25 Jotun Hein MMSC Case Study Projects

I have earlier formulated large number of projects, that changed a lot when the students started, ie I decided to involved the students in the project formulation as well.

One can home in on an interesting project in 2-3 conversations or possibly even faster if the student(s) have already something they want to do. If so, I just have to be convinced, that I can supervise it responsibly.

There at least 3 steps in finding an ideal project:

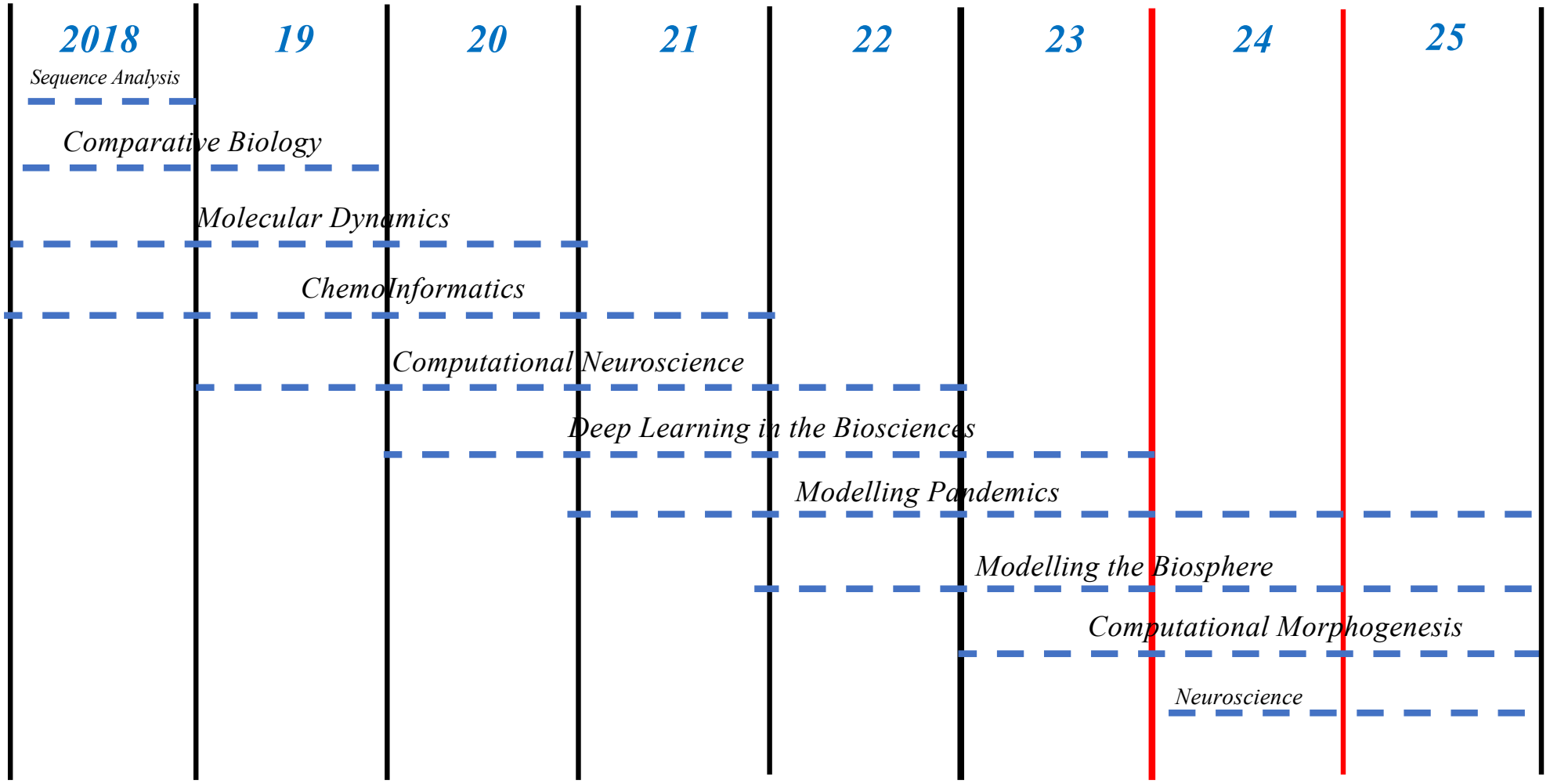
> ***1 – what are the technical expertise of the student(s): algorithms, data analysis, stochastic models, dynamical systems,…***
>
> ***2 – what is the domain of application?***
>
> ***3 – what is the idea/investigation that should be pursued?***

On the next slides (mostly without voice), that I hope that you will browse, you should find:

> ***Mini-Projects from the Course, Topics in Computational Biology [TiCB].***
>
> ***Links to lectures mainly given in this course.***
>
> ***I hope this is interesting and defines what I could supervise in.***

Topics in Computational Biology

Each year a sub-topic is added [2 weeks] and a sub-topic is deleted



I spend 6-8 months reading and preparing slides. If I read 100 pages/day, this amounts to 20K pages. Sounds like much, but it is less than 10% of a real expert will have read.

Some Earlier MiniProjects I

Examination by Essay 2020.

1. **Stochastic Context Free Grammars in RNA Secondary Structure Prediction**
2. **Substitution Models with Rate Heterogeneity**
3. **Clustering Biological Networks**
4. **Quantum algorithms for Protein folding**
5. **Probability Theory of Networks**
6. **Inference of Gene Regulatory Networks using Differential Equations**
7. **Hidden Markov Models and their Applications to Bioinformatics**
8. **Computational Models for Gene prediction**
9. **Alignment-based De Novo Prediction of Non-coding RNA**
10. **Automated Annotation of Genes**
11. **Network flow and its applications to the analysis**
12. **Identification of Regulatory Elements – Phylogenetic Footprinting**
13. **Probable and Improbable Paths in Sequence Evolution**
14. **Simulative Approach to Alignment**
15. **Sequence RAFs**
16. **Birth and Death Processes**
17. Haplotype Imputation
18. **Prediction of drug targets**
19. **Computational Approaches to Nanopore Sequencing**
20. **Molecular Dynamics for Modelling Dimers**
21. **Persistent Homology**
22. **One Algorithm Fits All**
23. **Spiking Neural Networks**
24. Statistical Approach against COVID-19 Pandemic
25. Multi-objective optimisation techniques applications to gene regulatory network inference
26. Deep Learning Methods for Modelling Quantitative Structure-Activity Relationships
27. Deep Learning and Gene expression
28. Protein Tertiary Structure Prediction
29. Trial and Error ThePowerof EvolutionandReinforcement Learning
30. Constructing Phylogenies TheBayesianWay
31. UnpackingAlphaFold A ReviewofAdvancesinProteinFolding
32. Deep LearningMethodsforDNA MethylationinCancerStudy
33. Computational Approaches to Molecular Representations Shallow and Deep Learning Methods
34. Statistical FineMapping in Genome Wide Association Studies
35. CRISPR-Cas9GeneEditingMechanism
36. Genetic AlgorithmsInDrugDesign
37. Dopamine and Reinforcement Learning
38. BayesianNeuralNetworksforManagingUncertainty in BiomedicalImaging
39. The Role of Deep Neural Networks in Neuroscience
40. Computational Approaches for RNA Secondary Structure Prediction From Nussinov's Algorithm to E2Efold

Some Earlier MiniProjects II: 2021

1. *Predictive Computational Modelling for Epidemiology*
2. *An Overview of Several Time Series Methods for COVID-19 Forecasting*
3. *Causal Inference Methods for Epidemiology of the COVID-19 Pandemic*
4. *Modelling the effects of non-pharmaceutical interventions on COVID-19 transmission*
5. *Computational Models for COVID-19 Prediction*
6. *Mathematical Models of Infectious Disease Transmission*
7. *LSTM and GRU for COVID-19 prediction and their limitations*
8. *Modelling spread of COVID-19 by incorporating infectious period as a time-delay*
9. *Statistical Approach against COVID-19 Pandemic*
10. *Deep Learning Methods for Non-Invasive Diagnosis of Neurodegenerative Diseases*
11. *ANALYSIS OF TRANSPARENCY AND EXPLAINABILITY IN APPLICATIONS OF MACHINE LEARNING TECHNIQUES IN CANCER DIAGNOSIS*
12. *Generative Adversarial Networks in De Novo Drug Design*
13. *NEUROSCIENCE AND REINFORCEMENT LEARNING- THE PAST, PRESENT AND FUTURE*
14. *Predictive Coding- Perspectives from Neuroscience and Artificial Intelligence*
15. *Deep Learning models for the prediction of gene expression ab initio from DNA sequence*
16. *BRAIN-COMPUTER INTERFACES AND THE USE OF DEEP LEARNING MODELS*
17. *Graph Representational Learning in Biomedicine*
18. *Computational Biology Essay- The Language of Life- Advances in Protein Language Modelling*
19. *MACHINE LEARNING AND LIQUID BIOPSY FOR EARLY DIAGNOSIS OF CANCER*
20. *Alzheimer's Disease & Machine Learning*
21. *Modelling functional connectivity networks*
22. *Unobserved Confounding Problem in Treatment Effect Estimation from Clinical Data*
23. *GRAPH NEURAL NETWORKS FOR LEARNING MOLECULAR REPRESENTATIONS IN DRUG DISCOVERY*
24. *Persistent Homology in Computational Neuroscience*
25. *Identity By Descent- bridging population genetics, genomics and evolutionary theory*
26. *Phylogenetic Insights into CRISPR-Cas*
27. *Convolutional Neural Networks Are the livelihoods of radiologists threatened by the improving segmentation capabilities of convolutional neural networks?*
28. *Machine Learning and Deep Learning in Binding Affinity Prediction*
29. *Protein contact prediction based on multiple sequence alignments*
30. *Predicting Aberrant Splicing with Deep Learning*
31. *Deep Learning for Protein Structure Prediction*
32. *Applying deep learning to coarse grained models of molecular dynamics*
33. *Generative Models of Mental Disorders*
34. *Applying Markov decision problem and optimal control theory methods to the stag hunt game to phenotype Autism Spectrum Condition*
35. *Markov State Models and Protein Folding*
36. *From Cognitive Maps to Basis Sets- Models of Cognition in Spatial and Relational Domains*

Some Earlier MiniProjects III: 2022

1. Evaluating Social Distancing Interventions in the Context of Covid-19 Using Social Network Approaches
2. The development of spatial models for HIV transmission between heterosexual populations
3. A Computational Overview of Oceanic Dimethylsulfide (DMS) and Its Impact on Climate Modelling
4. Genotype-Phenotype Mapping and Alzheimer's Disease
5. Assembly Calculus
6. Deep Learning in COVID-19 Diagnosis and Assessment
7. Applications of Neural Network based models in the COVID-19 pandemic
8. A Review on Protein Contact Prediction Methods and the Potential Future Topics in This Field
9. Neuroevolution of plastic spiking networks: replaying nature's creative process
10. A model for Alzheimer's disease based on amyloid cascade hypothesis
11. An assessment of Computational Models and Techniques applied to ADHD
12. Computational Models of Human Vision
13. Convolutional Neural Networks in Medical Diagnostics
14. Genomic Motif Representations in CNN First Layer Filters with Varying CNN Architectures
15. Comparing 2 Different Methods of Recombination Detection of SARS-CoV-2
16. AlphaFold, deep learning and protein structure prediction
17. Computational Neuroscience and Modern Deep Learning: It Takes Two to Tango
18. Application of Deep Learning in Diagnosis of Breast Cancer
19. Network Science in COVID-19 Modeling
20. Computational Network Biology: Predicting Parkinson's Disease Genes with Network Embedding
21. Application and comparison of compartmental and agent-based models in pandemics
22. Modeling and predicting climate extremes
23. Deep Generative Modelling for One-Shot Molecule Generation
24. Brain-Computer Interfaces and Neural Networks in BCIs
25. Assessing the effects of non-pharmaceutical interventions in the initial phase of the COVID-19 pandemic with an SIR type model
26. Graph Neural Network for Antibody Sequence-Structure Co-design
27. A Bayesian Approach to Statistical Genomics Applied to SARS-CoV-2
28. Biologically Plausible Neural Networks
29. Deep Learning Techniques for Drug-Target Binding Affinity Prediction
30. Deep learning generative methods and their impact on drug discovery
31. Biological Computing through On-Chip Neuronal Networks
32. Deep Learning in Anti-aging Drug Discovery
33. Is the brain a quantum computer?
34. From AlphaFold1 to AlphaFold2: Development of Deep Learning Methods in Protein Structure Prediction
35. Bayesian Inference for Infectious Disease Models
36. Graph Neural Networks for De Novo Drug Design
37. Modelling Aerosol-Cloud Interactions
38. Quantum Algorithms for Protein Folding
39. Self-supervised Protein Language modelling to generate de novo SARS-CoV-2 Mutational Landscape
40. Graph Representational Learning in Computational Neuroscience

Mini-Projects IV: 2023

1. Study of Surrogate Model Approaches for Explaining the Importance of Blood Sample Features in the Prediction of COVID-19 Mortality
2. HIGH-LEVEL AGENT-BASED MODELLING OF THE COVID-19 PANDEMIC
3. Generalization of Prediction Models for COVID-19
4. Quantifying the Effects of Government Interventions on COVID-19 Spread
5. A Comparison of Two Mechanistic Models
6. An Overview of Mobility Network Models in Predicting Epidemics
7. Deterministic vs Stochastic Compartmental Models
8. Forecasting of the COVID-19 Pandemic
9. Evolution of disease modelling with SIR type models
10. Review - Modelling the transmission of Onchocerciasis
11. Infectious Disease Model and Model Fitting Techniques about A (H1N1) Influenza
12. Forecasting of the COVID-19 Pandemic - A Study of SIR, SEIR, and ARIMA Models
13. Forecasting of the COVID-19 Pandemic - Compartmental and Time-series models
14. ***Modelling HIV/AIDS pandemic to assess accuracy of treatment methods***
15. An Overview of several compartmental epidemic models
16. Climate Modelling - A Brief History and the Evaluation of Uncertainty
17. A report on the Meta-Statistical Extreme Value Distribution as an alternative to the Generalised Extreme Value Distribution for modelling yearly rainfall maximums
18. A Comparison of Reinforcement Learning Models for Chemical Plume Tracing
19. The Evolution of El Ni˜no Forecasting
20. A Review of the Carbon Cycle, and the Major Carbon Sinks
21. Representing Unresolved Processes into Climate Models through Machine-Learning-Based Parameterizations
22. MORTALITY ASSOCIATED WITH TEMPERATURE - CASE STUDY OF CHICAGO HEAT WAVE
23. Turing patterns in predator-prey modelling
24. Turing Patterns and Growth in Biology
25. Topological Data Analysis in Computational Biology
26. Multiscale modelling of environmental stimuli in plant tropism
27. A Monte Carlo Simulation of Protein Crystal Twinning
28. Hyperbolic Phylogenetics
29. The Emergence of Large Language Models in Healthcare
30. ***Deep Neural Networks for the Next Pandemic Diagnosis***
31. Multi-task Learning with Deep Neural Networks for Discrete-time Survival Analysis
32. Deep learning in CRISPR gene editing via effective off-target predictions
33. Applications of Deep Learning and Genomics in Cancer Diagnosis
34. Deep Learning in Ovarian Cancer Diagnosis
35. Benchmarking Graph Neural Networks for Protein-Protein Interaction
36. Developments in Protein Structure Predictions
37. Convolutional Neural Networks in Drug Discovery
38. Metabolic Engineering and Machine Intelligence - a match made in heaven.
39. Diffusion Models on Generating Fluorescent Channel of the Cell Image
40. Towards the Design of Next-Generation Medical Chatbots - A Multimodal Deep Learning Approach
41. Geometric deep learning on non-Euclidean data for modelling cardiac anatomy.

Mini-Projects V: 2024

1. Uncertainty in Climate Predictions
2. The East African Climate Paradox
3. A Review of Contrail Detection and Avoidance
4. Research Dissemination of Climate Change Science Through Interactive Climate Simulations
5. Analysing the Effect of Climate Change on Models for Tuberculosis
6. Attribution Studies in Climate Science and Policy
7. Measuring the effect of COVID-19 on Labour Supply and Demand
8. Predicting the Curtain Call - Computing the Probability of Outbreaks Ending
9. Models for Describing and Forecasting the COVID-19 Pandemic
10. Using Mathematical and Statistical Techniques to Investigate the Transmission of Dengue
11. Modelling Happiness on a Social Network with Multiple Modelling Paradigms from Epidemiology
12. Adaptations in epidemiological modelling for co-infection
13. The Mathematical Modelling of Zombie Outbreaks - Why it Went Viral
14. Forecasting of the COVID-19 Pandemic - Agent Based Models
15. Exploring Epidemic Seeding Effects Through Geometric Random Graph Models
16. The Evolution of Cancer and a Cancer's Evolution
17. Dating the Origins of Coronaviruses
18. Neural Learning in Brain Organoids
19. Chromatic Number of Intersection Graphs with Certain Girth in Different Dimensions
20. Hopfield Networks and their Applications
21. State of the Art Computational Models for Alzheimer's Disease Progression
22. Decoding Decision-Making - Integrating Reinforcement Learning with Neural Mechanisms
23. A Review on Hopfield Network - Past, Present and Future
24. Computational neuroscience models in ADHD
25. Computational Modelling of Seizure Dynamics - The Epileptor and Whole Brain Modelling of Epilepsy
26. In Silico Modelling of Adaptive Deep Brain Stimulation for Parkinson's Disease
27. Graph Machine Learning for Neuroimaging Analysis - A Wholistic Review
28. AI and Neuroscience - Answer to Unlocking AGI?
29. Decoding the Human Mind - The Capabilities and Challenges in Speech Brain-Computer Interfaces
30. Learning Mechanisms of Artificial Neural Networks and the Brain
31. Navigating the Brain - Charting the Intersection of Space, Relations, Memory and Artificial Intelligence
32. Mathematical modelling of cell proliferation and tumour growth using fluorescent cell-cycle indicators
33. Turing Patterns in Chemical Systems - an Investigation of the Chlorite–Iodide–Malonic Acid Reaction
34. Agent Based Modelling of Collective Movement in Animals
35. Cellular Automata versus Partial Differential Equations - Sea Shells and Traffic Flow
36. Towards Large-Scale Computational Morphogenesis
37. Active Matter in Embryo Morphogenesis
38. Kalman Filters in Computational Biology
39. Deep Learning in Biomedical Segmentation
40. Generative Diffusion Models for De Novo Drug Molecule and Protein Design
41. Natural Language Processing Techniques for De Novo Protein Design
42. Fairness in Healthcare Machine Learning Applications
43. Advances in de novo protein design by deep learning methods
44. Computational Models of Working Memory in Cognitive Neuroscience
45. Surveying Machine Learning Methods for Predicting the Outcomes of Prime Editing
46. Decoding Nature's Symphony - Advances in Computational Bioacoustics
47. Beyond Traditional SIR - Advanced Models for COVID-19 Forecasting
48. Meta-Reinforcement Learning and Neuroscience
49. A Comparative Study of Deep Learning Techniques for Prediction of CO2 Emission in Traffic Vehicles
50. the human ectoparasite hypothesis for plague transmission

Why didn't somebody write on?:

There is a wonderful variety in the reports, but there also some clustering like a lot on Compartmental Models in Pandemics, so here are some topics I would have written on in case I was to hand in a set of reports to be graded.

ChemoInformatics

How does one efficiently sample chemical space subject to different constraints?

Can one restrict the set of relevant molecular graphs by knowing they have to be 3D realizable?

Pandemics

The Models are advanced, but the data noisy and biased. How does models deal with this?

How do you rank possible scenarios for the next Pandemic?

How do you measure the Cost of Covid? Of Lockdowns?

Molecular Dynamics

What has MD done for Sars Cov-2?

How do you represent movements of a virion rationally?

Is comparative MD useful?

Modelling the Biosphere

Why are Climate forecasts so noisy? Where does the error enter?

What it the cost of Climate Change? Social Cost of Carbon

Granger Causality – Causality between Processes

Morphogenesis

Why did Catastrophe Theory go Extinct? Could it still have a role to play?

Population Genetics, Recombination and Mapping

Formulate a Birth-Death Process with Recombination

Machine Learning

How do you quantify memory in Artificial and in Biological Networks?

LLMs are a huge success? But how do you represent more abstract concepts (Space, mathematics,..) in an Artificial Structure?

Comparative Biology

Is there a role for comparative modelling in morphogenesis?

Computational Neuroscience

How do you quantify memory in Artificial and in Biological Networks?

What are the simplest Neural Systems and have they been modelled?

What function does a biological neuron implement?

Sequence Analysis

Write up the recursions for Long Indel Model for n sequences in Statistical Alignment

Modelling Cells, Organs, Individuals

What is the prospects for predictive modelling of a prokaryote?

The Biosphere and Climate Change

Why this topic?

It is the worlds most important problem!!!

It will only become more important in coming decades.

It will swamp all news ad nauseum

CC research needs statistics, modelling, computer science and more

I could have given: alignment, recombination, origin of life, ….- but this is more rewarding for all.

The Biosphere

1 Climate Earth System

2 Models

3 Climate Statistics

4 Climate Change

Preparation

Modelling the Dynamics of the Biosphere

Demystifying global climate models for use in the life sciences

Extreme weather impacts of climate change: an attribution perspective

Browse Stainforth!!

Appendix Lectures

1 IPCC6 I

2 IPCC6 II-III

3 Climate Books

Extras Lectures: This Lecture + QA1 + QA2 + Expert (Stainforth)

Overall Assessment – ***A wonderful topic, with a great diversity of subtopics, ranging from difficult mathematics to applications of real consequence. And good reviews/textbooks on almost any subtopic.***

The Biosphere and Climate Change

Overall Objectives:

Dynamic Modelling of Earth with Focus on Biosphere

Forecasting, Causality and Control

Consequences for Humanity

Wikipedia

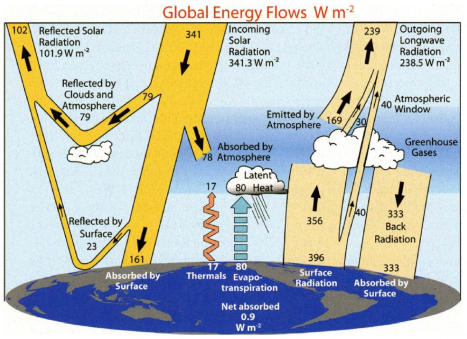
Needed:

Formal Representation of Biosphere

Models

Quantitative Data

Model Selection, Parametrization and Quality Evaluation



Trenberth.

Challenges:

Size and Time-Scale of the System

Unpredictability

Stochasticity

Dependency on Human Behaviour

In even weeks you also you also have a class, where you present a paper of your choice in about 10 minutes and write about 1 page summary of your chosen paper. Below are 3 suggestions for papers, but students normally have no problems finding a paper themselves that they find interesting.

A high-resolution record of early Paleozoic climate Trajectories of the Earth System in the Anthropocene

Estimating global mean sea-level rise and its uncertainties by 2100 and 2300 from an expert survey

Computational Virology

Why this topic?

Humanity Population Size is 8+ Billion, heading for 11+. This is a huge "Petri Dish" for pathogens, so more Pandemics is heading our way.

Like CC it will fill the media also post-COVID.

This research also needs statistics, modelling, computer science and more

Computational Virology I : The Basics of COVID-19

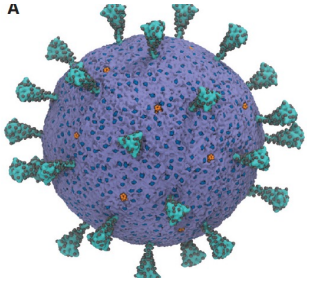
Computational Virology II : Epidemiological Models

Computational Virology III: NPI, Forecasting, Cost, Epidemiological Parameters, Demography,..

Computational Virology IV: Disease X, Clinical Trials, Variants, Outbreak Detection, ..

Overall Assessment *– Horrible to read about. A flood of un-reviewed papers and textbooks and it is impossible to sort it according to quality and conceptual clarity. For a period more than 700 papers and more than a book was published on this per day. After 4 years it is getting a lot better.*

Computational Virology



Overall Objectives:

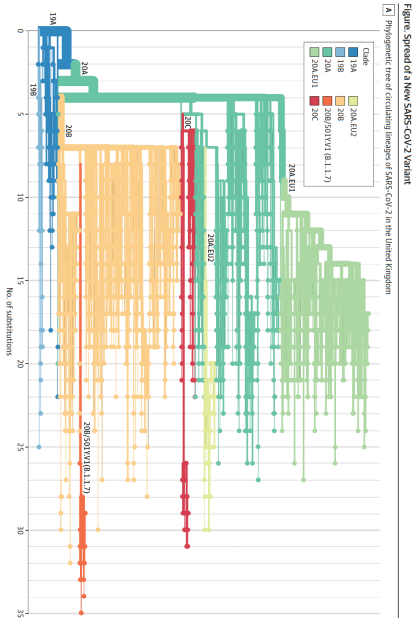
Map Key Epidemiological Parameters [infectionesss, mortality,..]

Functionally characterize the virus

Describe evolutionary processes and infer history of virus.

Describe virus-host interaction.

Forecast and evaluate control measures

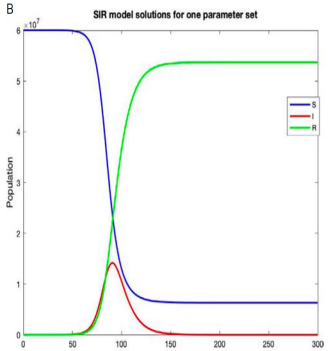


Needed:

Models

Data

Inference

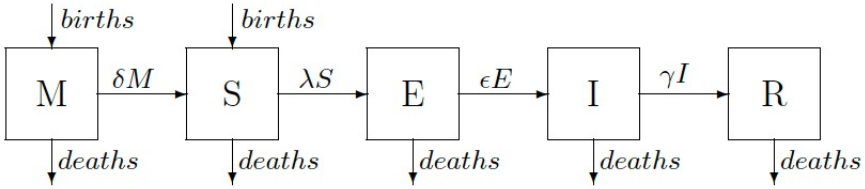


Challenges:

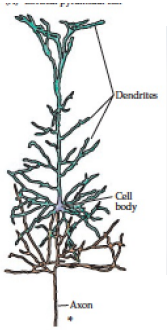
Computational Issues

Unbiased Data

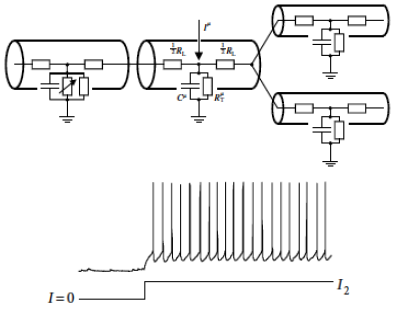
Doing all in real-time



Neuroscience

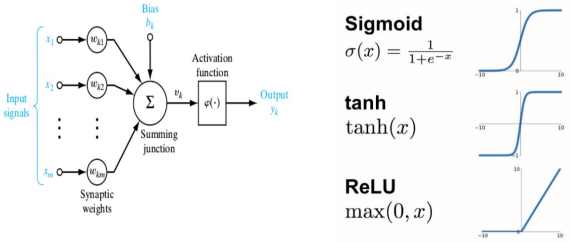


The Biological and Artificial Neuron



Modelling Neurons

Modelling Neural Networks



Computational Modelling of the Biological Brain

Overall Assessment *– A massively challenging and fascinating topic that will dominate coming decades. The human brain is still "unknown" in terms of detailed wiring, despite massive progress. Even C. elegans [302 Neurons] cannot be simulated reliably. An interesting "parallel lives" between artificial and biological neurons/brains.*

Computational Models of Shape and Form

$$\begin{cases} u_t = D_u \nabla^2 u + \gamma(u + av - uv^2 - puv) \\ v_t = D_v \nabla^2 v + \gamma(bv + hu + uv^2 + puv) \end{cases}$$

Why this topic?

"Genotype → Shape/Pattern" is one of the few Holy Grails of the Biosciences.

It will take decades or more to solve.

If you want to model or analyze Shape/Pattern, they must be represented.

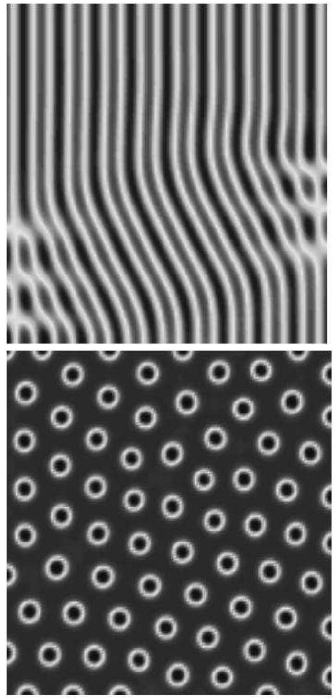
The field is experiencing much progress presently.

Shape and Form in Multicellular Organisms

The Classic Models

Advanced Models

Functions: Genomes → Shape/Form



Computational/Mathematical Models of Shape and Form

Overall Objectives:

Represent Shape/Pattern

Model/Predict Shapes/Patterns

Model Shape/Pattern Evolution

Compare Shapes/Patterns

Needed:

Dynamic realistic models

Detailed Ontogenic [Life History] Shape/Pattern Data

Challenges:

Organism are big computationally

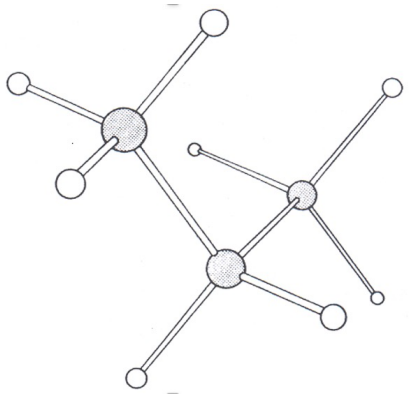
Data not sufficiently detailed

The Genotype → Shape/Pattern Map is simply now known at present

Overall Assessment – A wonderful topic, with a great readable literature. It is bound to be of increasing importance in coming decades.

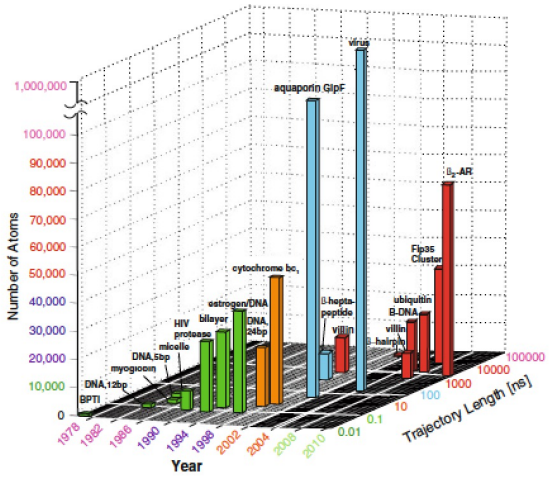
Earlier Topic: Molecular Dynamics

Physics of Molecules: QM and MM



Integrators and Approximations

MD of Protein Folding



Schlick, 2010

History and Applications of MD

Overall Assessment *– At the bottom of the ladder of reductionism and is closer to explaining biology in terms of physics. However, the model are very heuristic and main exciting/progress is in more computation and thus applying them to larger and larger systems.*

Earlier Topic: Deep Learning [DL] in the Biosciences [BS]

Goal of the 4 Lectures: 1. Basic introduction to ML+DL
2. Describing domains and achievements in 3 Bioscience Areas.

Why this topic?

DL/ML (Machine Learning) has amazing achievements within the last decade within BS.

It will only become more important in coming decades.

Where will go? And what will be the role of traditional physical and evolutionary models?

There are many other application areas than the 3 chosen.

The Basics of Machine Learning [ML] and Deep Learning

Deep Learning and Structural Biology

Deep Learning and ChemoInformatics

Deep Learning and Genomics

Overall Assessment – Amazingly successful in the last decade, but challenging to read about, since the field evolves very fast. There is no established terminology and results can be hard to understand since it can't be translated into model-parameters.

Deep Learning [DL] in the Biosciences

Overall Objectives:

Predict

Classify

Transfer Knowledge

Needed:

Large Data Sets

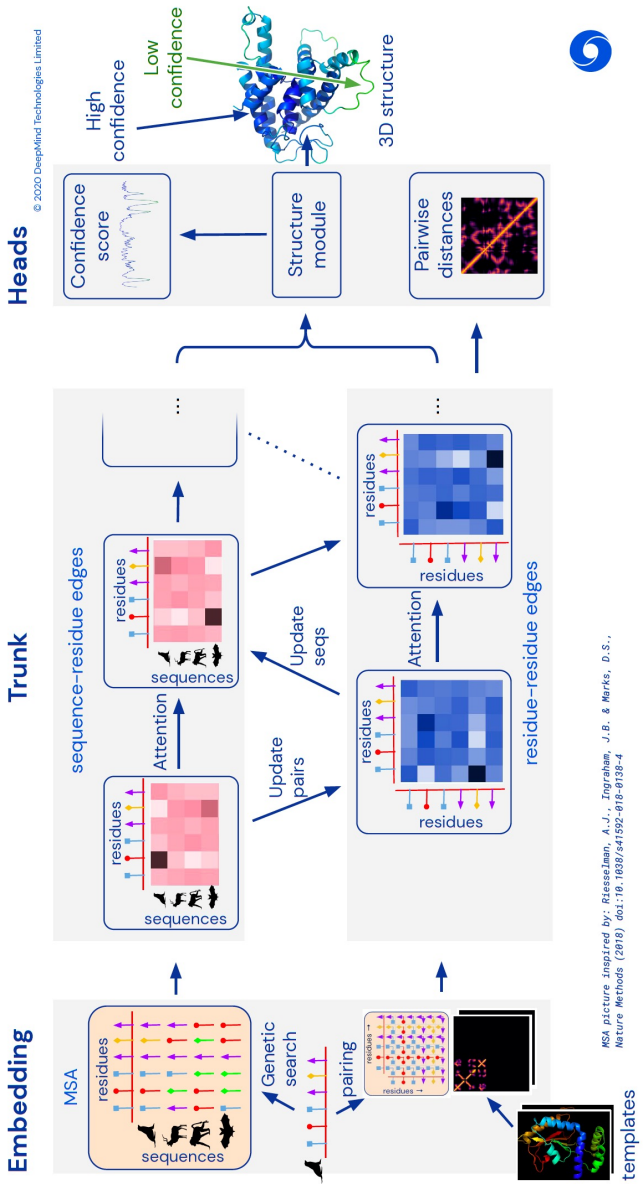
Appropriate Deep Learning Model

Challenges:

Interpretation

Relate it to traditional methods

Nature 2021 July AlphaFold2



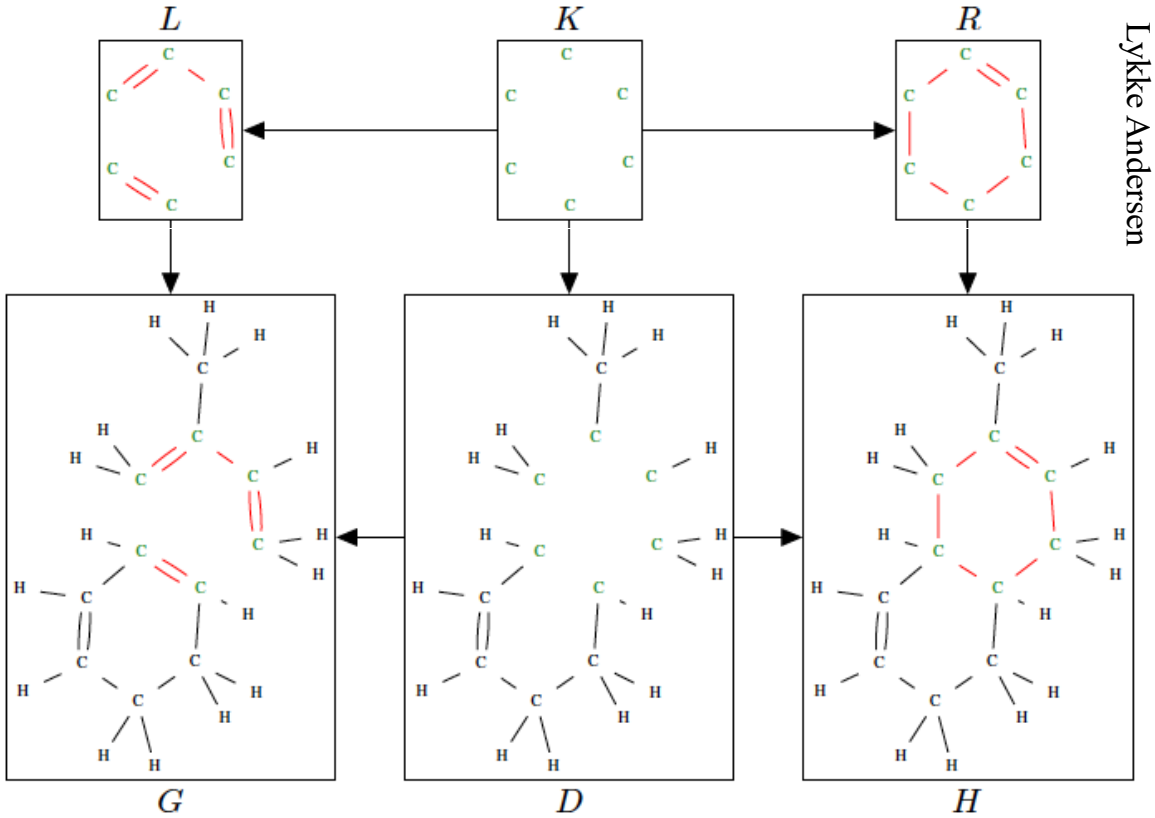
Earlier Topic: ChemoInformatics

Mathematical Models of Origins of Life

Combinatorics of Small Molecules

Chemical Space

Reactions



Lykke Andersen

Table 2. Overview of the Structure Generation Process

nodes	graphs[a]	generated[b]	accepted[c]	unique tautomers (GDB)[d]	all tautomers	stereoisomers[e]
1	1	4	4	4	4	4
2	1	10	9	9	9	9
3	2	52	20	20	21	20
4	4	332	80	80	88	87
5	8	2294	357	352	397	469
6	20	18 066	1906	1850	2135	2911
7	57	154 542	10 953	10 568	12 438	19 904
8	194	1 445 073	69 563	66 706	79 899	153 601
9	705	14 213 741	464 402	444 313	540 002	1 258 963
10	2822	146 004 340	3 259 036	3 114 041	3 827 907	10 898 065
11	11 912	1 558 491 448	23 875 101	22 796 628	28 240 425	98 645 474
total	**15 726**	**1 720 329 902**	**27 681 431**	**26 434 571**	**32 703 325**	**110 979 507**

JP Reymond 2011

Overall Assessment – ***Being close to drug-design, this is well funded and close to industry. It is good fun with lots of combinatorics, graph algorithms and DL has recently invaded it big time.***

Earlier Topic: Sequence Analysis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CTAGG
TT-GT
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Overall Assessment – ***This is CLASSIC Bioinformatics with surprisingly much to do still.***

Earlier Topic: Population Genetics and Evolution

Molecular Evolution

Models in Molecular Evolution

Rates in Molecular Evolution

The Mutational Process

Selection in Molecular Evolution

The Evolution of Multigene Families

Molecular Evolution and the Organism

Population Genetics

Models in Population Genetics

The Coalescent

The Coalescent and Recombination I

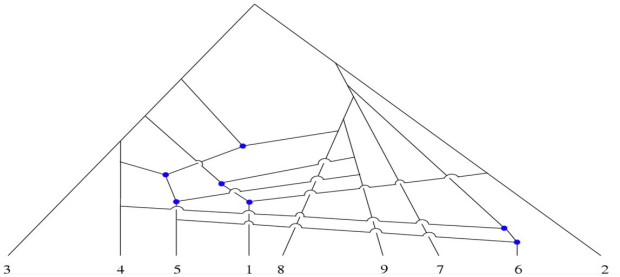
The Coalescent and Recombination II

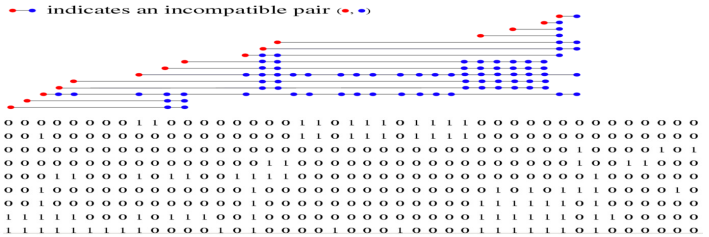
The Coalescent and Recombination III

Data Analysis in Population Genetics

Human Population Genetics

Birth-Death Processes





Overall Assessment – ***Population Genetics and Evolution used to be fun little fringe topics, but have in the last 2 decades have become functionally important and thus exploded in funding. Evolution is the foundation of Comparative Genomics and PG of Genetic Mapping.***