Chapter 73
Artificial Neural Networks in Medicine:
Recent Advances

Steven Walczak

https://orcid.org/0000-0002-0449-6272
University of South Florida, USA

ABSTRACT

Artificial neural networks (ANNs) have proven to be efficacious for modeling decision problems in medicine, including diagnosis, prognosis, resource allocation, and cost reduction problems. Research using ANNs to solve medical domain problems has been increasing regularly and is continuing to grow dramatically. This chapter examines recent trends and advances in ANNs and provides references to a large portion of recent research, as well as looking at the future direction of research for ANN in medicine.

INTRODUCTION

Medicine is a field closely coupled with and producing big data (Najafabadi et al., 2015), especially with the growing adoption of electronic health records (EHRs) in the United States (Bourgeois & Yaylacicegi, 2010; Mennemeyer et al., 2016) and the world (Wager et al., 2013, Appendix C). Medical big data serves as a critical resource for medical research and clinical decision making. Artificial neural networks (ANNs), along with other machine learning approaches, have been shown to be an effective method for analyzing medical big data to develop diagnostic and prognostic systems (Pastur-Romay et al., 2016).

Although ANNs have a short history of application in the field of medicine, with the first published research appearing in 1990 (Asada et al., 1990; Baxt, 1990; Dassen et al., 1990), there has been a continuing and growing trend of research investigating ANNs in medicine. Interestingly, two of the three articles published in 1990 were published in medical journals, while only Baxt's (1990) article on diagnosing heart attacks (myocardial infarctions) was published in an information technology journal, but he followed this work up with multiple publications in medical journals (Baxt, 1991, 1992). Searching

the National Library of Medicine PubMed database for articles containing the term "artificial neural network" combined with any of the terms: medicine, medical, hospital, patient, diagnosis, prognosis, clinic, or pharma (https://www.ncbi.nlm.nih.gov/pubmed/?term="artificial+neural+network"+AND +(medicine+OR+medical+OR+hospital+OR+patient+OR+diagnosis+OR+prognosis+OR+clinic +OR+pharma)) produces the results shown in Figure 1, which displays the annual increase in articles focusing on ANNs in medicine.

Figure 1. Medline/PubMed ANN articles in medicine as of July 15, 2020
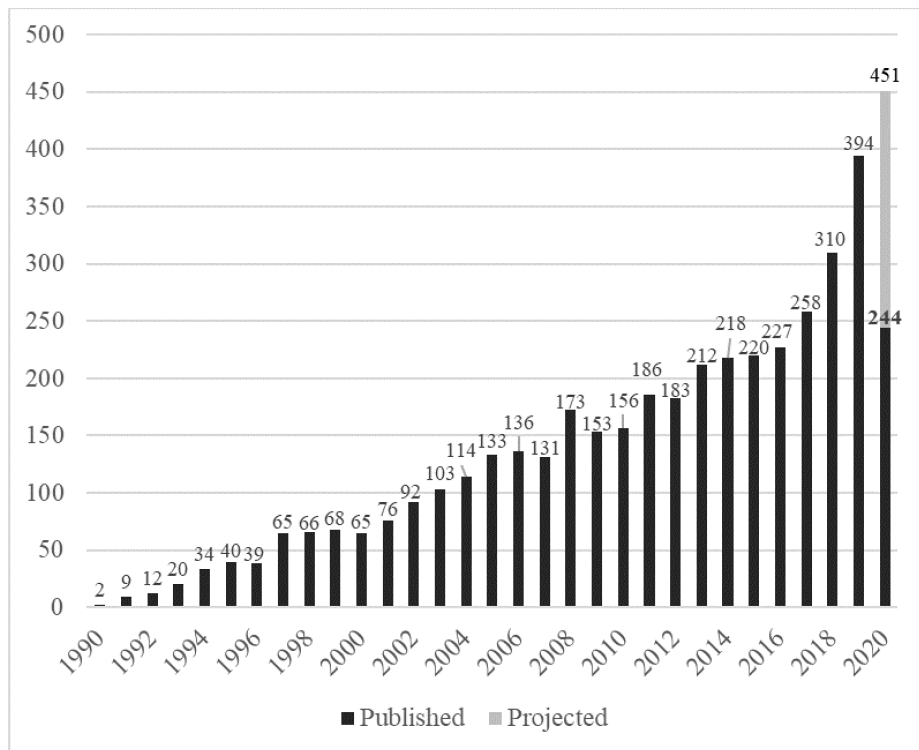
The amount of ANN in medicine research is even greater than depicted in Figure 1, since terms like "deep learning neural network" or "convolution network" or "evolutionary network," which are all types of ANN, are not included. Other researchers have also indicated a larger quantity of ANN research in medicine, with 473 articles in 1998 (Dybowski, 2000) as opposed to the 66 articles identified with the more specific search criteria. Other research claims an earlier start date, 1981, for the beginning of ANN usage in medical decision support (Miller, 1994), but here we report only those articles listed in the PubMed database.

ANN research in medicine is used to develop models and systems for a variety of applications including: decision support systems for both patients and surgeons, diagnosis, prognosis, resource planning and allocation, and variable significance and protocol heuristic evaluation. The goal of any research in the field of medicine should primarily be to improve the quality of life of the patient and secondarily to promote workflow efficiencies and cost reductions.

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