Mesterséges intelligencia az orvosbiológiában
Artificial intelligence in biomedicine

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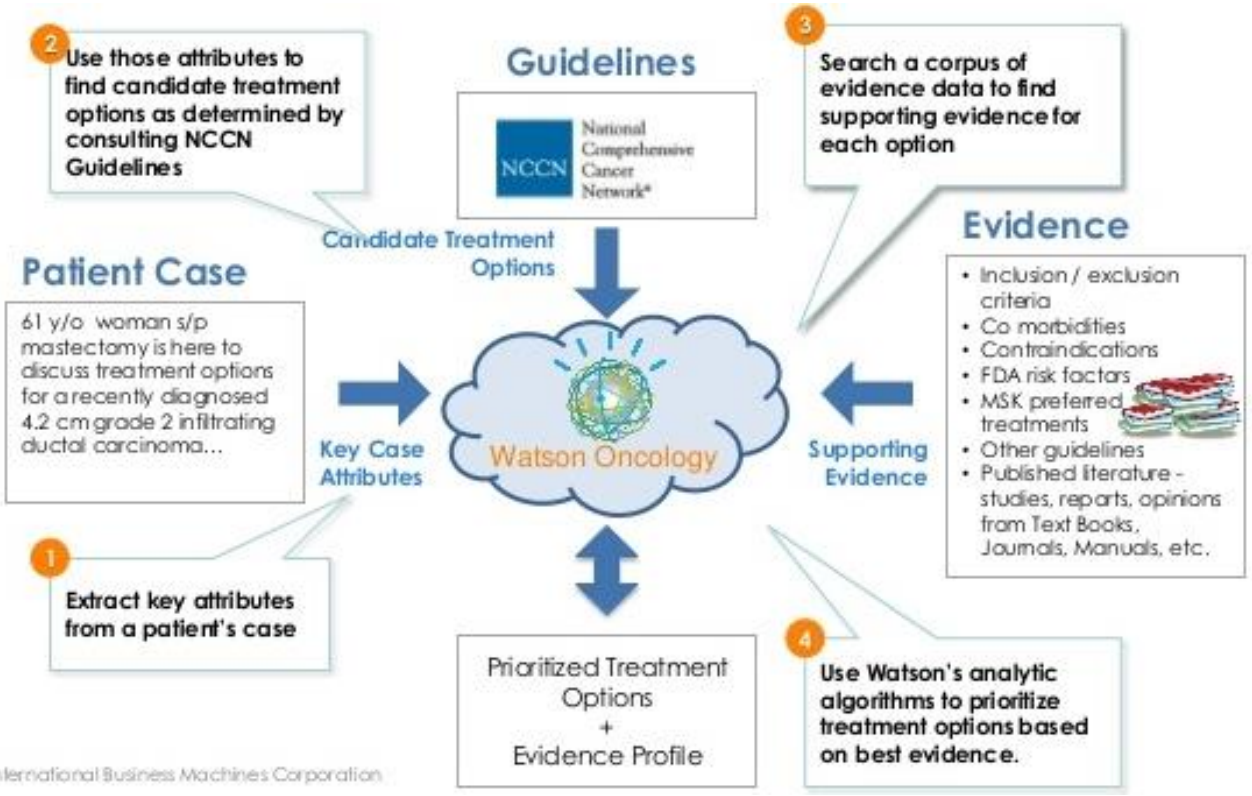
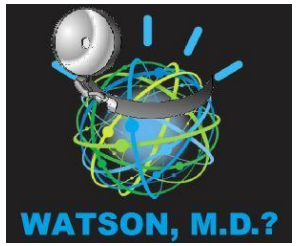
Ágenda

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

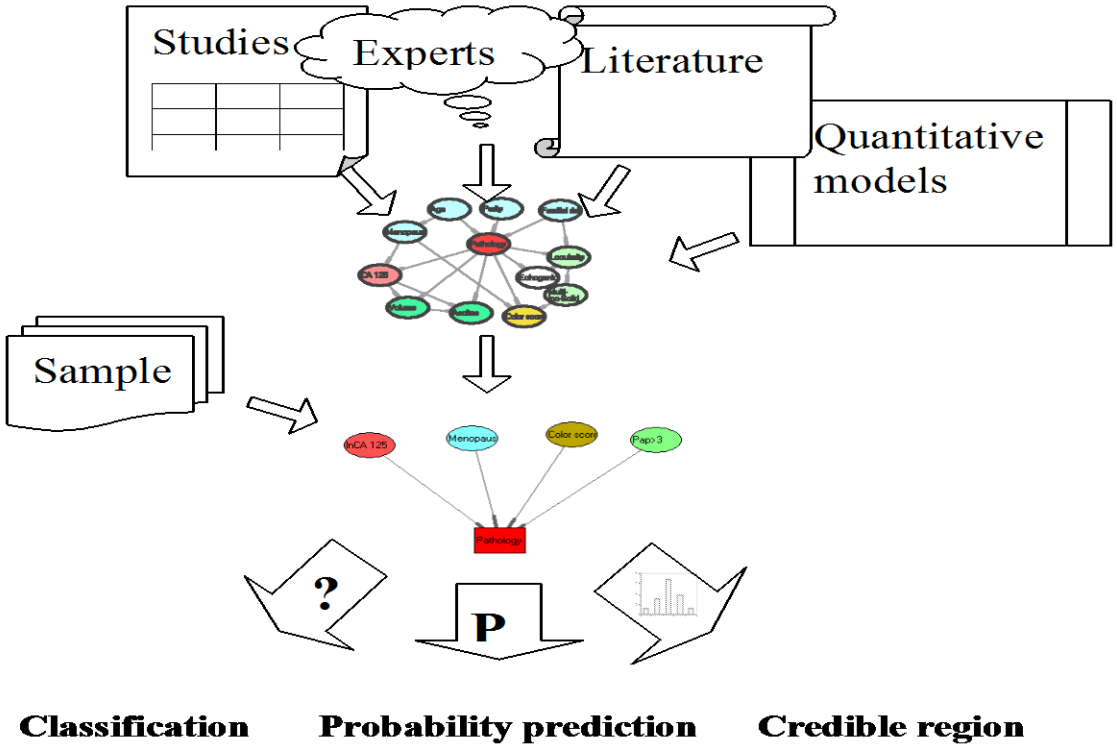
Medical decision support systems





Watson for Oncology – assessment and advice cycle
www.avanteoconsulting.com/machine-learning-accelerates-cancer-research-discovery-innovation/

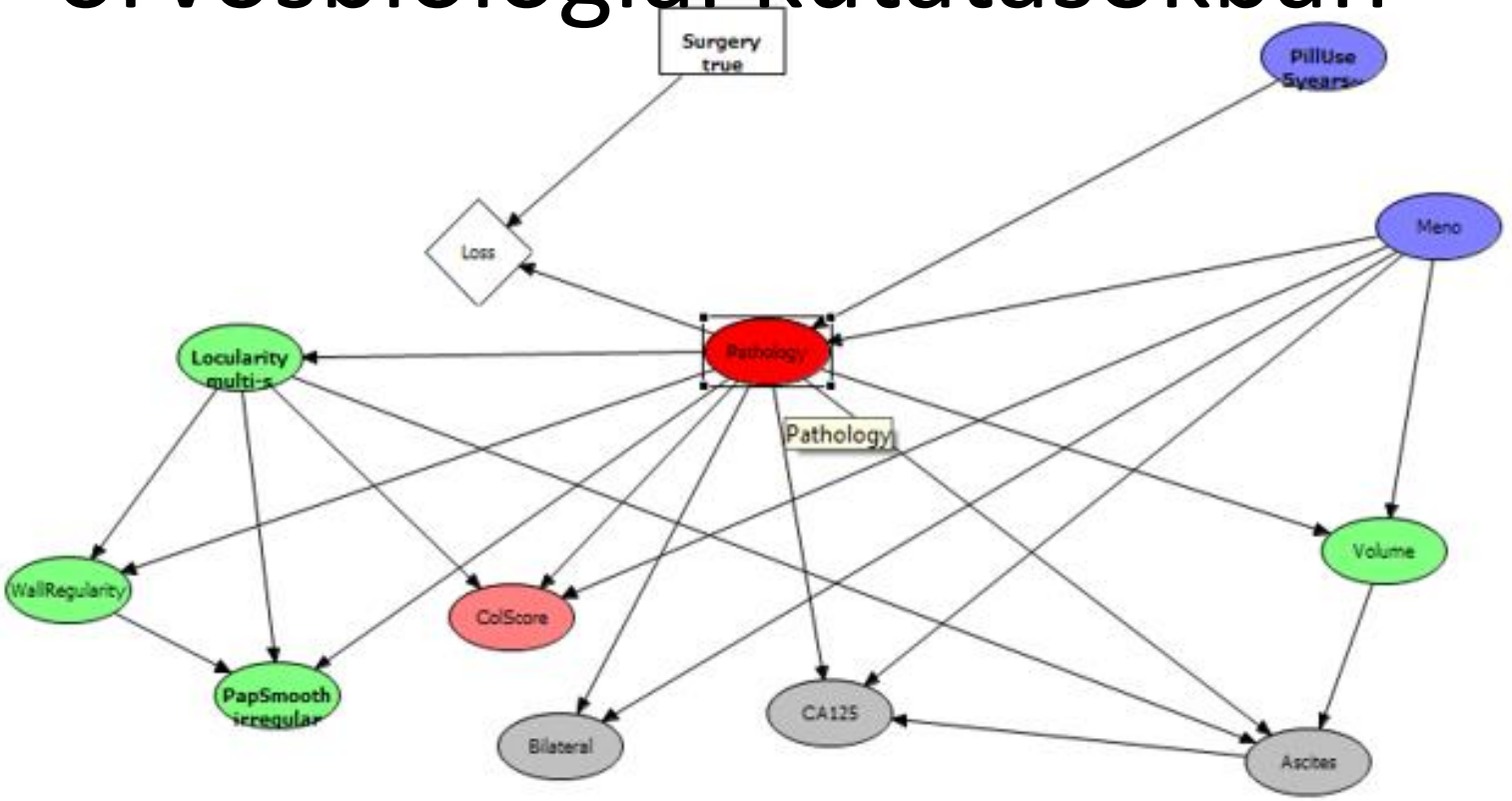
Mesterséges intelligencia az egészségügyi adatelemzésben



- 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

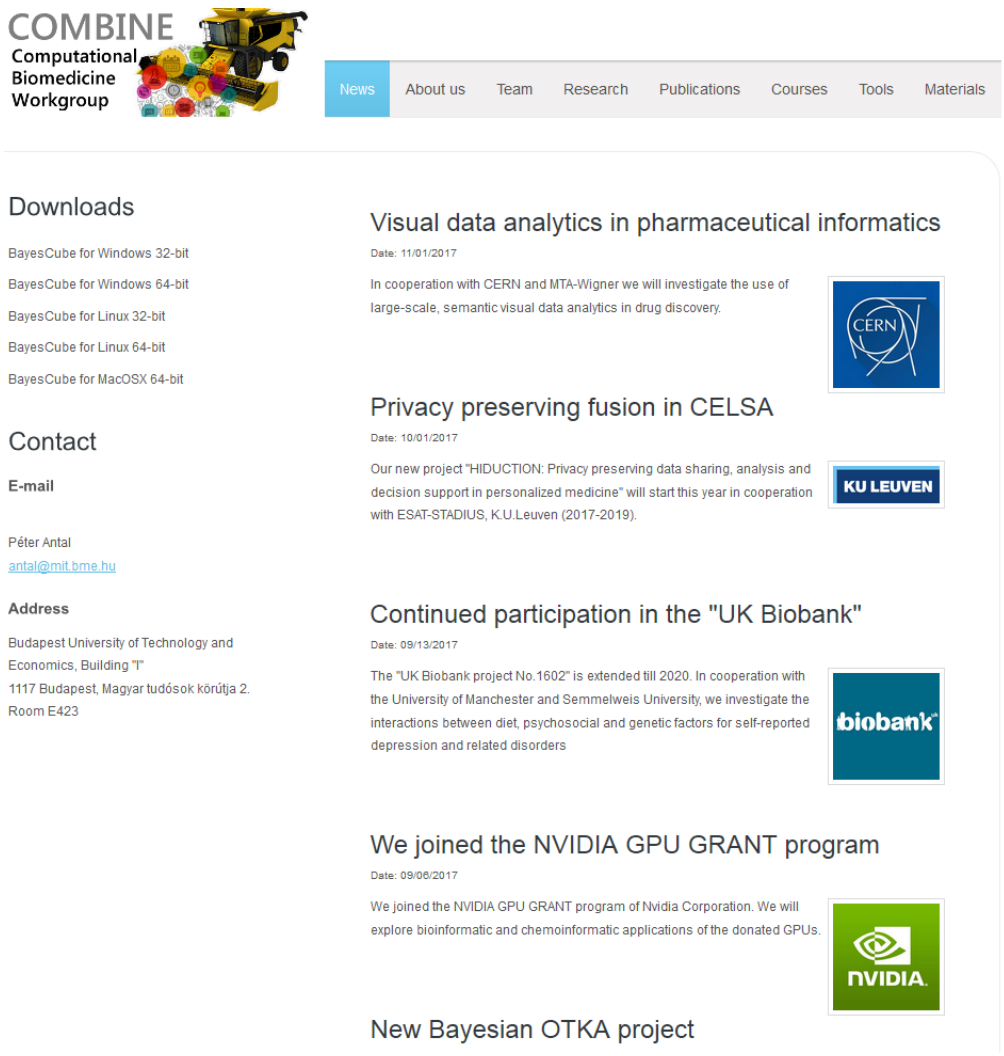
Mesterséges intelligencia az orvosbiológiai kutatásokban



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



Team

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

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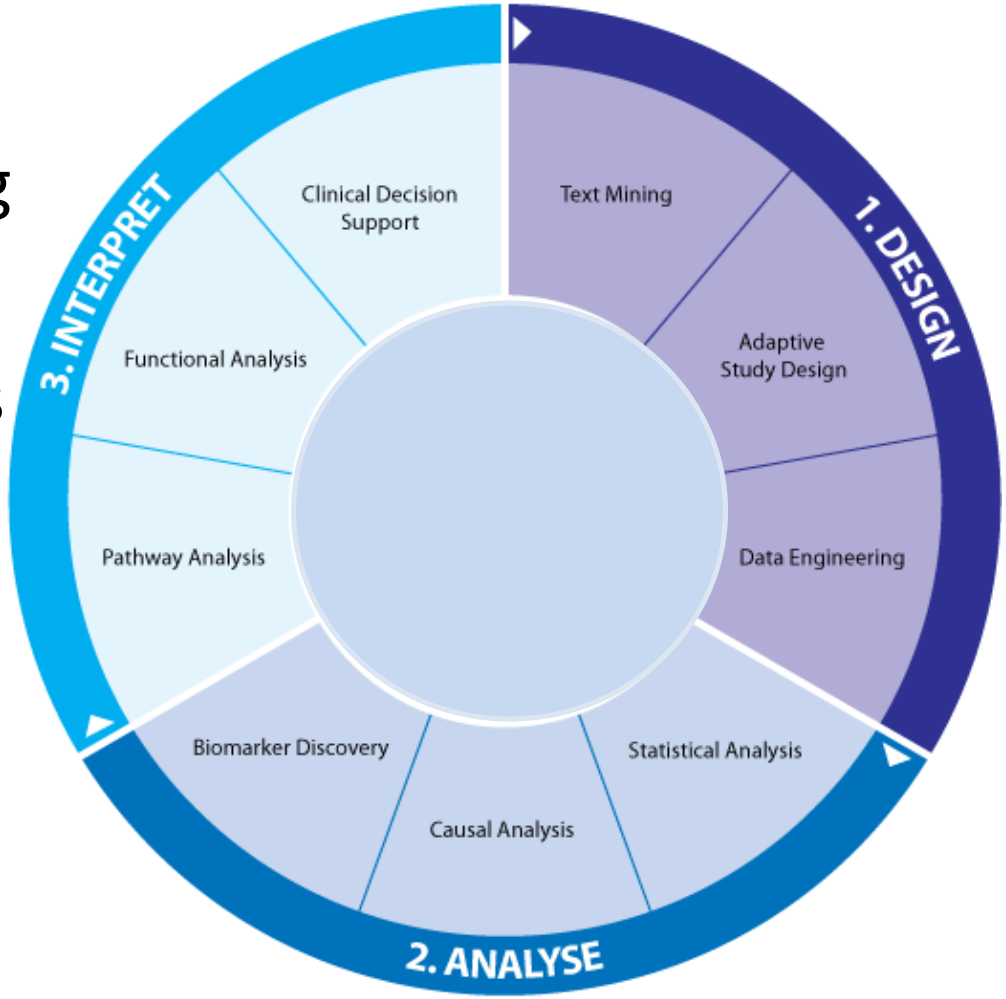
ComBineLab.hu: Themes

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

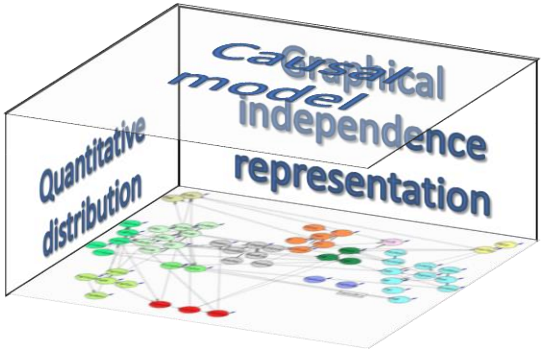


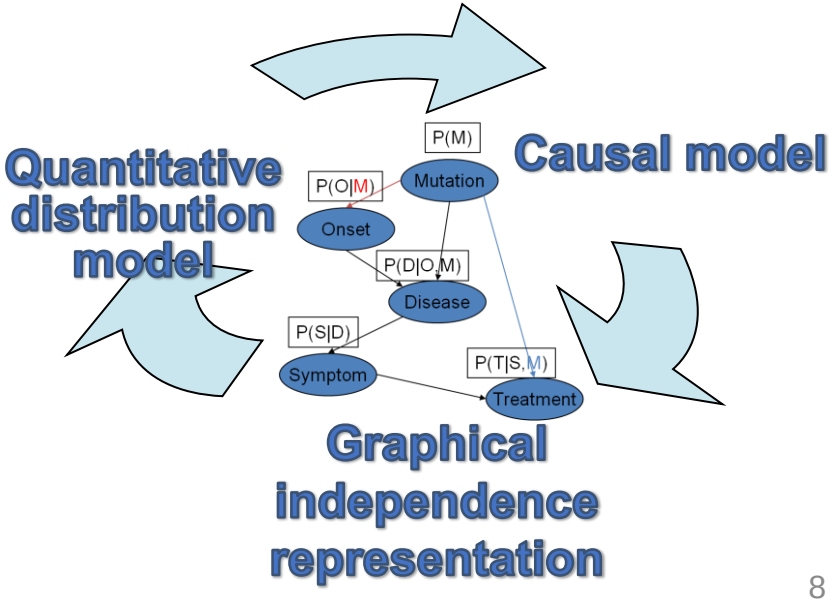
Probabilistic graphical models: Bayesian Networks

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

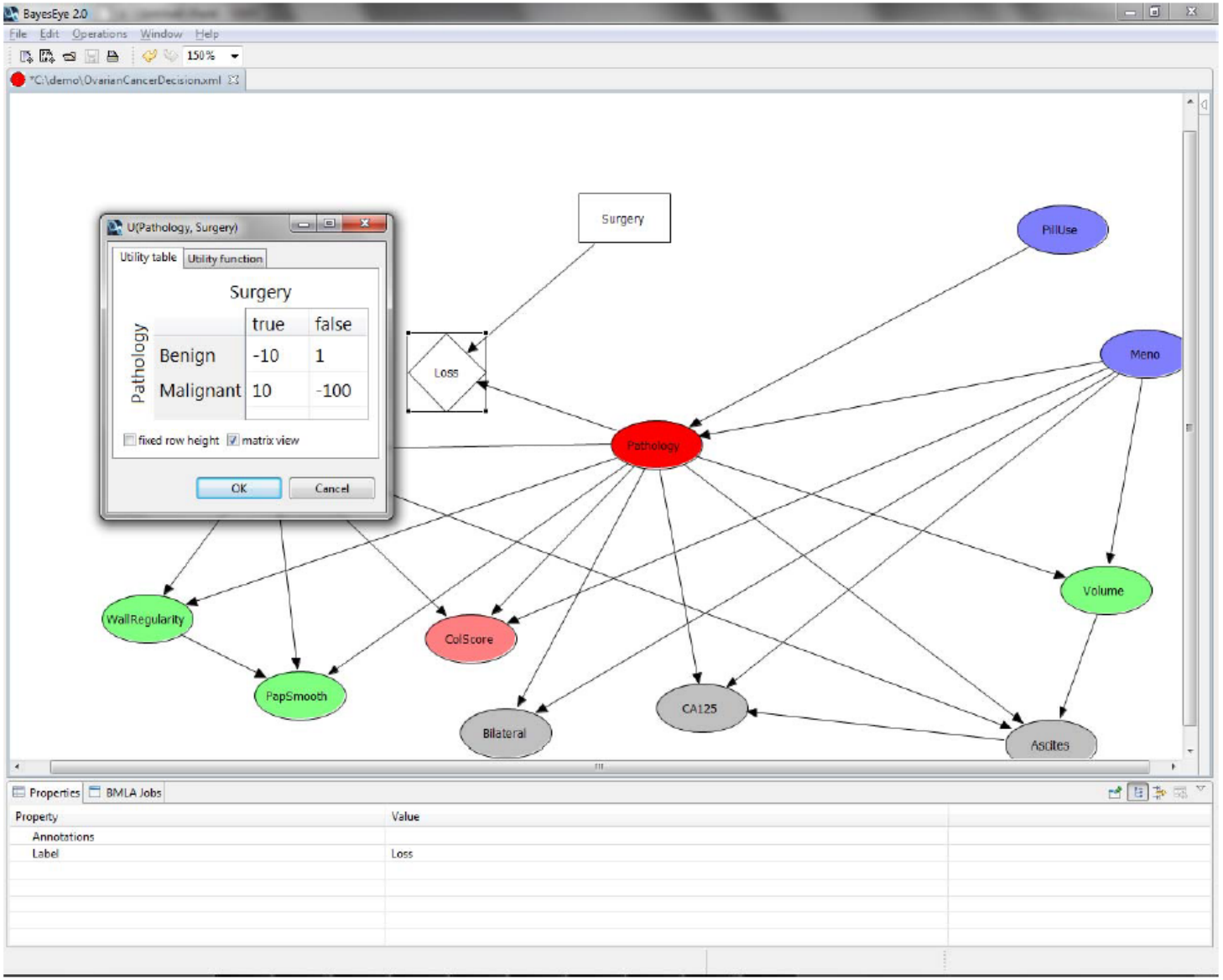
Thomas Bayes
(c. 1702 – 1761)

$$P(Model \mid Data) \propto P(Data \mid Model)P(Model)$$

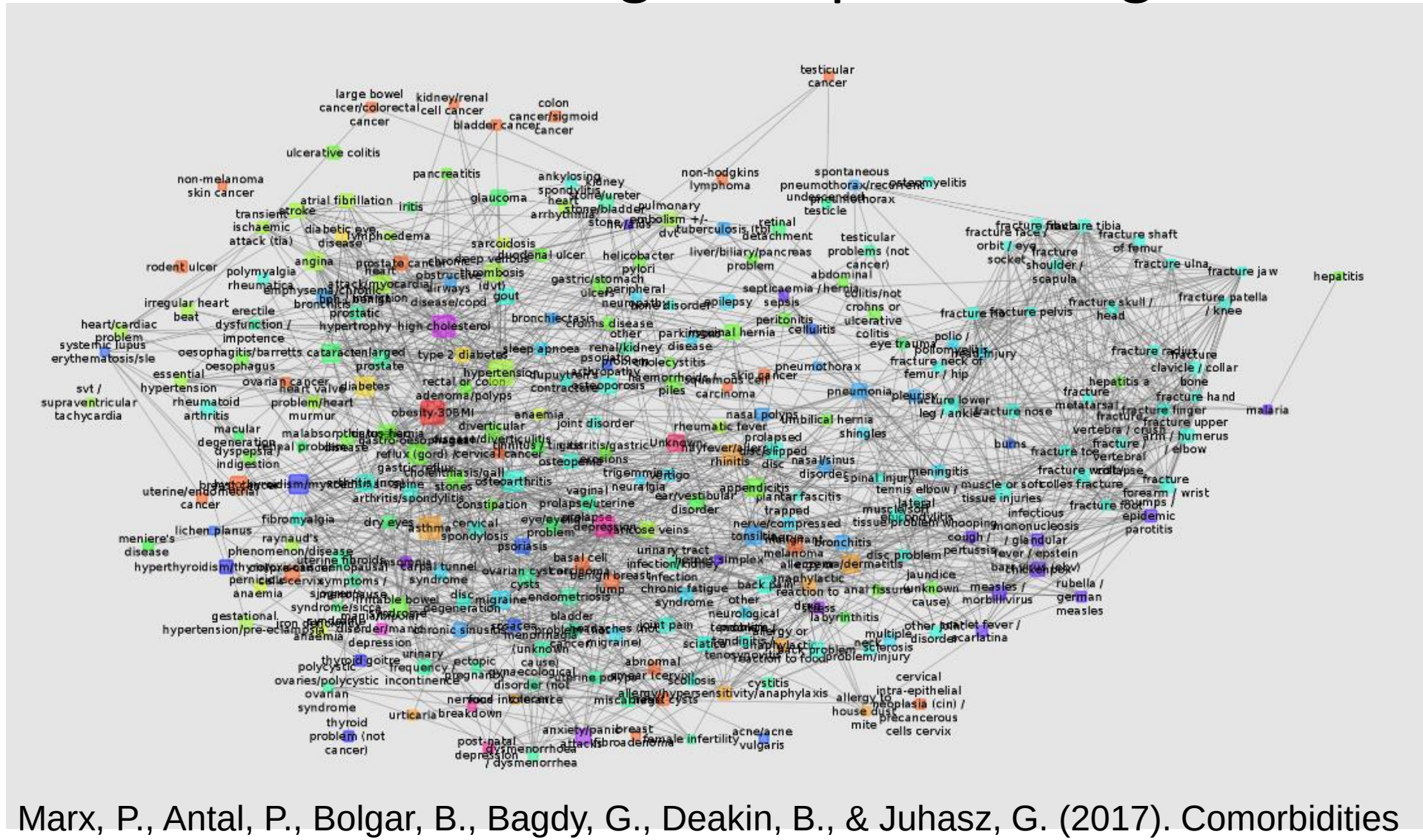




Decision networks

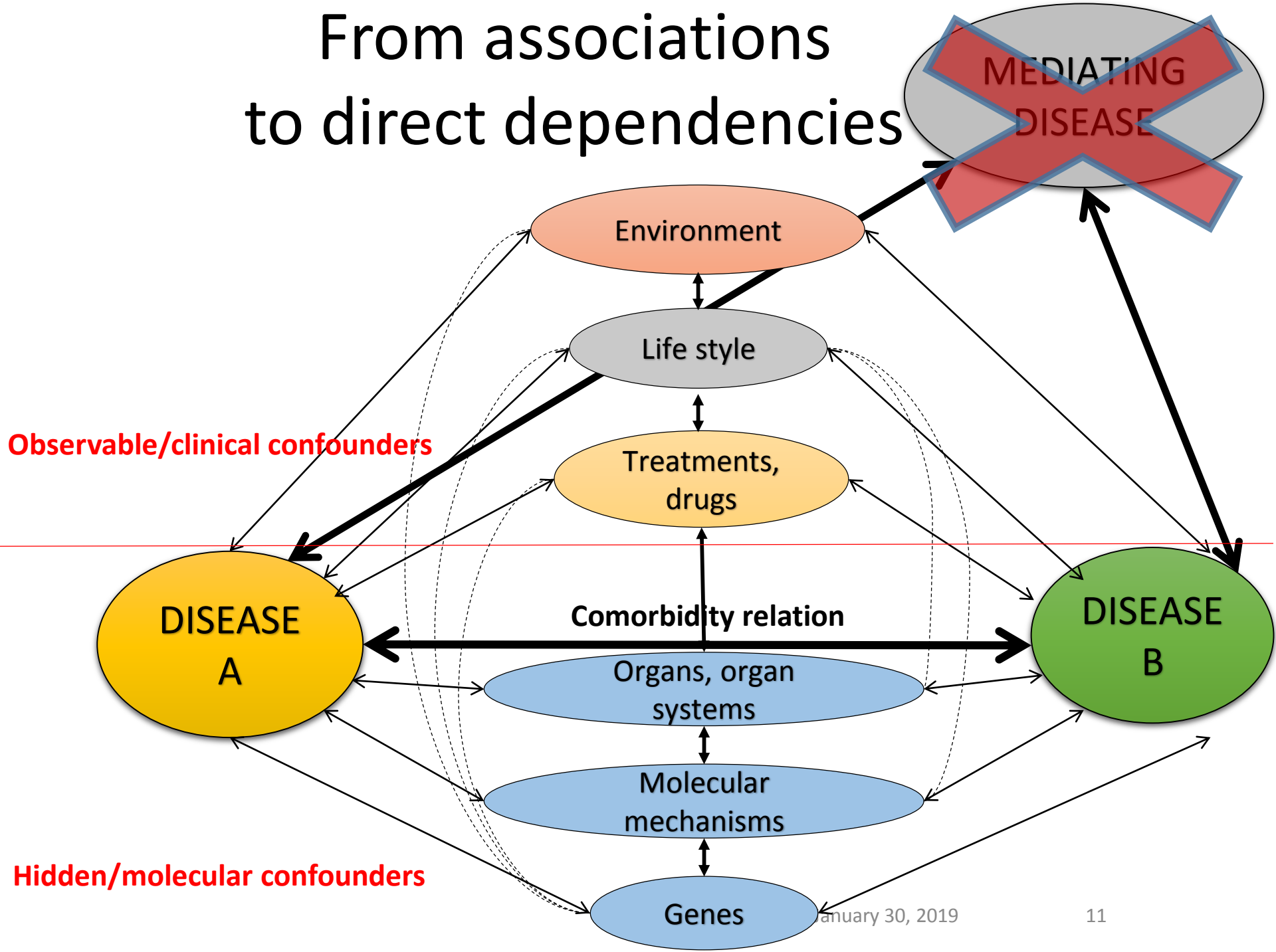


The diseasome using real epidemiological data

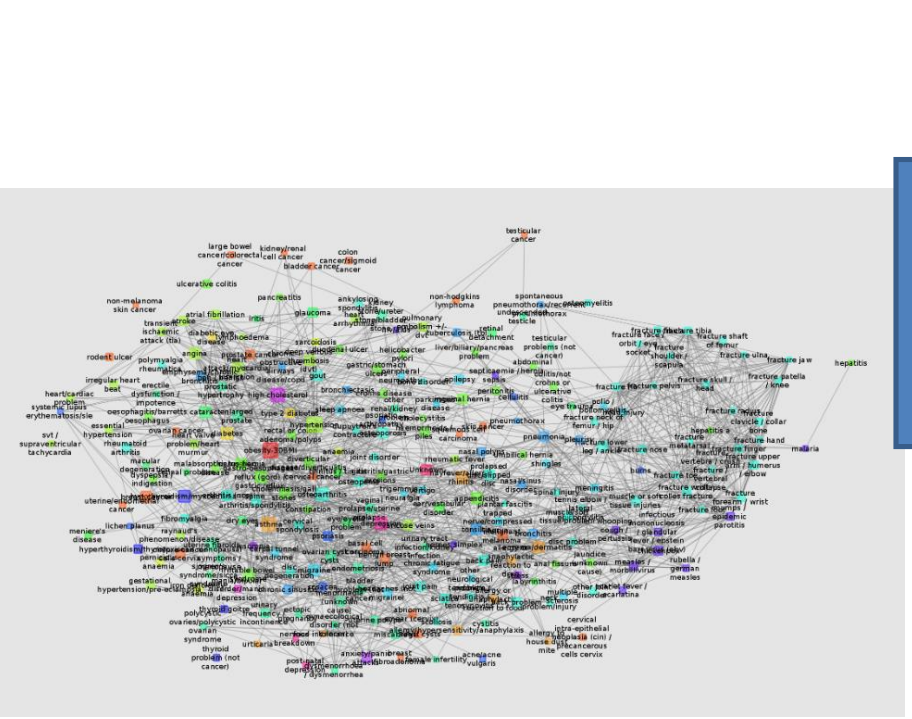


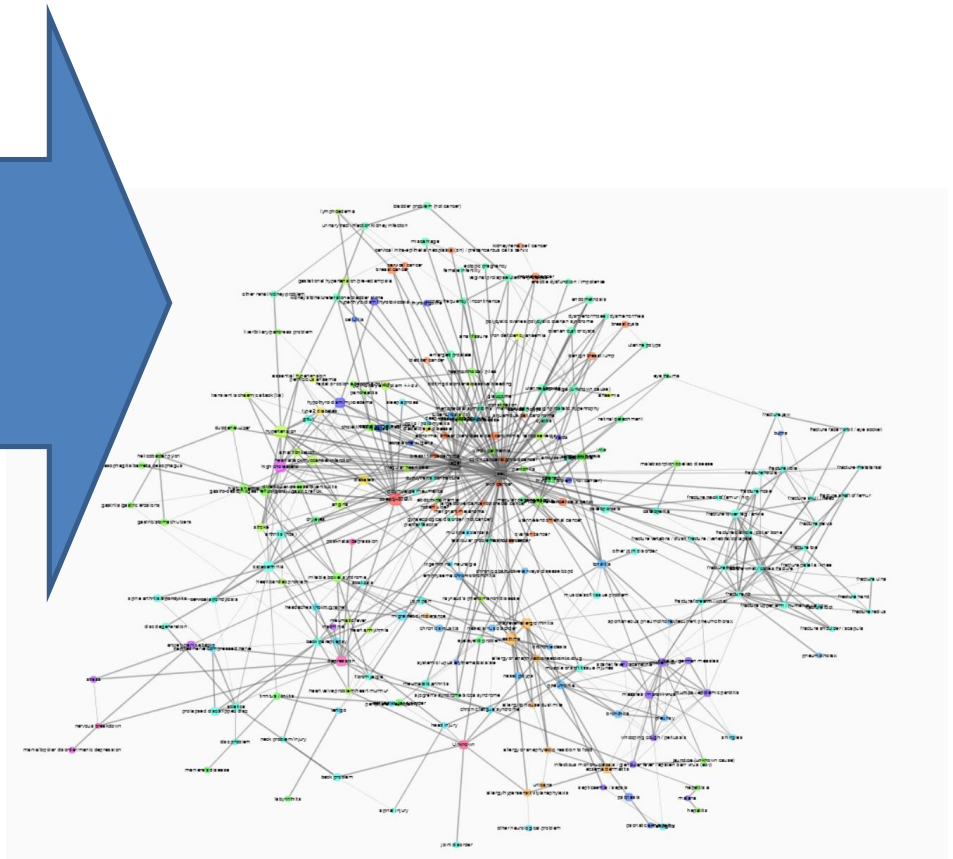
Marx, P., Antal, P., Bolgar, B., Bagdy, G., Deakin, B., & Juhasz, G. (2017). Comorbidities in the diseasome are more apparent than real: What Bayesian filtering reveals about the comorbidities of depression. *PLoS computational biology*, *13*(6), e1005487.

From associations to direct dependencies



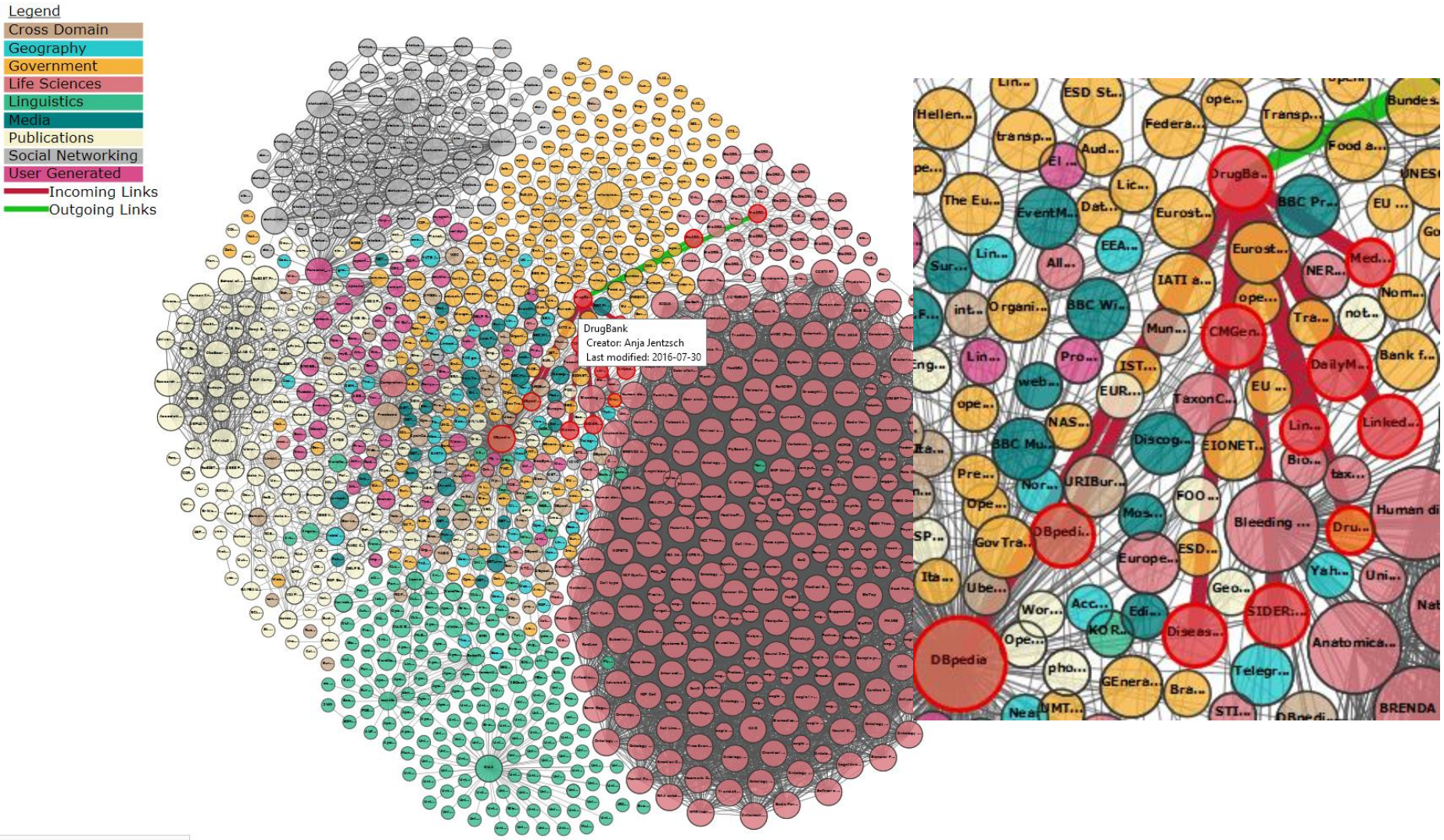
From associations to direct dependencies II. (off:80%)





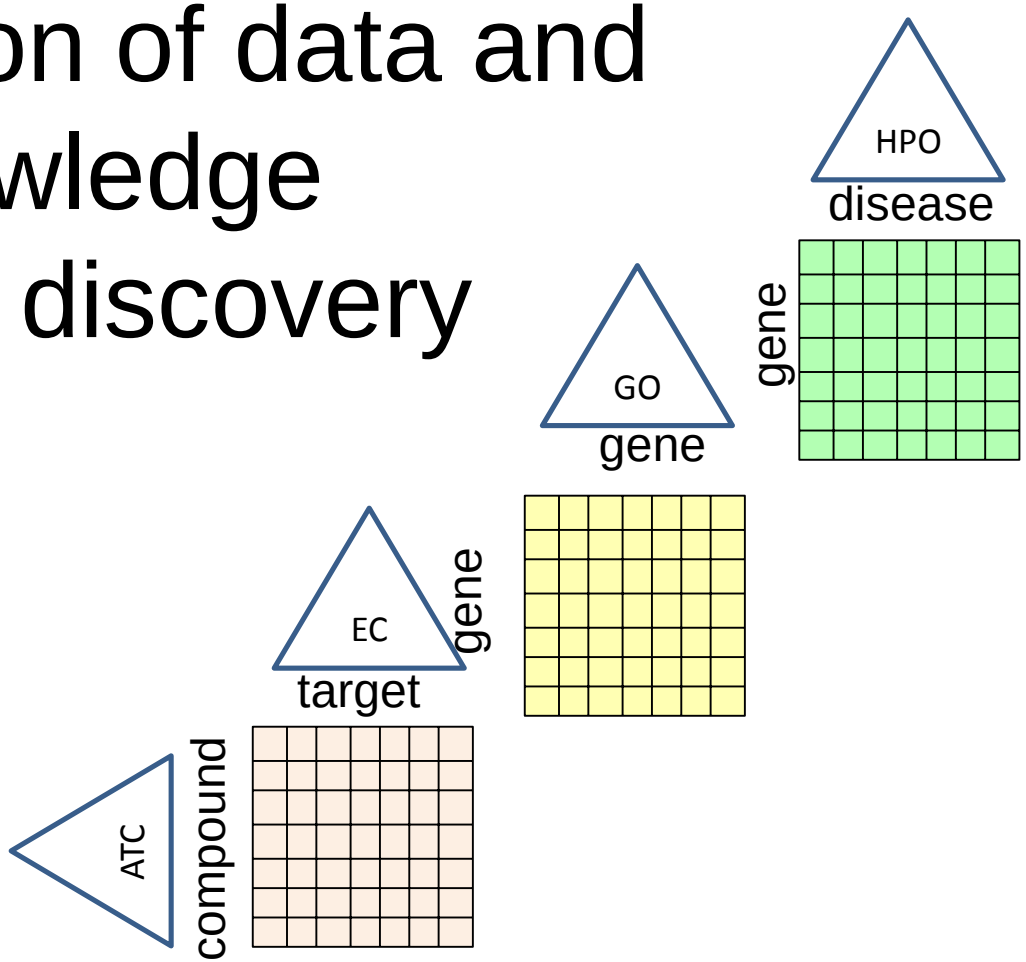
Marx, P., Antal, P., Bolgar, B., Bagdy, G., Deakin, B., & Juhasz, G. (2017). Comorbidities in the diseasome are more apparent than real: What Bayesian filtering reveals about the comorbidities of depression. *PLoS computational biology*, *13*(6), e1005487.

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

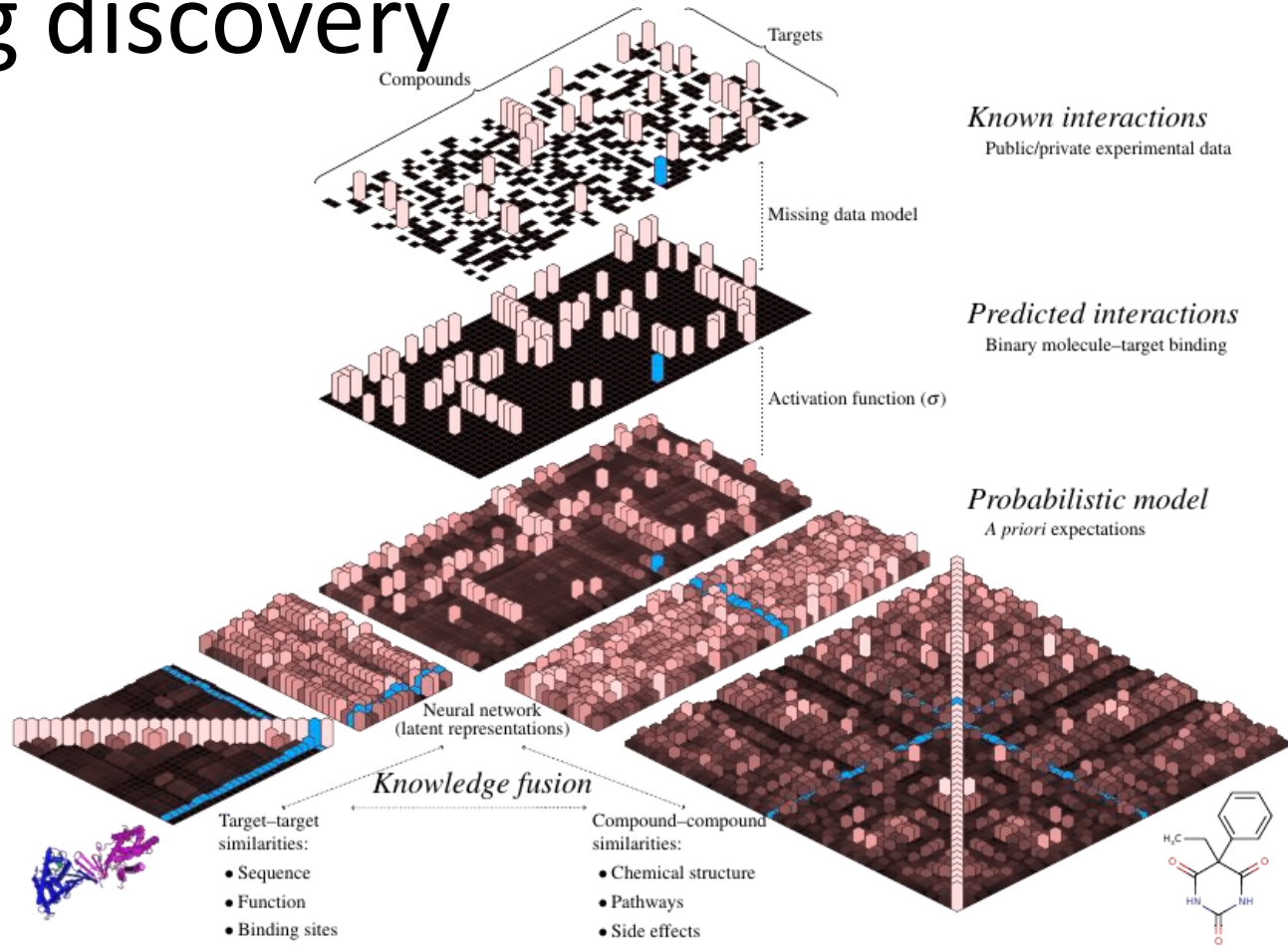


Ádám Arany, Bence Bolgár, Balázs Balogh, Peter Antal, Péter Mátyus: Multi-Aspect Candidates for Repositioning: Data Fusion Methods Using Heterogeneous Information Sources, Current Medicinal Chemistry, 2013, 20(1):95-107

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
- …

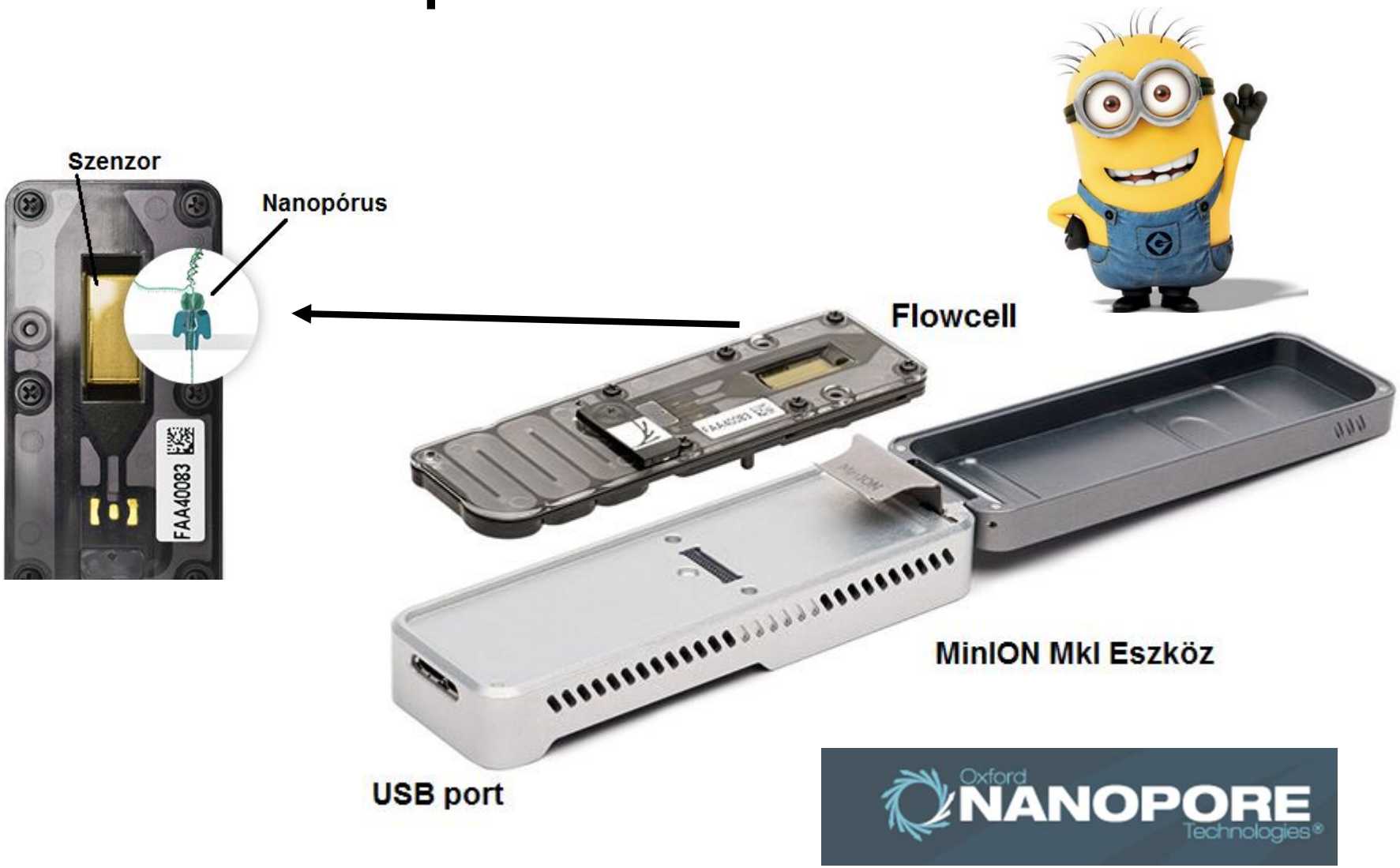
Illumina HiSeq X Ten Sequencer: az 1. 1000$ genom

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

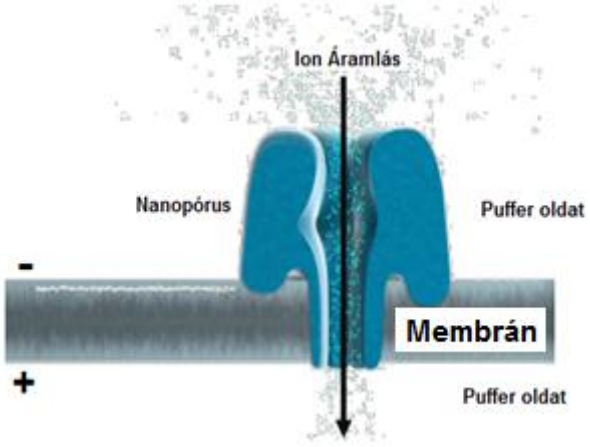
Oxford Nanopore MinIon

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

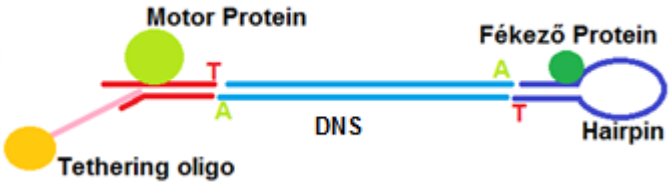
Nanopore MinION MkI



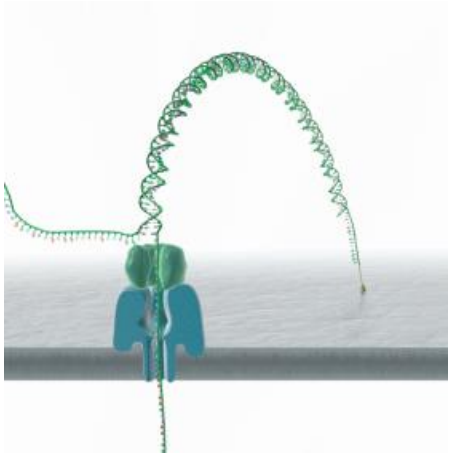
Nanopore MinION MkI



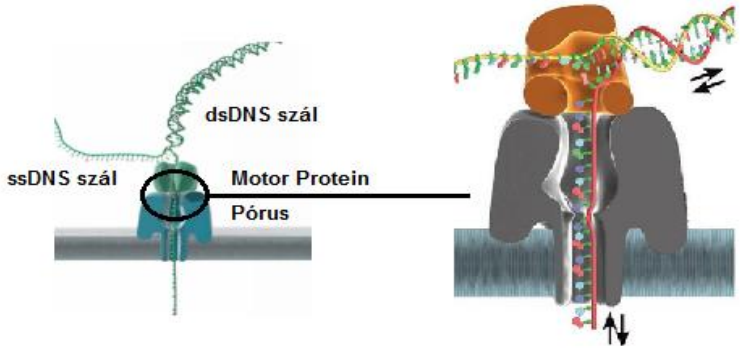
Protein Nanopórus



Szekvenálásra Előkészített DNS szál



Tethering



A DNS szál leolvasása

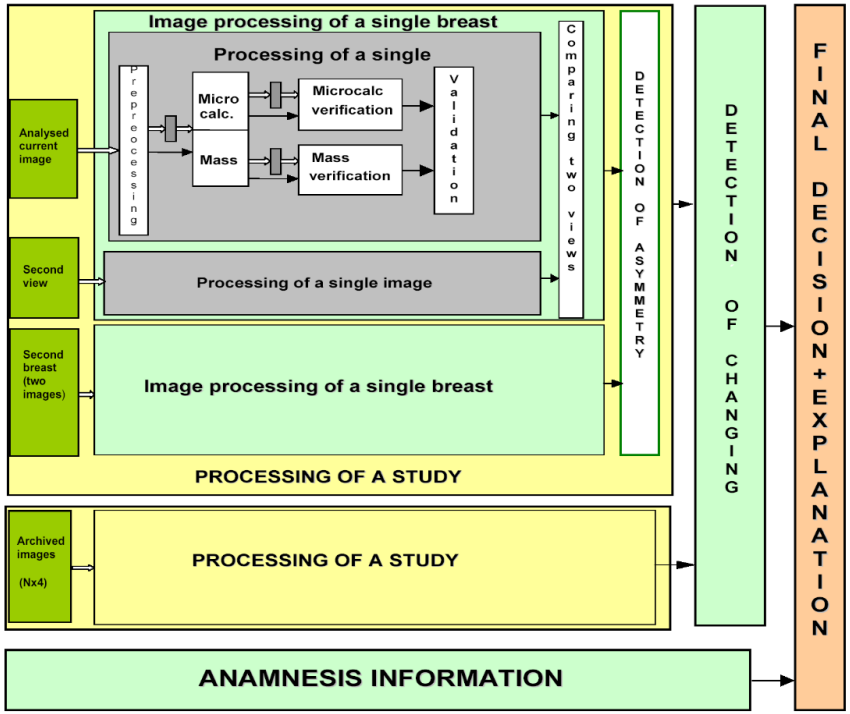
Szekvencia

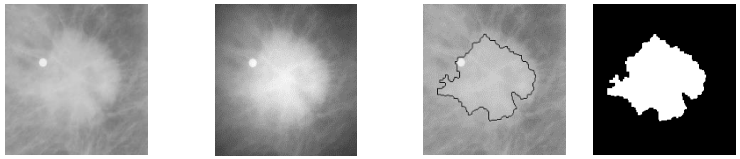
További témák a tanszékről

- Képfeldolgozás
- Viselhető elektronikai eszközök és okos környezet

Mammographic Image Analysis

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

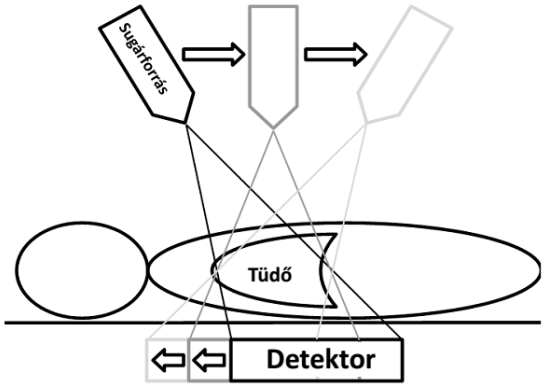




Horváth, Gábor, et al. "Intelligent advisory system for screening mammography." *Instrumentation and Measurement Technology Conference, Proceedings of the 21st IEEE*. Vol. 3., 2004

Digital tomosythesis

Goal: Based on digital tomosythesis 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 geingWell 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 VIMIAV10

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