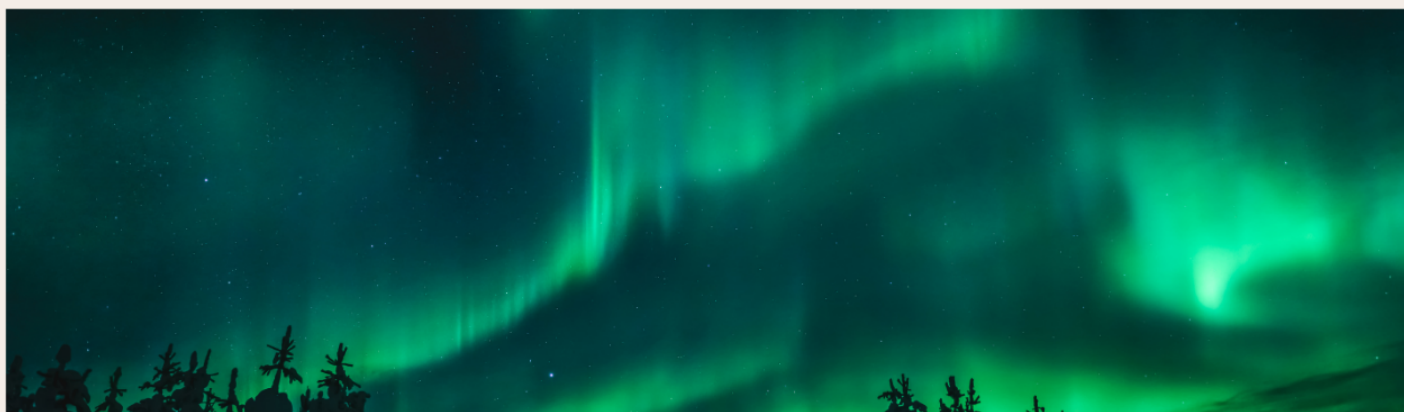


SCIENCE ASCEND

05-11 November 2024



Highlights

Astrophysics: CNN-assisted reanalysis of LAMOST survey with Hertzsprung-Russell diagram and novel 483,166 binary star candidates

Analytical Chem.: Cold argon plasma preprocessing to enhance peptide/protein mass spectrometry

Remote Sensing: PQAT-trained edge-computing neural networks for plant disease detection

Environmental Chem.: A comprehensive review of urban methane emission sources in the U.S. and Canada

Data Decomposition: Identifiability guaranteed latent component models

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Science Ascend

Rising to New Heights of Discovery!

Science Ascend teleports you to the frontiers of science. It compiles and discuss the scientific research preprints from arXiv, bioRxiv, chemRxiv just from the previous week to be cognizant of the *state-of-the-art* of knowledge in astrophysics, chemistry, environmental chemistry, remote sensing, and applied statistics/data science. Light from the *Science Ascend* will keep brightening the dark horizon beyond the limits of our comprehension. FIRE Araştırma Eğitim Ltd. Şti. guarantees the weekly publication and dissemination of this journal, and make it available for everyone at most fifteen days after its publication freely.

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Bilim Yükselişi

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Foreword

Greetings everyone!

In this issue covering preprints from November 5 to 11, 2024, a lower number of environmental chemistry and data decomposition papers were found, but remote sensing scanning algorithm was better. Further improvements in the chemistry and data decomposition paper filtering will be introduced in next issues.

A CNN reanalysis of LAMOST survey in astrophysics generated hundreds thousands of binary star candidates.

Using direct and radiofrequency-generated cold argon plasma was successfully removed interfering redundant chemicals while conducting protein mass spectroscopic analysis.

Remote sensing had interesting reviews and published datasets, and also an edge-computing method which can easily be run over a mobile phone and detect plant abiotic and biotic stresses. Urban methane emission sources from 103 papers on the U.S. and Canada cities was reviewed systematically.

A biochemical-oriented latent component analysis provided a theoretical framework which proves that it can guarantee identifiability in the latent factors, and then, validated it on experiments.

See you all at the next issue!

Güray Hatipoğlu

Last week in Astrophysics

Author: *Yasin Güray Hatipoğlu*

The preprints summarized here were published between November 5, November 11, 2024. These are from arXiv's astro.EP cross-fields

Reviews - Chapters - Software

Clement et al.[1] provided a review on the formation of terrestrial planets with the following sections: the early stages of planet formation, late stage accretion of terrestrial planets in the Solar System, Terrestrial planet formation in the context of exoplanets, and Putting our Solar System in context.

Ipatov[2] reviewed the celestial body migrations in the solar system and other stellar systems.

Razumovskiy et al.[3] the Molecular atmospheric Absorption with Rapid and Flexible Analysis - MARFA tool for line-by-line atmospheric absorption signatures in pressure-temperature lookup table forms.

Serabyn and Bottom[4] provided a chapter on Stellar Coronagraphy.

Balakrishnan et al.[5] provided the MAUVE (Mission to Analyze the Ultraviolet Universe) mission concept, similar to the Hubble Space Telescope's onboard THISTLE with an extreme UV extension.

Shimonishi[6] provided a proceeding talk on metallicity role in the chemical evolution of star-forming regions in the following subsections: molecular clouds at low metallicity, embedded protostellar cores at low metallicity, and hot molecular cores at low metallicity.

Stellar Systems - Populations - Clusters

Jing et al.[7] employed a convolutional neural network approach to identify binary stars from the LAMOST survey's low-resolution spectra by looking at Hertzsprung-Russell diagram position differences between the main-sequence stars and binaries. They provided the candidate binary star catalog here.

Squicciarini et al.[8] reanalyzed 400 stars from the GPIES survey of GPI at Gemini South, reduced these direct imaging data cubes by the PACO algorithm, and reported improved detection limits.

Honaker and Gizis[9] simulated brown dwarfs in the solar neighborhood from the Gaia-derived star formation histories and mass, metallicity, and

age relationships, and they enforced the cloudless Sonora Bobcat, hybrid SM08, and gravity-dependent hybrid Sonora Diamondback evolutionary models to their sample.

Single Star System (Star, Exoplanet)

McKee et al.[10] reported a new exoplanet candidate orbiting near the Hot Jupiter TOI-2818 b according to the transit timing variations. They used TESS photometry from TOI-2818, ground-based El Sauce and Las Cumbres observatories at the Cerro Tololo Inter-American Observatory, and radial velocities from the CTIO High-Resolution Spectrometer and VLT/ESPRESSO.

Ipatov[11] presented the results on the migration of bodies in the Proxima Centauri and TRAPPIST-1 planetary systems as a proceeding in the Proceedings IAU Symposium No. 393, 2024.

Aguilera-Gómez et al.[12] tried to infer the planetary interior's chemical composition from the observationally-constrained host star. They chose to work on the binary system with a polluted white dwarf SDSS J082019.49+253035.3 and its binary companion HD 69962, with the latter's spectrometry analysis done by iSpec, while for the former, briefly SDSS ugriz photometry. They reported the importance of grouping the chemical elements based on their condensation temperatures to link stellar and planetary compositions.

Leggett and Tremblin[13] used PH_3 -free ATMO 2020++ models to reproduce JWST NIRSpec and MIRI spectra of several late-T and Y dwarfs and also updated WISE photometry values and better reproduced some cases with different parameters.

Fonesca and Dodson-Robinson[14] reanalyzed the data of the M dwarf GJ 3942 also including Hipparcos, SuperWASP, HARPS-N, and TESS photometry data, but did not provide a directly different result from the stated 16.3 days of stellar rotation period out of the ambiguity in the TESS rotation detection.

Balmer et al.[15] observed the AF Lep b system with the Very Large Telescope Interferometer/GRAVITY instrument and combined observations from it with the Hipparcos-Gaia Catalogue of Accelerations and reported its orbit, spin-orbit alignment, a dynamical mass, and a metallicity, C/O ratio estimates.

Liu and Pu[16] presented a new fitting for impact parameter variation, the Simultaneous Impact Parameter Variation Analysis, outperforming individual fitting and being more computationally efficient than dynamical fitting. They simulated lightcurves with PyTransit Python

package and presented satisfactory results in analyzing transit variations with an alternative method.

Zhao et al.[17] worked on the separation of starspots and quiet parts of the star utilizing the starry package, PHOENIX package, and different configurations of this toy model in one, multi or various star spots in different locations. The name of their approach is Compact, Coherent Variability Framework, where the spots and quiet parts, Doppler shift, and the fraction star subtended are considered.

Han et al.[18] studied the short-timescale microlensing KMT-2024-BLG-1044 from the KMT-Net survey and after Bayesian analysis, they stated that the stellar system is most likely a star-brown dwarf boundary host and a sub-Uranus.

Sowinski et al.[19] discussed the Exo-Daisy world concept through the lens of the Semantic Information Theory, the information flow between the planetary environment and the biosphere and other concepts from the Daisy World model itself.

Exoplanet Atmospheres

Alam et al.[20] observed the L 168-9 b (also TOI-134 b), a hot super-Earth with around 1.39 Earth radius and 4.60 Earth mass, with the James Webb Space Telescope Near-Infrared Spectrograph (JWST NIRSpec) G395H and also JWST Mid-Infrared Instrument Low Resolution Spectroscopy (MIRI/LRS) and reported interesting results regarding its atmosphere after also comparing its transmission spectrum to 1D thermochemical equilibrium forward models.

Gruijter et al.[21] simulated the potential pathways to sulfur dioxide (SO_2) in the exoplanet atmosphere, with the fiducial model as HD 189733 b, a hot Jupiter around a K-type star, using the VULCAN code and its SNCHO thermo-photochemical network, Artful modeling Code for Exoplanet Science (ARCiS) to generate the transmission spectrum from the temperature-pressure profile and chemical composition, and presented a near-UV-driven pathway to generate SO_2 with additional insights.

Lewis et al.[22] studied the brown dwarf companion HIP 93398 B with the SCExAO/CHARIS spectroscopic observations and classified its spectral type as a cloudy L/T transition.

Protoplanetary - Circumstellar Disks

Cecil and Flock[23] simulated the inner disk edge of the protoplanetary disks around a Class II T Tauri star, focused on thermal instability (TI) with the 2D axisymmetric radiation hydrodynamic simulations in 0.05 to 10 au distances with

the finite volume method of the PLUTO code and reported immense effects of TI up to 1 au distance.

Donati et al.[24] studied the T Tauri star PDS 70 with the SPIRou at the 3.6 meters Canada-France-Hawaii Telescope in 2020 and 2024 and reported results on its disk, magnetic field, and accretion status. Ma et al.[25], too, studied the PDS 70 protoplanetary disk. They examined the polarized and scattered light from the outer disk of PDS 70 with the N_R filter on SPHERE/ZIMPOL's high-contrast polarimetric differential imaging and combined them with the archival VLT/SPHERE data.

Kutra et al.[26] observed the DF Tau binary system disks with the ALMA and Keck II NIRC2 and adaptive optics system, and Keck NIRSPEC Behind Adaptive Optics, and also utilized TESS, K2 photometry time-series and ground-based Lowell robotic 0.7-m telescope, and Lowell Hall 1.1-m telescope. They updated the stellar parameters and stated that the secondary object of the binary system does not seem to have a disk.

Solar System

Earth - Space relationship

Ipatov[27] calculated the endpoints of the ejected bodies from the Earth at the Late Heavy Bombardment stage with the rmvs-3 symplectic code of SWIFT for integrating motion equations and stated that Venus and Mars might have similar materials to Earth, and organic material might be carried to Mars after collisions from Earth. Similar results were also presented as a proceeding in the Proceedings IAU Symposium No. 393 by Ipatov[28].

Nimmo et al.[29] discussed the bulk silicate earth, and how it incorporated carbonaceous chondrite materials while Mars did not with the available observations and their modelling approach.

Sarajlic and He[30] considered the global scale cosmic ray distribution estimation and introduced the Earth Cosmic Ray Shower software which incorporated the U.S. Standard Atmospheric Model and a time-dependent geomagnetic field based on Tsyganenko and IGRF models.

Moon

Thoresen et al.[31] employed a variational autoencoder and a clustering algorithm results from the Moon Mineral Mapper (M3) hyperspectral data and provided a global spectral cluster map with five different mineral mixture clusters.

Near-Earth Objects

Fenucci et al.[32] provided a summary on the Aegis system, the European Space Agency’s Near-Earth Object Coordination Centre’s (NEOCC) newly developed Orbit Determination and Impact Monitoring System.

Lan et al.[33] presented the visual analysis system to track NEOs by planetary defense experts. They provided the code implementation under the OpenSpace system here.

Comets

Manna et al.[34] observed the Oort Cloud non-periodic C/2022 E3 (ZTF) comet with the Giant Metrewave Radio Telescope (GMRT) band L¹ and the Atacama Large Millimeter/submillimeter Array (ALMA) band 6². They reported dust production rate, methanol emission, and its estimated abundance.

Solar System Ice Giants

Hasler et al.[35] provided new flux measurements of Uranus from the Multispectral Visible Imaging Camera of the New Horizons at the following phase angles: 43.9, 44.0, and 52.4, compared it to Hubble Wide Field Camera 3 and ground-based community observations and put further constraints on the Uranus atmosphere.

(Magneto)hydrodynamics

Hazra et al.[36] examined the close-in planet atmospheric loss from the coronal mass ejections (CMEs) by 3D radiation magnetohydrodynamic models using BATS-R-US tools and reported several orientation and magnetic field cases, as well as an estimated LY- α transit spectrum while a CME passes through.

Shariff and Umurhan[37] provided a locally isothermal 3D protoplanetary disk turbulence. The vertical shear instability (VSI)-caused turbulence was calculated with a high-resolution fourth-order Padé (also the simulation code) scheme.

Skene et a.[38] studied the geodynamo by combining the direct-adjoint looping to find the minimum magnetic field that can attract a nonlinear dynamo solution and the Newton-hookstep algorithm converged the travelling wave solutions. They solved the resulting equations with the partial differential equation solver Dedalus.

¹Approx. 1400 MHz mean frequency

²211-275 GHz frequency range

N-body and Gravitational Works

Weldon et al.[39] studied the cold-Jupiter eccentricity with numerical models to see if it is consistent with the Eccentric Kozai-Lidov (EKL) mechanism or not. They had different initial conditions, not just circular orbits but the ones in different eccentricities and semi-major axes with hundreds of simulations and reported that EKL mechanism is in line with the observations of cold Jupiters.

Segretain et al.[40] theoretically and numerically discussed the gravitational collapse in a gaseous environment that results in planetesimal formation, focusing on reaching the temperature checkpoints via monitoring the temperature evolution during the process with the 1D symmetric IDEFIX code for Godunov finite volume scheme hydrodynamical equation simulations.

Robles and Meighen-Berger[41] proposed that Jupiter may be a dark matter catcher target and reported that with their neutrino detectors, limits, and direct detection results from the sun were surpassed.

Instrumentation

Greaves[42] examined the dynamic ranges for single-dish telescope observations, its post-processing to improve signal retrieval and future directions. One of the recommendations of the author was to use a time-dependent Fourier-based method by injecting synthetic signal and post-processing data automatically.

Arimatsu[43] provided an overview of the OASES project, which stands for Organized Autotelescopes for Serendipitous Event Survey, to detect kilometer-sized TNOs.

Last week in Chemistry

Author: Yasin Güray Hatipoğlu

The preprints summarized here were published between November 5, November 11, 2024. They are more in nature of spectroscopy alone, and hence several studies regarding biochemistry, chromatography, and several other disciplines might be missed here.

Mass Spectroscopy

McGill et al.[44] developed a preprocessing step for mass spectrum imaging of peptides/proteins via direct and radiofrequency current cold argon plasma surface treatment to weed out macromolecules from the system while not disturbing the analyte.

Erick et al.[45] utilized reversed-phase ultra-high performance liquid chromatography-mass spectrometry, multisegment injection-capillary electrophoresis-mass spectrometry, and capillary electrophoresis UV detection setups for vitamin D metabolite and lipidomic examinations.

Gravimetric Methods

Raksha and Nanishankar[46] considered the chicory-coffee mixture and how much impact the chicory percentage has on the overall total dissolved solids and percentage extraction of components with a newly developed gravimetric method (filtration-oven-rinsing combinations). They reported that over 30 % of chicory dominates in both variables.

Raman Spectroscopy

Reichmayr et al.[47] made an *operando* Raman spectroscopy investigation while trying to synthesize two-dimensional metal-organic framework (MOF) catalysts (phthalocyanine-based) to check the result of the synthesis. They revealed that several Raman spectrum markers are in line with the quality of MOF crystallite distribution according to the transmission electron microscopy results.

Nuclear Magnetic Resonance - NMR

Arnaud et al.[48] studied the non-intentionally added substances to polystyrene (NIAS to PS) by systematically incorporating additives and measuring the results with gas chromatography-mass spectrometry and nuclear magnetic resonance (GC/MS and NMR) analyses. The method they

developed did not require much solvent and it is possible to implement it in a common laboratory setting.

Gioiosa et al.[49] utilized state-of-the-art dissolution dynamic nuclear polarization (dDNP) methodologies in 7.05 T Bruker dDNP Polarizer to enhance the sensitivity of ^{13}C -NMR of battery electrolytes, to better understand their efficiency and degradation dynamics with up to 3 orders of magnitude sensitivity gains in 600 MHz spectrometer.

Last week in Remote Sensing

Author: *Yasin Güray Hatipoğlu*

The preprints summarized here were published between November 5, November 11, 2024. These are generally based on the preprints retrieved when “remote sensing” words are given between quotation marks within arXiv’s cs.CV and similar cross-fields.

Reviews - Datasets

Sun et al.[50] reviewed the multi-modal language models for remote sensing, basically, the ones interpreting remote sensing images and providing a textual prompt after taking them as inputs. The review included an interesting overarching chart for “taxonomy”, and foundations, remote sensing data characteristics, applications, challenges, and future directions.

Noppitak et al.[51] provided a collection of 5400 aerial images in 2014-2018 from the Google Earth, EcoCropsAID, containing rice, sugarcane, cassava, rubber, and longan economic crops in Thailand from that period. The data can be downloaded here.

Zhao et al.[52] reviewed the synthetic aperture radar data for urban flood mapping, before-after comparisons, InSAR, and Polarimetric SAR, and even provided a technology readiness level for urban flood mapping techniques.

Zhao et al.[53] reviewed on graph neural network techniques for earth observation domain tasks.

Segmentation

Li et al.[54] constructed the DDFAV dataset for large vision language models via different data augmentation and mixing strategies. Moreover, they developed a remote sensing LVLMM hallucination evaluation RSPOPE in a zero-shot semantic segmentation task. All related data and materials are here.

Lu et al.[55] introduced the Aquila model (a combination of a multi-layer deep alignment LLM and Hierarchical Spatial Feature Integration) that hierarchically captures important information in different scales via the Hierarchical Spatial Feature Integration module. Lu[56] individually presented the Aquila-plus (mask-text instruction tuning) algorithm for pixel-level remote sensing image understanding with the ConvNeXt-Large convolutional CLIP visual encoder.

Lyu et al.[57] developed an Unsupervised Domain Adaptation for Remote Sensing Semantic

Segmentation (UDA-RSSeg) by incorporating a joint-optimized adversarial network and Segment Anything Model (SAM-JOANet)³. Utilizing a way that utilizes SAM and a fine-tuning decoder to map its results to predictive logits (masks, too) and a logits-level adversarial discriminator, their method outperformed the state-of-the-art (SOTA) on the ISPRS Potsdam/Vaihingen and CITY/OSM datasets.

Modelling-Forecast

Willmes et al.[58] tackled the climate-resilient agriculture challenge and among other things, they used Sentinel-2 top-of-atmosphere reflectance data (L1C product) for remote sensing data and France’s Registre Parcellaire Graphique ground truth polygon vector data for 328 unique crops, among them the winter wheat was the study focus. S2Cloudless captured the clouds. Their algorithms were a spatial-spectral CNN - UNet and ResNet50 architecture. They also incorporated spectral-temporal (LSTM), and a spatial-spectral-temporal type algorithm.

Lu et al.[59] devised an approach to enhance vision transformer with pattern integration augmentation (PIEViT) for self-supervised learning and presented improved results in change detection, object detection, and segmentation cases. The separate important modules of this algorithm are as follows: the geospatial pattern cohesion, feature integration projection, and the overall PIE architecture and dual-stream feature learning framework.

Klein et al.[60] introduced a method, Projection Integration for Variable Orientation in Computed Tomography (PIVOT-CT), to utilize multiview camera poses to recover the 3D structure of clouds. They reported a better result for sun-varying angle BOMEX datasets (a dataset for 3D cloud fields) than VIP-CT.

Zuo et al.[61] developed the algorithm Neural Radiance Field (NeRF)-based color consistency (CC) to aid in the mosaicking of images with varying illuminations to eliminate the stitching look. They used the Superview-1 satellite (50 cm spatial resolution and UAV images from different times.

Silva and Almeida[62] presented a deep learning method of edge-computing to plant disease detection with the InceptionV3, MobileNetV1, MobileNetV2, and VGG-16. They stated that the Pruning-Quantization Aware Training (PQAT) successfully prepared the models for edge-computing for a Raspberry Pi 4B.

Jha[63] examined domain generalization and domain adaptations and introduced APPLeNet and AD-CLIP, respectively for those cases.

³You can the SAM-JOANet GitHub repository here.

Singla[64] tried to estimate population from 3D city modeling using multi-view Carto2S series of high-resolution images to generate a precise digital elevation and terrain model, and then, a 3D city model was estimated. After deriving number of floors and relevant other surrogates, the population was estimated accordingly.

King et al.[65] presented the transformer architecture Sensor-Agnostic Spectral Transformers - STARS, containing a Universal Spectral Representation, a spectral transformer encoder, and an operator-theoretic decoder (Deep Operator Network).

Super-Resolution

Zhang et al.[66] developed a method, Enhancing Spatial Correlations in Multi-Image Super-Resolution - ESC-MISR, to generate super-resolution images from multiple lower-resolution ones. They introduced a multi-image spatial transformer and attenuated temporal dependencies via shuffling the temporal order and successfully employed this methodology on the PROVA-V dataset.

Last week in Environmental Chemistry

Author: Yasin Güray Hatipoğlu

The preprints summarized here were published between November 5, November 11, 2024 in chemRxiv's Earth, Space, and Environmental chemistry preprints are being surveyed, and unfortunately, not many preprints are published under environmental topics in this field.

Vollrath et al.[67] reviewed 103 peer-reviewed articles on urban methane (CH_4) emissions in the U.S. and Canada. They reported important insights on differences in top-down estimations and bottom-up calculations and inventories, as well as different types of emission sources.

Wu et al.[68] considered the effect of autochthonous and allochthonous dissolved organic matter on the halogenated disinfection byproducts taking an urban eutrophic algal-bloomed lake as an example, and used ultra-high resolution mass spectrometry analyses to observe if there is any difference. They reported that microcystin metabolism and its DOM and microbially-metabolised Xn-DBPs were quite influential.

González et al.[69] provided a techno-economic analysis for cyanobacteria digestion of processed manure (ReNuAl) and generating crop-specific fertilizers in different N/P ratios from them via bioengineering. Cyanobacteria was also reported to generate biogas-based electricity, and biogas itself besides the fertilizer, and was found to be a better choice to process manure.

Last week in Data Decomposition/Transformation

Author: Yasin Güray Hatipoğlu

The preprints summarized here were published between November 5, November 11, 2024. This is generally from arXiv's stat.ML or stat.ME cross-list. The section focuses on preprints heavily worked with or developed data decomposition/transformation techniques, such as principal component analysis (PCA) or Fourier Transformation.

Dimensional Reduction

Pandolfi et al.[70] presented the positive impact of conjugate-gradient methods while working with high-dimensional generalized linear mixed models. One focus was on Cholesky factorization for high-dimensional Gaussian sampling. They made theoretical analyses and experiments, and the experiments are provided here.

Feng et al.[71] studied congestive heart failure (CHF) with Weibull regression and R2D2 frameworks, MCMC sampler, and how they perform against other variable selections. The predictand was time to CHF and the target was finding important mediators, with one of them being higher socioeconomic inequality.

Hijikata et al.[72] employed the Bayesian joint modal estimation for the exploratory item factor analysis. They found higher accuracy and computational efficiency scores in simulated data, and also successfully applied it to a psychological assessment of the Big Five personality traits.

Modelling

Qin et al.[73] improved upon the cluster-weighted factor analyzers (CWFA) via simultaneous multiple response variable estimation and also estimating their interactions among themselves, and identifying factors with disjoint groups of explanatory variables, hence the Multivariate Cluster-Weighted Disjoint Factor Analyzers (MCWDFAs) model. The researchers successfully applied this to UCI Machine Learning Repository-accessible crime data from the United States.

Ghosh et al.[74] presented the Soft Bayesian Additive Regression Trees (SBART) to account for spatially clustered survival data with unknown covariates and their interactions and random cluster effects. They utilized these in mitigating present racial disparity in breast cancer survival in 67 counties in Florida from two datasets.

Luo et al.[75] worked on developing an identifiability-guaranteed latent component containing models for multi-modal biological data studies. They provided a theoretical basis for the latent component identifiability and moved on to experiments to successfully validate their methodological framework.

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