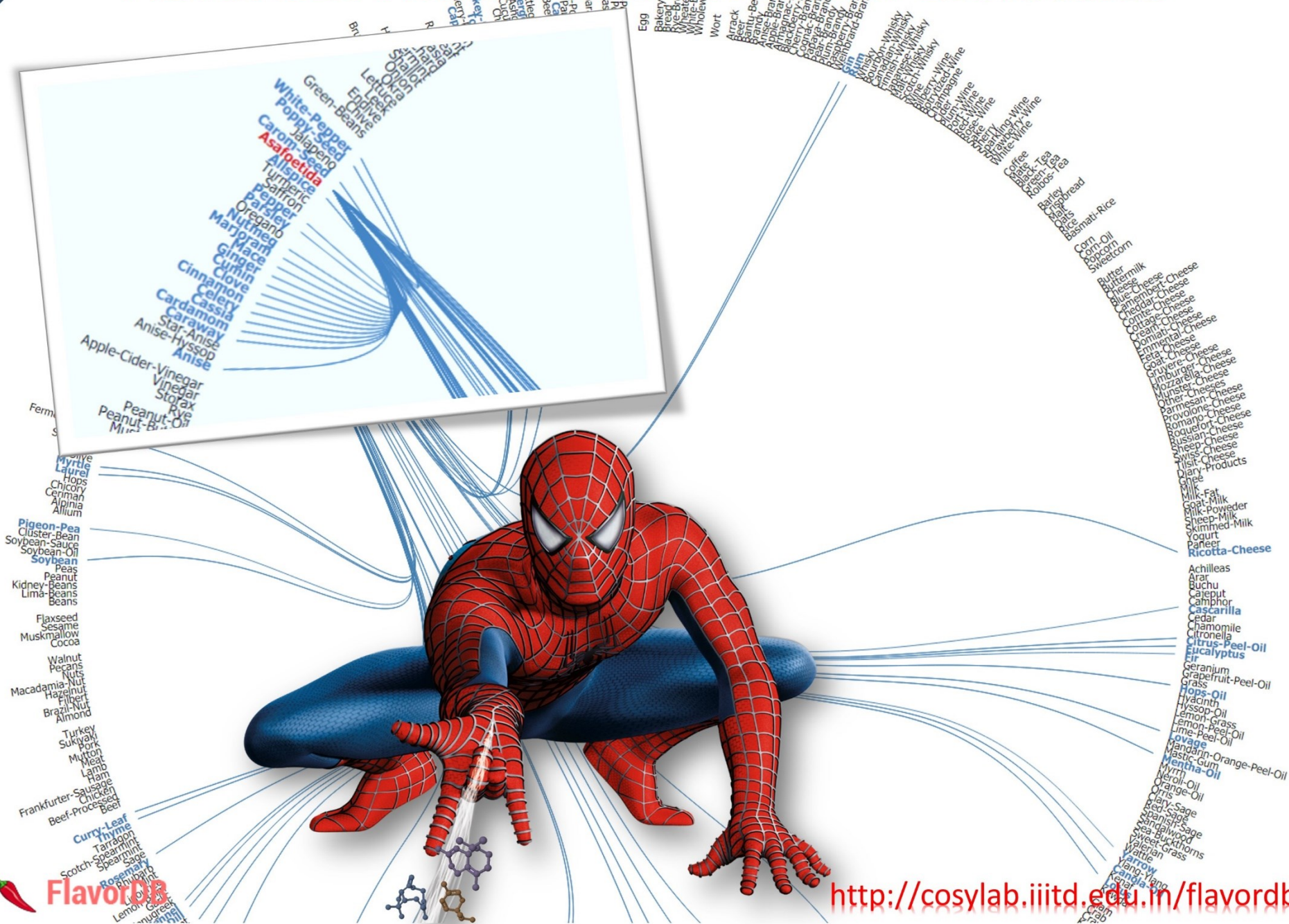
Best of 2015

MIT Technology Review

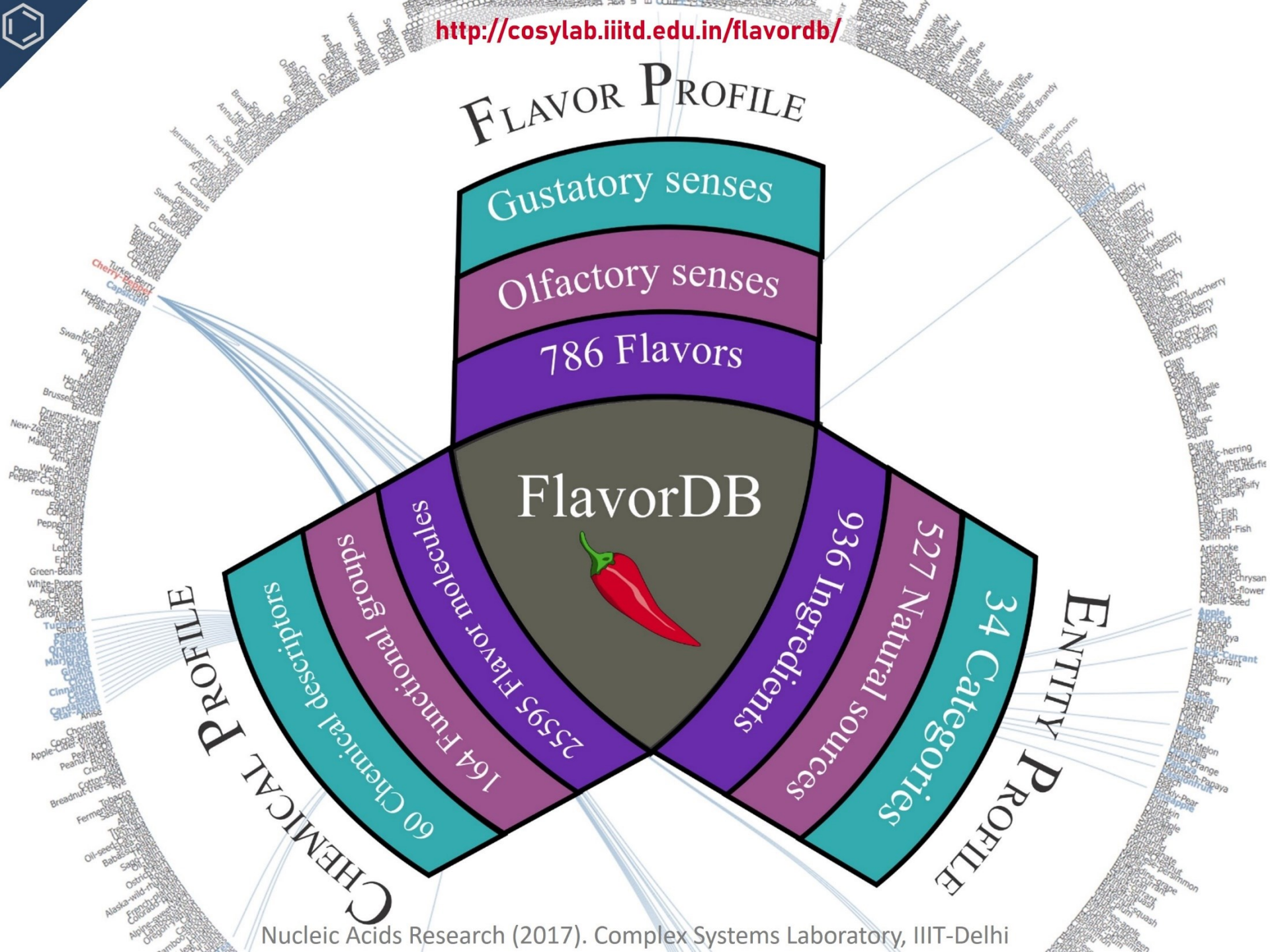
“The intersection of food science, data and computation is one of the most exciting frontiers, and your work is right in this sweet spot.”

Sam Arbesman
Scientist in Residence, Lux Capital





<http://cosylab.iiitd.edu.in/flavordb>





LAUNCHED@
World Heritage Cuisine Summit



FlavorDB

Trending Flavors

↗fruity

↗vanilla

↗mousy

↗balsamic

↗sweet

↗apple

Ingredient Categories



Dairy



Fruit



Fish



Herb



Meat

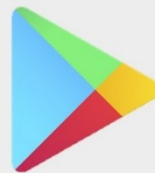
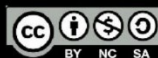


Bakery

[VIEW ALL INGREDIENT CATEGORIES](#)



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Google Play



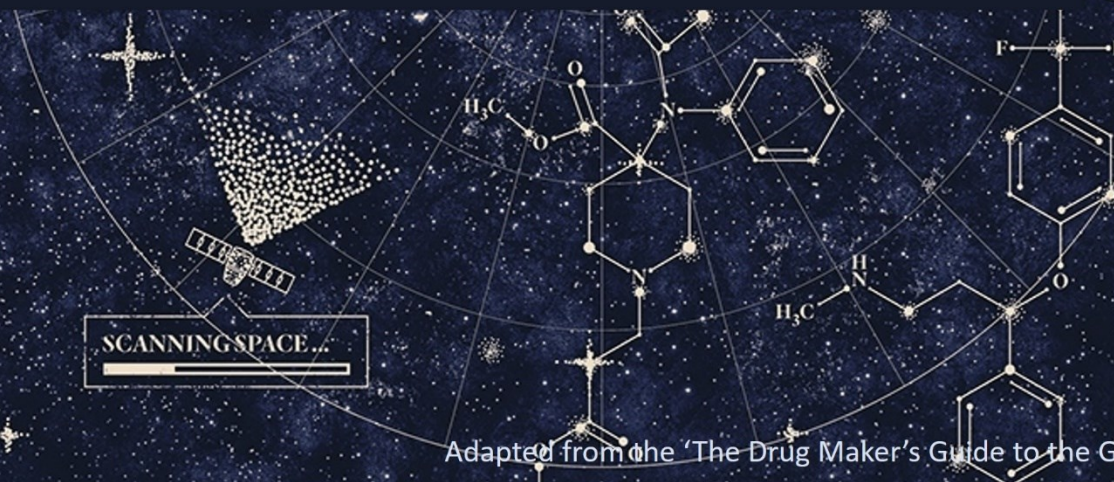


Computational Food

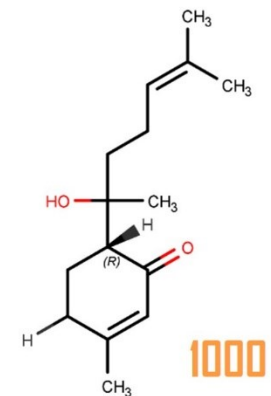
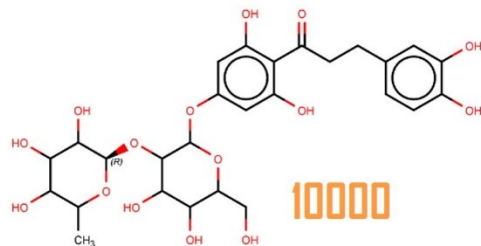
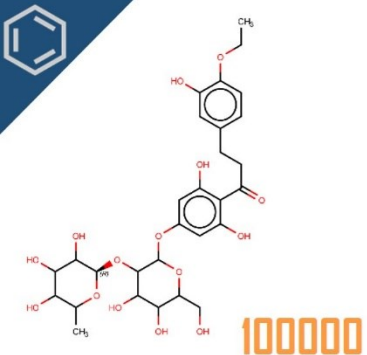


The Food Maker's Guide to the Galaxy

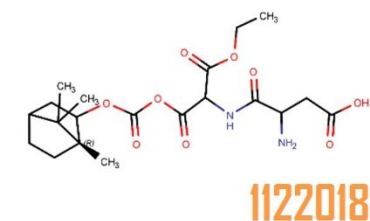
How Machine Learning and Big Data can help chemists search the vast chemical universe for better food



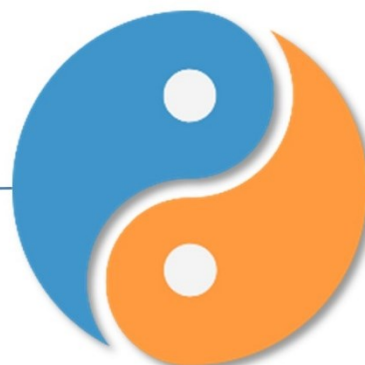
Adapted from the 'The Drug Maker's Guide to the Galaxy,' A. Mullard, Nature, (2017)



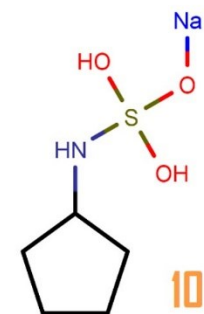
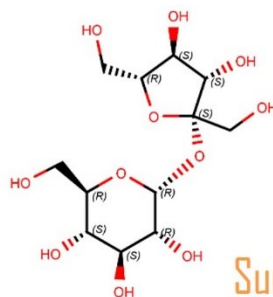
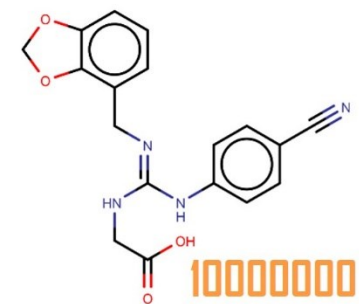
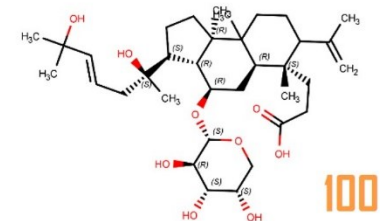
Taste Classification & Prediction



Bitter

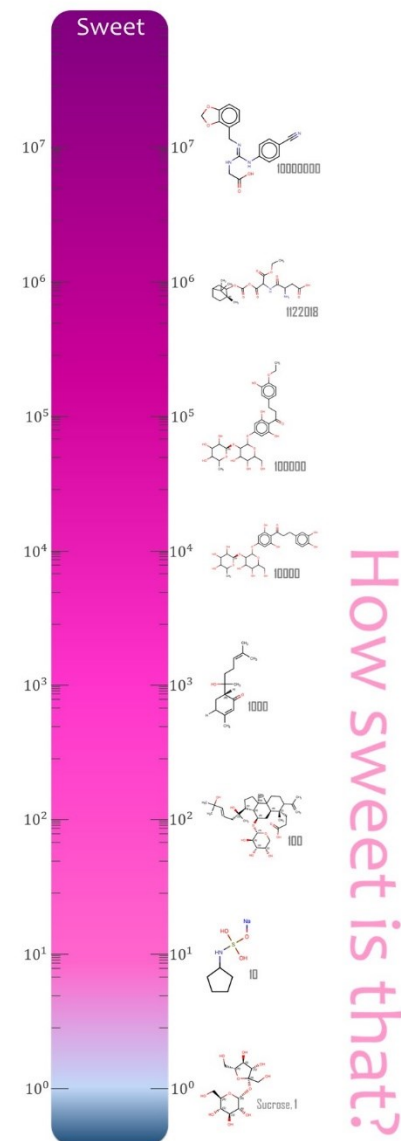
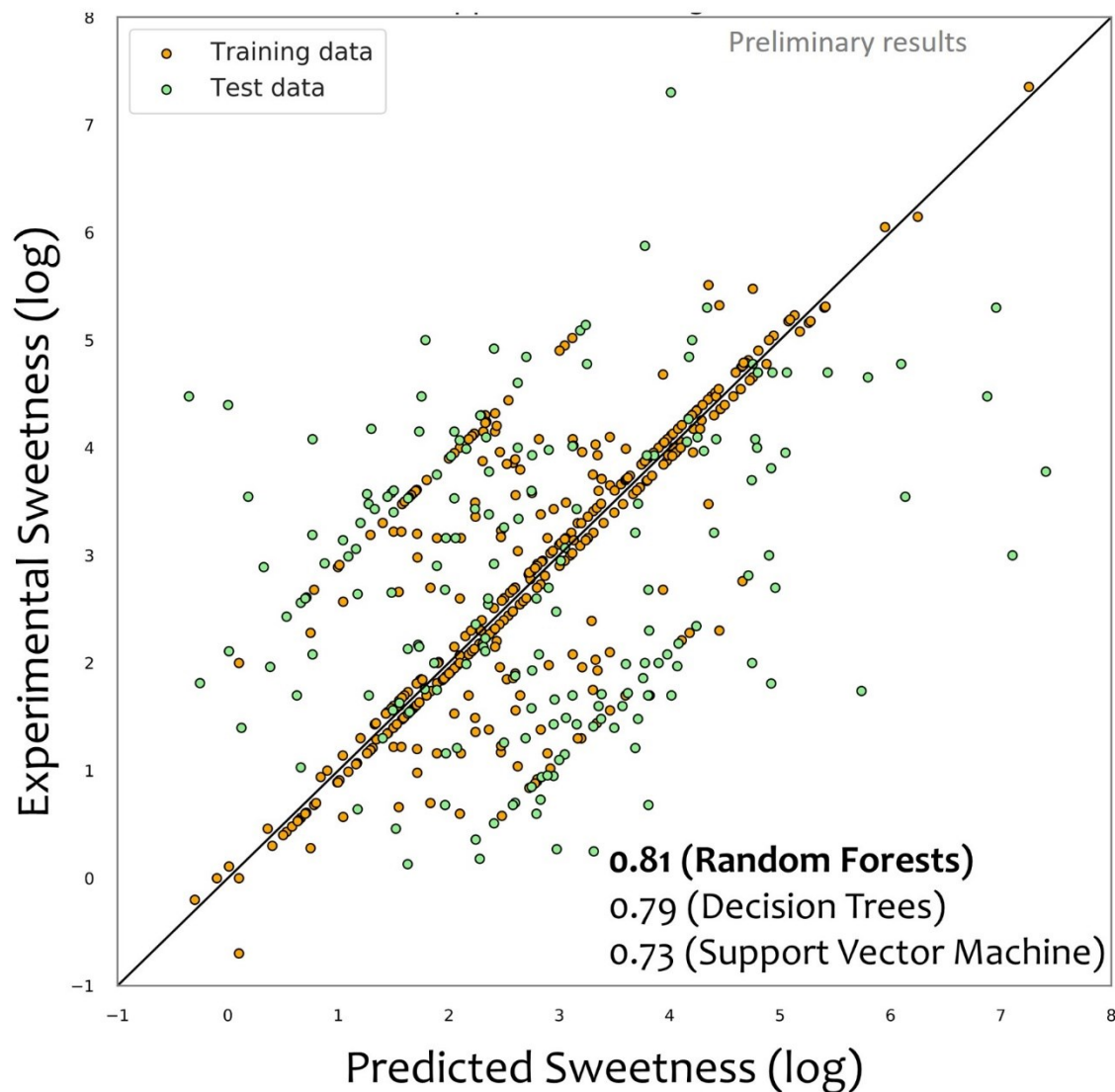


Sweet





How sweet is that?



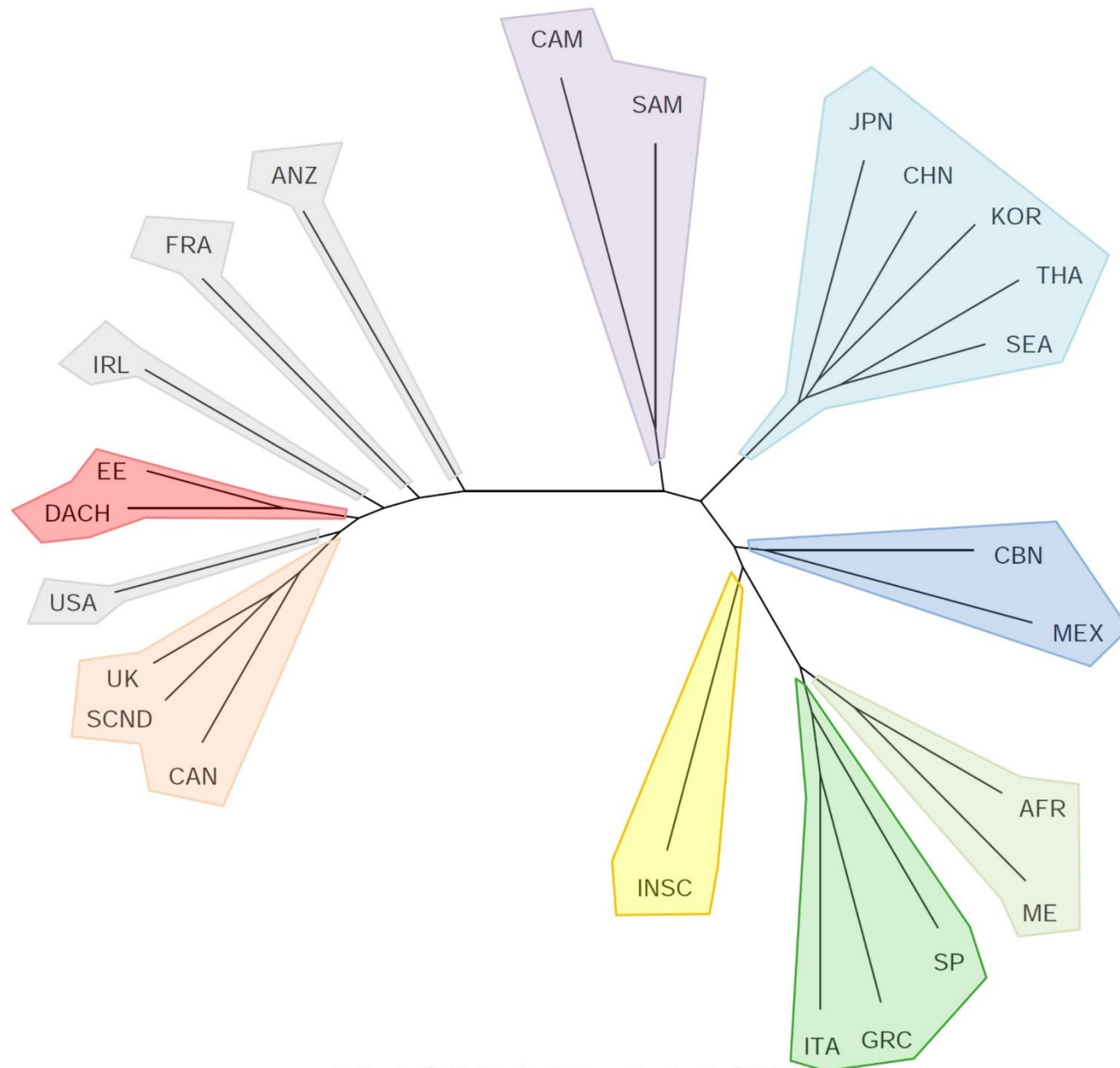


Culinary Fingerprints of the World Cuisine





Culinary Evolution: A Darwinian look at the World Culinary Landscape



G Bagler*, N Singh, R Tuwani, et. al. (2018).

'Culinary Evolution: A case for the evolution of cuisines as an integral part of the culture', Ganesh Bagler, 2018 (Draft Essay).



10^{30}



The Ratatouille World





Dietary Interventions Strategies

$$f(\text{person} \times \text{dietary cube}) = \text{stethoscope}$$

The diagram illustrates a dietary intervention strategy. It features a function f applied to the product of a person icon and a dietary cube. The dietary cube is a 3x3x3 grid containing various food items, including vegetables, fruits, grains, and proteins. The result of the function is represented by a stethoscope icon, symbolizing health or medical intervention.



Why spices? Broad-spectrum benevolence of culinary herbs and spices

“Data-driven analysis of biomedical literature suggests broad-spectrum benefits of culinary herbs and spices,”
Rakhi NK, Tuwani R, Mukherjee J, Bagler G, PLoS ONE 13(5): e0198030 (2018).

VOLUME 73, No. 1

MARCH 1998

THE QUARTERLY REVIEW of BIOLOGY



ANTIMICROBIAL FUNCTIONS OF SPICES:
WHY SOME LIKE IT HOT

JENNIFER BILLING* AND PAUL W. SHERMAN

Section of Neurobiology and Behavior, Cornell University
Ithaca, NY 14853 USA



Darwinian Gastronomy: Why We Use Spices

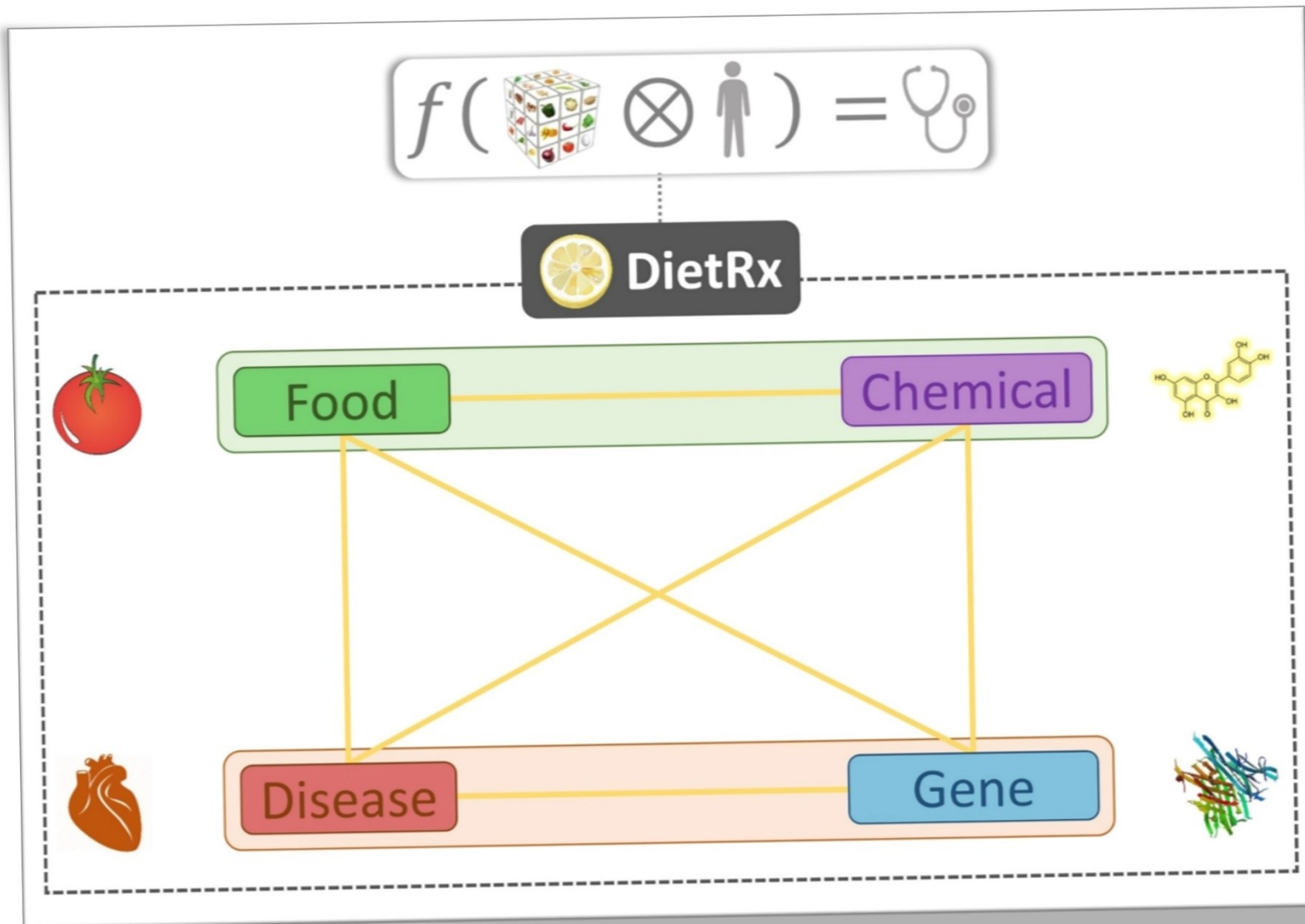
Spices taste good because they are good for us

Paul W. Sherman and Jennifer Billing

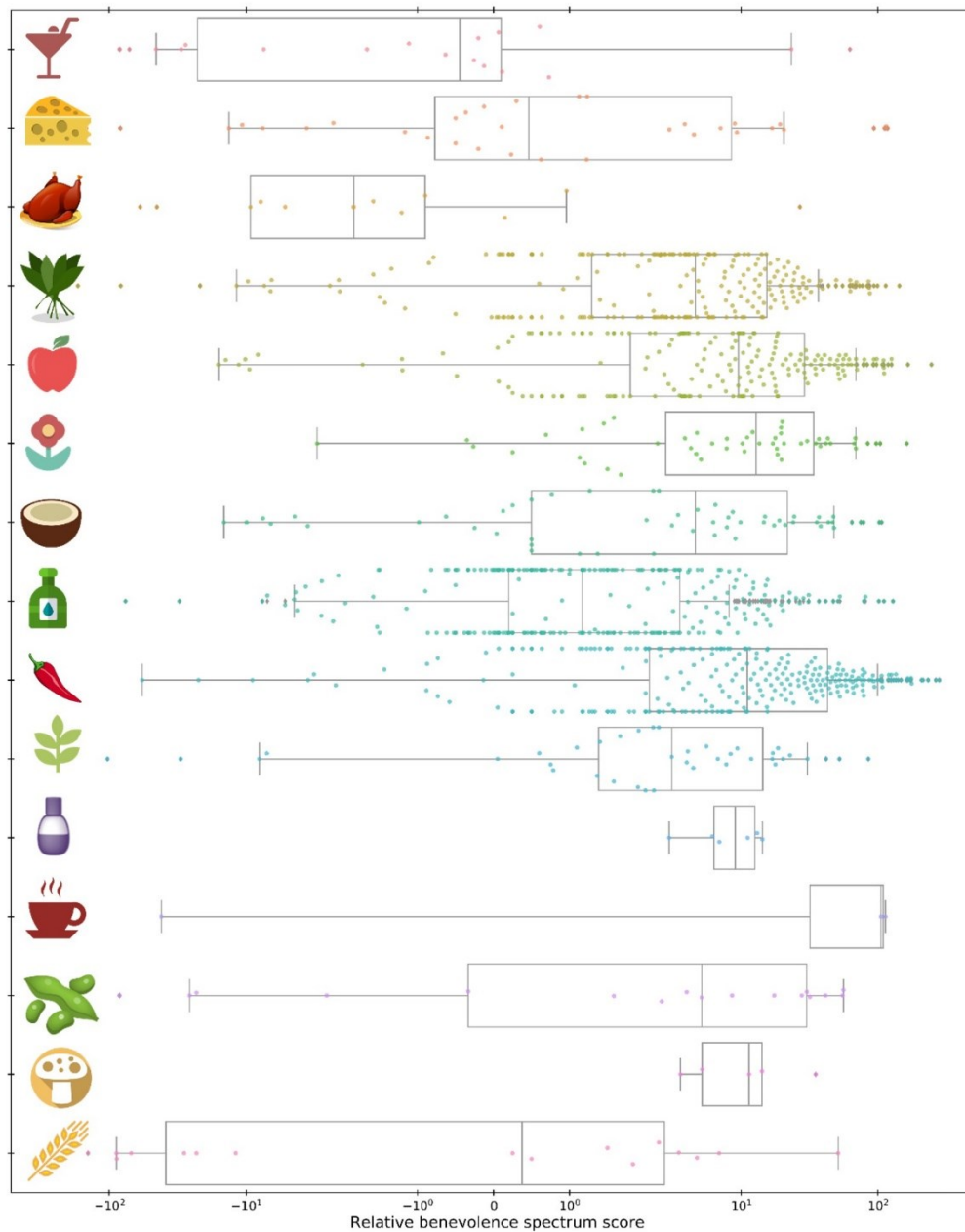
Humans have borrowed
plants' chemical “recipes”
for evolutionary survival
for use in cuisine to
combat foodborne
microorganisms and to
reduce food poisoning



DietRx: An integrated resource for health impact of food



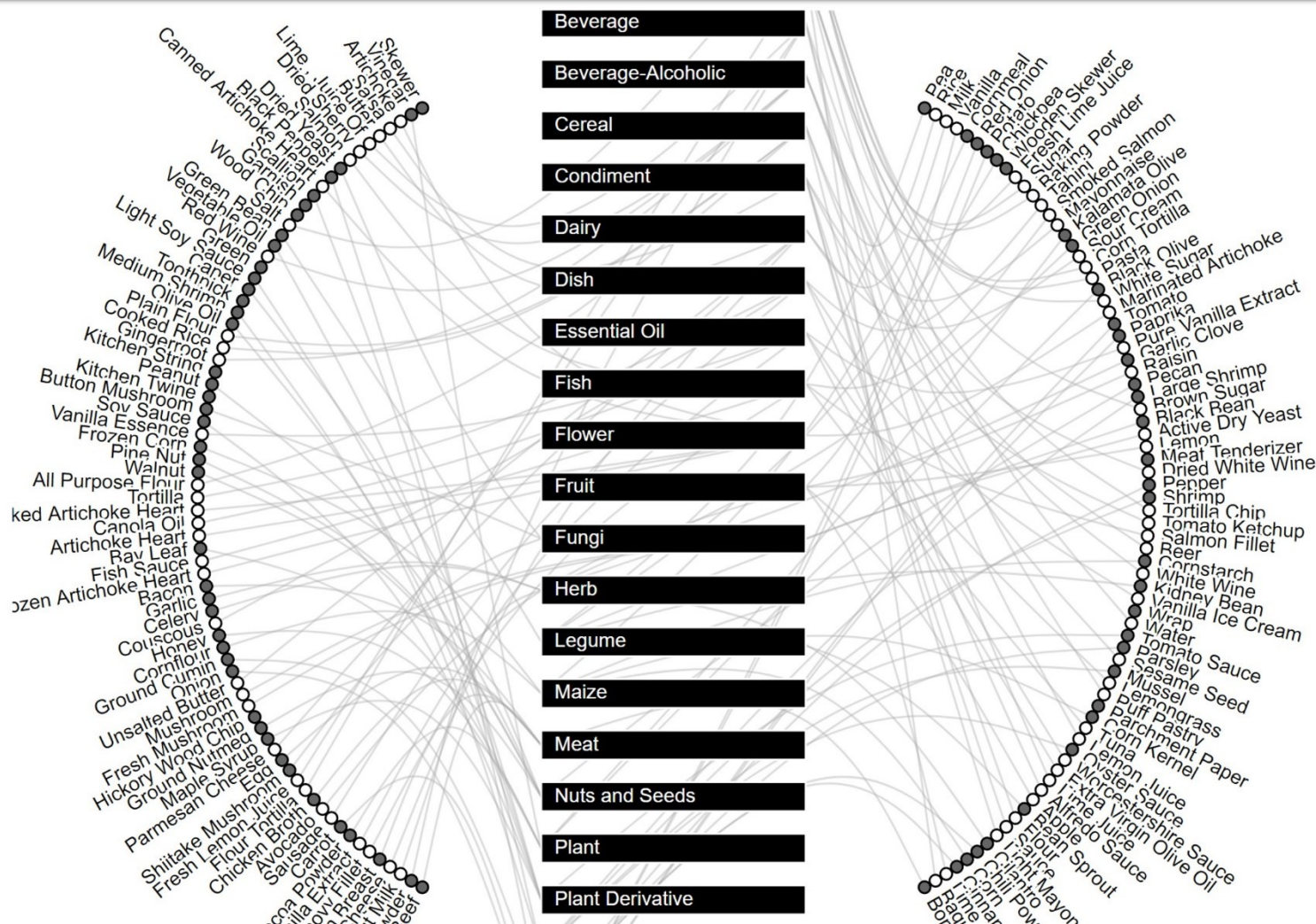
Relative Benevolence of Food





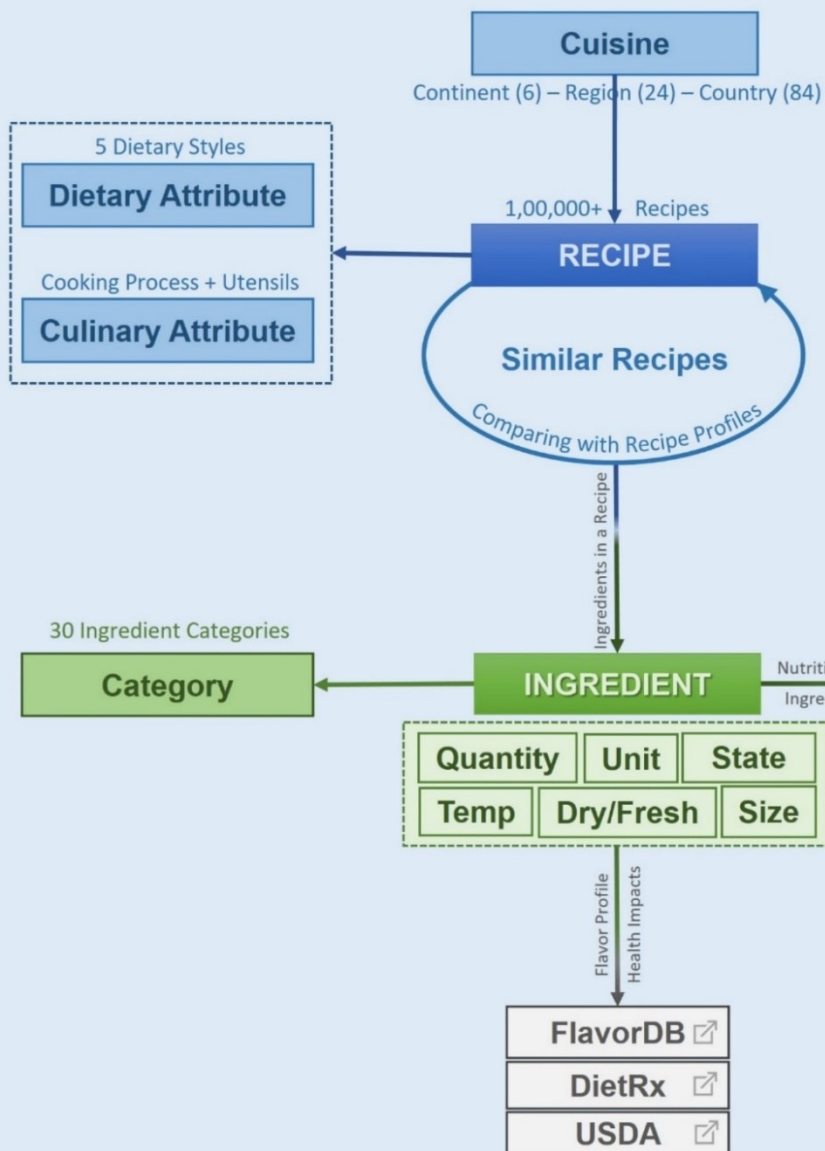
A resource for exploring recipes, their culinary, nutritional, flavor and health correlates

CONTACT US

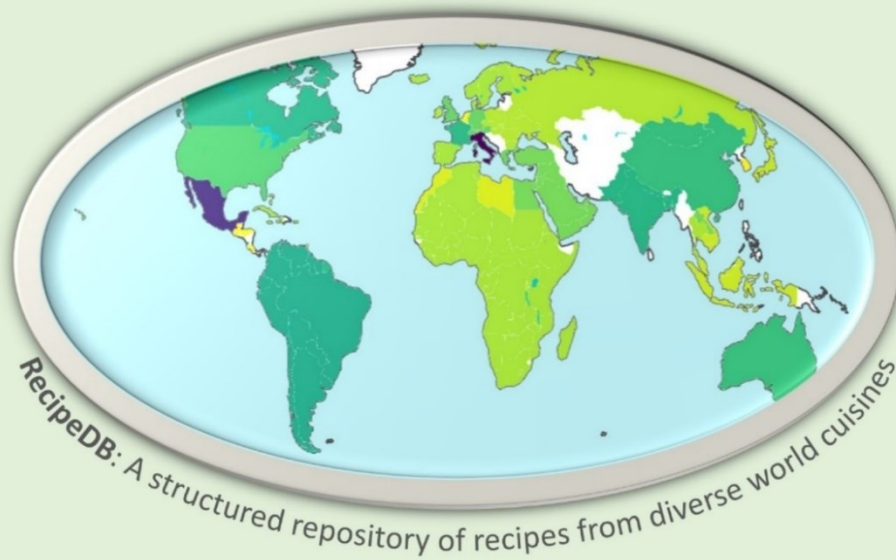




Recipe Space



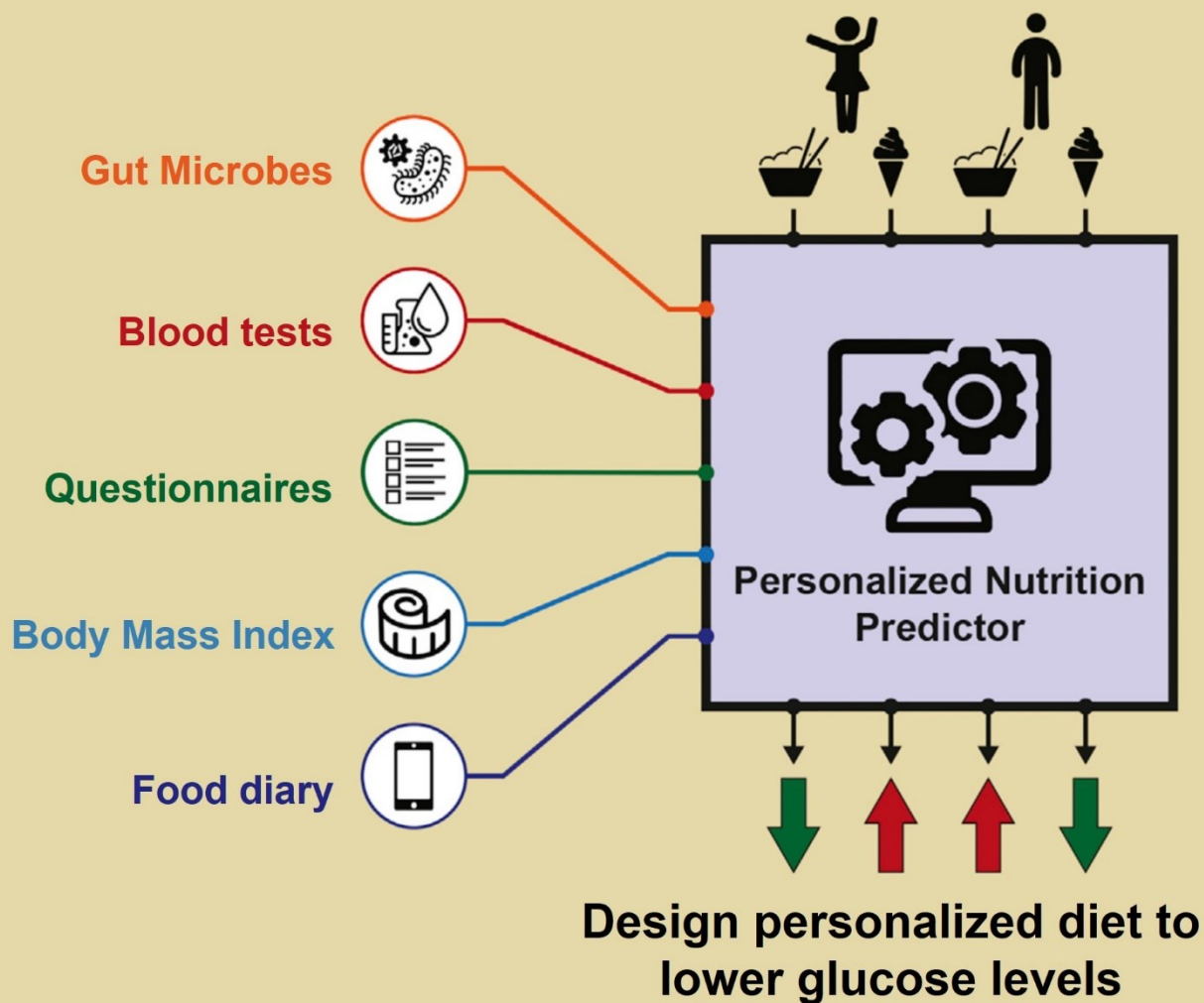
Nutrition Space



NUTRITION PROFILE OF RECIPE			
Nutrition Profile of Ingredients			
Energy	Carbohydrates	Protein	Fats
Fiber	Sugars	Water	
Minerals: Ca, Fe, Mg, P, Na, K, Zn, Cu, Mn, Se			
Vitamins: C, Thiamin, Riboflavin, Niacin, Pantothenic acid, Folate, Choline, Betaine, A, D, K, B-12, Retinol, Carotene, Tocopherol, ...			
Lipids	Amino Acids	Anthocyanidins	
Other Nutritional Factors			



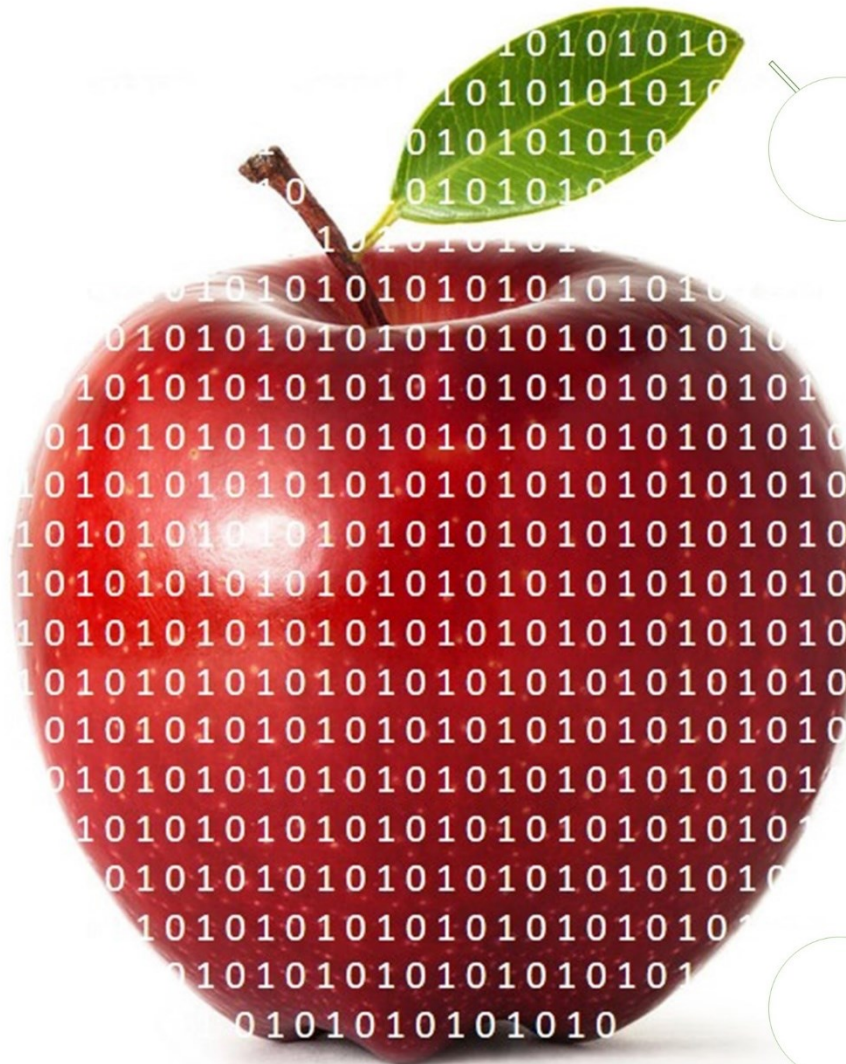
Personalized Nutrition



ED Sonnenburg and JL Sonnenburg, Nature, 528, 484 (2015).

Zeevi et al., "Personalized nutrition by prediction of glycemic response", Cell, 163, 1079 (2015).

Computational Gastronomy — Data-driven food innovations



Food-Beverage Pairing

Taste/Odor Prediction

Culinary Fingerprinting

Dietary Interventions

Food & Beverages Design

Sustainable Food Innovations

“



The discovery of a new **dish** confers more happiness on humanity, than the discovery of a new **star**.”



Jean Anthelme Brillat-Savarin

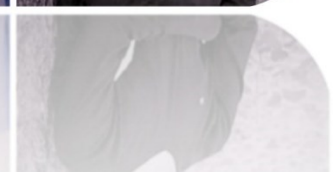
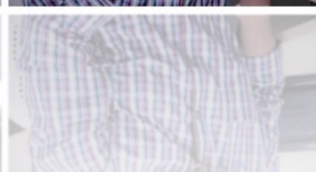
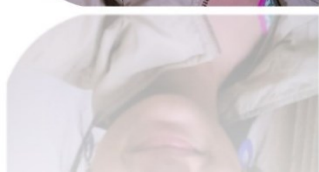
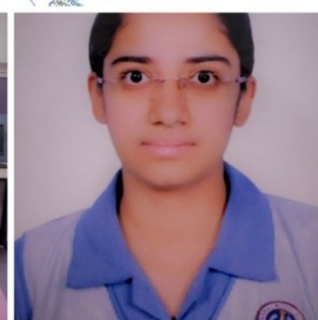
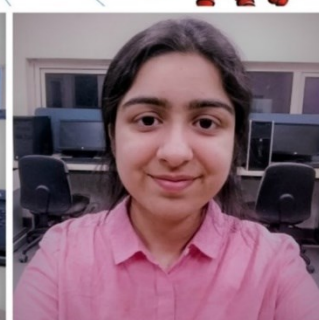
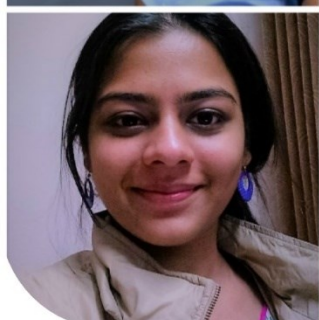
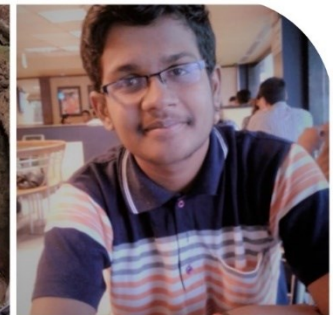
M.Tech. Project Research Scholars

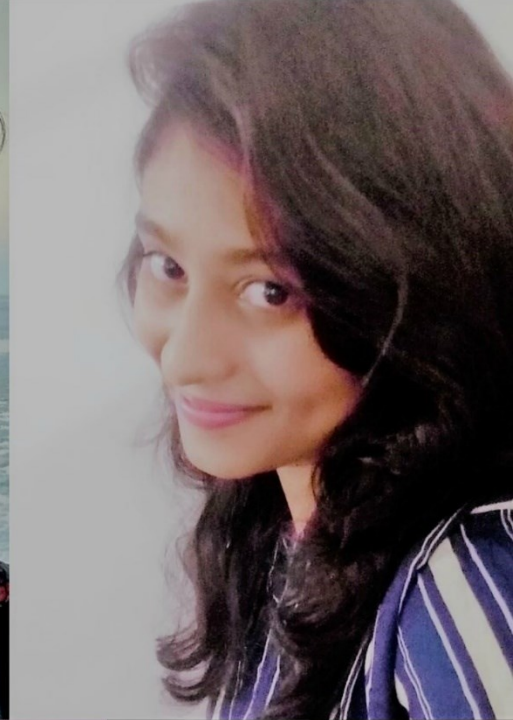
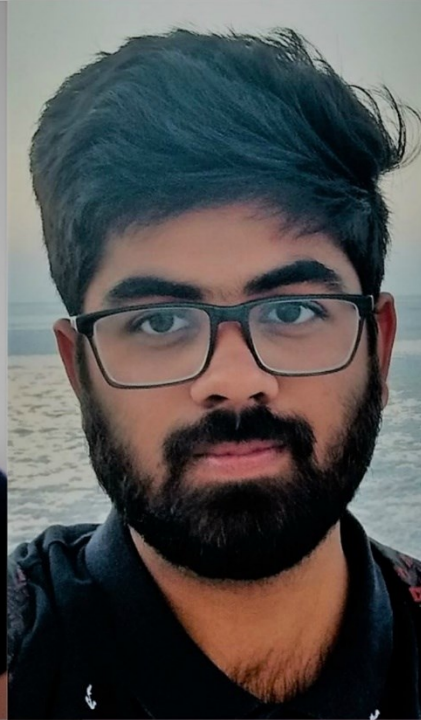
PhD Research Scholars

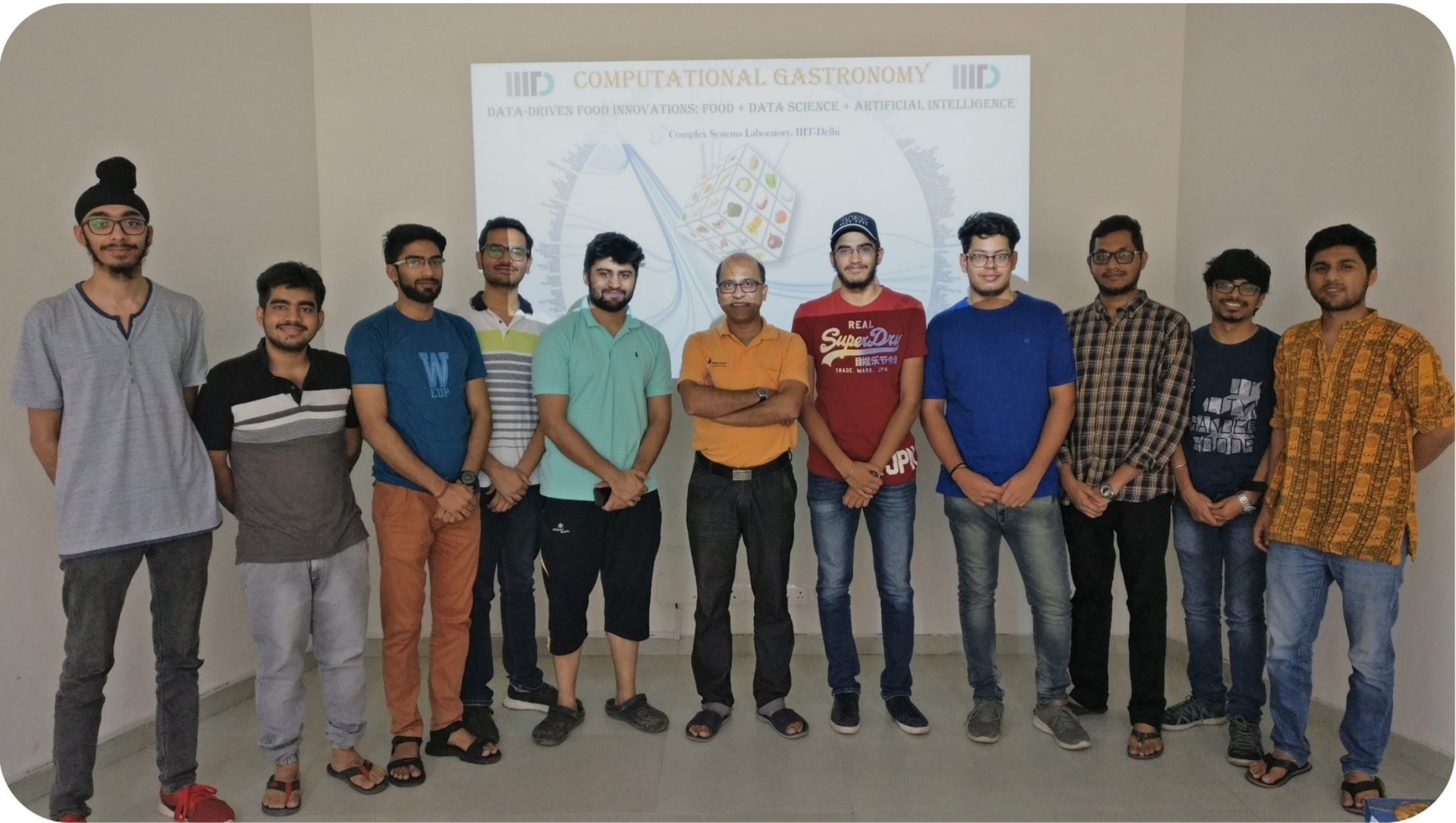
B.Tech. Project Students

Thank you!

Image Credits: Wikipedia, Google Images (wherever applicable)







Summer19@CoSyLab



PhD Positions

:: Opportunities for the PhD research :: Computational Gastronomy, Machine Learning, Complex Networks, Data Analytics for Biomedical Applications, *in silico* Drug Discovery, Chemoinformatics, Systems and Network Biology.

Skills: Machine Learning, Data Analytics, Text Mining, Python/R, Natural Language Processing, Database & Webserver Design, Supervised Classification, High-Dimensional Data Analysis, Association Rule Learning...

Summer 2019

:: Summer Research Internships ::

- Culinary fingerprinting
- Novel Recipe Generation Algos
- Odor and Taste Prediction with Machine Learning
- Making sense of the flavor space
- Food-Disease associations
- Dietary Interventions Strategies
- Chemical Space: *in silico* chemical synthesis
- Recipe Data Structure Design
- Perfume and fragrance analytics
- Android Apps: FlavorDB
Premium, DietRx, NutriBot,
Recipe Crowdsourcing Project.



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<http://cosylab.iiitd.ac.in>

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Supporting partners:

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