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Reduced Energy Consumption for Cellular Networks Using TACT with Fading Detection

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Abstract--Recent works have valid the possibility of increase the energy efficiency in radio access networks (RANs), done by dynamically turning on/off some base stations (BSs). in keeping with this paper, to increase the analysis over Base Stations change operations that have to be compelled to match up with traffic load variations. . we\'ve an inclination to initial of all formulate the traffic variations as a markov decision method. then minimize the energy consumption of RANs, and to style a reinforcement learning framework based totally BSs change operation theme. What is more, to hurry up the continued learning methodology, a transfer actor-critic algorithm (TACT), that utilizes the transferred learning expertise in historical periods or near regions, is planned and provably converges. The planned thoughtfulness algorithm contributes to a performance jumpstart and demonstrates the practicable ness of nice energy efficiency improvement at the expense of tolerable delay performance.

Index Terms —Radio access networks, base stations, , green communications, energy saving, reinforcement learning, transfer learning, actor-critic algorithm.

I. INTRODUCTION

Wireless cellular networks ar growing apace inside the previous couple of decades. The subscriber vary and traffic volume in cellular networks have explosively increased . very cheap station(BS) transmits common management signals and knowledge signals to mobile users (MUs). Network planning, cell size and capability unit usually mounted supported the estimation of peak traffic load. for a cellular network in associate extremely city, the traffic load inside the day time is relatively vital in geographic point areas and light-weight in residential areas, whereas the choice things happen inside the evening. the huge vary of BSs contribute a big portion of the energy consumption of cellular networks. once a SB is in its operative mode, the energy consumption of method circuits and cooling system takes up regarding 60percent of the general consumption the info and communication technology (ICT) business accounts for 24 to100% of the world's overall power consumption presently, over80% of the power consumption takes place inside the radio access networks (RANs), notably the bottom stations (BSs). Luca Chiaraviglio et alshowed the chance of energy saving by simulations. and projected the way to dynamically regulate the operative standing of bs, wishing on the anticipated traffic tons of. However, to reliably predict the traffic lots remains quite troublesome, that creates these works suffering in wise applications. On the alternative hand, and presented dynamic baccalaureate switch algorithms with the traffic lots a previous and preliminarily evidenced the effectiveness of energy saving. Besides, it\'s collectively found that turning on/off variety of the bss will directly have an impact on the associated bs of a mobile terminal (MT). Moreover, selections of user associations in turn end in the traffic load variations of BSs. Hence, any two consecutive bss witch operations ar connected with each other and current bs

switch operation additionally can further influence the overall energy consumption at intervals the long-term. In different words, the expected energy saving theme ought to be farsighted whereas minimizing the energy consumption. It need to concern its result on every the current and future system performance to deliver a visionary bss witch operation answer. The authors in presented a partially farsighted energy saving theme that mixes bs switch operation and user association, by giving a heuristic answer on the premise of a stationary traffic load profile. throughout this paper, we have a tendency to tend to undertake and solve this disadvantage from a novel perspective. instead of predicting the amount of traffic lots, we have a tendency to tend to use a Markoff decision technique to model the traffic load variations. Afterwards, the solution to the developed MDP disadvantage is attained by making use of actor-critic rule a reinforcement learning (RL) approach actor-critic algorithmic rule ,a reinforcement learning (RL) approach ,one advantage of that\'s that there is no necessity to possess a previous data temporal and special affiliation at intervals the traffic a whole lot and hurrying the on-going learning technique in regions of interest as drawn in Fig one. As a result, the coaching frame work of bs shift operation is a lot of enlarged by in corporating the construct of metal into the classical actor-critic rule particularly the Transfer Actor-Critic rule throughout this paper. Firstly, we\'ve got a bent to indicate that the coaching framework is feasible to save|to avoid wasting} lots of the energy consumption in RANs whereas not the data of traffic a whole lot a previous. Moreover, the performance of the coaching framework approaches that of the progressive theme (SOTA) that\'s assumed to possess altogether data of traffic a whole lot. These preliminary results have already been conferred in second, we\'ve got a bent to increase the construct of metal to the standard RL rules and show that the planned considerateness rule outperforms the classical AC algorithmic rule with a performance jumpstart. Thirdly, this paper details the convergence analysis of the tactfulness rule and thereby contributes to the final literature in RL field, particularly the final AC rule.

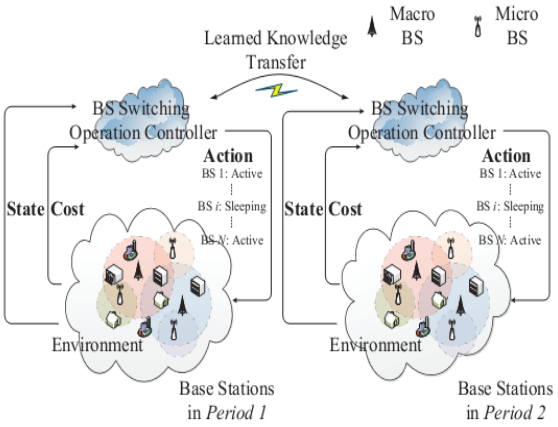


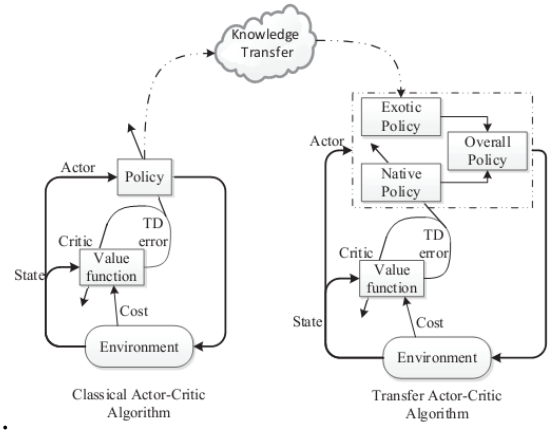
Fig. 1. Transfer learning for reinforcement learning in BS switching operation scenario.

II. STOCHASTIC BS SWITCHINGO PERATION IN REINFORCEMENT LEARNING FRAMEWORK

A. Markov decision process

Markov decision processes (MDPs), named once Andrey Markov, offer a mathematical framework for modeling higher cognitive process in things wherever outcomes ar partially random and partially underneath the management of a choice maker. mathematical framework for modeling higher cognitive process in things where outcomes ar partly random and partly beneath the management of a alternative maker. MDPs square measure useful for learning an oversized vary of optimisation problems resolved via dynamic programming and reinforcement learning..More specifically, a Andre markov call methodology

can be a definite time random methodology. At when step, the method is in some state , and also the top dog might opt for any action that's on the market in state . the method responds at following time step by every which way getting in a brand new state , and giving the choice maker a corresponding reward



B. The actor-critic learning framework for energy saving

There square measure some well-known ways to unravel the MDP issues like dynamic programming [16].sadly, these ways heavily depend upon previous info of the environmental dynamics. However, it's troublesome to know the end of the day traffic tons of precisely ahead. Therefore, throughout this paper, we tend to tend to use reinforcement learning approaches to unravel the MDP downside whereas not requiring the data of traffic tons of a previous and specifically adopt the actor-critic algorithm. as a result of the name implies, the actor-critic algorithm encompasses 3components: actor, critic, and surroundings At a given state, the actor selects Associate in Nursing action in an passing random suggests that then executes it. This execution transforms the state of surroundings to a replacement one with sure likelihood, and feeds back the worth to the actor. Then, the critic criticizes the action dead by the actor and updates the price perform through a time distinction (TD) error. once the criticism, the actor will update the policy to love the action with a smaller price, and also the alternative means around. The algorithm repeats the upper than procedure until convergence. the reasons to adopt actor-critic algorithm ar three-folded: (i)since it generates the action directly from the hold on policy, it desires little or no computation to select out Associate in Nursing action to perform; (ii) it\'ll learn Associate in Nursing expressly random policy which may be useful in non-Markov traffic variation setting of RANs (iii) it one by one updates the price perform and policy[16]. As a result, it would be further merely to implement the policy info transfer in Section IV, compared to various critic-only algorithms like ε -greed and Q-learning [30], .We vogue Associate in actor-critic learning framework for energy saving theme as illustrated in Fig. 3.(i) Action selection: Beforehand, let's assume that the system is at the beginning of stage k . Meanwhile, the traffic load state is s(k). Thereafter, the controller should select Associate in Nursing action per a random strategy, the aim of that\'s to reinforce performance whereas expressly effort a pair of competitor objectives: a) sorting out a much better bs modification operation (exploration) and b) taking as little or no value as realizable (exploitation). As a result, the controller not entirely performs an honest bs modification operation supported its past experience.

III. TRANSFER A CTOR –CRITIC ALGORITHM FOR STOCHASTIC BS SWITCHINGO PERATION

A. Motivation and formulation of transfer actor-critic formula

The previous section addresses the methodology to require advantage of the classical AC rule to conduct the bs switch operation, culminating during a smart energy saving strategy among the end throughout this section, we present the implies that the controller utilizes the knowledge of learned ways in which throughout historical periods or neighboring regions to be among the groove of finding the optimum bs switch operations. Basically, the policy, say p(s,a), that finally determines

the strategy π (s, a) in one learning task, indicates the tendency of action a to be chosen in state s. once the coaching technique converges, the tendency to make your mind up on a specific action a throughout a selected state is comparatively larger than that of different actions. In different words, it implies that if the bs switch operation is conducted supported one learned strategy, the energy saving among the full system tends to be optimized among the top of the day. Hence, if the knowledge of this policy p (s, a)is transferred to a special task, the knowledge transferred from quantity one to quantity 2 (target task)among an analogous region of interest in Fig. 1, the controller among the target task can produce an attempt by taking an analogous action a once the traffic plenty get state s. Compared to learning from the scratch, the controller may directly produce the wisest different at the really beginning. **Block diagram**

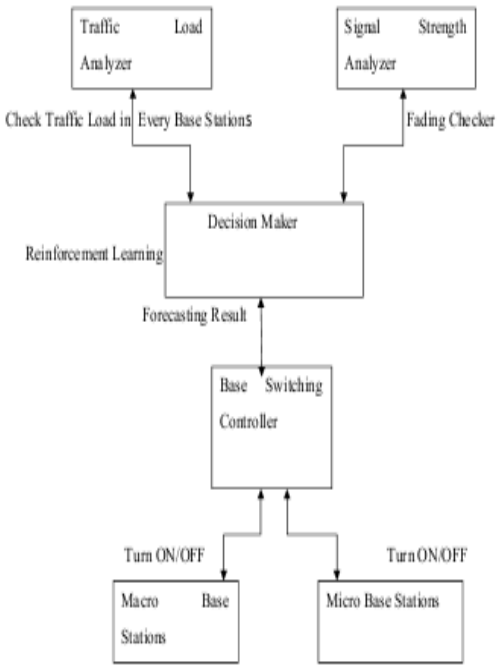


Fig:4.1 Architechture of classical transfer actor critic algorithm

option to flip further BSs into sleeping mode, thus saving further energy consumption. Consequently, throughout this case, the transferred policy guides throughout a negative manner throughout this section, we present the suggests that the controller utilizes the data of learned ways throughout historical periods or neighboring regions to be at intervals the groove of finding the optimum bs switch operations. the However, in spite of the similarities between the provision task and additionally the target task, there may still exist some variations. as an example, the system may get an analogous state in a pair of all completely different tasks, whereas the traffic plenty among the provision task may be generally on the far side that among the target one thence, instead of staying on the chosen action a in provide task, the controller in target task can produce a further aggressive controller has tried to choose this action and nurtured its own learning experience. Taking the upper than problems into account, we have a tendency to tend to propose a replacement policy update technique, named Transferred Actor-Critic algorithm (TACT)as Fig. 2. within the tact algorithmic rule, the policy (i.e., po) to pick an action is split as a native one p n and an exotic one p e. while not loss of generality, let's assume that at stage k , the traffic load state is s (k) and also the chosen action could be a (k) consequently, the policy p o is updated as

$$p_{\mathrm{o}}^{(k+1)}(\boldsymbol{s}^{(k)},\boldsymbol{a}^{(k)}) = \Big[(1-\zeta(\nu_2(\boldsymbol{s}^{(k)},\boldsymbol{a}^{(k)},k)))p_{\mathrm{n}}^{(k+1)}(\boldsymbol{s}^{(k)},\boldsymbol{a}^{(k)}) + \zeta(\nu_2(\boldsymbol{s}^{(k)},\boldsymbol{a}^{(k)},k))p_{\mathrm{e}}(\boldsymbol{s}^{(k)},\boldsymbol{a}^{(k)})\Big]_{-p_{\mathrm{t}}}^{p_{\mathrm{t}}},$$

Besides that, p n(s, a) still updates itself per the classical actor-critic formula, particularly(11). Initially, the exotic policy p e(s, a) dominates within the overall strategy. Hence, once the atmosphere enters a state s, the presence of p e(s, a) contributes to decide on the action, that can be best to s inside the availability task. Consequently, the projected policy update methodology ends up in a possible performance jumpstart. On the other hand, since ζ (•) ∈ (0 , 1) is that the transfer rate and ζ (k) →0 as k →∞, the impact of the transferred exotic policy p e(s,a) endlessly decreases. Therefore, the controller cannot alone advantage of the learned expertise inside the availability task, but jointly swiftly get obviate the negative tips Besides that, p n(s, a) still updates itself per the classical actor-critic formula, particularly(11).Initially, the exotic policy p e(s, a) dominates inside the strategy. Hence, once the atmosphere enters a state s, the presence of p e(s, a) contributes to decide on the action, that can be best to s inside the availability task. Consequently, the projected policy update methodology ends up in a possible performance jumpstart. On the other hand, since ζ (•) ∈ (0 , 1) is that the transfer rate and ζ (k) →0 as k →∞, the impact of the transferred exotic policy p e(s,a) endlessly decreases. Therefore, the controller can't solely benefit of the learned experience within the supply task, however conjointly fleetly get obviate the negative tips 1fig of considerateness theme over classical C theme versus Kullback-Leibler divergence. The bars appreciate the left coordinate axis mirror the CECR improvement whereas the line corresponding the correct coordinate axis represents the Kullback-Leibler divergence

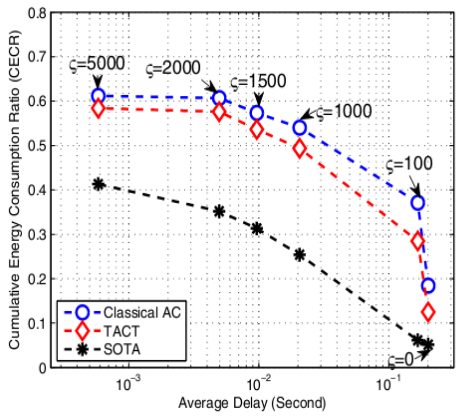


Fig.2 . Performance tradeoff between en ergy and delay under different delay equivalent cost scenarios.

VI. CONCLUSION

In this paper, we've developed a learning framework for bs energy saving. we've got a bent to specifically developed the bs shift operations below variable traffic lots of as a markov decision technique. Besides, we've got a bent to adopt the actor-critic technique, a reinforcement learning rule, to gift the bs shift resolution to decrease the overall energy consumption. After-wards, to wholly exploit the temporal connection in traffic lots of, we've got a bent to propose a transfer actor-critic rule to spice up the ways that by taking advantage of learned knowledge from historical periods. Our projected rule incontrovertibly converges given positive restrictions that arise throughout the coaching technique, and thus the full simulation results manifest the effectiveness and hardiness of

our energy saving schemes below various wise configurations. rather like the simulated temporal knowledge transfer, our projected thoughtfulness approach is perhaps viable to be applied in special things to appreciate a performance improvement. sadly, he mapping of knowledge area unit getting to be generally less easy among the latter case, due to the underlying bs geographical preparation variations. Therefore, we've got a bent to face live dedicated to handle theconnected pregnant but more durable issues over spatial knowledge transfer among the longer term.

V. FADING DETECTION

Channel weakening happens chiefly as a result of the user moves from one station to different station If the user is stationary nearly no time variations of the channel occur. the common fade length quantifies however long the signal spends below the brink. owing to weakening there ought to be delay Initially node checking for network convenience, node perpetually offers the a lot of priority to possess network kind If the own network isn't on the market mean then node selects another network Let contemplate the amount base station connected to the SM, in this if there's a number of the bottom station needs to be visit sleep, however at an equivalent time any on will choose sleep and different ought to be in active with increase coverage. During this case, the SM can want the bottom station change supported initial| the primary} came first manner. If each base station intimated at same time, anyone are going to be hand-picked every which way by the SM to sleep and cell zooming.

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