Deep EHR: A Survey of Recent Advances in Deep Learning Techniques for EHR Analysis

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@ https://qdata.github.io/deep2Read/

Roadmap

1. Background
2. Motivation
3. Survey of Recent Advances in “Deep EHR”
4. Future Directions

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Background - Electronic Health Records (EHRs)

- Huge increases in the numbers of EHRs in the US in the last 10 years
- Heterogeneous data

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- Lab tests/results
- Radiological images
- Genomic data
- ICD codes
- Clinical notes (free text)

EHRs

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- Secondary uses:
  - Medical concept extraction
  - Patient trajectory modeling
  - Disease inference
  - Clinical decision support systems
  - Deidentification
  - Phenotyping

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- Recent: MLP, Autoencoder, RBM, Deep Belief Nets, CNN, RNN, GRU, and LSTM
- Most “Deep EHR” papers published in last 3 years
  - Several hundred total

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Motivation

- Catalog advances
- High-level overview of what’s been going on in EHR analysis in the last few years
- Future directions

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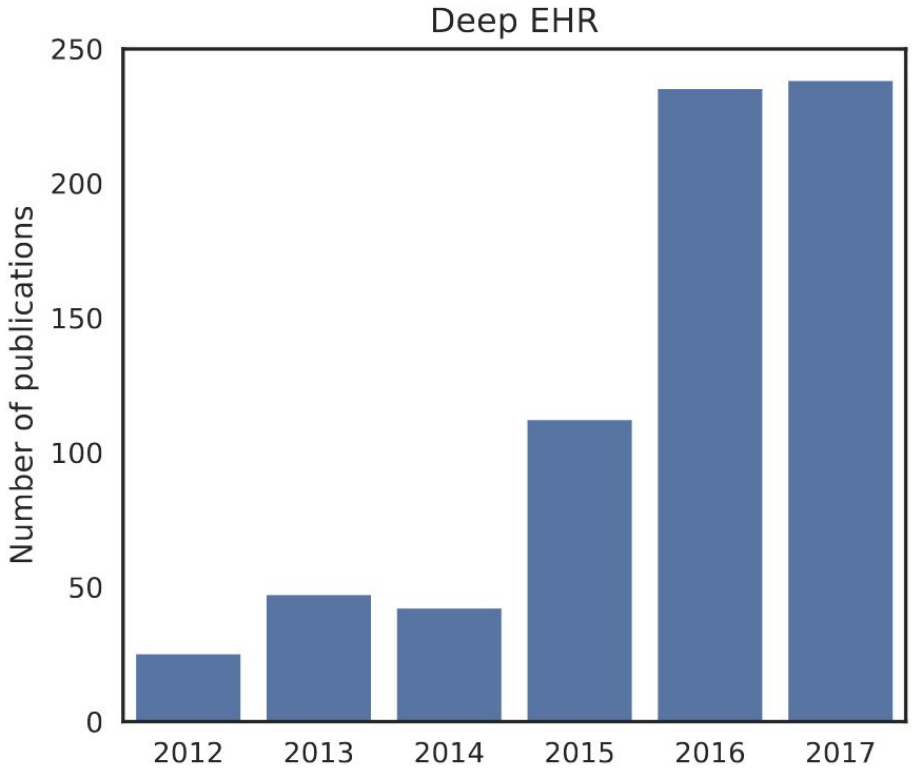
Deep EHR Overview



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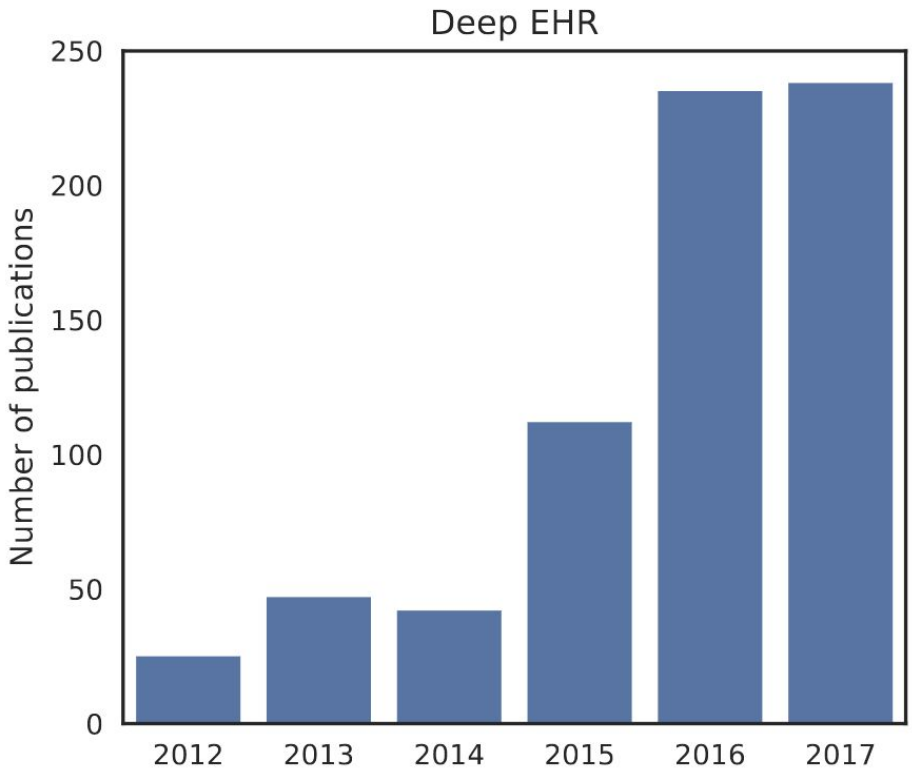

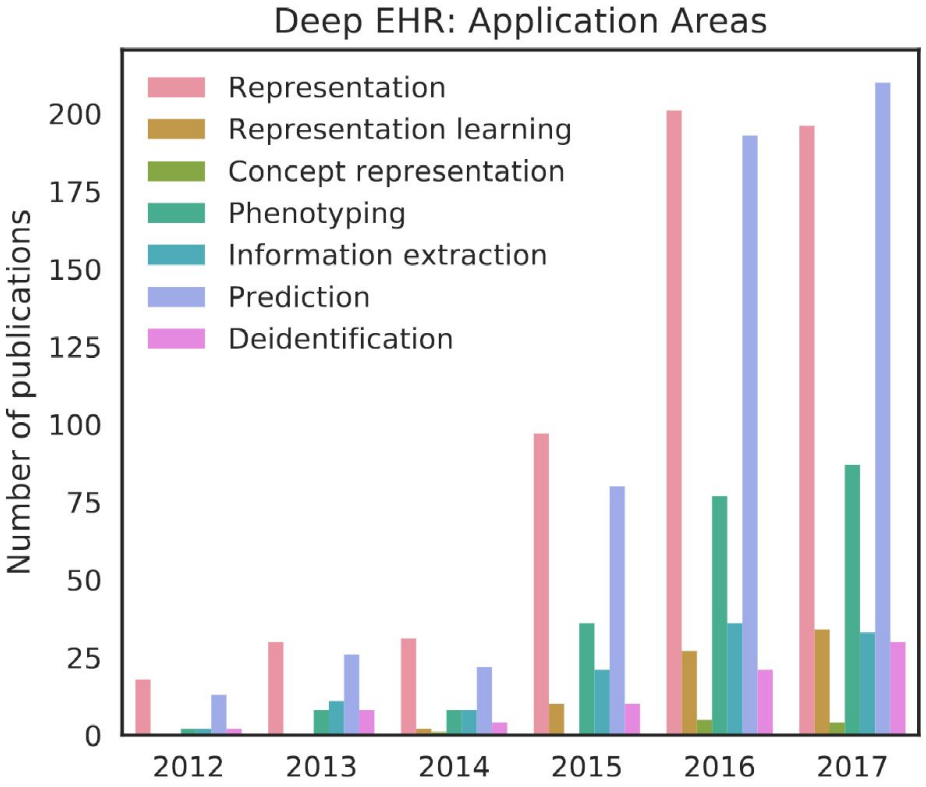

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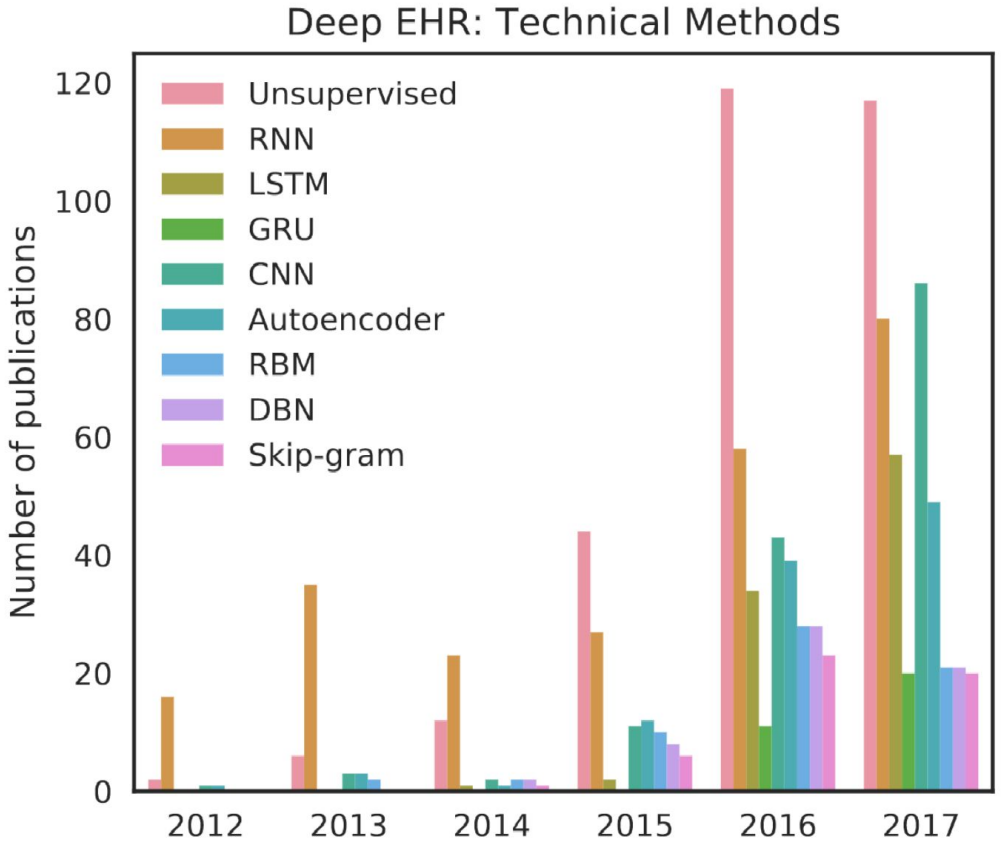

Deep EHR Overview

Task	Subtasks	Input Data	Models
Information Extraction	(1) Single Concept Extraction (2) Temporal Event Extraction (3) Relation Extraction (4) Abbreviation Expansion	Clinical Notes	LSTM, Bi-LSTM, GRU, CNN RNN + Word Embedding AE Custom Word Embedding
Representation Learning	(1) Concept Representation (2) Patient Representation	Medical Codes	RBM, Skip-gram, AE, LSTM RBM, Skip-gram, GRU, CNN, AE
Outcome Prediction	(1) Static Prediction (2) Temporal Prediction	Mixed	AE, LSTM, RBM, DBN LSTM
Phenotyping	(1) New Phenotype Discovery (2) Improving Existing Definitions	Mixed	AE, LSTM, RBM, DBN LSTM
De-identification	Clinical text de-identification	Clinical Notes	Bi-LSTM, RNN + Word Embedding

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- Many things are not incorporated into representations/embeddings
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- “Holy grail”: unified representation

Future Directions: Benchmarks

- Lack of universal benchmarks
- Difficult reproducibility
- Everyone claims “state-of-the-art performance”
- Proprietary data sets
- Hyperparameters can make or break an algorithm

Future Directions: Interpretability

- Models need to be transparent and trustworthy
- Explored so far: maximum activation, clustering illustrations, word clouds, heat maps, “Mimic learning”