

Mesterséges intelligencia az orvosbiológiában

Artificial intelligence in biomedicine

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Computational Biomedicine (ComBine) Workgroup

Intelligent Systems Group

Faculty of Electrical Engineering and Informatics (VIK)

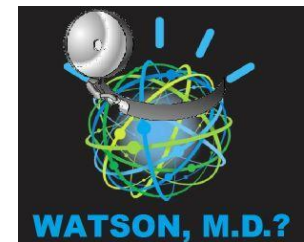
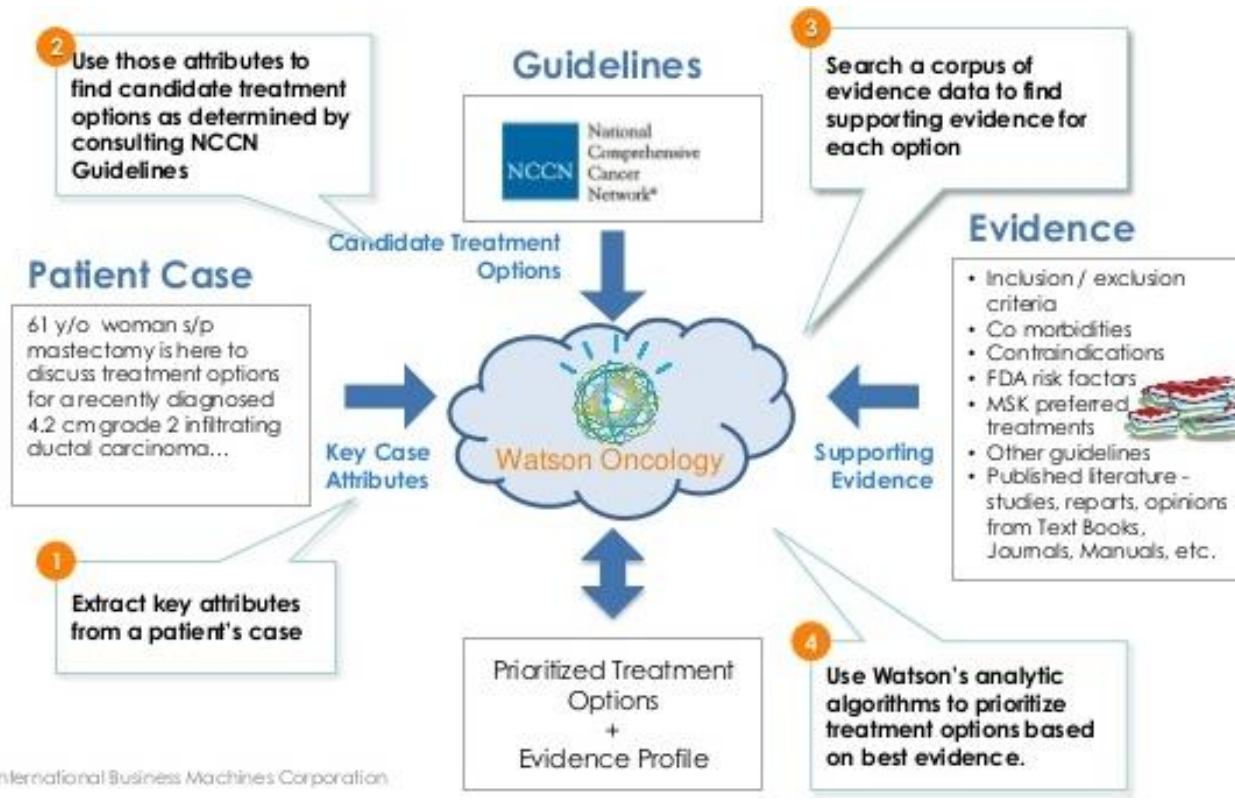
Department of Measurement and Information Systems

Budapest University of Technology and Economics (BME)

Ágenda

- A „Computational biomedicine” (ComBine) labor bemutatása
- Mesterséges intelligencia az orvosbiológiában és a klinikumban
 - Genetikai mérés technika
 - Képfeldolgozás
 - Adatelemzés
 - Szövegelemzés
 - Döntéstámogatás
- Javasolt témák és kapcsolódó kurzusok

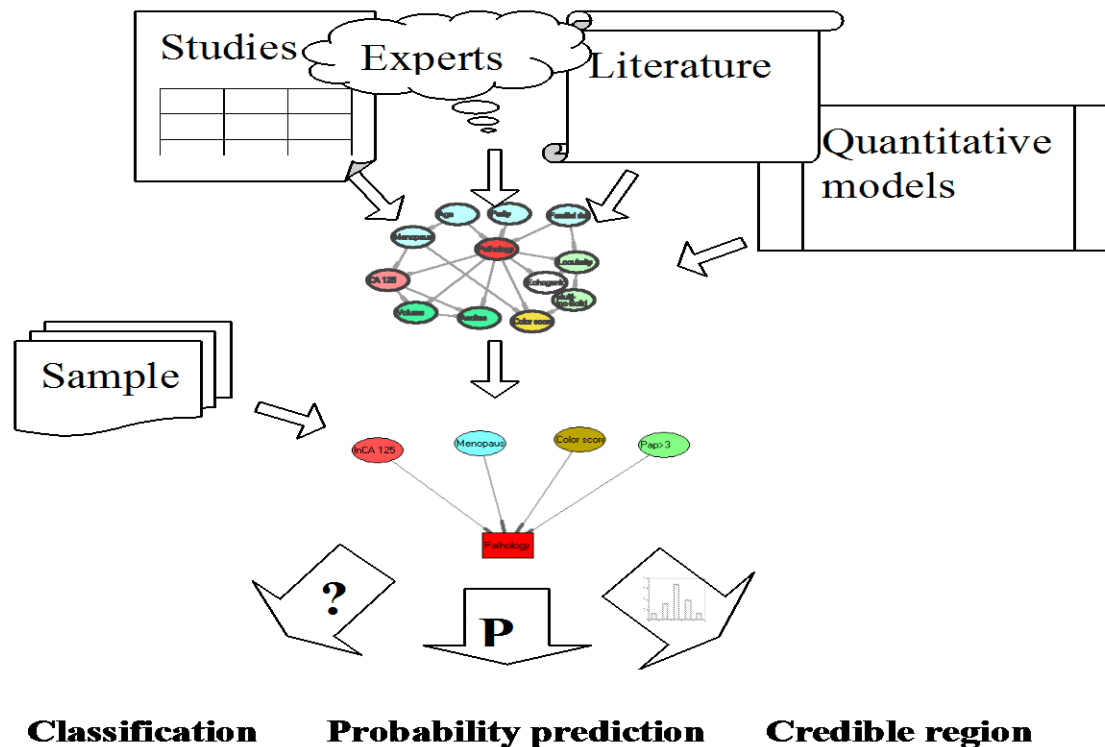
Medical decision support systems



Watson for Oncology – assessment and advice cycle

www.avanteoconsulting.com/machine-learning-accelerates-cancer-research-discovery-innovation/

Mesterséges intelligencia az egészségügyi adatelemzésben

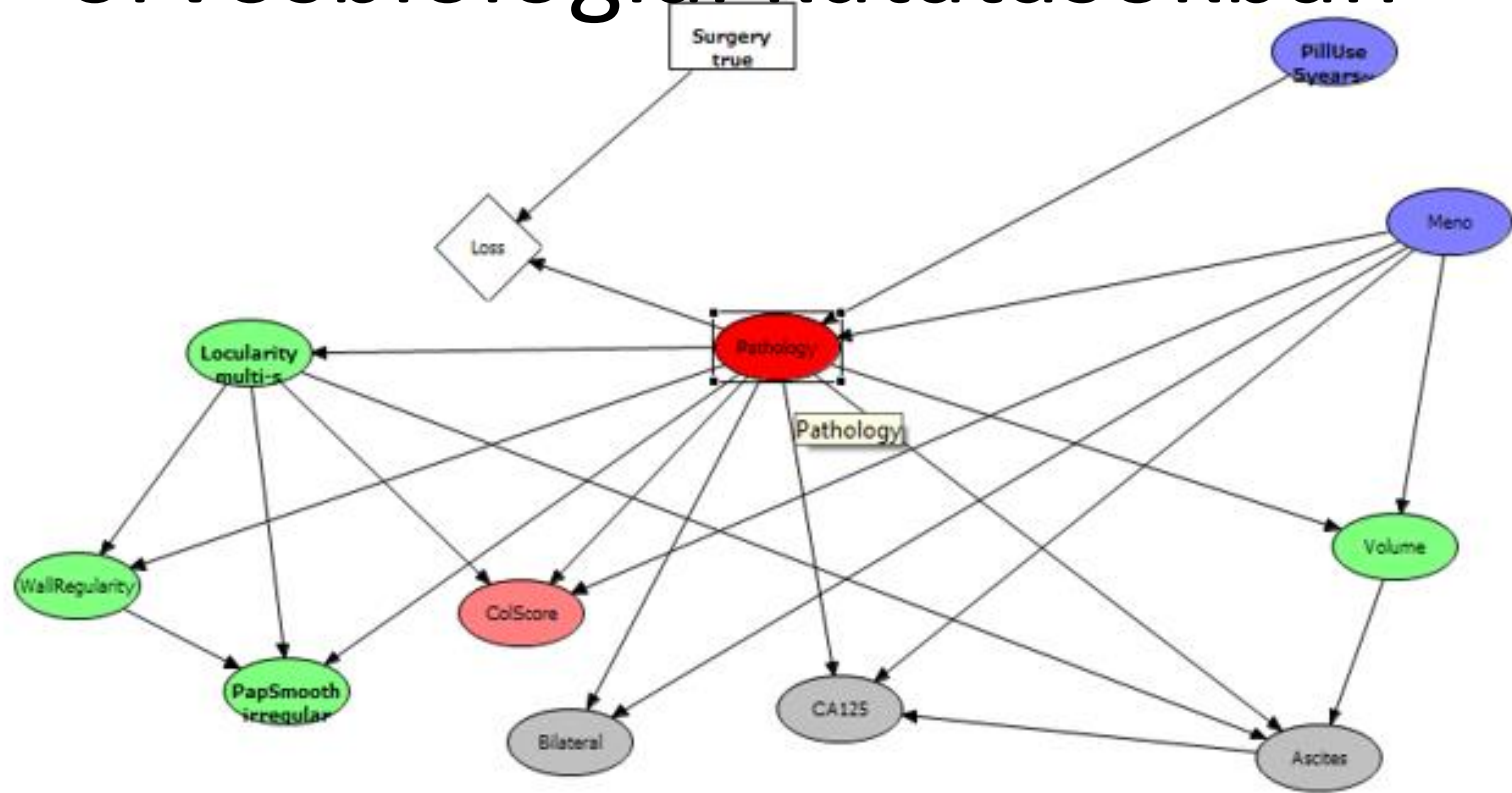


- Petefészekrák nem-invazív diagnosztikája

- International Ovarian Tumor Analysis (IOTA, Dirk Timmerman)

P. Antal, G. Fannes, D. Timmerman, Y. Moreau, B. De Moor: Bayesian Applications of Belief Networks and Multilayer Perceptrons for Ovarian Tumor Classification with Rejection, *Artificial Intelligence in Medicine*, vol. 29, pp 39-60, 2003

Mesterséges intelligencia az orvosbiológiai kutatásokban



International Ovarian Tumor Analysis (IOTA, Dirk Timmerman)

Antal, P., Fannes, G., Timmerman, D., Moreau, Y. and De Moor, B., 2004. Using literature and data to learn Bayesian networks as clinical models of ovarian tumors. *Artificial Intelligence in medicine*, 30(3), pp.257-281.

Computational Biomedicine COMBINE lab



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Downloads

BayesCube for Windows 32-bit
BayesCube for Windows 64-bit
BayesCube for Linux 32-bit
BayesCube for Linux 64-bit
BayesCube for MacOSX 64-bit

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Visual data analytics in pharmaceutical informatics

Date: 11/01/2017

In cooperation with CERN and MTA-Wigner we will investigate the use of large-scale, semantic visual data analytics in drug discovery.



Privacy preserving fusion in CELSA

Date: 10/01/2017

Our new project "HIDUCTION: Privacy preserving data sharing, analysis and decision support in personalized medicine" will start this year in cooperation with ESAT-STADIUS, K.U.Leuven (2017-2019).



Continued participation in the "UK Biobank"

Date: 09/13/2017

The "UK Biobank project No.1602" is extended till 2020. In cooperation with the University of Manchester and Semmelweis University, we investigate the interactions between diet, psychosocial and genetic factors for self-reported depression and related disorders



We joined the NVIDIA GPU GRANT program

Date: 09/06/2017

We joined the NVIDIA GPU GRANT program of Nvidia Corporation. We will explore bioinformatic and chemoinformatic applications of the donated GPUs.



New Bayesian OTKA project

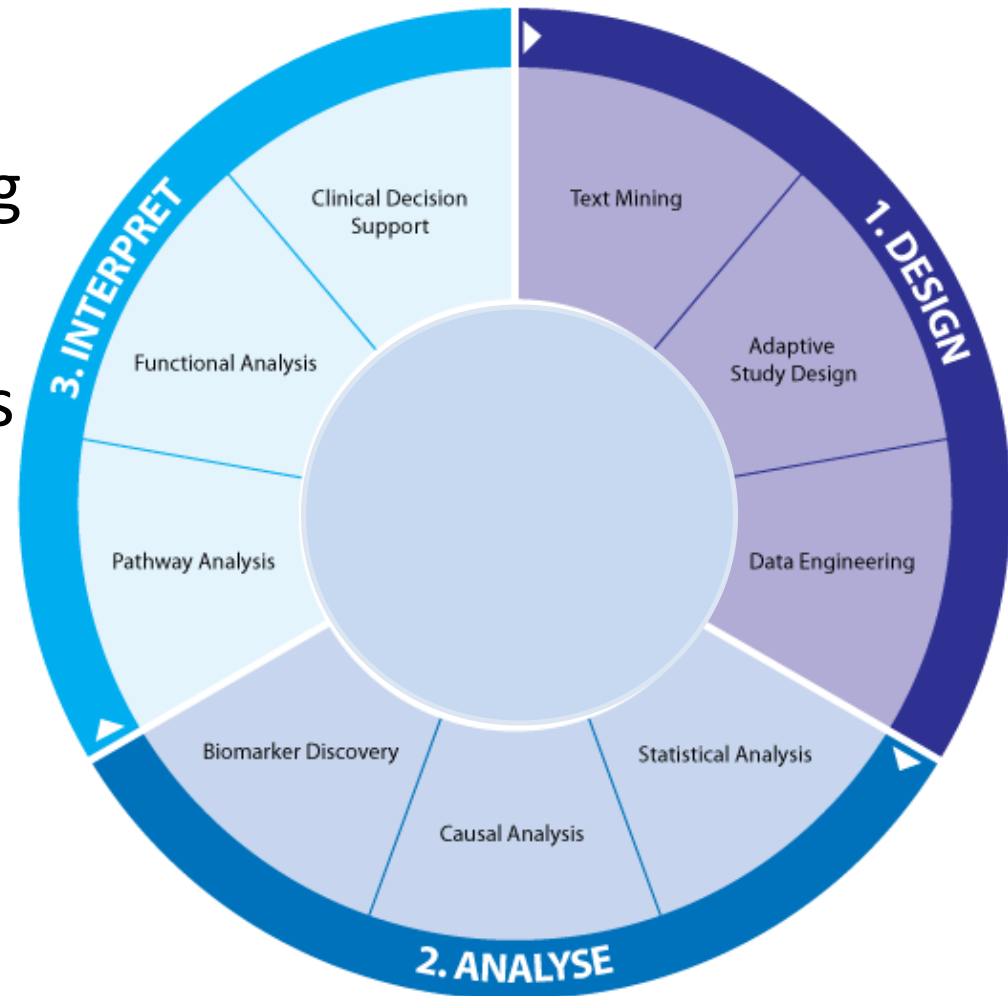
Team

Bence Bolgár
András Gézsi
Gábor Hullám
András Millinghoffer
Péter Sárközy
Péter Antal

<http://bioinfo.mit.bme.hu/>

ComBineLab.hu: Themes

- Knowledge engineering
- Study design
- Genetic measurements
- Data engineering
- Data analysis
- Interpretation
- Decision support



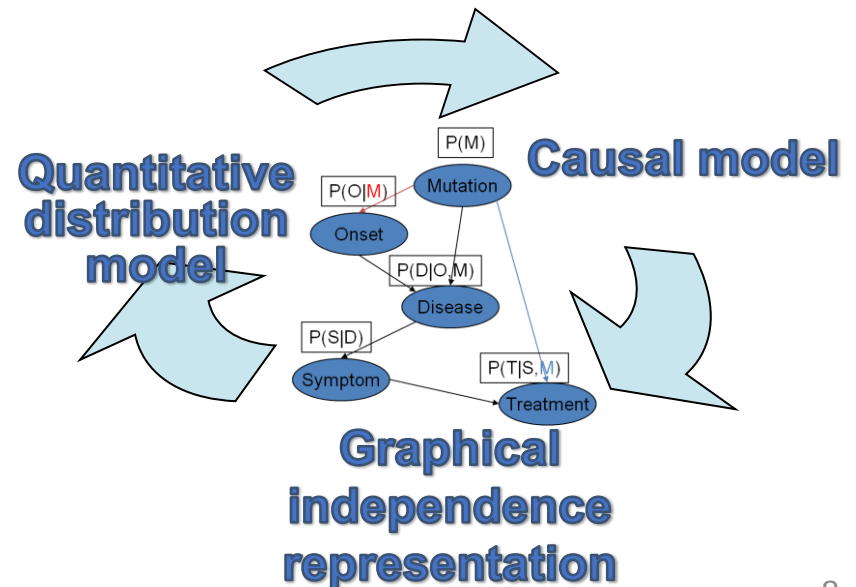
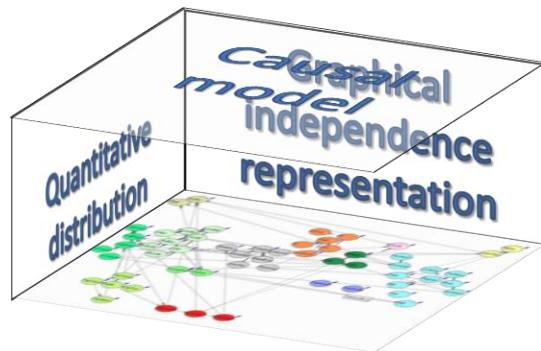
Probabilistic graphical models: Bayesian Networks

- A directed acyclic graph (DAG)
- Nodes are random variables
- Edges represent direct dependence (causal relationship)
- Local models: $P(X_i | \text{Pa}(X_i))$
- Offers three interpretations

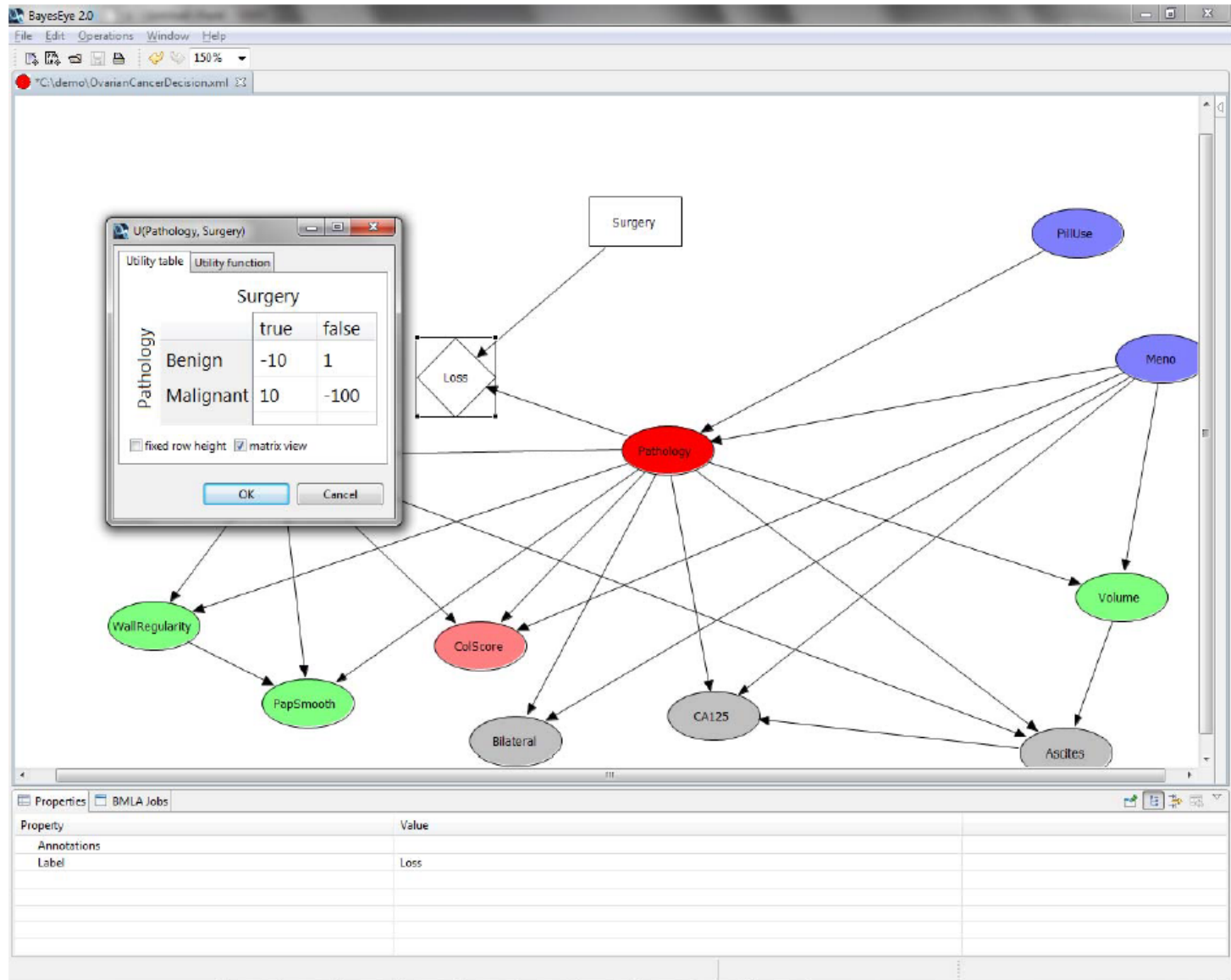
Thomas Bayes
(c. 1702 – 1761)



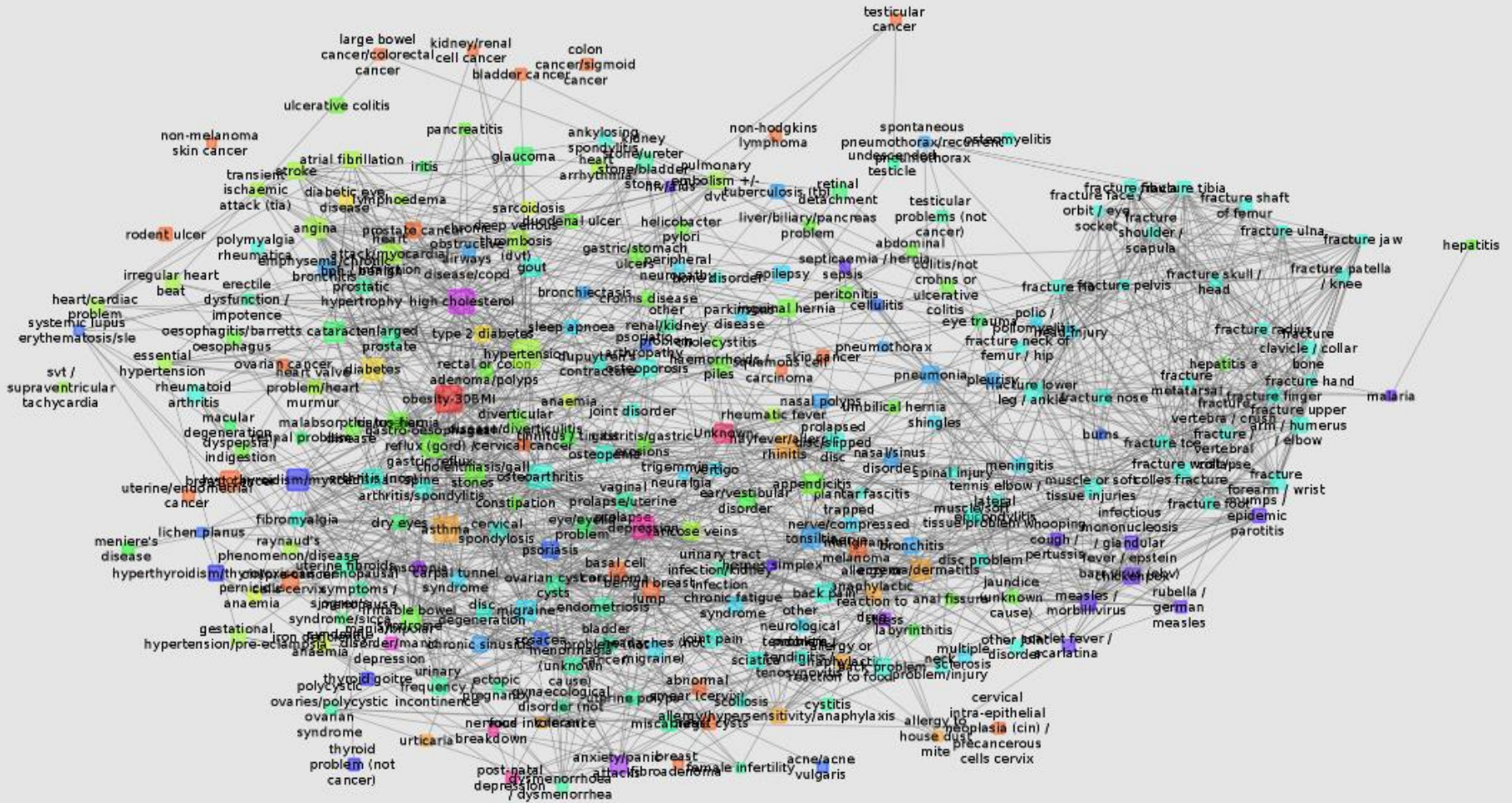
$$P(\text{Model} | \text{Data}) \propto P(\text{Data} | \text{Model})P(\text{Model})$$



Decision networks

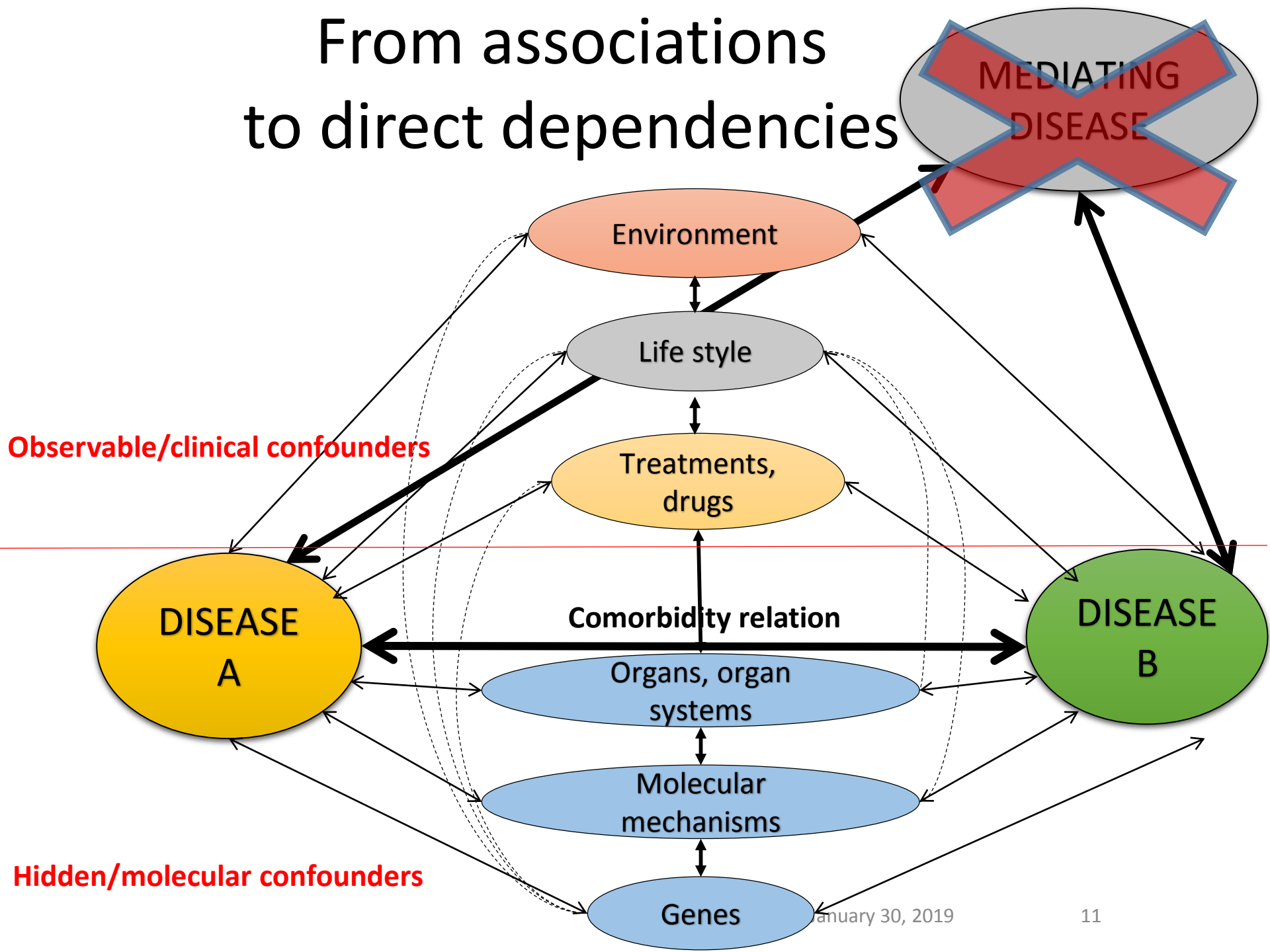


The diseasesome using real epidemiological data

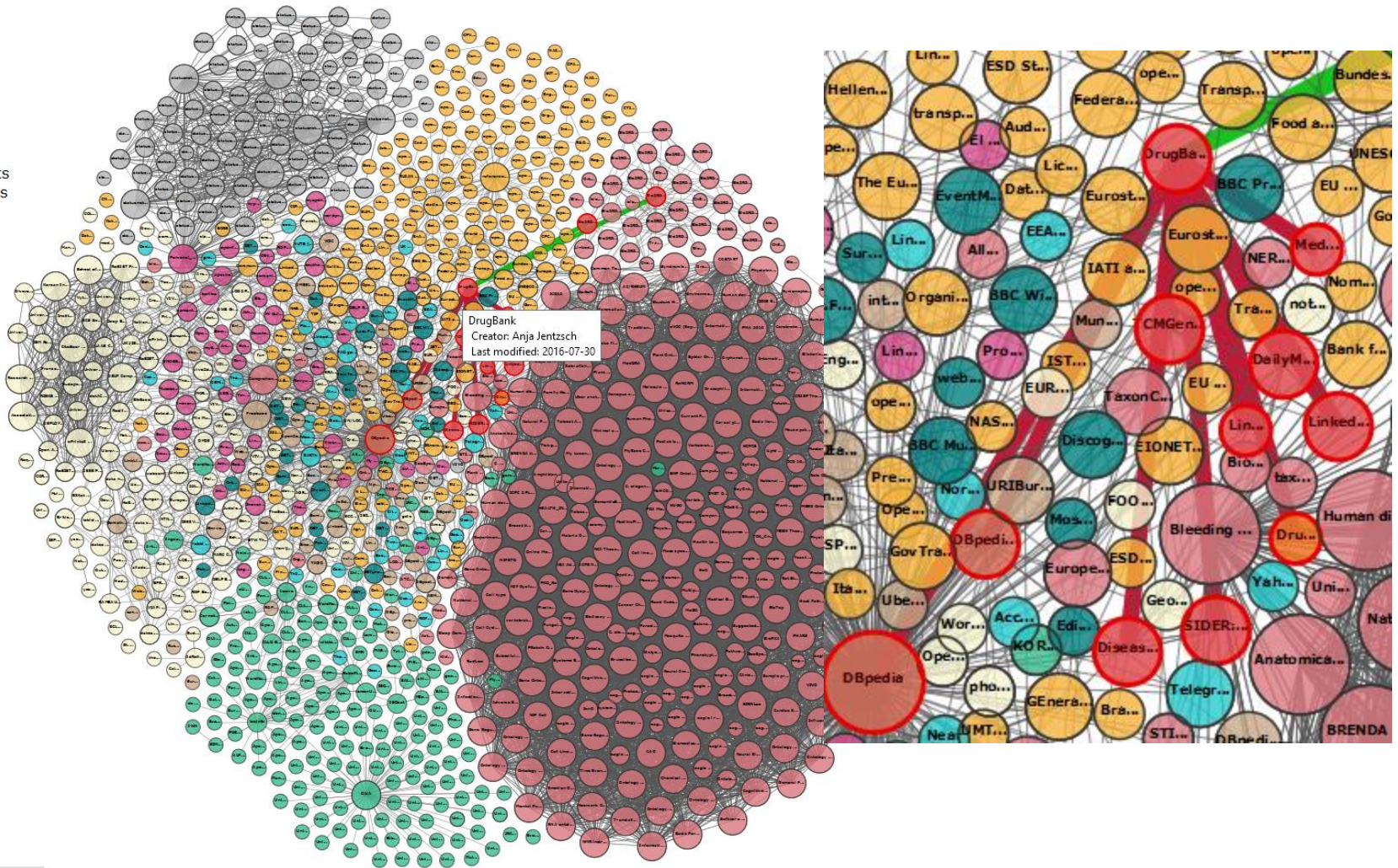


Marx, P., Antal, P., Bolgar, B., Bagdy, G., Deakin, B., & Juhasz, G. (2017). Comorbidities in the diseasesome are more apparent than real: What Bayesian filtering reveals about the comorbidities of depression. *PLoS computational biology*, 13(6), e1005487.

From associations to direct dependencies

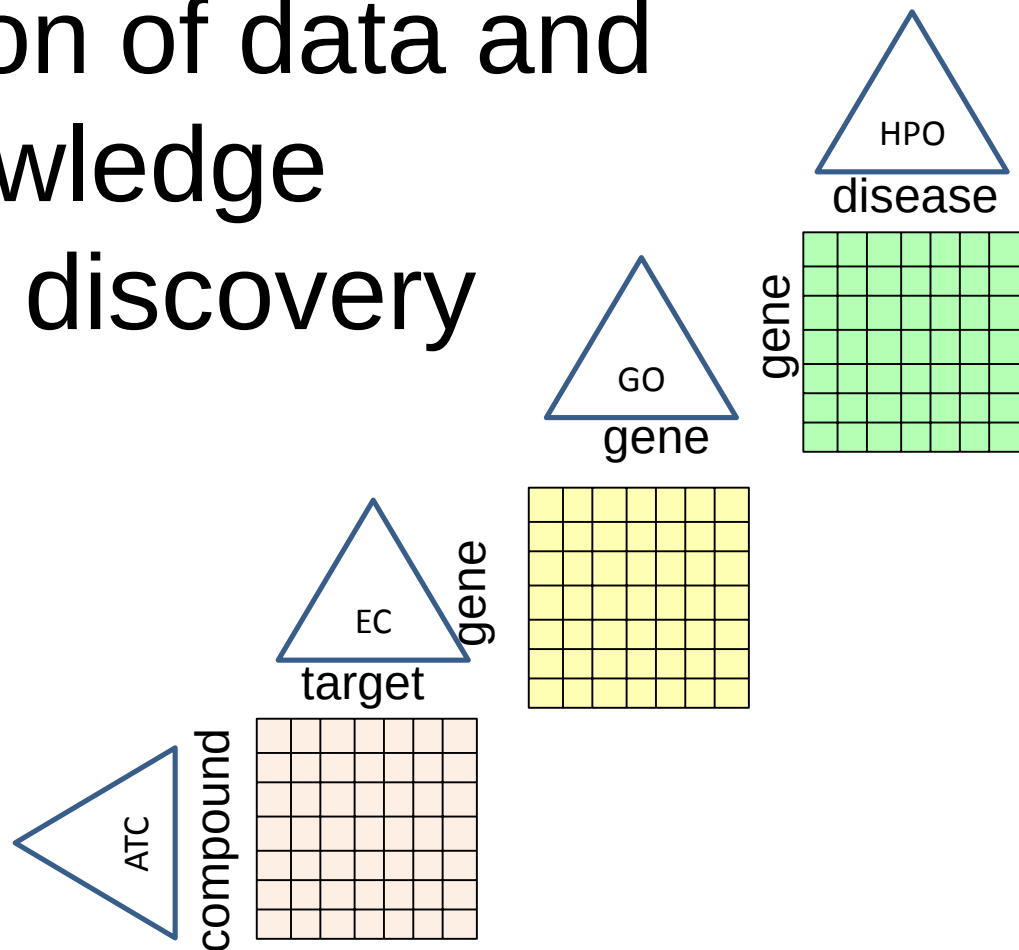


Knowledge: Linked open data



Linking Open Data cloud diagram 2017, by Andrejs Abele, John P. McCrae, Paul Buitelaar, Anja Jentzsch and Richard Cyganiak. <http://lod-cloud.net/>

Combination of data and knowledge in drug discovery

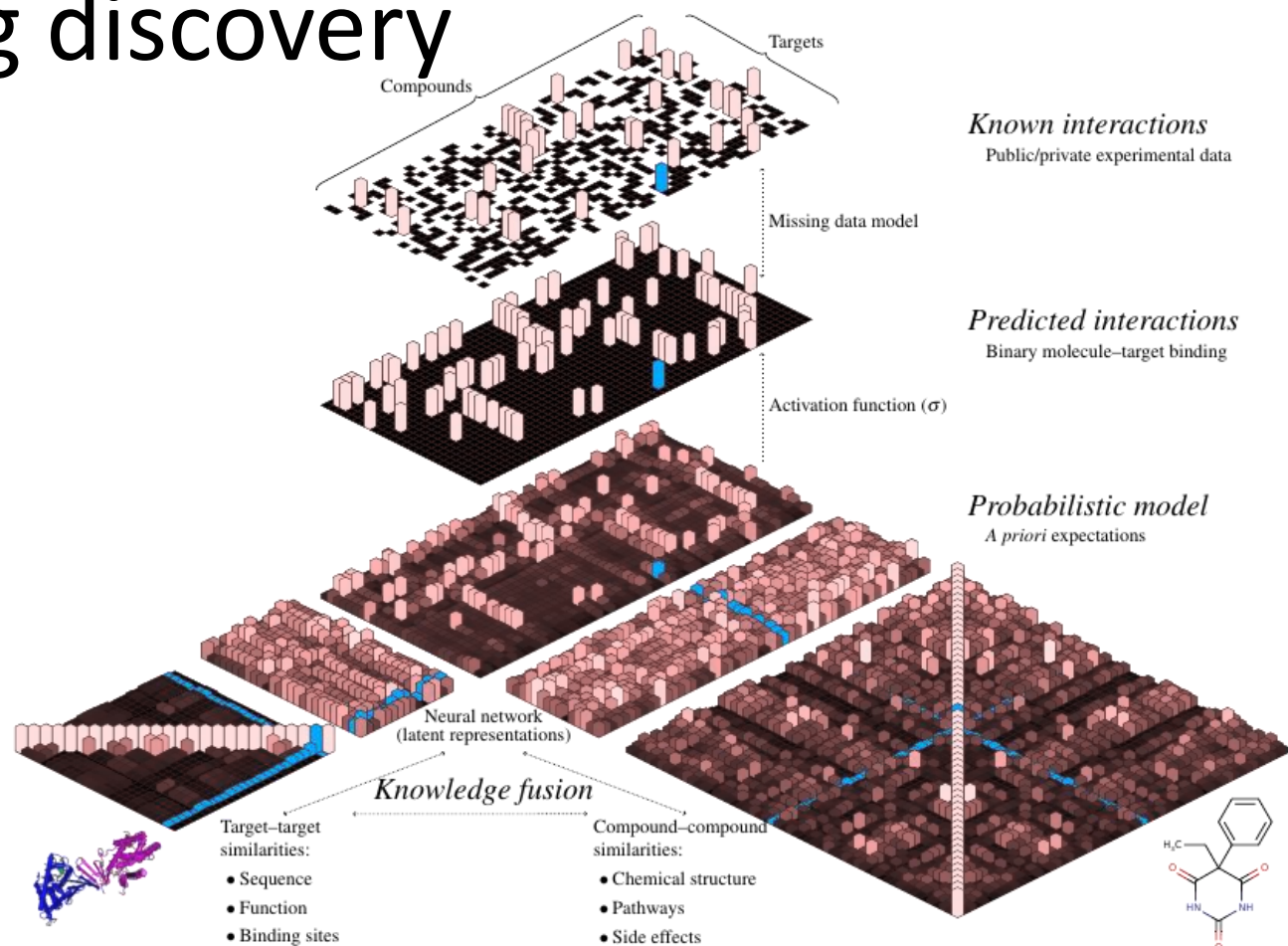


Ádám Arany, Bence Bolgár, Balázs Balogh, Peter Antal, Péter Mátyus: Multi-Aspect Candidates for Repositioning: Data Fusion Methods Using Heterogeneous Information Sources, Current Medicinal Chemistry, 2013, 20(1):95-107

Bence Bolgár, Ádám Arany, Gergely Temesi, Balázs Balogh, Péter Antal, Péter Mátyus Drug repositioning for treatment of movement disorders: from serendipity to rational discovery strategies, Current topics in medicinal chemistry, 2013;13(18):2337-63

G. Temesi, B Bolgár, Á. Arany, C. Szalai, P. Antal, P. Mátyus: Early repositioning through Compound Set Enrichment Analysis: A knowledge recycling strategy, Future Medicinal Chemistry, 6(5):563-75, 2014

Data and knowledge fusion for drug discovery



Bolgár, B. and Antal, P., 2017. VB-MK-LMF: fusion of drugs, targets and interactions using variational Bayesian multiple kernel logistic matrix factorization. *BMC bioinformatics*, 18(1), p.440.

Újgenerációs szekvenálás

- Piroszekvenálás
- Félvezető alapú szekvenálás
- Nanotechnológia alapú szekvenálás
- Biotechnológiai alapú szekvenálás
- ...



Illumina HiSeq X Ten Sequencer: az 1. 1000\$ genom

- **Hossz:** 100-200, fedés: x10
- Reagens: 797\$
- Mintaelőkészítés: 55\$-65\$
- Amortizáció: 137\$ mintánként



Oxford Nanopore Minlon

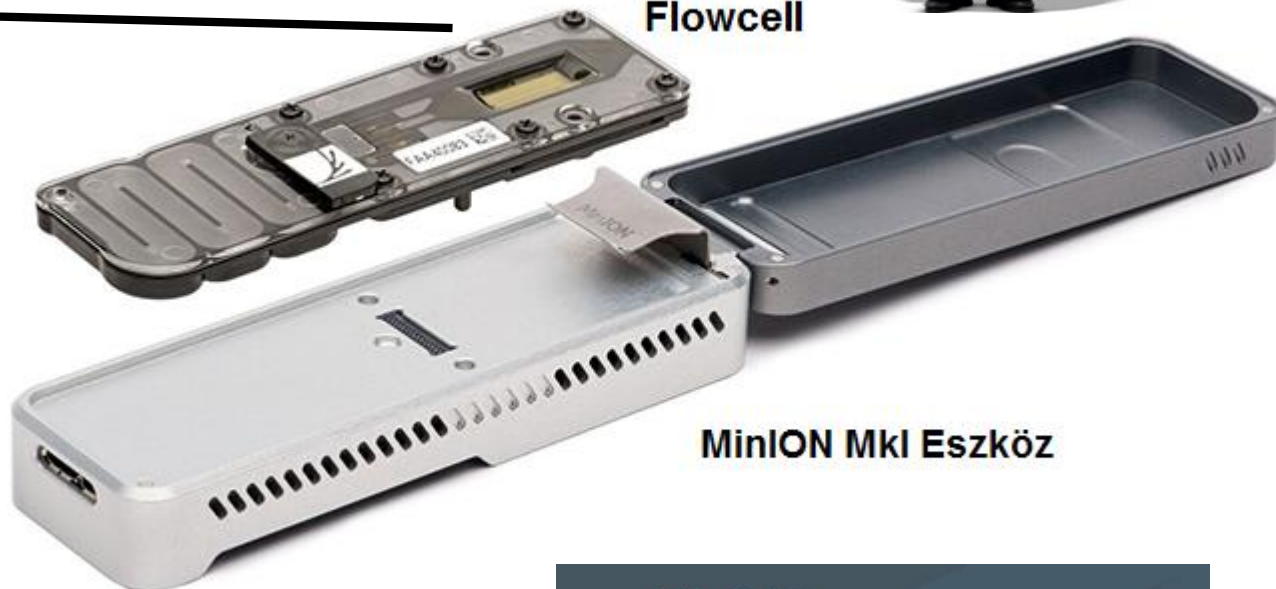
- Hossz: 1000-2000, fedés: ∞
- Reagens: 0
- Mintaelőkészítés: ?
- Amortizáció: ???

Nanopore MinION MkI



Nanopórus

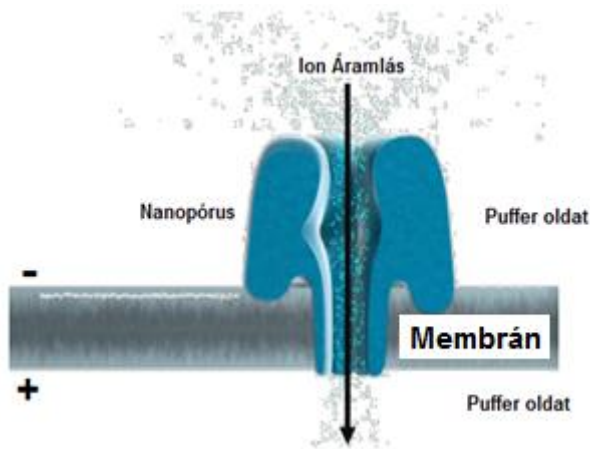
Flowcell



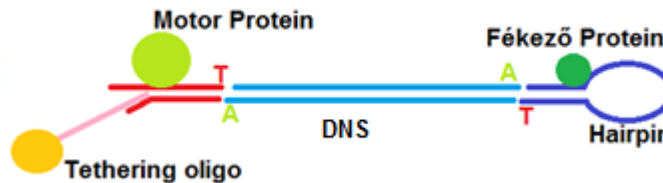
MinION MkI Eszköz

USB port

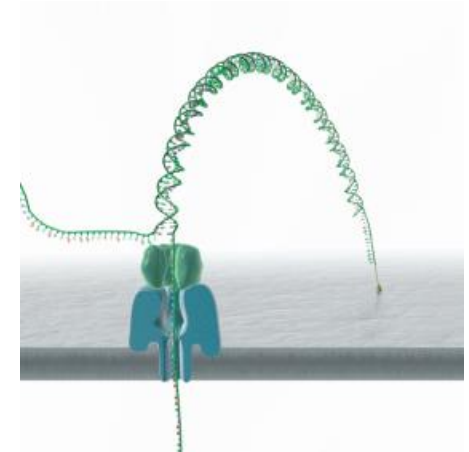
Nanopore MinION Mki



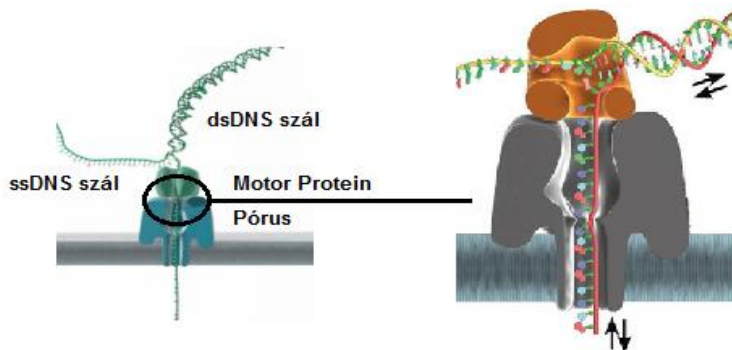
Protein Nanopórus



Szekvenálásra Előkészített
DNS szál



Tethering



A DNS szál leolvasása



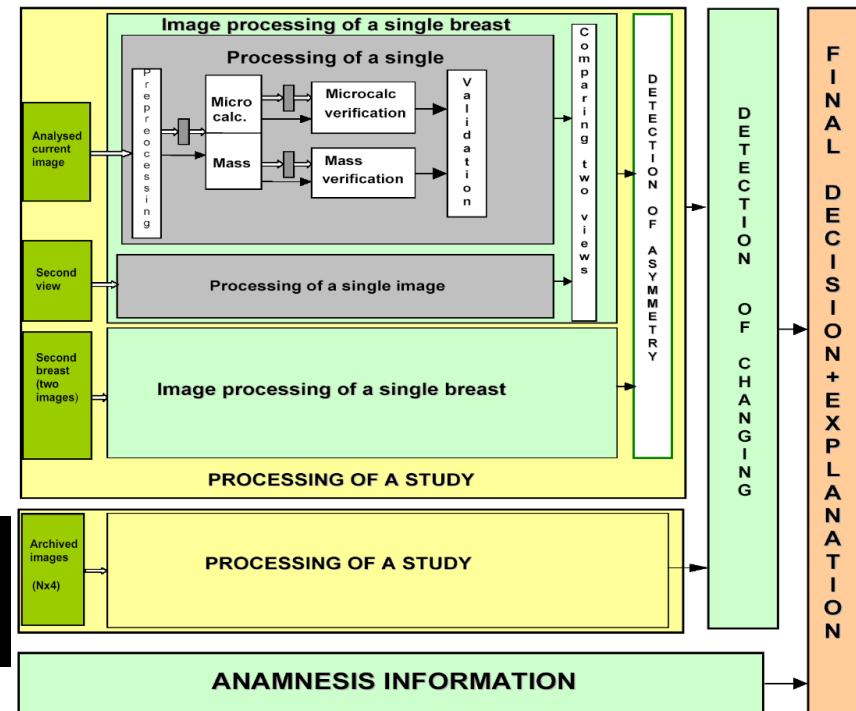
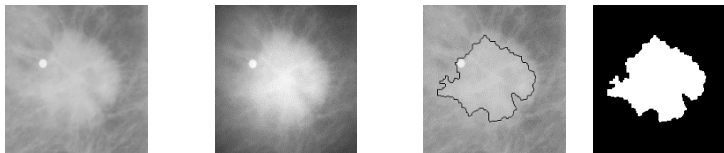
Szekvencia

További témák a tanszékről

- Képfeldolgozás
- Viselhető elektronikai eszközök és okos környezet

Mammographic Image Analysis

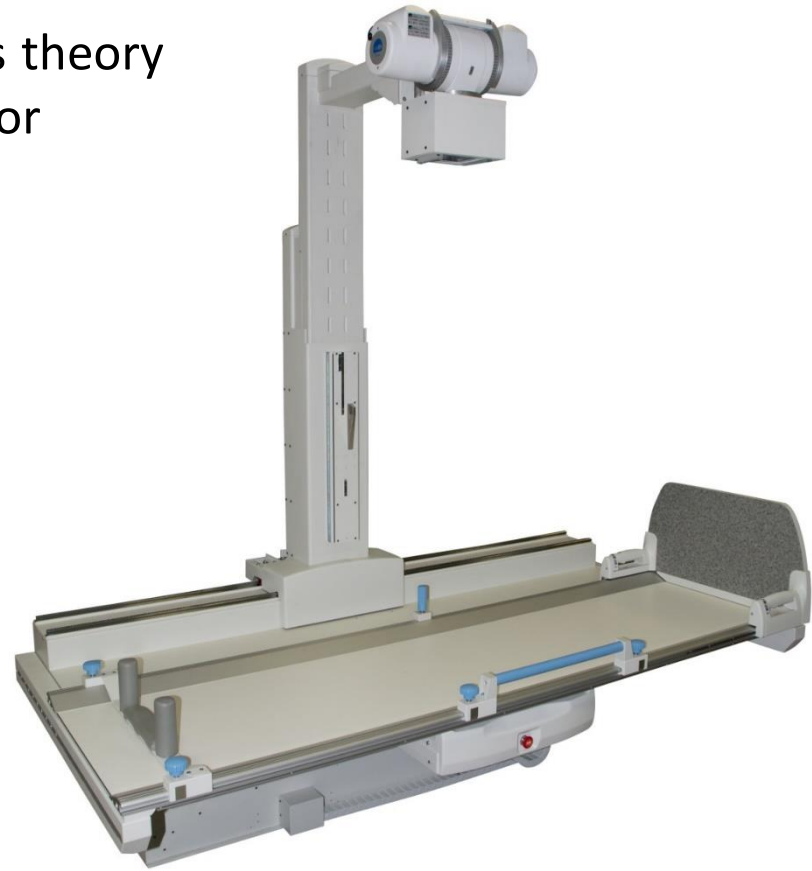
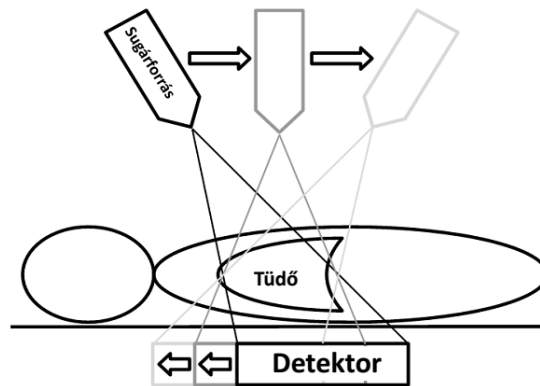
- Hard task even for an expert
- Heterogeneous information
- Exact model is not available



Horváth, Gábor, et al. "Intelligent advisory system for screening mammography." *Instrumentation and Measurement Technology Conference, Proceedings of the 21st IEEE*. Vol. 3., 2004

Digital tomosynthesis

Goal: Based on digital tomosynthesis theory
new imaging device development for
chest diagnostics



AAL: Ambient Assisted Living

- Goal: Maintaining or improving quality of life
- Target group
 - People with physical or mental sicknesses
 - People with disabilities
 - Aged people
 - Home fitness
- Target group is growing...



Pataki B, Hanák P, Csukly G, Surpassing Entertainment with Computer Games: Online Tools for Early Warnings of Mild Cognitive Impairment, In: Information and Communication Technologies for Ageing Well and e-Health: First International Conference, ICT4A ageingWell 2015. , Lisbon, Portugal, May. 2015. Heidelberg; New York: Springer, 2015. pp. 217-237.

Györke P, Pataki B, Energy Harvesting Wireless Sensors for Smart Home Applications
In: 2015 IEEE International Instrumentation and Measurement Technology Conference, I2MTC 2015. Pisa, Italy, May 2015., pp. 1757-1762.

Javasolt témák és kurzusok

- Javasolt témák ([ComBineLab](#))
 - Képfeldolgozás (CT, MR)
 - Viselhető okos eszközök/környezetek adatfeldolgozása
 - Szövegbányászati eszközök
 - Genetikai adatok mérése, elemzése, felhasználása
 - Gyógyszerkutatás gépi tanulási és neurális hálózatok
 - Orvosbiológiai adatok statisztikai elemzése
 - Klinikai döntéstámogatási modellek
- Egészségügyi mérnöki közös tárgyak
 - [Egészségügyi informatika és biostatisztika](#) VIMIM206
- Szabadon választható tárgyak
 - [Bioinformatika](#) VIMIIV10

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