



BCG

THE BOSTON CONSULTING GROUP

AI & Automation in R&D

The Retreat 2018

Starting point (always): productivity

A  **More winners**
Better Science

Scientific talent, technologies and capabilities to generate and test intervention hypotheses for transformative therapies

B  **Lower cost of failure**
Better Decisions

Organizational and behavioral drivers of rapid unbiased decision making

C  **Lower cost / time**
Better Efficiency

Operational improvements to support more efficient execution of discovery and development activities

"R&D on a page"

A



Strategy



Scientific strategy: right investments in biology, modalities, models...

Portfolio choices (asset, DA/TA, pathway...)

B



Organization and culture



Talent, expertise and capabilities

Governance, decision-making

Structure

Culture, incentives

C



Operations



Agile processes, interfaces

Tools and platforms

Site footprint

External collaboration, variabilization

D



Supports others

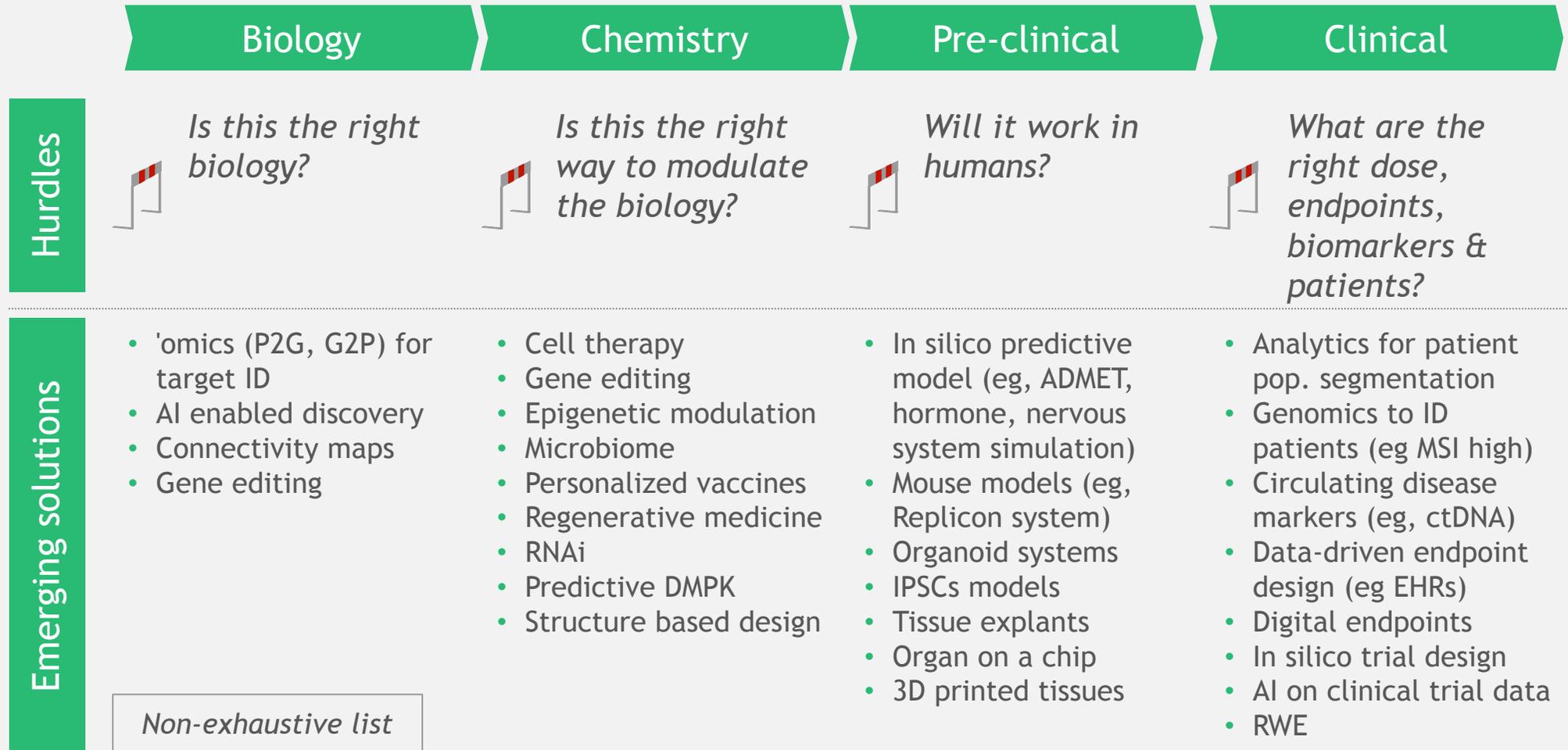
Digital technologies



Digitization/ automation of processes

Analytical support of decisions

The big decisions



Breakthroughs happen when all the "hurdles" comes down

Example: HCV



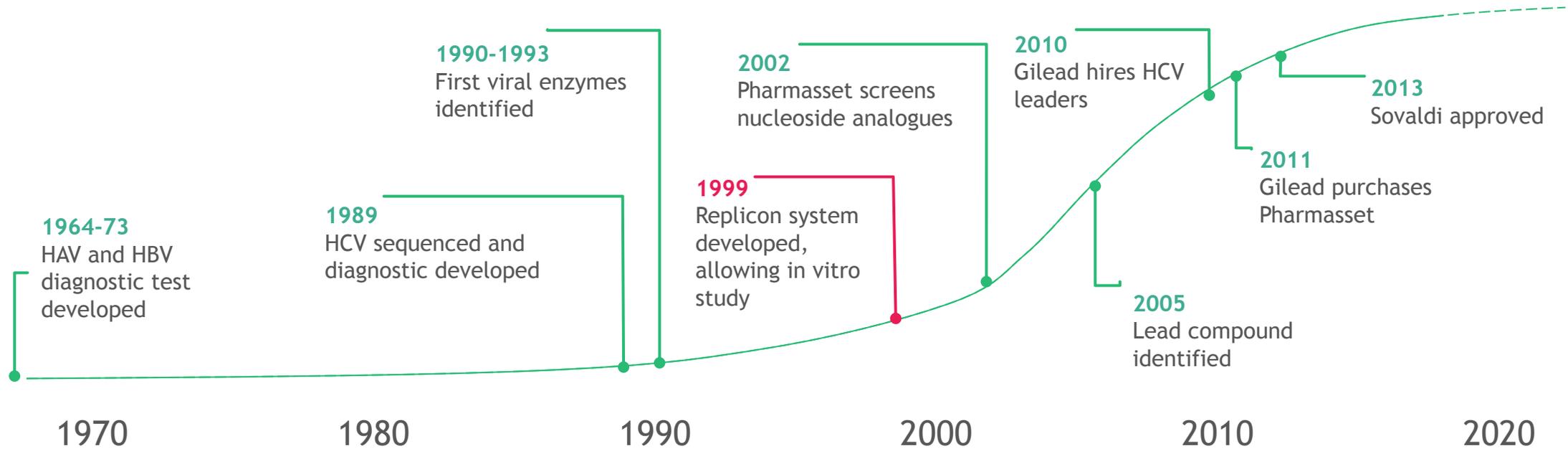
Biology, chemistry and clinical in place... but no translational model



Replicon model enabled HCV screening

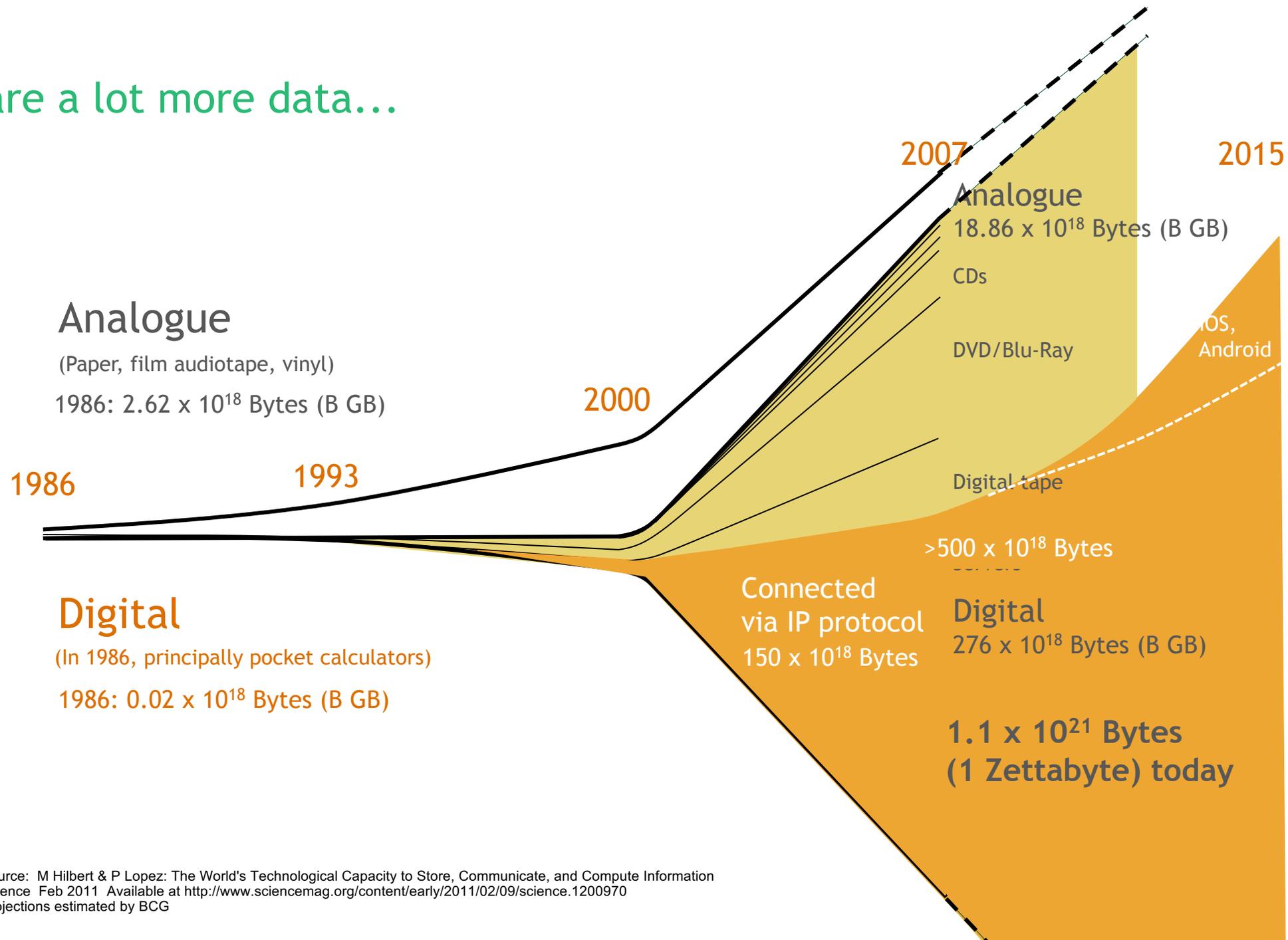


Rapid screening to approval of Sovaldi



Is digital going to bring down multiple hurdles across multiple DAs?

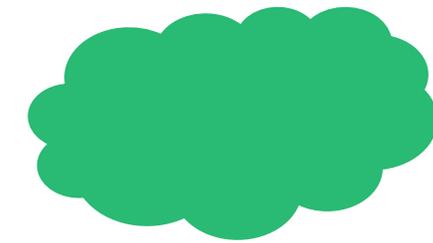
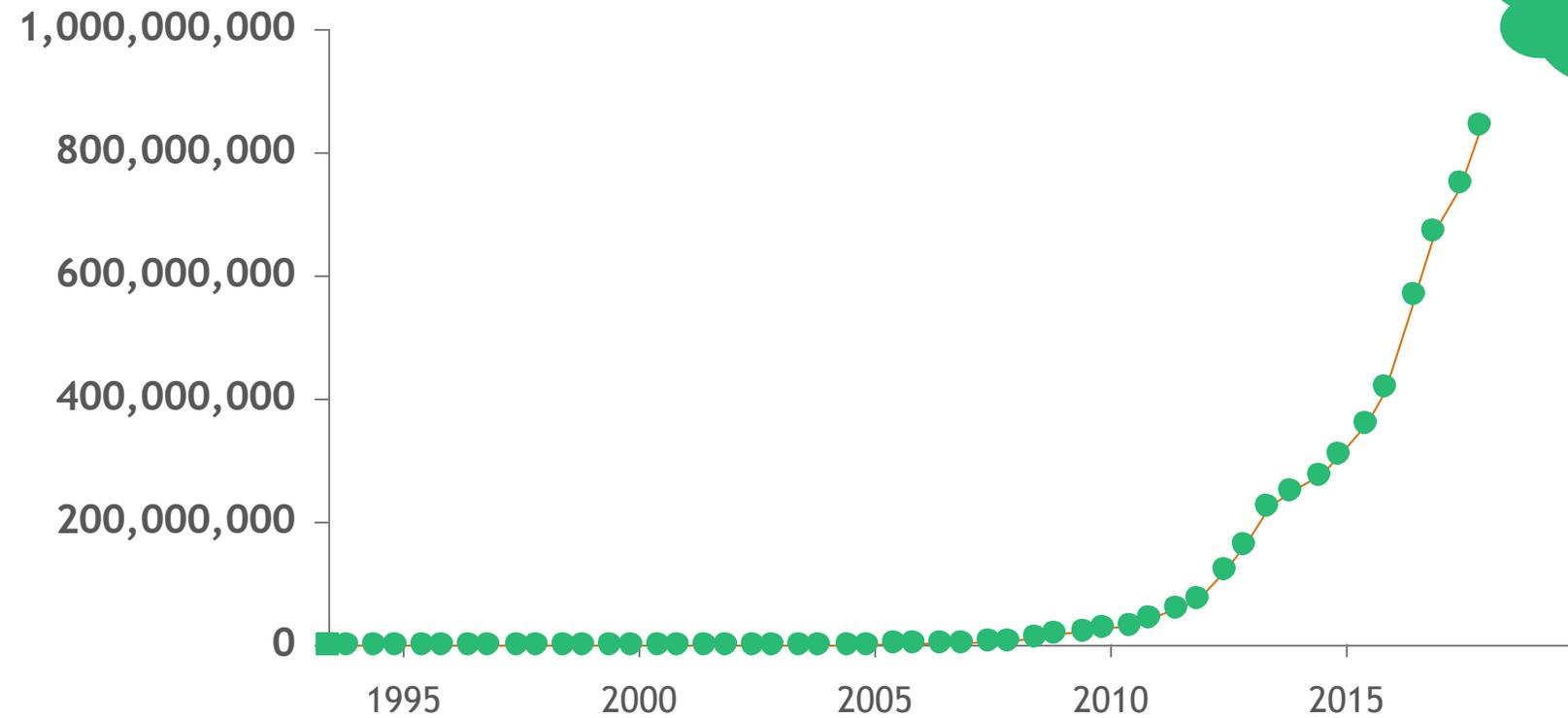
There are a lot more data...



Source: M Hilbert & P Lopez: The World's Technological Capacity to Store, Communicate, and Compute Information
Science Feb 2011 Available at <http://www.sciencemag.org/content/early/2011/02/09/science.1200970>
Projections estimated by BCG

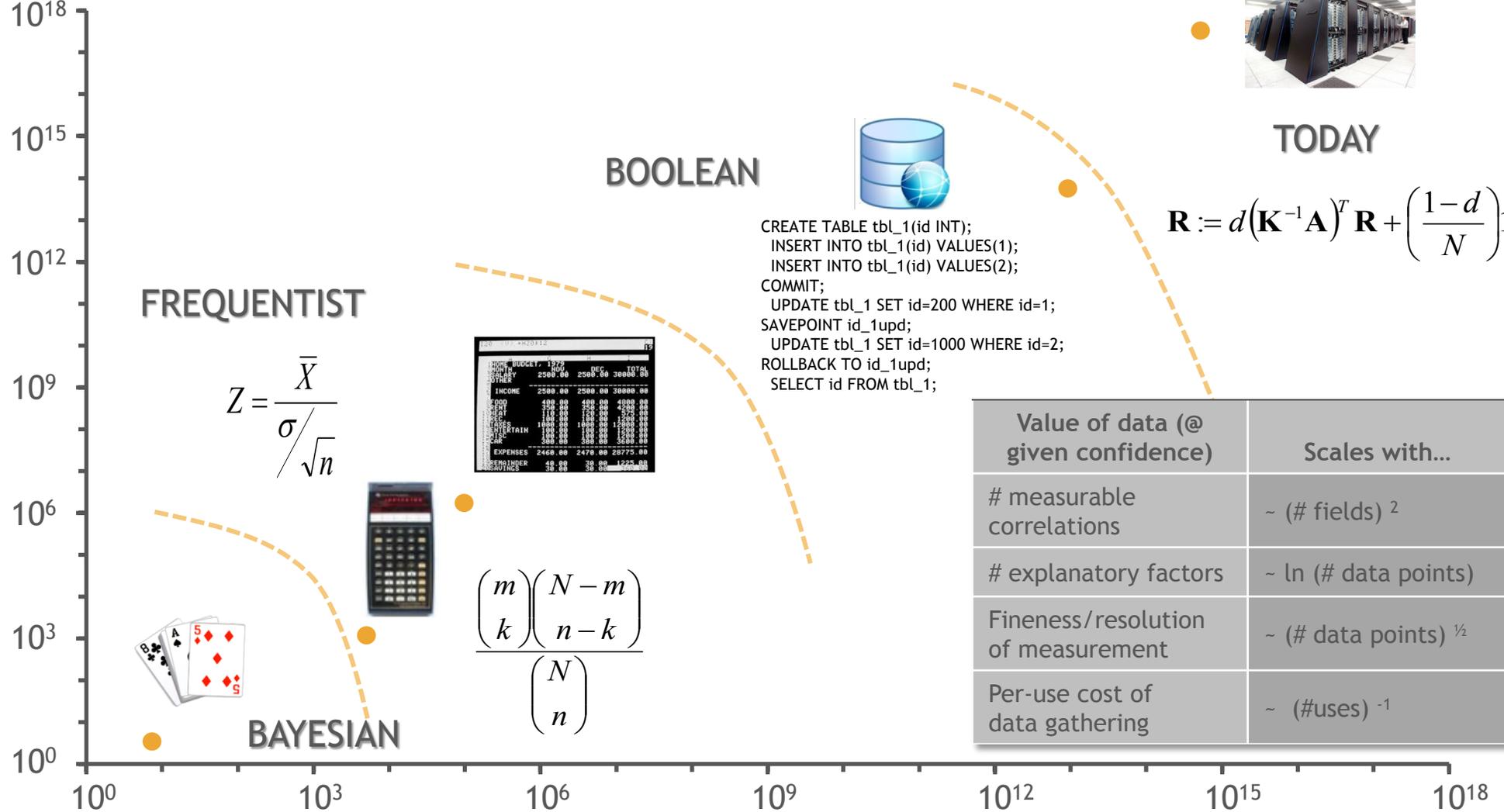
...and a lot more computing power

Performance (GFlop/s)



Putting those together

Instructions Per Second



Data for TI 59, IBM PC, BCG servers 2011, Google (guess)timates based on power consumption estimates by Jonathan Koomey
<http://iopscience.iop.org/1748-9326/3/3/034008>. BCG analysis

Bytes

BCG machine learning model predicts company success



Hurdles

Emerging solutions

Is this the right

Is this the right

Will it work in

What are the

X variables

-  Patents Count, growth spikes, quality...
-  Sci. Lit. Count, growth spikes, impact factor...
-  Funding Amounts, stages, timeline...
-  Financial R&D spend, revenue, profit...
-  Founders Experience, relationships, collaboration networks...
-  Media Volume, media spikes...
-  Other Employee count, projects in clinical trials, sub-technology ranking...

Tested on 235 imm-onc startups

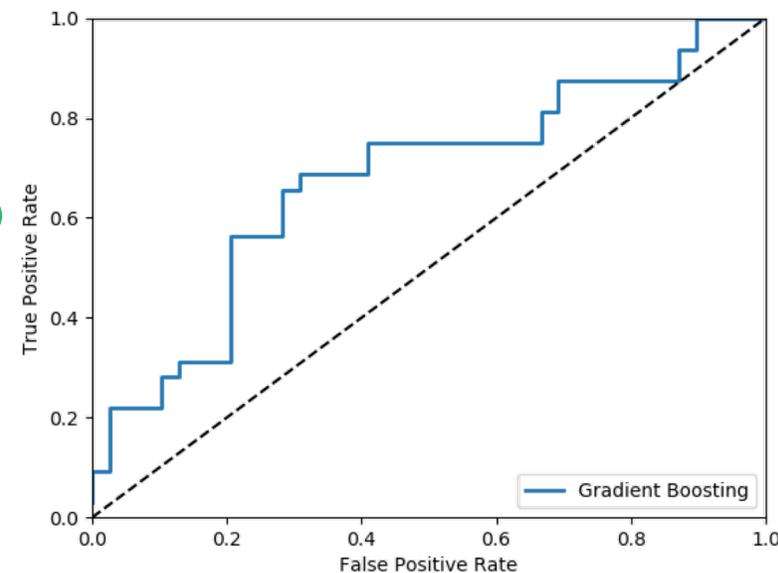
191 public and 44 private companies

Prediction based on data at end 2014 and outcomes on data at end 2016

Y variable composite: TSR, rev. growth, acquisition, failure

Training set and test set selected randomly

Predicts with AUC 0.71



Source: BCG experience

Chemistry treated like computer vision



Hurdles

Is this the right

Is this the right

Will it work in

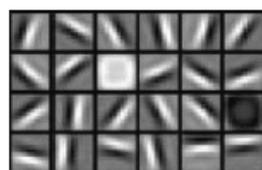
What are the

AlexNet / ImageNet

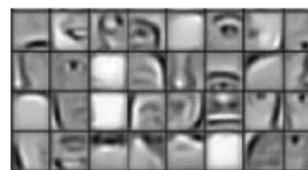
<https://papers.nips.cc/paper/4824-imagenet-classification-with-deep-convolutional-neural-networks>



Pixels



Edges



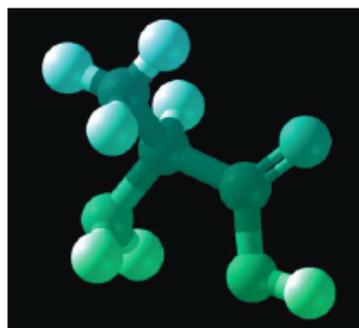
Eyes, Noses, Mouths



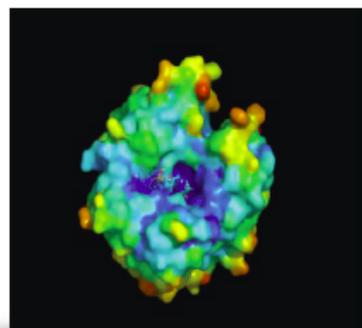
Faces

AtomNet™

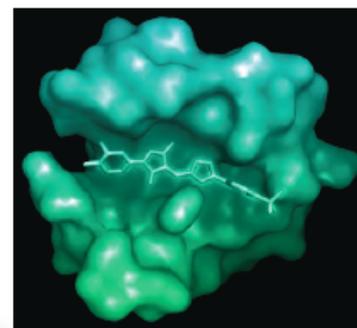
<https://arxiv.org/abs/1510.02855>



Atoms in 3D Space

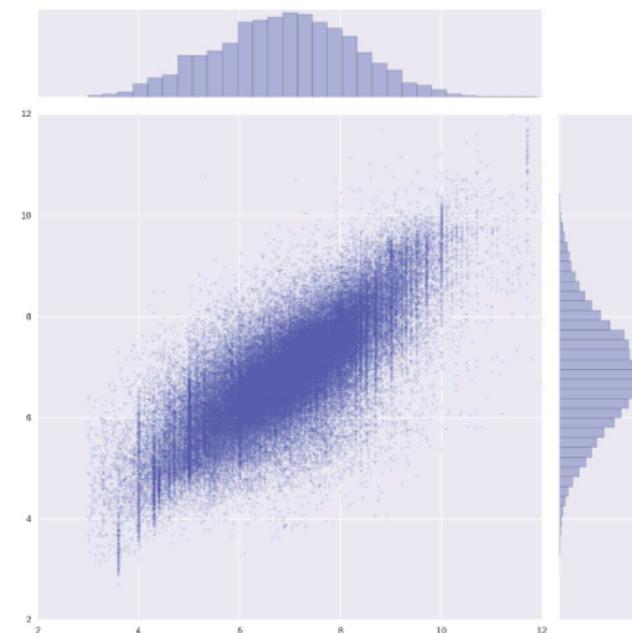


Biochemical Features



Molecule-Protein Binding

Predicted (pKi)



Observed (pKi)

Source: BCG experience

Emerging solutions

For discussion:

What is real and what is over-hyped?

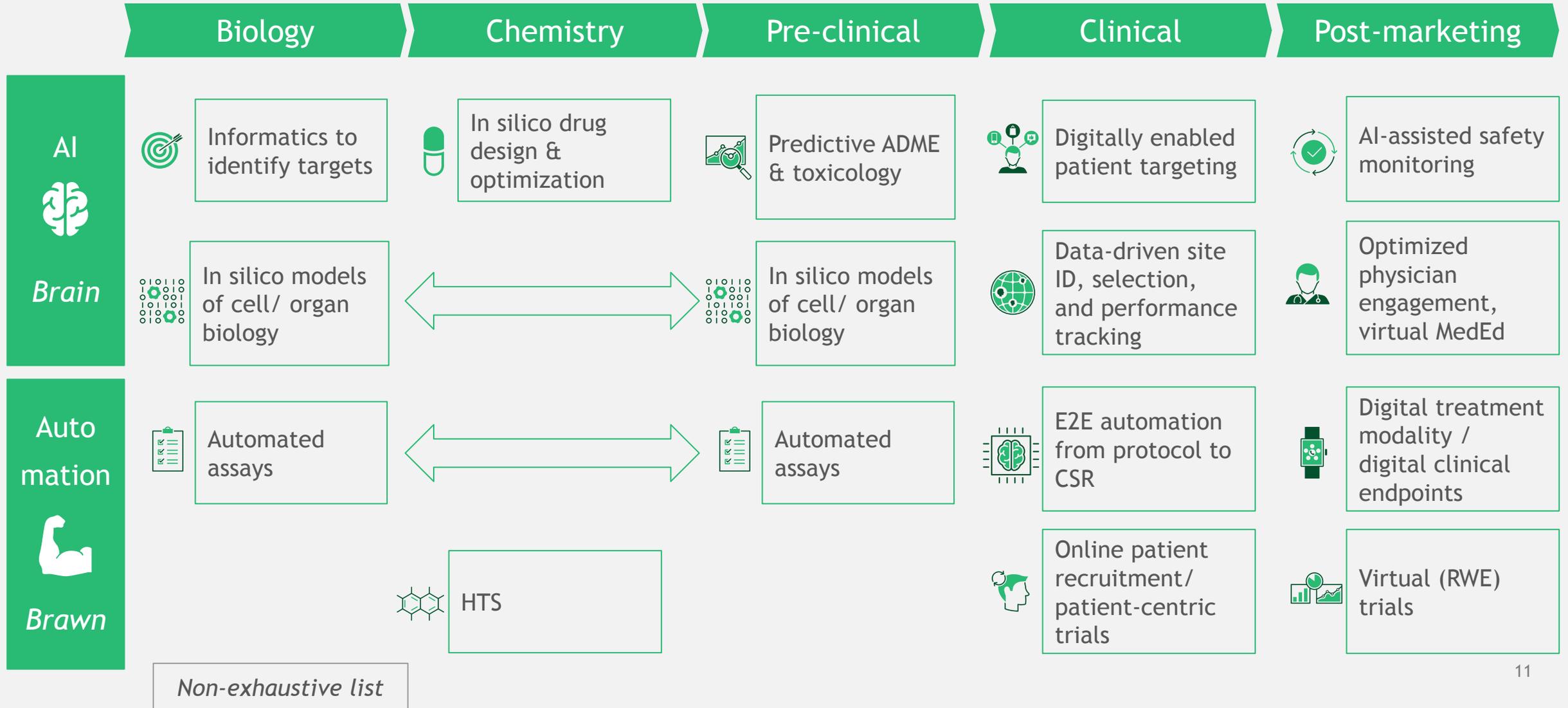
What has the most potential for long-term impact?

What are the best near-term opportunities?

What are the constraints (data availability, privacy, etc.) and how should they be addressed?

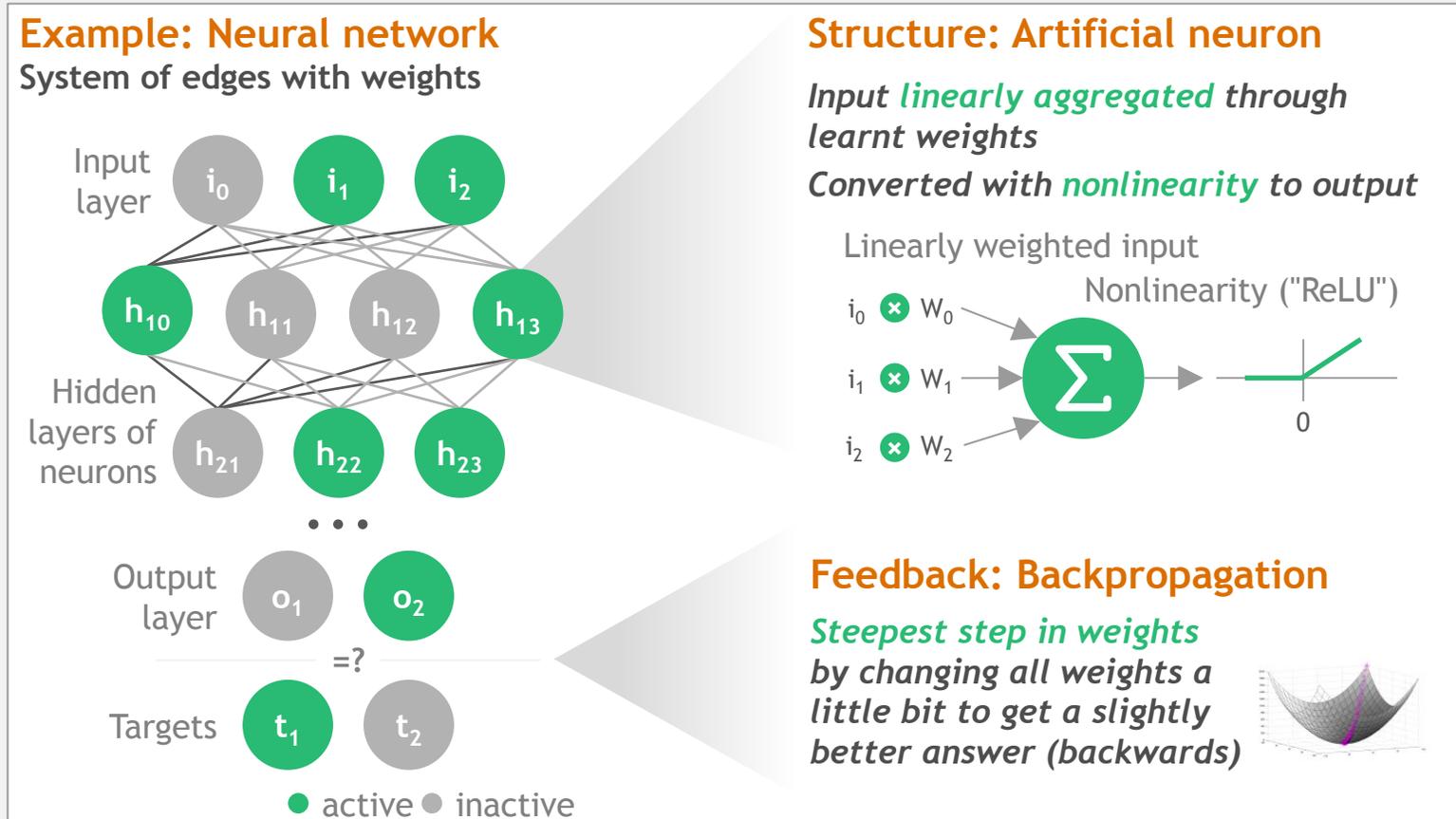
What are the risks (cost, reputation, error, etc.) and how should they be managed?

Thought-starters for potential R&D opportunities



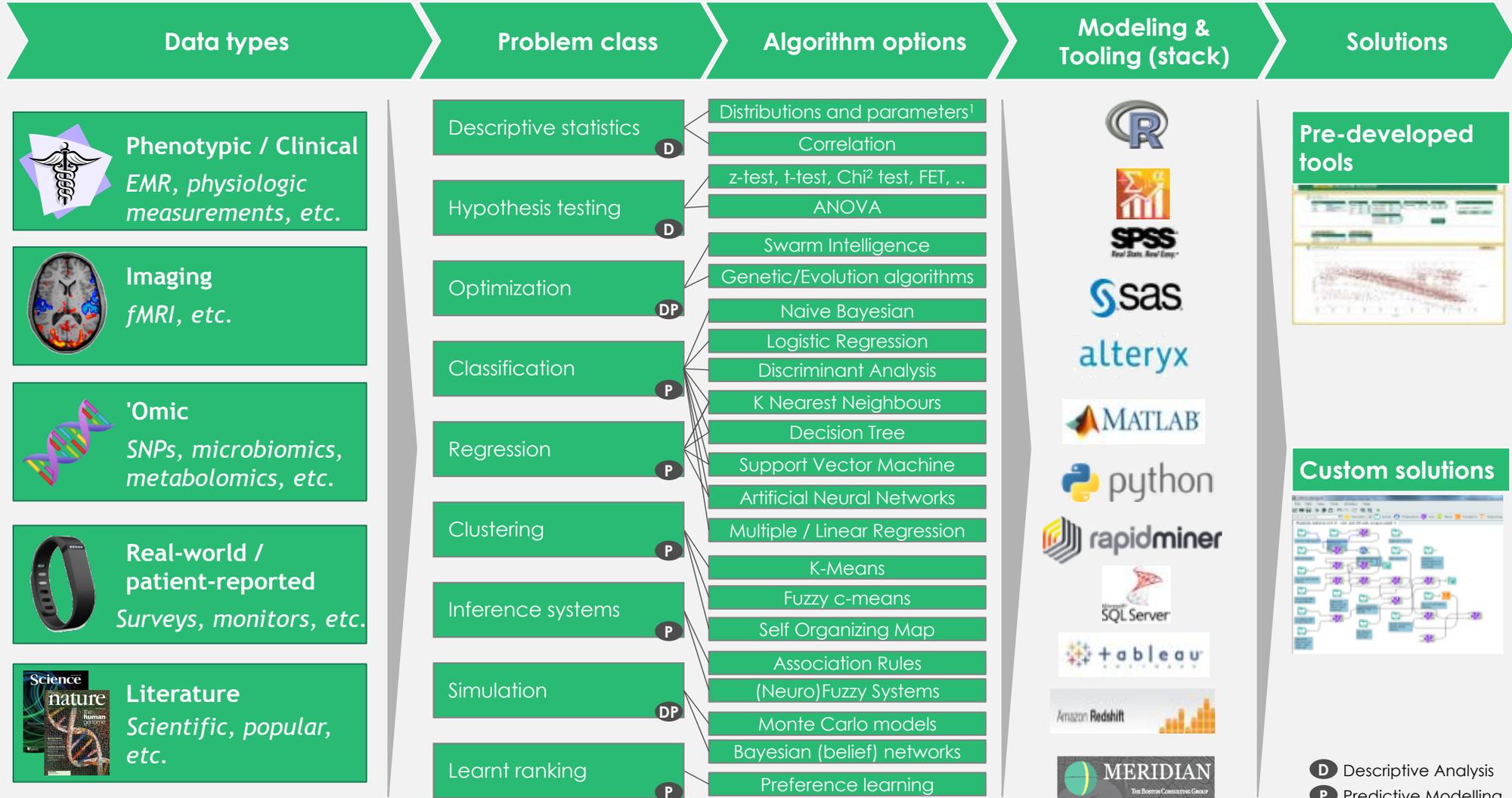
Non-exhaustive list

Just a big nonlinear regression...



Value heavily dependent on the training set

...with a lot of variants



D Descriptive Analysis
P Predictive Modelling

Note: Lists of methodologies and tools are not exhaustive