5G-Advanced Toward 6G: Past, Present, and Future

Move 1, Step 1:
"Since the start of 5G work in 3GPP in early 2016, tremendous progress has been made in both standardization and commercial deployments."

Move 1, Step 2:
"3GPP is now entering the second phase of 5G standardization, known as 5G-Advanced, built on the 5G baseline in 3GPP Releases 15, 16, and 17."

Move 2, Step 1:
"Since the start of 5G work in 3GPP in early 2016, tremendous progress has been made in both standardization and commercial deployments."

Move 2, Step 2:
"3GPP Release 18, the start of 5G-Advanced, includes a diverse set of features that cover both device and network evolutions, providing balanced mobile broadband evolution and further vertical domain expansion and accommodating both immediate and long-term commercial needs."

Move 3, Step 1:
"5G-Advanced will significantly expand 5G capabilities, address many new use cases, transform connectivity experiences, and serve as an essential step in developing mobile communications towards 6G."

Move 3, Step 2:
"This paper provides a comprehensive overview of the 3GPP 5G-Advanced development, introducing the prominent state-of-the-art technologies investigated in 3GPP and identifying key evolution directions for future research and standardization."

Move 9:
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A Comprehensive Survey on Transfer Learning

Move 1, Step 1:
"Transfer learning aims at improving the performance of target learners on target domains by transferring the knowledge contained in different but related source domains."

Move 1, Step 2:
"In this way, the dependence on a large number of target-domain data can be reduced for constructing target learners."

Move 2, Step 1:
"Due to the wide application prospects, transfer learning has become a popular and promising area in machine learning."

Move 2, Step 2:
"Although there are already some valuable and impressive surveys on transfer learning, these surveys introduce approaches in a relatively isolated way and lack the recent advances in transfer learning."

Move 3, Step 1:
"Due to the rapid expansion of the transfer learning area, it is both necessary and challenging to comprehensively review the relevant studies."

Move 3, Step 2:
"This survey attempts to connect and systematize the existing transfer learning research studies, as well as to summarize and interpret the mechanisms and the strategies of transfer learning in a comprehensive way, which may help readers have a better understanding of the current research status and ideas."

Move 4, Step 1:
"Unlike previous surveys, this survey article reviews more than 40 representative transfer learning approaches, especially homogeneous transfer learning approaches, from the perspectives of data and model."

Move 4, Step 2:
"The applications of transfer learning are also briefly introduced."

Move 5, Step 1:
"In order to show the performance of different transfer learning models, over 20 representative transfer learning models are used for experiments."

Move 5, Step 2:
"The models are performed on three different data sets, that is, Amazon Reviews, Reuters-21578, and Office-31, and the experimental results demonstrate the importance of selecting appropriate transfer learning models for different applications in practice."

A Graph-Transformer for Whole Slide Image Classifification

Move 1, Step 1:
"Deeplearning is a powerful tool for whole slide image (WSI) analysis."

Move 1, Step 2:
"Typically, when performing supervised deep learning, a WSI is divided into small patches, trained and the outcomes are aggregated to estimate disease grade."

Move 1, Step 2:
"However, patch-based methods introduce label noise during training by assuming that each patch is independent with the same label as the WSI and neglect overall WSI-level information that is significant in disease grading."

Move 2, Step 1:
"Here we present a Graph-Transformer (GT) that fuses a graph-based representation of a WSI and a vision transformer for processing pathology images, called GTP, to predict disease grade."

Move 2, Step 2:
"We selected 4,818 WSIs from the Clinical Proteomic Tumor Analysis Consortium (CPTAC), the National Lung Screening Trial (NLST), and The Cancer Genome Atlas (TCGA), and used GTP to distinguish adenocarcinoma (LUAD) and squamous cell carcinoma (LSCC) from adjacent non-cancerous tissue (normal)."

Move 3, Step 1:
"First, using NLST data, we developed a contrastive learning framework to generate a feature extractor."

Move 3, Step 2:

"This allowed us to compute feature vectors of individual WSI patches, which were used to represent the nodes of the graph followed by construction of the GTP framework."

Move 4, Step 1:
"Our model trained on the CPTAC data achieved consistently high performance on three-label classification (normal versus LUAD versus LSCC: mean accuracy = 91.2 ± 2.5%) based on five-fold cross-validation..."

Move 4, Step 2:
"...and mean accuracy = 82.3 ± 1.0% on external test data (TCGA)."

Move 5, Step 1:
"We also introduced a graph-based saliency mapping technique, called GraphCAM, that can identify regions that are highly associated with the class label."

Move 5, Step 2:
"Our findings demonstrate GTP as an interpretable and effective deep learning framework for WSI-level classification."

A Survey of Optimization Methods From a Machine Learning Perspective

Move 1, Step 1:
"Machine learning develops rapidly, which has made many theoretical breakthroughs and is widely applied in various fields."

Move 1, Step 2:
"Optimization, as an important part of machine learning, has attracted much attention of researchers."

Move 1, Step 3:
"With the exponential growth of data amount and the increase of model complexity, optimization methods in machine learning face more and more challenges."

Move 1, Step 4:
"A lot of work on solving optimization problems or improving optimization methods in machine learning has been proposed successively."

Move 2, Step 1:

"The systematic retrospect and summary of the optimization methods from the perspective of machine learning are of great significance, which can offer guidance for both developments of optimization and machine learning research."

Move 2, Step 2:
"In this article, we first describe the optimization problems in machine learning."

Move 2, Step 3:
"Then, we introduce the principles and progresses of commonly used optimization methods."

Move 2, Step 4:
"Finally, we explore and give some challenges and open problems for the optimization in machine learning."

A Survey on Active Simultaneous Localization and Mapping: State of the Art and New Frontiers

Move 1, Step 1:
"Active simultaneous localization and mapping (SLAM) is the problem of planning and controlling the motion of a robot to build the most accurate and complete model of the surrounding environment."

Move 1, Step 2:
"Since the first foundational work in active perception appeared, more than three decades ago, this field has received increasing attention across different scientific communities."

Move 1, Step 3:
"This has brought about many different approaches and formulations, and makes a review of the current trends necessary and extremely valuable for both new and experienced researchers."

Move 2, Step 1:

"In this article, we survey the state of the art in active SLAM and take an in-depth look at the open challenges that still require attention to meet the needs of modern applications."

Move 2, Step 2:
"After providing a historical perspective, we present a unified problem formulation and review the well-established modular solution scheme, which decouples the problem into three stages that identify, select, and execute potential navigation actions."

Move 2, Step 3:
"We then analyze alternative approaches, including belief-space planning and deep reinforcement learning techniques, and review related work on multirobot coordination."

Move 2, Step 4:
"This article concludes with a discussion of new research directions, addressing reproducible research, active spatial perception, and practical applications, among other topics."

Active RIS vs. Passive RIS: Which Will Prevail in 6G?

Move 1, Step 1:
"As a revolutionary paradigm for controlling wireless channels, reconfigurable intelligent surfaces (RISs) have emerged as a candidate technology for future 6G networks."

Move 1, Step 2:
"However, due to the “multiplicative fading” effect, the existing passive RISs only achieve limited capacity gains in many scenarios with strong direct links."

Move 2, Step 1:
"In this paper, the concept of active RISs is proposed to overcome this fundamental limitation."

Move 2, Step 2:
"Unlike passive RISs that reflect signals without amplification, active RISs can amplify the reflected signals via amplifiers integrated into their elements."

Move 2, Step 3:

"To characterize the signal amplification and incorporate the noise introduced by the active components, we develop and verify the signal model of active RISs through the experimental measurements based on a fabricated active RIS element."

Move 2, Step 4:
"Based on the verified signal model, we further analyze the asymptotic performance of active RISs to reveal the substantial capacity gain they provide for wireless communications."

Move 3, Step 1:
"Finally, we formulate the sum-rate maximization problem for an active RIS aided multi-user multiple-input single-output (MU-MISO) system..."

Move 3, Step 2:
"...and a joint transmit beamforming and reflect precoding scheme is proposed to solve this problem."

Move 3, Step 3:
"Simulation results show that, in a typical wireless system, passive RISs can realize only a limited sum-rate gain of 22%, while active RISs can achieve a significant sum-rate gain of 130%, thus overcoming the “multiplicative fading” effect."

Beyond Transmitting Bits: Context, Semantics, and Task-Oriented Communications

Move 1, Step 1:
"Communication systems to date primarily aim at reliably communicating bit sequences."

Move 1, Step 2:
"Such an approach provides efficient engineering designs that are agnostic to the meanings of the messages or to the goal that the message exchange aims to achieve."

Move 2, Step 1:
"Next generation systems, however, can be potentially enriched by folding message semantics and goals of communication into their design."

Move 2, Step 2:

"Further, these systems can be made cognizant of the context in which communication exchange takes place, thereby providing avenues for novel design insights."

Move 3, Step 1:
"This tutorial summarizes the efforts to date, starting from its early adaptations, semantic-aware and task-oriented communications, covering the foundations, algorithms and potential implementations."

Move 3, Step 2:
"The focus is on approaches that utilize information theory to provide the foundations, as well as the significant role of learning in semantics and task-aware communications."

Broadband LEO Satellite Communications: Architectures and Key Technologies

Move 1, Step 1:
"This article aims to provide a comprehensive overview for key issues in broadband LEO satellite communication systems."

Move 2, Step 1:
"First of all, the network architecture is introduced, which is the basis of the whole system."

Move 2, Step 2:
"The space-based LEO system with ISL, which requires a small number of ground gateways, is the focus."

Move 2, Step 3:
"In this system, the satellite constellation design is important with impact on key system performances such as coverage."

Move 3, Step 1:
"Two popular LEO constellations, the walker Delta and Star constellations, are introduced."

Move 3, Step 2:
"Given satellite constellations, proper beam coverage schemes should be employed at satellites to provide seamless coverage all over the world."

Move 3, Step 3:
"A hybrid wide and spot beam coverage scheme is presented, where the LEO provides a wide beam for large area coverage and several steering spot beams for high-speed data access."

Move 4, Step 1:
"Moreover, special coverage schemes should be designed in broadband LEO systems for the interference coordination between LEO and GEO."

Move 4, Step 2:
"To protect GEO communications, LEO satellites should be turned off if they cause interference to GEO."

Move 4, Step 3:
"In this case, to provide services for users covered by the turned-off LEO satellites, a progressive pitch method and a coverage expanding method can be employed."

Move 5, Step 1:
"Finally, the coverage performance of LEO is also closely related to resource management schemes."

Move 5, Step 2:
"The global resource management for broadband LEO systems is complicated, involving a large amount of data, and a two-level management structure should be employed."

Move 5, Step 3:
"Using this structure, an NMC with powerful storage and processing capabilities is employed to carry out the first-level management, making strategies based on all information collected from the whole system. Then satellite base stations with limited capabilities are employed to respond to the strategies generated by NMC in real time."

Channel Estimation for Extremely Large-Scale MIMO: Far-Field or Near-Field?

Move 1, Step 1:

"Extremely large-scale multiple-input-multiple-output (XL-MIMO) is promising to meet the high rate requirements for future 6G."

Move 1, Step 2:
"To realize efficient precoding, accurate channel state information is essential."

Move 2, Step 1:
"Existing channel estimation algorithms with low pilot overhead heavily rely on the channel sparsity in the angular domain, which is achieved by the classical far-field planar-wavefront assumption."

Move 2, Step 2:
"However, due to the non-negligible near-field spherical-wavefront property in XL-MIMO, this channel sparsity in the angular domain is not achievable."

Move 2, Step 3:
"Therefore, existing far-field channel estimation schemes will suffer from severe performance loss."

Move 3, Step 1:
"To address this problem, in this paper, we study the near-field channel estimation by exploiting the polar-domain sparsity."

Move 3, Step 2:
"Specifically, unlike the classical angular-domain representation that only considers the angular information, we propose a polar-domain representation, which simultaneously accounts for both the angular and distance information."

Move 3, Step 3:
"In this way, the near-field channel also exhibits sparsity in the polar domain, based on which, we propose on-grid and off-grid near-field XL-MIMO channel estimation schemes."

Move 4, Step 1:
"Firstly, an on-grid polar-domain simultaneous orthogonal matching pursuit (P-SOMP) algorithm is proposed to efficiently estimate the near-field channel."

Move 4, Step 2:
"Furthermore, an off-grid polar-domain simultaneous iterative gridless weighted (P-SIGW) algorithm is proposed to improve the estimation accuracy."

Move 5, Step 1:
"Finally, simulations are provided to verify the effectiveness of our schemes."

Consensus Problems in Networks of Agents With Switching Topology and Time-Delays

Move 1, Step 1:
"In this paper, we discuss consensus problems for networks of dynamic agents with fixed and switching topologies."

Move 1, Step 2:
"We analyze three cases: 1) directed networks with fixed topology; 2) directed networks with switching topology; and 3) undirected networks with communication time-delays and fixed topology."

Move 2, Step 1:
"We introduce two consensus protocols for networks with and without time-delays and provide a convergence analysis in all three cases."

Move 2, Step 2:
"We establish a direct connection between the algebraic connectivity (or Fiedler eigenvalue) of the network and the performance (or negotiation speed) of a linear consensus protocol."

Move 2, Step 3:
"This required the generalization of the notion of algebraic connectivity of undirected graphs to digraphs. It turns out that balanced digraphs play a key role in addressing average-consensus problems."

Move 2, Step 4:
"We introduce disagreement functions for convergence analysis of consensus protocols. A disagreement function is a Lyapunov function for the disagreement network dynamics."

Move 2, Step 5:
"We proposed a simple disagreement function that is a common Lyapunov function for the disagreement dynamics of a directed network with switching topology."

Move 3, Step 1:
"A distinctive feature of this work is to address consensus problems for networks with directed information flow."

Move 3, Step 2:
"We provide analytical tools that rely on algebraic graph theory, matrix theory, and control theory."

Move 4, Step 1:
"Simulations are provided that demonstrate the effectiveness of our theoretical results."