Hasso Plattner Institut
Digital Engineering · Universität Potsdam

Data Management for Digital Health
Revision of Exercise III

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Data Management for Digital Health
Winter 2023

Exercise III
Topics

- Clinical Interpretation of Molecular Data (Guest Lecture)
- Natural Language Processing
- Neural Networks, Word Embeddings
- Foundation Models
- Medical Use Case Nephrology
- Clinical Prediction Models

Exercise II
Key Stats

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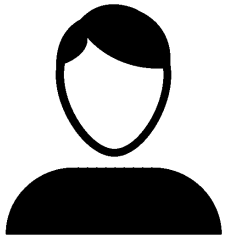
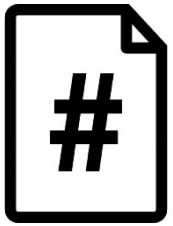
25 Questions 50 Points	26 Students 26 Passed	Average score 44.2 / 88.4%	Average time 92 min





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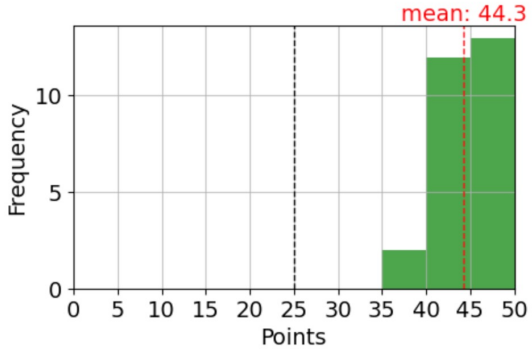
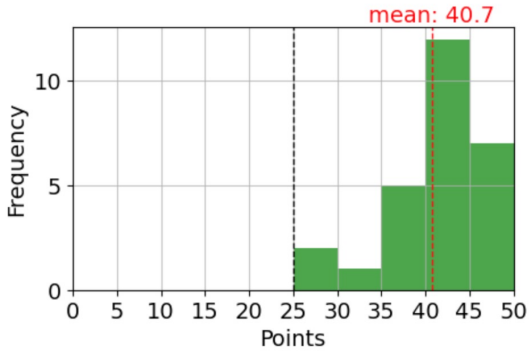
Exercise III
Key Stats



Exercise I (2023)



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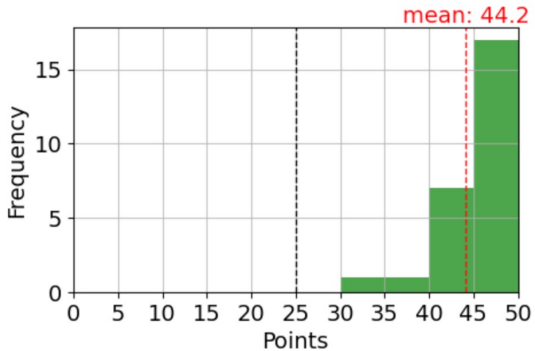

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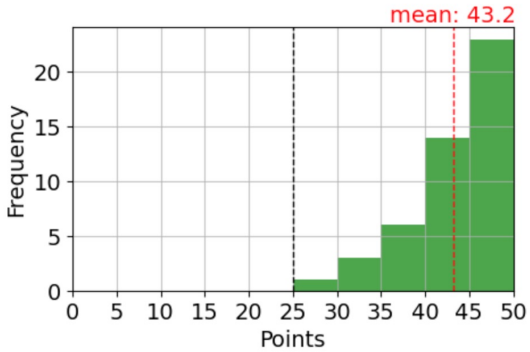
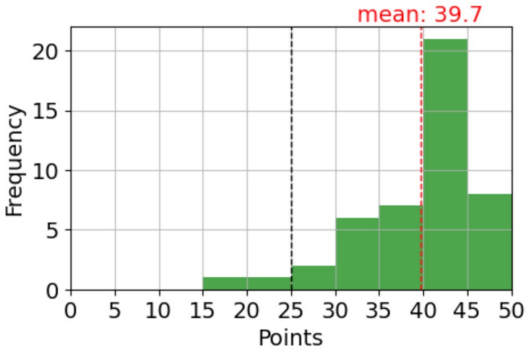
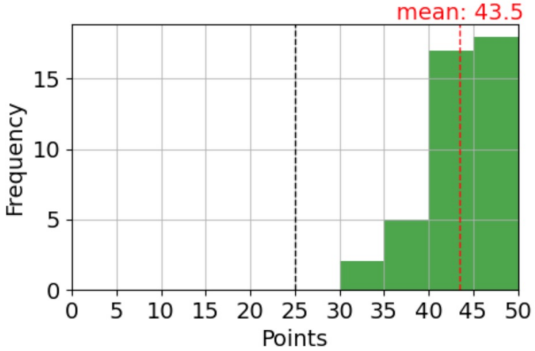


Exercise I (2022)



Exercise II (2022)



Exercise III (2022)

Q1 Which of the following statements are true for the use of molecular genetic data in course of precision oncology [...]?

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- ✓ Clinical relevance of genetic variants is assessed through knowledge bases like CIViC or OnkoKB.
- ✓ Today, whole genome sequencing is applied only for a limited number of severe ill patients, e.g., when enrolled in the DKTK MASTER program.
- ✗ A biological rationale constitutes the highest level of evidence, e.g., using molecular pathways only.
- ✗ Clinical interpretation of molecular data is already fully automated through general-purpose large language models.

Frequently missed

Frequent incorrect answer

Q1 Which of the following statements are true for the use of molecular genetic data in course of precision oncology […]?

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NGS (accredited/validated)
- Oncomine Focus/Precision DNA Assay
- Oncomine Focus/Precision RNA Assay
- ColonLung Panel V2
- Cancer Hotspot Panel
- Myeloid Panel (Custom)
- (B-cell) Lymphoma Panel
- Oncomine cfDNA (Liquid Biopsies)
- Breast cfDNA Panel (Liquid Biopsies)
- BRCA1/2 Panel
- Tumor Mutational Burden (1.7 Mbases)
- Molecular Health 600+ Panel (3 Mbases); NextSeq
- Oncomine Comprehensive Assay V4 (500+) Panel
- TSO500 (DNA/RNA) Panel
- Ig/TCR Clonality Panel
- Archer RNA Panel

IHC/FISH
- nTRK screening
- TMB
- Other Targets (e.g. HER2,
- Fusion Gene validation

Other
- e.g. EPIC (Methylom)

DKTK MASTER
- WES/WGS
- RNASeq

ExLiquid
- ctDNA

Functional Analyses

Single cell analyses

Evidence-based Assessment of Clinical Cancer Therapies

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- The higher the GoR and LoE, the more evidence about a success of the desired treatment is available

GoR	LoE	Type of Study
A	1a	Systematic review of (homogeneous) randomized controlled trials
A	1b	Individual randomized controlled trials (with narrow confidence intervals)
B	2a	Systematic review of (homogeneous) cohort studies of "exposed" and "unexposed" subjects
B	2b	Individual cohort study / low-quality randomized control studies
B	3a	Systematic review of (homogeneous) case-control studies
B	3b	Individual case-control studies
C	4	Case series, low-quality cohort or case-control studies
D	5	Expert opinions based on non-systematic reviews of results or mechanistic studies

https://guides.library.stonybrook.edu/evidence-based-medicine/levels_of_evidence

Q1 Which of the following statements are true for the use of molecular genetic data in course of precision oncology [...]?

Gleiche Tumorentität	**m1A**	In der **gleichen Tumorentität** wurde der prädiktive Wert des Biomarkers oder die klinischeWirksamkeit in einer **Biomarker-stratifizierten Kohorte** einer adäquat gepowerten **prospektiven Studie** oder **Metaanalyse** gezeigt.
	m1B	In der **gleichen Tumorentität** wurde der prädiktive Wert des Biomarkers oder die klinische Wirksamkeit in einer **retrospektiven Kohorte** oder **Fall-Kontroll-Studie** gezeigt.
	m1C	Ein oder mehrere **Fallberichte** in der **gleichen Tumorentität**.
Andere Tumorentität	**m2A**	In einer **anderen Tumorentität** wurde der prädiktive Wert des Biomarkers oder die klinische Wirksamkeit in einer **Biomarker-stratifizierten Kohorte** einer adäquat gepowerten **prospektiven Studie** oder **Metaanalyse** gezeigt.
	m2B	In einer **anderen Tumorentität** wurde der prädiktive Wert des Biomarkers oder die Klinische Wirksamkeit in einer **retrospektiven Kohorte** oder **Fall-Kontroll-Studie** gezeigt.
	m2C	Unabhängig von der Tumorentität wurde beim Vorliegen des Biomarkers eine **klinische Wirksamkeit** in einem oder mehreren **Fallberichten** gezeigt.
In vitro oder Tiermodell	**m3**	**Präklinische Daten** (*in vitro*-/*in vivo*-Modelle, funktionelle Untersuchungen) zeigen eine Assoziation des Biomarkers mit der Wirksamkeit der Medikation, welche durch eine wissenschaftliche Rationale gestützt wird.
Biologische Rationale	**m4**	Eine **wissenschaftliche, biologische Rationale** legt eine Assoziation des Biomarkers mit der Wirksamkeit der Medikation nahe, welche bisher **nicht durch (prä)klinische Daten** gestützt wird.

Q4 [...] search for “FOLFIRI antineoplastic chemotherapy regimen”. [...] What can you infer from the SNOMED CT ontology?

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- ✓ The concept is connected to its included substances through the “Direct Substance” attribute.
- ✗ The concept only has a single parent, as SNOMED CT is a classification system.
- ✗ The concept is connected to its included substances through the “Method” attribute.
- ✗ “FOLIFIRINOX” is a preferred synonym for the concept.

Frequently missed

Frequent incorrect answer

Q4 [...] search for "FOLFIRI antineoplastic chemotherapy regimen". [...] What can you infer from the SNOMED CT ontology?

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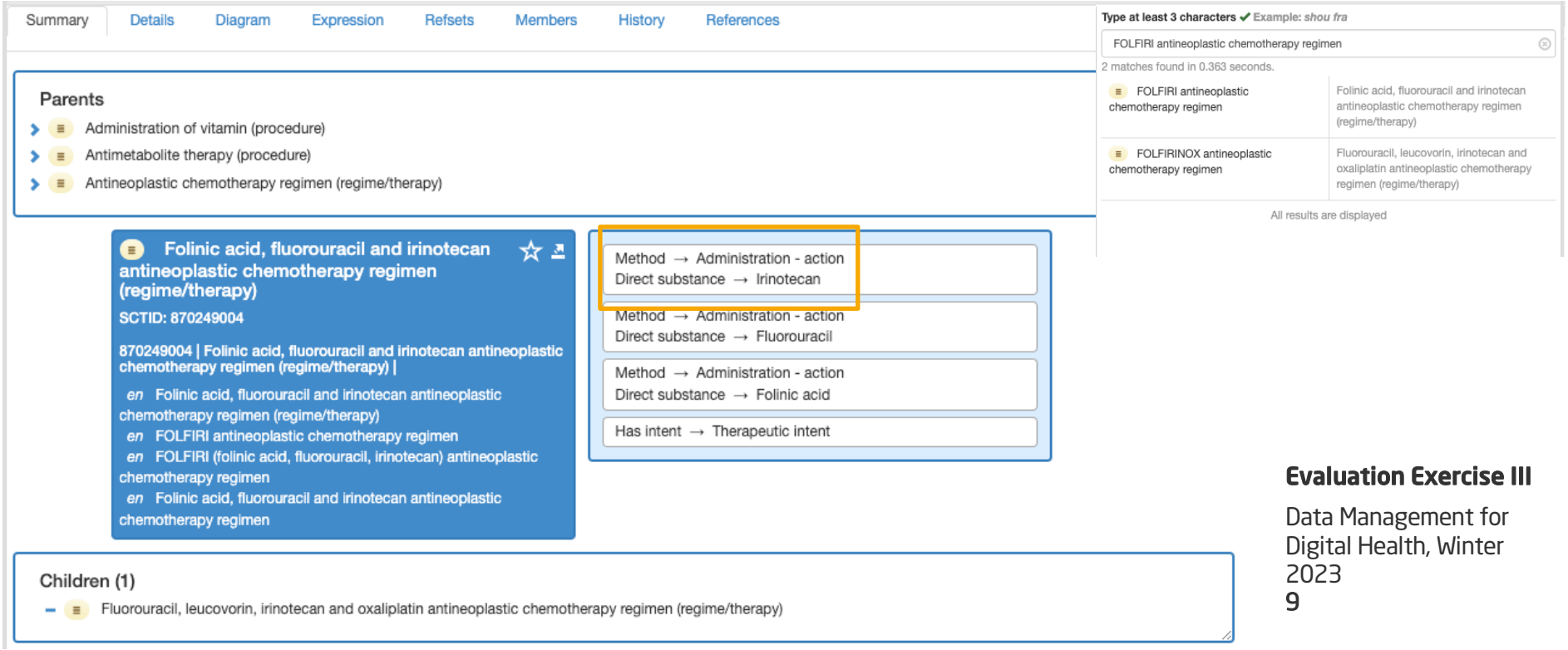

Evaluation Exercise III

Data Management for Digital Health, Winter 2023

Q14 Which statements are true about few-shot prompting in the context of large language models (LLMs)? Select all that apply:

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- ✓ Few-shot prompting is a type of in-context learning, where provided examples are used as context for the LLM predictions.
- ✗ Few-shot prompting requires a fixed set of examples in the prompt to be used for each execution on a new input sample.
- ✗ As opposed to zero-shot prompting, few-shot prompting requires parameter updates to the underlying model.
- ✗ Few-shot prompting prevents LLM hallucinations.

Frequently missed

Frequent incorrect answer

Few-Shot Prompting / In-context Learning

```
Your task is to determine the smoking status
of the person described in a clinical note.

Here are some examples:
Input: "Smoker until 1999“
Output: ex-smoker

Input: "SOCIAL HISTORY: Widowed since 1972,
no tobacco, no alcohol, lives alone.“
Output: non-smoker

Input: "He is a heavy smoker and drinks 2-3
shots per day at times."
Output: current smoker

Input:
"Social History: No alcohol use and quit
tobacco greater than 25 years ago with a 10-
pack year smoking history.”
Output:
```

Prompt Template

Few-Shot Examples

Input

- In-context learning (ICL) refers to the model's ability to adapt and respond based on the immediate context provided within a prompt.
- Few-shot prompting is a type of ICL where the model is given a few examples to illustrate the task
- Examples can be fixed or based on the input

Q17 Please select all appropriate statements about the Glomerular Filtration Rate (GFR) as discussed in class.

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- ✓ GFR can be used as a good indicator for the kidney function and its cleaning quality.
- ✓ Amongst others, personal serum creatine, sex, and age can be used to estimate GFR.
- ✗ Amongst others, renal blood flow (RBF) and renal plasma flow (RPF) can be used to estimate GFR.
- ✗ GFR is defined as the quotient of renal plasma flow (RPF) and urine flow rate (UFR).

Frequently missed

Frequent incorrect answer

Kidney Diseases: Glomerular Filtration Rate

- Measuring GFR (mGFR) is complex → Estimated Glomerular Filtration Rate (eGFR) is good approximation for the kidney's function and cleaning quality
- eGFR depends on multiple factors, e.g. age, sex, ethnicity, etc.
- eGFR = *141 × min(Scr/κ, 1)α × max(Scr/κ, 1)−1.209 × 0.993 Age × 1.018 [if female] _ 1.159 [if African American]* [1]
  - with Scr = serum creatinine,
  - κ is 0.7 for females, 0.9 for males,
  - α is -0.329 for females, -0.411 for males,
  - the minimum of Scr/κ or 1, and
  - the maximum of Scr/κ or 1.

[1] Levey AS et al.; CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration). A new equation to estimate glomerular filtration rate. Ann Intern Med. 2009 May 5;150(9):604-12. doi: 10.7326/0003-4819-150-9-200905050-00006. Erratum in: Ann Intern Med. 2011 Sep 20;155(6):408. PMID: 19414839; PMCID: PMC2763564.

Q23 During training of your CPM, you figure out that the model performance lacks behind your expectations. Which of the following aspect can be helpful to address this?

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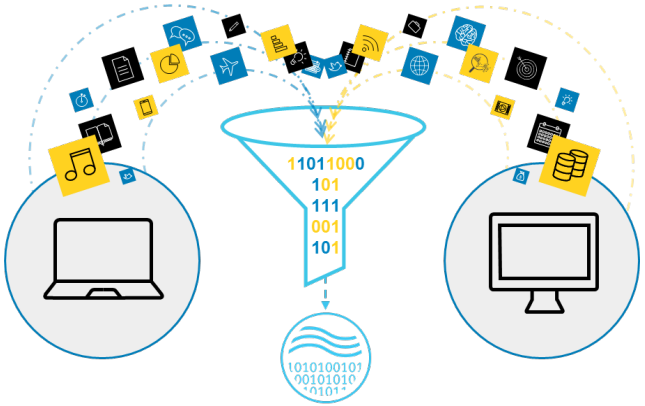
- ✓ Conduct imputation of missing values to improve prediction quality, e.g., use mean values for missing eGFR measurements.
- ✓ Consider feature engineering to improve model accuracy, e.g., select most important features for the clinical endpoint of interest and remove less important features for model training.
- ✗ Ask for additional training data from the same hospitals from 30 years ago.
- ✗ Perform min-max and variance scaling for all features of the complete training dataset.

Frequently missed

Frequent incorrect answer

3. Data Preparation: Data Transformation

- Scaling: Data may contain attributes with a mixtures of scales, but some ML methods require attributes to have the same scale
- Decomposition: Features may represent a complex concept that may be more useful to a ML method when split into its parts, e.g. data, zip code, etc.
- Aggregation: Features that might be aggregated into a single feature



https://blog.dellemc.com/en-us/digital-transformation-just-got-easier-with-analytic-insights/