BÖLÜM 1

KANSER TANI VE TEDAVİSİNDE YAPAY ZEKANIN GÜNCEL ROLÜ

Yasemin BERBEROĞLU[1]
Aylin KÖSELER[2]

GİRİŞ

1956-1956 yılında Dartmouth konferansında yapay zekanın (Artificial intelligence, AI) temellerinin atıldığına inanılmaktadır. Yıllarca süren gelişmelerin ardından makine öğrenimi (Machine Learning, ML), derin öğrenme (Deep learning, DL) gibi tüm teknolojiler ve bağlantılı alt dalları yapay zeka veya AI olarak adlandırılmıştır (1,2). Yapay zeka, çok katmanlı sinir ağı (Deep Neural Networks, DNN) ile insan beyni nöronlarından ilham alınan matematiksel modeller ile DL'nin temelini oluşturur. Mantıksal muhakeme yeteneği ile çok büyük miktarda veriden öğrenerek istatistiksel çıkarımlar yapar ve böylece belirli görevlerde insan düşünme biçimini kısmen taklit edebilir (3,4). Araştırmacılar DL algoritmalarını onkoloji, dermatoloji ve kardiyoloji gibi birçok farklı alanda hastalığın teşhis ve tedavisinde kullanabilirler (5,6). Yapay zeka destekli genomlar, transkriptomik ve proteomik veriler kişiselleştirilmiş moleküler imzaların belirlenmesine ve kişiye özel tedavi yaklaşımlarına imkan vermektedir (7). Bu bölüm kapsamında kanser tanı ve tedavisinde yapay zekanın kullanımına odaklanılmıştır.

KANSER ALANINDA YAPAY ZEKANIN KULLANIMI

Kanser gelişiminin altında yatan moleküler mekanizmaları aydınlatmak amacıyla genler, proteinler, mRNA'lar ve metabolitler ile gen ekspresyonu, sinyal iletimi, gen regülasyonu ve protein–protein etkileşimleri tanımlanarak ağ yapıları mo-

[1] Arş. Gör, Pamukkale Üniversitesi Tıp Fakültesi Temel Tıp Bilimleri Bölümü Biyofizik AD., yasemins@pau.edu.tr, ORCID iD: 0000-0003-4226-674X
[2] Prof. Dr., Pamukkale Üniversitesi Tıp Fakültesi Temel Tıp Bilimleri Bölümü Biyofizik AD., akoseler@pau.edu.tr, ORCID iD: 0000-0003-4832-0436

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hip olduğu görülmektedir. Genomik, transkriptomik ve proteomik verilerin entegrasyonu ile elde edilen kişiselleştirilmiş moleküler imzalar, kanserin karmaşık patofizyolojik ve moleküler yapısının anlaşılması ile hedefe yönelik tedavi stratejilerinin geliştirilmesine katkı sağlamaktadır. Ayrıca yapay zeka destekli tanı, sınıflandırma, prognostik biyo-belirteçlerin değerlendirilmesi, ilaç keşfi ve radyoterapi planlaması gibi alanlarda sağlanan yenilikler sayesinde hem erken teşhis hem de hasta bazlı tedavi optimizasyonu mümkün kılınmaktadır. Bu nedenle yapay zeka gelecekte kanser yönetiminde daha etkili, güvenilir ve kişiselleştirilmiş yaklaşımların geliştirilmesine önemli ölçüde katkı sağlayacaktır.

KAYNAKLAR

1. Benko A, Sik Lányi C. History of Artificial Intelligence. In Encyclopedia of Information Science and Technology, Second Edition 2009;1759-1762. https://doi.org/10.4018/978-1-60566-026-4.CH276.
2. Bhinder B, Gilvary C, Madhukar NS, Elemento O. Artificial Intelligence in Cancer Research and Precision Medicine. Cancer Discov 2021;11:900–15. https://doi.org/10.1158/2159-8290.CD-21-0090.
3. Houssami N, Kirkpatrick-Jones G, Noguchi N, Lee CI. Artificial Intelligence (AI) for the early detection of breast cancer: a scoping review to assess AI's potential in breast screening practice. Expert Rev Med Devices 2019;16:351–62. https://doi.org/10.1080/17434440.2019.1610387.
4. Sherbet G V., Woo WL, Dlay S. Application of Artificial Intelligence-based Technology in Cancer Management: A Commentary on the Deployment of Artificial Neural Networks. Anticancer Res 2018;38:6607–13. https://doi.org/10.21873/ANTICANRES.13027.
5. Nagarajan N, Yapp EKY, Le NQK, Kamaraj B, Al-Subaie AM, Yeh HY. Application of Computational Biology and Artificial Intelligence Technologies in Cancer Precision Drug Discovery. Biomed Res Int 2019;2019:8427042. https://doi.org/10.1155/2019/8427042.
6. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature 2017;542:115–8. https://doi.org/10.1038/NATURE21056;SUBJMETA.
7. Chadha S, Mukherjee S, Sanyal S. Advancements and implications of artificial intelligence for early detection, diagnosis and tailored treatment of cancer. Semin Oncol 2025;52:152349. https://doi.org/10.1016/J.SEMINONCOL.2025.152349.
8. You Y, Lai X, Pan Y, Zheng H, Vera J, Liu S, et al. Artificial intelligence in cancer target identification and drug discovery. Signal Transduct Target Ther 2022;7:1–24. https://doi.org/10.1038/S41392-022-00994-0;SUBJMETA.
9. Luchini C, Pea A, Scarpa A. Artificial intelligence in oncology: current applications and future perspectives. Br J Cancer 2022;126:4–9. https://doi.org/10.1038/S41416-021-01633-1;SUBJMETA.
10. Perez-Lopez R, Ghaffari Laleh N, Mahmood F, Kather JN. A guide to artificial intelligence for cancer researchers. Nat Rev Cancer 2024;24:427–41. https://doi.org/10.1038/S41568-024-00694-7;SUBJMETA.
11. Shirini D, Schwartz LH, Dercle L. Artificial intelligence for aging research in cancer drug development. Aging (Albany NY) 2023;15:12699. https://doi.org/10.18632/AGING.204914.
12. Zhavoronkov A, Mamoshina P, Vanhaelen Q, Scheibye-Knudsen M, Moskalev A, Aliper A. Artificial intelligence for aging and longevity research: Recent advances and perspectives. Ageing Res Rev 2019;49:49–66. https://doi.org/10.1016/J.ARR.2018.11.003.
13. Liang G, Fan W, Luo H, Zhu X. The emerging roles of artificial intelligence in cancer drug development and precision therapy. Biomed Pharmacother 2020;128:110255. https://doi.or-

g/10.1016/J.BIOPHA.2020.110255.

14. Fiorino C, Guckemberger M, Schwarz M, van der Heide UA, Heijmen B. Technology-driven research for radiotherapy innovation. Mol Oncol 2020;14:1500–13. https://doi.org/10.1002/1878-0261.12659.
15. Lou B, Doken S, Zhuang T, Wingerter D, Gidwani M, Mistry N, et al. An image-based deep learning framework for individualising radiotherapy dose: a retrospective analysis of outcome prediction. Lancet Digit Heal 2019;1:e136–47. https://doi.org/10.1016/S2589-7500(19)30058-5.
16. Meyer P, Noblet V, Mazzara C, Lallement A. Survey on deep learning for radiotherapy. Comput Biol Med 2018;98:126–46. https://doi.org/10.1016/J.COMPBIOMED.2018.05.018.
17. Mendes Serrão E, Klug M, Moloney BM, Jhaveri A, Gullo R Lo, Pinker K, et al. Current Status of Cancer Genomics and Imaging Phenotypes: What Radiologists Need to Know. 2023;5. https://doi.org/10.1148/RYCAN.220153.
18. Wu M, Zhang Y, Zhang Y, Liu Y, Wu M, Ye Z. Imaging-based Biomarkers for Predicting and Evaluating Cancer Immunotherapy Response. 2019;1. https://doi.org/10.1148/RYCAN.2019190031.
19. Sufyan M, Shokat Z, Ashfaq UA. Artificial intelligence in cancer diagnosis and therapy: Current status and future perspective. Comput Biol Med 2023;165:107356. https://doi.org/10.1016/J.COMPBIOMED.2023.107356.
20. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. IARC – INTERNATIONAL AGENCY FOR RESEARCH ON CANCER n.d. https://www.iarc.who.int/ (accessed 15 September 2025).
21. Chen G, Tsoi A, Xu H, Zheng WJ. Predict effective drug combination by deep belief network and ontology fingerprints. J Biomed Inform 2018;85:149–54. https://doi.org/10.1016/J.JBI.2018.07.024.
22. Levine MN, Alexander G, Sathiyapalan A, Agrawal A, Pond G. Learning Health System for Breast Cancer: Pilot Project Experience. JCO Clin Cancer Informatics 2019:1–11. https://doi.org/10.1200/CCI.19.00032.
23. Dorman SN, Baranova K, Knoll JHM, Urquhart BL, Mariani G, Carcangiu ML, et al. Genomic signatures for paclitaxel and gemcitabine resistance in breast cancer derived by machine learning. Mol Oncol 2016;10:85–100. https://doi.org/10.1016/J.MOLONC.2015.07.006.
24. Gottesman MM. Mechanisms of cancer drug resistance. Annu Rev Med 2002;53:615–27. https://doi.org/10.1146/ANNUREV.MED.53.082901.103929/CITE/REFWORKS.
25. Sechopoulos I, Teuwen J, Mann R. Artificial intelligence for breast cancer detection in mammography and digital breast tomosynthesis: State of the art. Semin Cancer Biol 2021;72:214–25. https://doi.org/10.1016/J.SEMCANCER.2020.06.002.
26. Papadopoulos A, Fotiadis DI, Likas A. Characterization of clustered microcalcifications in digitized mammograms using neural networks and support vector machines. Artif Intell Med 2005;34:141–50. https://doi.org/10.1016/J.ARTMED.2004.10.001.
27. Díaz O, Rodríguez-Ruíz A, Sechopoulos I. Artificial Intelligence for breast cancer detection: Technology, challenges, and prospects. Eur J Radiol 2024;175:111457. https://doi.org/10.1016/J.EJRAD.2024.111457.
28. Kim HE, Kim HH, Han BK, Kim KH, Han K, Nam H, et al. Changes in cancer detection and false-positive recall in mammography using artificial intelligence: a retrospective, multireader study. Lancet Digit Heal 2020;2:e138–48. https://doi.org/10.1016/S2589-7500(20)30003-0.
29. Butt MA, Kaleem MF, Bilal M, Hanif MS. Using multi-label ensemble CNN classifiers to mitigate labelling inconsistencies in patch-level Gleason grading. PLoS One 2024;19:e0304847. https://doi.org/10.1371/JOURNAL.PONE.0304847.
30. Nagpal K, Foote D, Liu Y, Chen PHC, Wulczyn E, Tan F, et al. Development and validation of a deep learning algorithm for improving Gleason scoring of prostate cancer. Npj Digit Med 2019;2:1–10. https://doi.org/10.1038/S41746-019-0112-2;SUBJMETA.
31. Bushweller JH. Targeting transcription factors in cancer — from undruggable to reality. Nat

Rev Cancer 2019;19:611–24. https://doi.org/10.1038/S41568-019-0196-7;SUBJMETA.
32. Xia X, Gong J, Hao W, Yang T, Lin Y, Wang S, et al. Comparison and Fusion of Deep Learning and Radiomics Features of Ground-Glass Nodules to Predict the Invasiveness Risk of Stage-I Lung Adenocarcinomas in CT Scan. Front Oncol 2020;10:501314. https://doi.org/10.3389/FONC.2020.00418/BIBTEX.
33. Baskin II. The power of deep learning to ligand-based novel drug discovery. Expert Opin Drug Discov 2020;15:755–64. https://doi.org/10.1080/17460441.2020.1745183.
34. Stokes JM, Yang K, Swanson K, Jin W, Cubillos-Ruiz A, Donghia NM, et al. A Deep Learning Approach to Antibiotic Discovery. Cell 2020;180:688-702.e13. https://doi.org/10.1016/j.cell.2020.01.021.
35. Lind AP, Anderson PC. Predicting drug activity against cancer cells by random forest models based on minimal genomic information and chemical properties. PLoS One 2019;14:e0219774. https://doi.org/10.1371/JOURNAL.PONE.0219774.
36. Wang Y, Wang Z, Xu J, Li J, Li S, Zhang M, et al. Systematic identification of non-coding pharmacogenomic landscape in cancer. Nat Commun 2018;9:1–15. https://doi.org/10.1038/S41467-018-05495-9;TECHMETA.
37. Stanzione A, Cuocolo R, Del Grosso R, Nardiello A, Romeo V, Travaglino A, et al. Deep Myometrial Infiltration of Endometrial Cancer on MRI: A Radiomics-Powered Machine Learning Pilot Study. Acad Radiol 2021;28:737–44. https://doi.org/10.1016/J.ACRA.2020.02.028.
38. Günakan E, Atan S, Haberal AN, Küçükyıldız İA, Gökçe E, Ayhan A. A novel prediction method for lymph node involvement in endometrial cancer: machine learning. Int J Gynecol Cancer 2019;29:320–4. https://doi.org/10.1136/IJGC-2018-000033.
39. Hossain MA, Saiful Islam SM, Quinn JMW, Huq F, Moni MA. Machine learning and bioinformatics models to identify gene expression patterns of ovarian cancer associated with disease progression and mortality. J Biomed Inform 2019;100:103313. https://doi.org/10.1016/J.JBI.2019.103313.
40. McDonald JF. Back to the future - The integration of big data with machine learning is re-establishing the importance of predictive correlations in ovarian cancer diagnostics and therapeutics. Gynecol Oncol 2018;149:230–1. https://doi.org/10.1016/j.ygyno.2018.03.053.
41. Taninaga J, Nishiyama Y, Fujibayashi K, Gunji T, Sasabe N, Iijima K, et al. Prediction of future gastric cancer risk using a machine learning algorithm and comprehensive medical check-up data: A case-control study. Sci Rep 2019;9:1–9. https://doi.org/10.1038/S41598-019-48769-Y;-TECHMETA.
42. Liu C, Qi L, Feng QX, Sun SW, Zhang YD, Liu XS. Performance of a machine learning-based decision model to help clinicians decide the extent of lymphadenectomy (D1 vs. D2) in gastric cancer before surgical resection. Abdom Radiol 2019;44:3019–29. https://doi.org/10.1007/S00261-019-02098-W/FIGURES/5.
43. Zhu H. Big data and artificial intelligence modeling for drug discovery. Annu Rev Pharmacol Toxicol 2020;60:573–89. https://doi.org/10.1146/ANNUREV-PHARMTOX-010919-023324/CITE/REFWORKS.
44. Iorio F, Knijnenburg TA, Vis DJ, Bignell GR, Menden MP, Schubert M, et al. A Landscape of Pharmacogenomic Interactions in Cancer. Cell 2016;166:740–54. https://doi.org/10.1016/j.cell.2016.06.017.
45. Tong Z, Zhou Y, Wang J. Identifying potential drug targets in hepatocellular carcinoma based on network analysis and one-class support vector machine. Sci Rep 2019;9:1–9. https://doi.org/10.1038/S41598-019-46540-X;SUBJMETA.
46. Zugazagoitia J, Guedes C, Ponce S, Ferrer I, Molina-Pinelo S, Paz-Ares L. Current Challenges in Cancer Treatment. Clin Ther 2016;38:1551–66. https://doi.org/10.1016/J.CLINTHERA.2016.03.026.
47. Sarvepalli S, Vadarevu SD. Role of artificial intelligence in cancer drug discovery and development. Cancer Lett 2025;627:217821. https://doi.org/10.1016/J.CANLET.2025.217821.
48. Camacho DM, Collins KM, Powers RK, Costello JC, Collins JJ. Next-Generation Machi-

ne Learning for Biological Networks. Cell 2018;173:1581–92. https://doi.org/10.1016/j.cell.2018.05.015.
49. Wang L, Song Y, Wang H, Zhang X, Wang M, He J, et al. Advances of Artificial Intelligence in Anti-Cancer Drug Design: A Review of the Past Decade. Pharm 2023, Vol 16, Page 253 2023;16:253. https://doi.org/10.3390/PH16020253.
50. Tran NL, Kim H, Shin CH, Ko E, Oh SJ. Artificial intelligence-driven new drug discovery targeting serine/threonine kinase 33 for cancer treatment. Cancer Cell Int 2023;23:1–11. https://doi.org/10.1186/S12935-023-03176-2/FIGURES/5.
51. Mouchlis VD, Afantitis A, Serra A, Fratello M, Papadiamantis AG, Aidinis V, et al. Advances in De Novo Drug Design: From Conventional to Machine Learning Methods. Int J Mol Sci 2021, Vol 22, Page 1676 2021;22:1676. https://doi.org/10.3390/IJMS22041676.
52. Bulut C. Sağlık kurumlarında yapay zekâ destekli karar destek sistemlerinin kullanımı. Usaysad Derg 2025;11:27–37.
53. Zhou NA, Zhang C-T, Lv H-Y, Hao C-X, Li T-J, Zhu J-J, et al. Concordance Study Between IBM Watson for Oncology and Clinical Practice for Patients with Cancer in China. Oncologist 2019;24:812–9. https://doi.org/10.1634/THEONCOLOGIST.2018-0255.
54. Somashekhar SP, Sepúlveda MJ, Puglielli S, Norden AD, Shortliffe EH, Rohit Kumar C, et al. Watson for Oncology and breast cancer treatment recommendations: agreement with an expert multidisciplinary tumor board. Ann Oncol 2018;29:418–23. https://doi.org/10.1093/ANNONC/MDX781.
55. Trivedi H, Mesterhazy J, Laguna B, Vu T, Sohn JH. Automatic Determination of the Need for Intravenous Contrast in Musculoskeletal MRI Examinations Using IBM Watson's Natural Language Processing Algorithm. J Digit Imaging 2018;31:245–51. https://doi.org/10.1007/S10278-017-0021-3/TABLES/4.
56. Majkić-Singh N. What is a biomarker? from its discovery to clinical application. J Med Biochem 2011;30:186. https://doi.org/10.2478/V10011-011-0029-Z.
57. Moss EL, Gorsia DN, Collins A, Sandhu P, Foreman N, Gore A, et al. Utility of Circulating Tumor DNA for Detection and Monitoring of Endometrial Cancer Recurrence and Progression. Cancers 2020, Vol 12, Page 2231 2020;12:2231. https://doi.org/10.3390/CANCERS12082231.
58. Mouliere F, Chandrananda D, Piskorz AM, Moore EK, Morris J, Ahlborn LB, et al. Enhanced detection of circulating tumor DNA by fragment size analysis. Sci Transl Med 2018;10. https://doi.org/10.1126/SCITRANSLMED.AAT4921.
59. Bilgin GB, Bilgin C, Burkett BJ, Orme JJ, Childs DS, Thorpe MP, et al. Theranostics and artificial intelligence: new frontiers in personalized medicine. Theranostics 2024;14:2367. https://doi.org/10.7150/THNO.94788.
60. Johnson KB, Wei WQ, Weeraratne D, Frisse ME, Misulis K, Rhee K, et al. Precision Medicine, AI, and the Future of Personalized Health Care. Clin Transl Sci 2021;14:86–93. https://doi.org/10.1111/CTS.12884.
61. Ching T, Himmelstein DS, Beaulieu-Jones BK, Kalinin AA, Do BT, Way GP, et al. Opportunities and obstacles for deep learning in biology and medicine. J R Soc Interface 2018;15. https://doi.org/10.1098/RSIF.2017.0387.
62. Jin S, Zeng X, Xia F, Huang W, Liu X. Application of deep learning methods in biological networks. Brief Bioinform 2021;22:1902–17. https://doi.org/10.1093/BIB/BBAA043.
63. Vamathevan J, Clark D, Czodrowski P, Dunham I, Ferran E, Lee G, et al. Applications of machine learning in drug discovery and development. Nat Rev Drug Discov 2019;18:463–77. https://doi.org/10.1038/S41573-019-0024-5;SUBJMETA.