

NeuralCohort: Cohort-aware Neural Representation Learning for Healthcare Analytics

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- Electronic health records (EHR) consisting of patient demographics and temporal medical features are critical for advancing patient care in healthcare.
- Current EHR learning methods often overlook the in-depth analysis of patient groups with shared features, an approach typically referred to as cohort study.

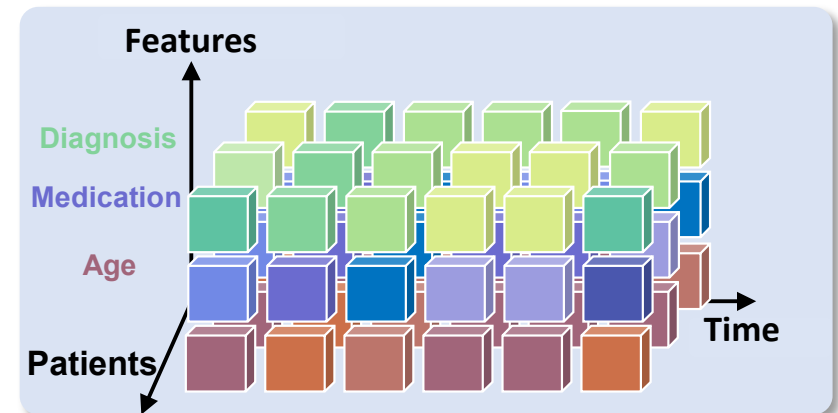


Fig 1. EHR Data Structure

- **Limitations**

- **Coarse-grained Cohort Division**
- **Fall short of delving into the in-depth analysis of patient cohorts**

- **NeuralCohort**, a cohort-aware neural representation learning method for healthcare analytics

- **Fine-grained Cohort Division**
- **Local intra-cohort and global inter-cohort information exploitation**

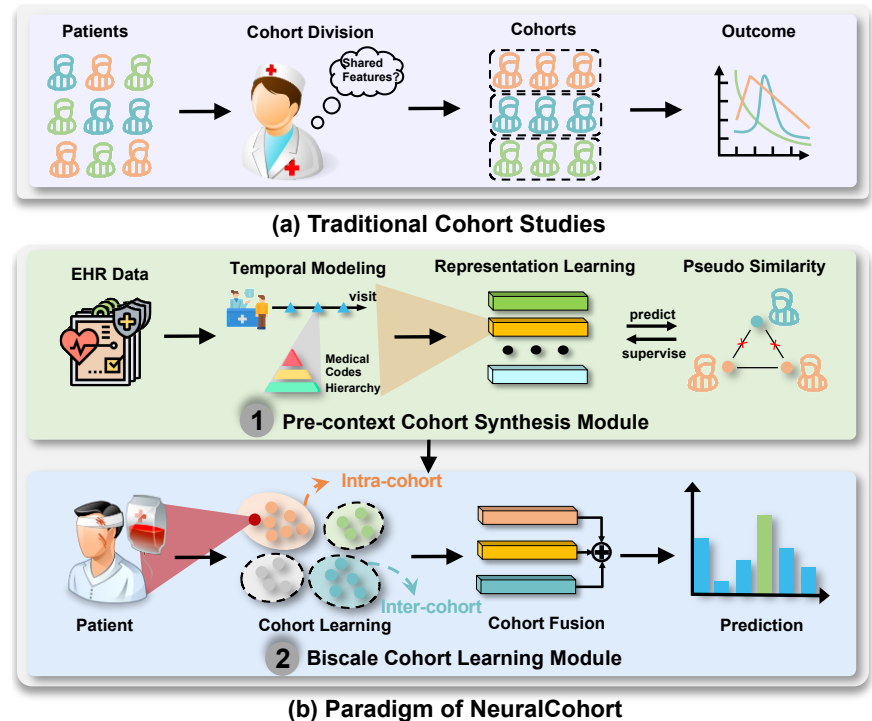


Fig 2. Coarse-grained Cohort vs. NeuralCohort

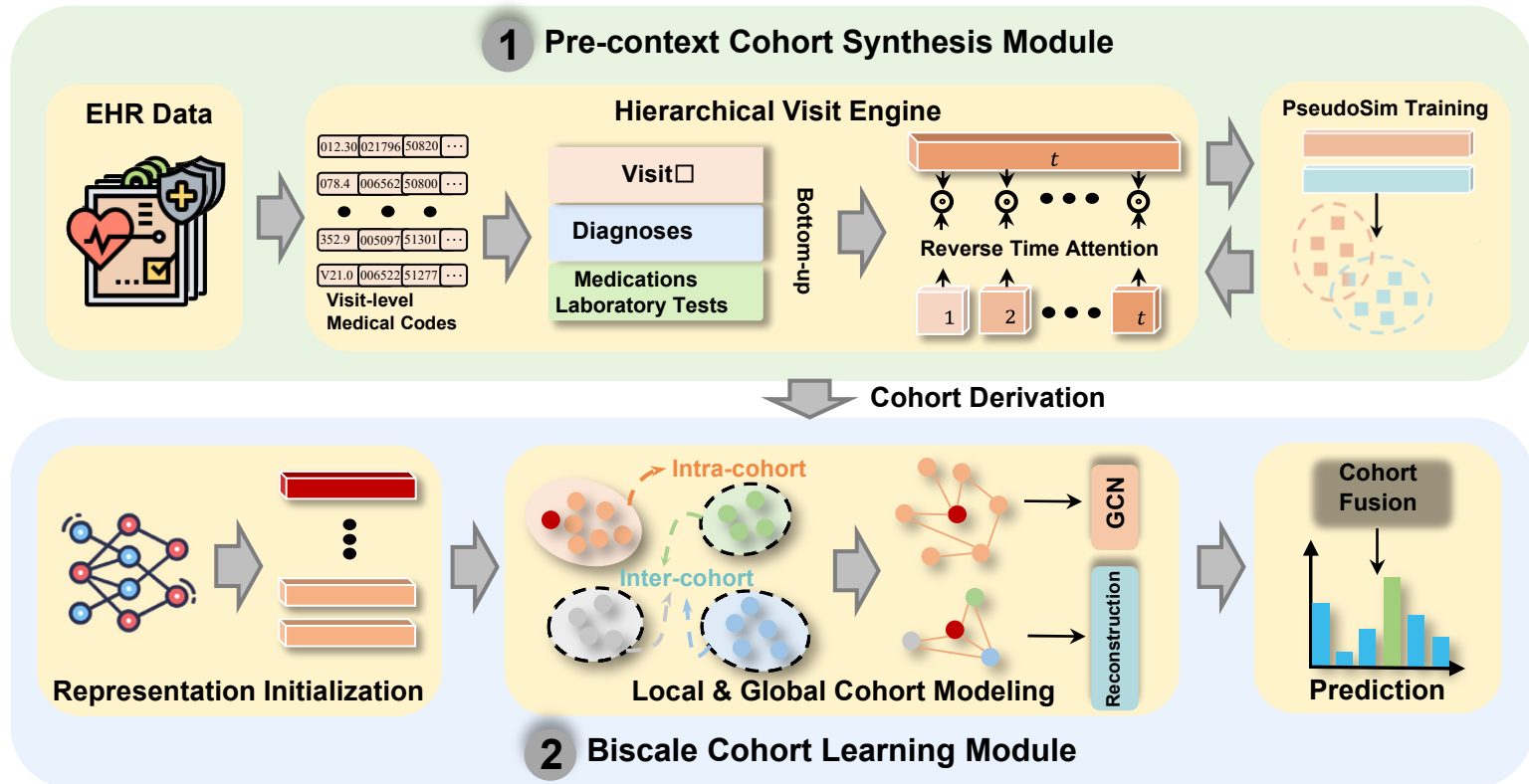


Fig 3. Overview of NeuralCohort

- Three real-world EHR datasets: MIMIC-III, MIMIC-IV, Diabetes130.
- Two medical tasks: cross-visit Hospital Readmission Prediction and within-visit Long Length-of-Stay Prediction.
- Well-established backbone models are used to derive initial representation.
- Baselines will be used to enhance the backbones for fair comparison.

Main Results on MIMIC-III dataset

Table 1. Overall performance of NeuralCohort against baselines for readmission prediction on the MIMIC-III dataset.

Model	Readmission Task on MIMIC-III		
	AUPRC	AUROC	Accuracy
ClinicalBERT	0.630±0.005	0.651±0.006	58.7%±0.5%
+ KNN	0.628±0.002	0.651±0.002	58.6%±0.2%
+ K-Means	0.629±0.001	0.650±0.001	58.4%±0.3%
+ DEC	0.632±0.005	0.654±0.002	58.4%±0.1%
+ DEKM	0.638±0.003	0.659±0.005	58.9%±0.2%
+ GRASP	0.618±0.002	0.617±0.001	56.2%±0.1%
+ DGLoS	0.635±0.003	0.533±0.002	58.0%±0.4%
+ IDC	0.638±0.003	0.657±0.004	59.0%±0.3%
+ NeuralCohort	0.662±0.003	0.681±0.005	61.2%±0.4%
Med2Vec	0.554±0.005	0.614±0.004	54.1%±0.7%
+ KNN	0.541±0.004	0.598±0.003	54.9%±0.5%
+ K-Means	0.544±0.005	0.600±0.004	54.5%±0.4%
+ DEC	0.550±0.003	0.611±0.002	54.3%±0.5%
+ DEKM	0.547±0.004	0.608±0.006	54.6%±0.4%
+ GRASP	0.542±0.003	0.601±0.006	53.8%±0.3%
+ DGLoS	0.559±0.004	0.542±0.002	54.5%±0.5%
+ IDC	0.562±0.004	0.622±0.003	54.5%±0.4%
+ NeuralCohort	0.574±0.003	0.634±0.005	56.9%±0.2%
MiME	0.543±0.006	0.602±0.005	56.8%±0.5%
+ KNN	0.543±0.004	0.610±0.003	56.5%±0.5%
+ K-Means	0.546±0.004	0.605±0.006	56.5%±0.7%
+ DEC	0.549±0.007	0.608±0.004	57.3%±0.9%
+ DEKM	0.548±0.002	0.611±0.003	57.1%±0.5%
+ GRASP	0.530±0.009	0.589±0.010	57.2%±0.9%
+ DGLoS	0.551±0.006	0.543±0.004	57.6%±0.7%
+ IDC	0.542±0.006	0.605±0.003	57.2%±0.4%
+ NeuralCohort	0.568±0.004	0.629±0.003	58.6%±0.3%

Table 2. Overall performance of NeuralCohort against baselines for long LOS prediction on the MIMIC-III dataset.

Model	Long LOS Task on MIMIC-III		
	AUPRC	AUROC	Accuracy
ClinicalBERT	0.658±0.002	0.590±0.002	59.7%±0.3%
+ KNN	0.659±0.002	0.594±0.001	59.9%±0.4%
+ K-Means	0.655±0.001	0.590±0.002	59.8%±0.3%
+ DEC	0.652±0.008	0.603±0.009	60.2%±0.3%
+ DEKM	0.661±0.003	0.592±0.002	60.1%±0.3%
+ GRASP	0.665±0.002	0.584±0.003	60.0%±0.4%
+ DGLoS	0.685±0.005	0.548±0.004	61.5%±0.9%
+ IDC	0.681±0.004	0.612±0.003	60.2%±0.4%
+ NeuralCohort	0.738±0.003	0.671±0.004	63.7%±0.7%
Med2Vec	0.908±0.001	0.894±0.001	64.4%±0.3%
+ KNN	0.876±0.002	0.876±0.001	75.1%±0.4%
+ K-Means	0.877±0.002	0.875±0.003	74.8%±0.3%
+ DEC	0.886±0.004	0.889±0.006	75.4%±0.7%
+ DEKM	0.903±0.002	0.897±0.004	73.8%±0.4%
+ GRASP	0.903±0.003	0.887±0.002	69.0%±0.5%
+ DGLoS	0.907±0.004	0.837±0.006	75.9%±0.5%
+ IDC	0.906±0.003	0.899±0.003	73.2%±0.4%
+ NeuralCohort	0.919±0.002	0.906±0.004	80.7%±0.3%
MiME	0.913±0.003	0.904±0.003	78.4%±0.5%
+ KNN	0.910±0.002	0.895±0.003	80.2%±0.4%
+ K-Means	0.904±0.003	0.891±0.002	79.0%±0.3%
+ DEC	0.912±0.005	0.907±0.008	79.6%±0.4%
+ DEKM	0.911±0.005	0.908±0.007	79.6%±0.4%
+ GRASP	0.898±0.004	0.896±0.003	81.1%±0.4%
+ DGLoS	0.917±0.002	0.854±0.008	80.7%±0.3%
+ IDC	0.919±0.005	0.910±0.004	80.3%±0.2%
+ NeuralCohort	0.936±0.004	0.923±0.002	82.8%±0.2%

Comparison between NeuralCohort and traditional cohorts

Table 4. Comparison between traditional cohorts and NeuralCohort on the backbone ClinicalBERT and Med2Vec for readmission prediction on the MIMIC-III dataset.

Model	MIMIC-III		
	AUPRC	AUROC	Accuracy
ClinicalBERT	0.630	0.651	58.7%
+ MC_G	0.629	0.651	58.5%
+ MC_A	0.631	0.651	58.3%
+ MC_D	0.629	0.652	58.7%
+ MC_H	0.621	0.643	58.1%
+ NeuralCohort	0.662	0.681	61.2%
Med2Vec	0.554	0.614	54.1%
+ MC_G	0.546	0.611	54.3%
+ MC_A	0.548	0.612	53.4%
+ MC_D	0.557	0.619	54.5%
+ MC_H	0.551	0.616	53.7%
+ NeuralCohort	0.574	0.634	56.9%

- Gender(G)
- Age(A)
- Diabetes diagnosis (D)
- Hypertension diagnosis (H)

Traditional medical cohorts tend to perform comparably to, and occasionally worse than the backbones.

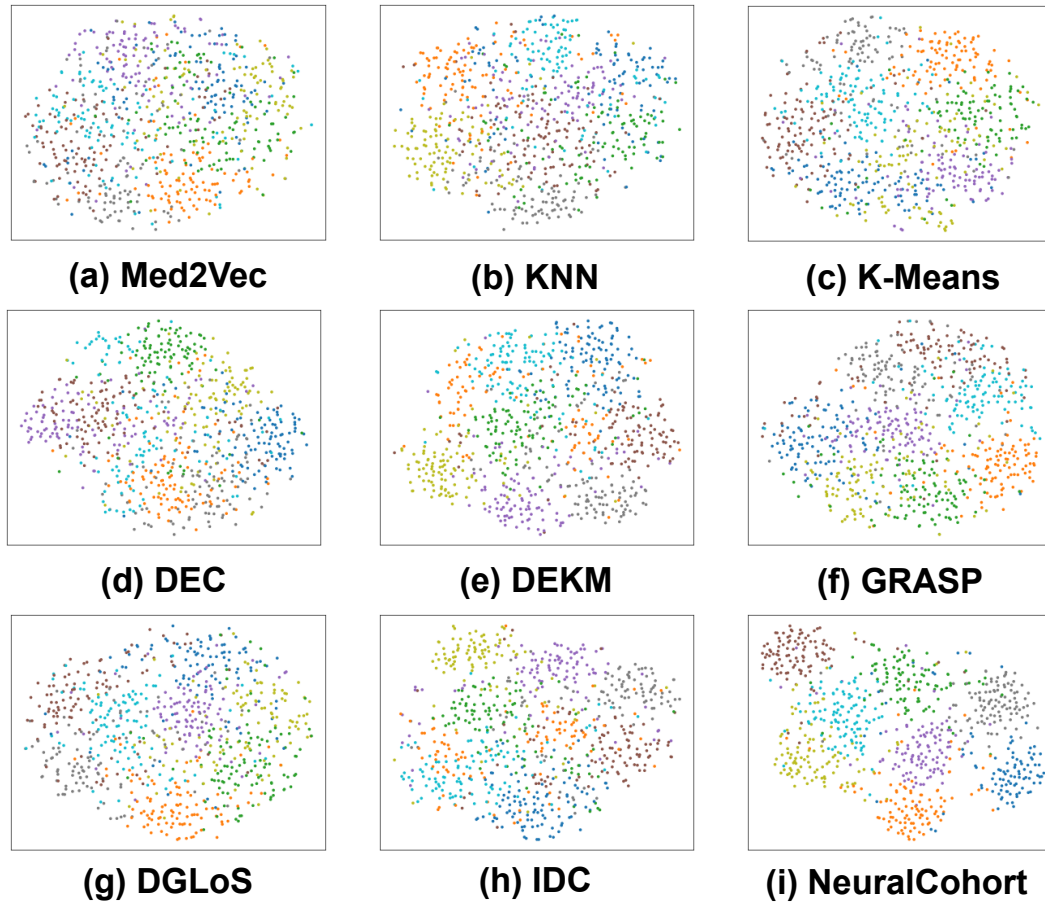


Fig 4. visualization of eight-cohort points

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Thanks!