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DVORAK MODEL FOR TYPHOON CYCLONE INTENSITY ESTIMATION

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Abstract— **This study fosters a goal profound learning-based model for Typhoon Cyclone (TC) power assessment. The model's essential design is a convolutional brain organization (CNN), which is a broadly involved innovation in PC vision errands. To streamline the model's design and to further develop the element extraction capacity, both remaining learning and consideration systems are installed into the model. Five cloud items, including cloud optical thickness, cloud top temperature, cloud top level, cloud successful span, and cloud type, which are level-2 items from the geostationary satellite Himawari-8, are utilized as the model preparation inputs. We tested the cloud items under the 13 rotational points of every TC to expand the preparation dataset. For the free test information, the model shows improvement, with a generally low RMSE of 4.06 m/s and a mean outright blunder (MAE) of 3.23 m/s, which are practically identical to the outcomes seen in past examinations. Different cloud association designs, storm spinning examples, and TC structures from the component maps are introduced to decipher the model preparation process. An investigation of the misjudged predisposition and underrated inclination shows that the model's presentation is profoundly impacted by the underlying cloud items. Also, a few controlled tests utilizing other profound learning structures show that our planned model is helpful for assessing TC power, in this manner giving knowledge into the determining of other TC measurements.**

Keywords— **CNN, Typhoon Cyclone, Intensity Estimation.**

I. INTRODUCTION

DEEP CONVOLUTIONAL NEURAL NETWORK

Profound brain networks succeed at capability estimate, yet they are commonly prepared without any preparation for each new capability. Then again, Bayesian techniques, like Gaussian Cycles (GPs), exploit earlier information to rapidly deduce the state of another capability at test time. However GPs are computationally costly, and planning suitable priors can be hard. In this paper we propose a group of brain models, Restrictive Brain Cycles (CNPs), that join the advantages of both. CNPs are enlivened by the adaptability of stochastic cycles like GPs, yet are organized as brain organizations and prepared through angle drop. CNPs make exact expectations subsequent to noticing just a modest bunch of preparing data of interest, yet scale to complex capabilities and huge datasets. We show the presentation and flexibility of the methodology on a scope of sanctioned AI undertakings, including relapse, characterization and picture consummation. Profound learning is an AI procedure used to abricate man-made reasoning (computer based intelligence) frameworks. It depends on the possibility of counterfeit brain organizations (ANN), intended to perform complex examination of a lot of information by going it through various layers of neurons.

There is a wide assortment of profound brain organizations (DNN). Profound convolutional brain organizations (CNN or DCNN) are the sort most normally used to distinguish designs in pictures and video. DCNNs have developed from customary fake brain organizations, utilizing a three-layered brain design enlivened by the visual cortex of creatures. Profound convolutional brain networks are essentially centered around applications like item location, picture characterization, proposal frameworks, and are additionally once in a while utilized for regular language handling. The strength of DCNNs is in their layering. A DCNN utilizes a three-layered brain organization to handle the Red, Green, and Blue components of the picture simultaneously. This extensively lessens the quantity of fake neurons expected to deal with a picture, contrasted with conventional feed forward brain organizations [2].

CONVOLUTION LAYER

A convolution — takes a bunch of loads and increases them with inputs from the brain organization. Pieces or channels — during the increase cycle, a bit (applied for 2D varieties of loads) or a channel (applied for 3D designs) ignores a picture on numerous occasions. To cover the whole picture, the channel is applied from right to left and through and through.

Spot or scalar item — a numerical cycle performed during the convolution. Each channel increases the loads with various information values. The complete sources of info are added, offering an interesting benefit for each channel position. The convolution maps are gone through a nonlinear enactment layer, like Corrected Direct Unit (ReLu), which replaces negative quantities of the separated pictures with zeros [3].

POOLING LAYER

The pooling layers continuously lessen the size of the picture, keeping just the main data. For instance, for each gathering of 4 pixels, the pixel having the most extreme worth is held(this is called max pooling), or just the normal is held (normal pooling).Pooling layers help control overfitting by decreasing the quantity of estimations and boundaries in the organization. After a few cycles of convolution and pooling layers (in some profound convolutional brain network models this might happen great many times), toward the finish of the organization there is a conventional multi-facet perceptron or quotation completely associated & quotation brain organization [4].

COMPLETELY ASSOCIATED LAYER

In numerous CNN designs, there are different completely associated layers, with actuation and pooling in the middle between them. Completely associated layers get an information vector containing the straightened pixels of the picture, which have been sifted, adjusted and diminished by convolution and pooling layers. The softmax capability is applied toward the finish to the results of the completely associated layers, giving the likelihood of a class the picture has a place with - for instance, is it a vehicle, a boat or a plane [5].

TYPES OF DEEP CONVOLUTIONAL NEURAL NETWORK R-CNN

Locale based Convolutional Brain Organization (R-CNN), is an organization able to do precisely separating objects to be distinguished in the picture. Notwithstanding, it is exceptionally delayed in the checking stage and in the ID of areas. The horrible showing of this engineering is because of its utilization of the particular inquiry calculation, which separates around 2000 locales of the beginning picture. A short time later it executes N CNNs on top of every locale, whose results are taken care of to a help vector machine (SVM) to order the district.

QUICK R-CNN

Quick R-CNN is an improved-on R-CNN design, which can likewise distinguish locales of interest in a picture however runs significantly quicker. It further develops execution by extricating highlights before it recognizes locales of interest. It involves just a single CNN for the whole picture, rather than 2000 CNN networks on each superimposed locale. Rather than the SVM which is computationally serious, a softmax capability returns the ID likelihood. The disadvantage is that Quick R-CNN has lower exactness than R-CNN in wording acknowledgment of the bouncing boxes of articles in the picture.

GOOGLE NET

Google Net, likewise called Commencement v1, is a huge scope CNN engineering which won the ImageNet Challenge in 2014. It accomplished a blunder pace of under 7%, near the degree of human execution. The engineering comprises of a 22-layer profound CNN in view of little convolutions, called quotation beginnings quotation, cluster standardization, and different methods to diminish the quantity of boundaries from several millions in past structures to 4,000,000.

VGG NET

A profound convolutional brain network engineering with 16 convolutional layers. It utilizes 3x3 convolutions, and prepared on 4 GPUs for over about fourteen days to accomplish its exhibition. The drawback of VGG Net is that not normal for Google Net, it has 138 million boundaries, making it hard to run in the deduction stage.

RESNET

The Leftover Brain Organization (ResNet) is a CNN with up to 152 layers. ResNet utilizes & quotation gated units & quotation to skirt some convolutional layers. Like GoogleNet, it utilizes weighty bunch standardization. ResNet utilizes a creative plan which allows it to run a lot more convolutional layers without expanding intricacy. It took part in the ImageNet Challenge 2015, accomplishing an amazing mistake pace of 3.57%, while beating human-level execution on the prepared dataset. The reanalysis information is 2D fields on a lattice of fixed size. Regarding them as pictures enjoys the benefit to give admittance to an enormous writing on picture handling, where CNN is the present status of-the-craftsmanship. We propose two comparable CNN networks for the breeze and the tension fields [5].

II. METHODOLOGY

We separate them into two organizations in light of the fact that the kind of information is unique and subsequently unique learning rates were required. We stacked the information over level (pressure level) and time, to such an extent that the contributions of the CNNs comprise of numerous 2D(long, lat) casings or channels. The Strain CNN has six info channels (every last one of size 25 × 25), while the Breeze CNN input comprises of 12 channels (u and v are stacked). We utilized a commonplace CNN design, exchanging convolutional layers (Conv layer) and max-pooling layers, with completely associated layers toward the end (Simonyan and Zisserman, 2014). Following standard way of thinking in the PC vision writing, all secret layers are outfitted with the amendment (ReLU) non-linearity and clump standardization. To choose the best design, the various arrangements that we have assessed for Wind CNN and Tension CNN are framed in one for each segment. All arrangements follow the nonexclusive plan portrayed above and vary just inside and out, not entirely settled by the quantity of convolutional layers. As displayed in to have fair correlations among the structures, we planned arrangements with roughly similar number of boundaries to gauge. We assessed the presentation on 24-h storm track expectation for the Breeze CNN. The aftereffect of the design assessment on the approval set is displayed in Table 3. We give two scores: Root Mean Square Mistake (RMSE) and Mean Outright Blunder (MAE), in kilometers. With the increment of model profundity, there is no unmistakable enhancement for the outcome. Since adding more convolutional layers permits the organization to learn highlights at additional degrees of deliberation, we picked the middle of the road Organization C, which comprises of 3 convolutional layers and one max pooling, trailed by 4 completely associated layers. We additionally assessed how adding additional verifiable highlights from previous time steps in the information can further develop execution. Notwithstanding t and t − 6 h, we noticed no perceptible improvement by including additional information from a similar area at past time steps. We consequently just kept the times t and t − 6 h [6].

CYCLONE INTENSITY ESTIMATION

Hurricane Force Assessment hurricane (TC) is a tempest framework described by huge air masses circling clockwise in the Southern Half of the globe and counter clock wise in the Northern Side of the equator. Its focus (eye) has low air pressure and a ring of extreme tempests and weighty downpour. The Most elevated breeze speed and downpour are found in the eye wall which is the ring right away Encompassing the eye. The medium size of the TC has 300 km to 600 km sweep with a 30 km to60 km eye's distance across. TC structures over huge surface of warm water in seas and empowers when sticky air ascends by delivering heat through centralization of water fume. A few natural factors are expected for development of a typhoon; for instance, sea waters' temperature of at any rate26.5º C from the surface to no less than 50 m of profundity.

In any case, processes that cause the development of a typhoon are as yet not completely perceived. The force of a TC is estimated by the base ocean level tension (MSLP) or surface most extreme supported breeze speed (MSW), which is characterized as the one-minute breeze speed normal. Wherever on the planet aside from the US, the MSW is estimated as a 10-minute breeze speed normal. In the Atlantic and Eastern North Pacific those typhoons whose powers are under 34 kt are called Tropical Discouragements, while those from 34 kt to 63 kt are named Hurricanes and those over 64 kt are alluded to as typhoons. In other sea bowls, similar to the Indian Sea, unique power limits and other subcategories are utilized (Lin, 2007). TCs have been portrayed utilizing quantifiable factors, similar to temperature, pressure and relative mugginess. These estimations are intriguing for TCs since quite a bit of their lives happen over the seas. Then again, satellite pictures can portray the elements, qualities and structure of TCs from a distance (Ritchie et al., 2003; Velden et al., 2006a) [7].

Satellites have made it conceivable to notice the TCs beginning around 1960. Today, series of the satellites give around complete inclusion of the tropical seas where conventional meteorological perceptions are uncommon. Forecasters depend on satellite perceptions as the principal technique to play out the assessment of TC force. The infrared and noticeable channels are two of the most often utilized groups and these give data about the design and area of air frameworks. The warm infrared band (8 μm - 16 μm) is consistently accessible and takes radiation discharged from the highest point of the clouds. Be that as it may, the apparent channels (0.35 μm - 0.7 μm) get dispersed and reflected sun oriented radiation from the highest point of the mists. Consequently, this information isn't accessible during the evening. Data about the climatic frameworks in the lower levels of the environment can't be given by those channels since they are frequently covered by mists. A TC spun through unpredictable shapes at beginning stages of their turn of events. When direct amounts of natural factors, for example, temperature and tension are not accessible, the identification of commonplace roundabout and bended examples from somewhat detected information is a potential strategy to finish up the creation and advancement of typhoons. The first complete design acknowledgment method for typhoon power assessment from satellite pictures was created by Dvorak (Dvorak, 1972, 1975, 1984). The Dvorak method (DT) is abstract, but it is as yet utilized as the essential force assessment and determining apparatus in numerous TC anticipating stations all over the planet (Velden et al., 2006a). The satellite-based strategy is the as it were gauge of TC power accessible to hurricane forecasters for sea bowls where there is no airplane observation. A specialist applies the strategy to quantify elements of the mists in satellite pictures by following a bunch of exactly resolved rules.

The master utilizes these measures to find the last power assessment in a query table Nonetheless, the DT is emotional, tedious, and reliant upon experience of the client. Improvement of the first DT advanced into the objective Dvorak strategy (ODT), which utilized PC based investigation to assess force (Velden et al., 1998). To defeat the impediments of the ODT, for example, manual determination of the tempest community or the powerlessness to work on feeble storms, the high level objective Dvorak strategy (AODT) was created. The latest rendition of ODT is the high level Dvorak method (ADT) (Olander and Velden, 2007).

Dissimilar to the ODT and AODT, whose centers were to copy the abstract procedure, the ADT focuses on expanding the strategy past the first application and limitations. Another potential strategy is to assess the breeze vector field from somewhat detected symbolism. Computerized procedures could be founded on building a breeze vector field from a grouping of pictures to gauge the power in view of wind speed. Cross connections (González and Woods, 2002) and optical stream (Horn and Schunck, 1981) are the commonplace ways to deal with develop a vector field from a progression of pictures. These strategies have two choices to distinguish and gauge the development of items by matching pixels between groupings of pictures. In any case, precise location and estimation of the article developments require little and smooth varieties between the pictures. Be that as it may, such pictures with high time goal are seldom accessible. By applying picture handling procedures like Hough Change

(González and Woods, 2002) and chain codes (Sheu and Chou, 2004), different shapes as vortices could be distinguished. For instance Sheu and Chou (2004) fostered a method to distinguish vortices from pictures utilizing chain codes. The Strategy begins with building a parallel picture of the vortex by utilizing a limit, and then, at that point, works out the 8 network chain code. By investigating the code, the vortex is recognized. These strategies normally utilized the edge identifier to decide the shapes in twofold pictures. Due to the elevated degree of goal in satellite pictures, applying methods over binary is hard pictures in a solid manner. Also, there are different procedures for assessing power in light of satellite estimations. Kossin et al. (2007a) portrayed a method in which the range of greatest wind, the basic breeze radii, and the two-layered surface breeze field were assessed utilizing mean 12-hour infrared symbolism. Besides, strategies for assessing the power of a hurricane were additionally evolved utilizing estimations from the high level microwave sounding unit (Demuth et al., 2004). A portion of these strategies were joined to upgrade the typhoon force assessment (Velden et al., 2006b). An as of late evolved technique called the deviation point difference (DAV) method utilized the slope of the splendor temperature field to decide the degree of balance of the hurricane cloud structure which was shown to be corresponded with the force of the TC (Piñeros et al., 2008, 2011). New DAV method depicted in (Ritchie et al., 2012) utilized the Public Storm Place's best-track data set to compel the procedure [8].

PROBLEM DEFINING AND CHALLENGES OF CYCLONE INTENSITY ESTIMATION

We speculate that finding obscure normalities and anomalies that might exist in the huge gathering of past perceptions could assist human specialists with interpreting TC power changes. This exploration is propelled by the accessibility of satellite symbolism for typhoons. Our objective is to give an information mining instrument which would give another computerized strategy to TC assessment utilizing just the typhoon satellite information. This exploration fostered an objective option to the Dvorak strategy for TC power assessment in view of important verifiable information utilizing just Assessment of the force of tempest Yvette (1992) announced from different organizations, in view of worldwide best track file for environment stewardship (IBTrACS) Infrared symbolism. The proposed procedure enjoys the additional benefits of straightforwardness, objectivity furthermore, consistency contrast with Dvorak method. The proposed strategy gave a superior comprehension of attributes of satellite symbolism in light of TC's power change; which isn't surely known at this point. The proposed research tends to the accompanying difficulties for assessing the power of a TC. In the first place, find highlights and examples in satellite pictures that are applicable to current power of the tempest. Second, working with questionable satellite pictures because of commotion make the assessment troublesome. Third, since restricted surveillance information are accessible particularly for powerless and extraordinary storms, make the approval and preparing systems inadequate [9].

THE DVORAK PROCEDURE FOR CYCLONE INTENSITY ESTIMATION

The methodology for assessing the T-number in view of DT (Dvorak, 1984) is displayed in Figure 2.1, which is a bunch of observational guidelines. As displayed, this procedure has ten stages and a few sub advances. It consolidated spatial examples in the noticeable and. The exact connection between the ongoing force number (CI), the most extreme mean breeze speed (MWS), and the base ocean level strain (MSLP) in typhoons. Tropical sadness (TD), typhoon (TS) and various classes (Feline 1 to 5) characterized for various force ranges infrared brilliance temperature (BT) of the mists. The method is utilized by a specialist to measure a few elements of the mists in the picture emotionally. To begin with, the specialists decide the power of TC by finding focus of the air unsettling influence and afterward by dissecting the focus' shape and its association with the virus billows of the pattern in two distinct ways, the not entirely set in stone by examining the tempests' cloud design. In sync 2, first, power gauge is made by estimating the cloud includes that were connected to storm power. This step is finished when the cloud design being examined had cloud highlights like the cloud designs that were recorded in sync 2A through 2E as displayed in For instance, in the event that the bend band of the pre-storm was recognized, design T number (PT) 1.5 was allotted to the TC.
At the point when the estimation got from stage 2 gave a power gauge that fell inside recommended limits, it would be utilized as the last power. Stage 3 is talked about later. Stages 4 through 6 decide the subsequent power gauge. At the point when estimations of tempest highlights are not accessible, stages 4 and 5 gave a force gauge called the model expected T-number (MET), and furthermore gave the cutoff points inside which the deliberate appraisals should fall. Still up in the air by looking at the ongoing picture of the tempest with past picture (24 hour prior) and concluding whether the tempest has forged ahead with its past pattern of improvement. The force gauge could then be gotten by extrapolation along the power change bend in the model that best fitted the past history of the tempest's turn of events. For model, to get this force gauge in the "Bended Band Example" type, the master would Advancements of cloud design types utilized in power examination. Design changes from passed on to right are commonplace 24-hourly changes. (Tropical, 2013) simply be expected to separate the example that best depicts the tempest by noticing the tempest more than a 24-hour time span. Stage 6 is a change to the power gauge in sync This gauge of the force would then be utilized at whatever point the cloud highlights connected with storm power are unmistakable however not satisfactory enough for estimation. This analyses designs in the model that matched to the advancement stage showed in sync 5 to the cloud example of the tempest. The

intensity gauge is then changed up or down when the cloud design being investigated appears to be plainly more grounded or more vulnerable than was normal from its past development rate appropriately.

In stages 7 through 9, the power gauge determined from the cloud highlights is then tried as per the principles of strategy (depicts in segment 3.4.1) to decide whether it falls inside indicated limits or on the other hand assuming it should be changed. Stage 3, which was recently skipped, is utilized when the cloud design showed a focal overcast cover (CCC). The CCC example is characterized when a pretty much round cloud cloudy mass of mists cover the tempest place or comma head (comma-like shape) clouding the normal rings of example advancement (Dvorak, 1984). The tempest's advancement stops (or before long will be) at the point when this example type shows up. The last move toward the strategy gave guidelines to estimating 24-hour power [10][11].

OBJECTIVE DVORAK PROCEDURE AND HIGH LEVEL DVORAK STRATEGY

Improvement of the first DT developed into the objective Dvorak method (ODT), which utilized PC based examination to gauge power (Velden et al., 1998). ODT depends on exact rules like those utilized in the first DT. Its utilization is restricted to areas of strength for just tempests furthermore, requires manual determination of the TC storm position to start the power assessment process.

The beginning of the strategy involves finding two temperatures from a picture. The first temperature is connected with the greatest temperature inside a span of 40 km around the focal point of the tempest. The subsequent temperature is the base temperature from the pixels that comprised concentric rings around the focal point of the tempest, which might shift from 24 km to 136 km ring sweep. The power of the hurricane increments or diminishes if the distinction between the most noteworthy temperature and the temperature at the encompassing rings increments or diminishes 15 as needs be. A query table depicted in (Dvorak and Smigielski, 1990) showed the relationship between the adjustment of temperatures and the last force gauges as far as T-number. The high level objective Dvorak strategy (AODT) (Olander and Velden, 2004) broadened the ODT to deal with both powerless and solid tempests. The AODT is furnished with a goal storm focus assurance conspire, which made it totally robotized [12].

ADVANCED DVORAK TECHNIQUES

The latest rendition of ODT is the High level Dvorak Strategy (ADT) (Olander and Velden, 2007). In contrast to the ODT and AODT whose centers are to imitate the emotional procedure, the ADT focuses on expanding the technique past the first application and requirements. New requirements and a few changes have been presented. This strategy utilizes infrared and apparent symbolism as well as incorporates water fume and microwave channels to play out the force assessment. This procedure is depicted in (Olander and Velden, 2007, 2009, 2012) and the product libraries can be found at Olander and Velden (2008). Nonetheless, complete specialized detail has not been distributed at this point. Proceeded with progress of the ADT will likewise be investigated as new strategies and procedures are recognized [13].

MEASURING TROPICAL CYCLONE INTENSITY ESTIMATION

To classify typhoons all over the planet, the Saffir-Simpson Tropical storm Wind Scale is utilized characterizing occasions by their breeze speed and effects. Albeit created in the USA, typhoons all over the planet are estimated by the Saffir-Simpson Storm Wind Scale which began from 1971 with Herbert Saffir, a structural specialist and Weave Simpson of the US Public Typhoon Community. The Saffir-Simpson Storm Wind Scale comprises of a five point size of typhoon force and starts at 74 mph. Typhoons with wrap speeds up to 38mph are named tropical dejections and those with wind speeds from 39 - 73 mph are delegated hurricanes [14].

SAFFIR-SIMPSON HURRICANE WIND SCALE

Class 1
Wind (mph): 74 - 95
Harm: Negligible - No huge primary harm, can evacuate trees and cause some flooding in seaside regions.

Class 2
Wind (mph): 96 - 110
Moderate - No significant annihilation to structures, can evacuate trees and signs. Waterfront flooding can happen. Auxiliary impacts can incorporate the deficiency of water and power.

Class 3
Wind (mph): 111 - 129
Broad - Underlying harm to little structures and serious waterfront flooding to those on low lying land. Departure might be required.

Class 4
Wind (mph): 130-156
Outrageous - All signs and trees blown down with broad harm to rooftops. Level land inland may become overwhelmed. Clearing likely.

Class 5
Wind (mph): more prominent than 156
Horrendous - Structures annihilated with little structures being toppled. All trees and signs blown down. Departure of up to 10 miles inland.

III. CONCLUSION

In this study we propose a model for TC power assessment utilizing the H-8 L2 cloud items Clump, CLTT, CLTH, CLER, and CLTY. The model purposes VGG as the fundamental engineering and incorporates "consideration component" and "remaining learning" to lessen the quantity of boundaries as well as to further develop the assessment accuracy. The model was prepared and advanced under six-overlap cross-approval information and was additionally assessed utilizing free test information. The accompanying valuable ends can be drawn:

(a) For cross-approval, the model acts distinctively for various TC power stretches. For the most part, error is seen areas of strength for in, and misjudgement is seen in frail TCs. Over unambiguous locales, predispositions in assessed powers for landfall TCs have more modest changes than those for nautical TCs because of the unevenness in the recorded TC tests, which might influence the model's preparation and element portrayal. For the free test, our model created a generally low RMSE of 4.06 m/s and a MAE of 3.23 m/s, which are equivalent not entirely set in stone from existing examinations utilizing Dvorak-based procedures and different other CNN-based DL procedures.

(b) By envisioning the results from one of the convolutional layers, we had the option to obviously distinguish different cloud association designs, storm spinning examples, and TC structures, which assisted the model with addressing the perplexing changes in the TC force and produce solid assessments. Besides, the underlying cloud items had the option to mirror a portion of the variables related with TC power, like warm clammy air, intermingling, disparity, and convective action. Moreover, by inspecting the underlying cloud items under various power levels, we had the option to verify that our model tends to misjudge (misjudge) (serious areas of strength for frail. At long last, the predominance of the model planned in this paper is exhibited through a correlation with other leftover learning and CBAM-based designs.

By and large, the proposed DL-based model is promising for TC power assessment and future examinations are exceptionally expected to further develop the model further. To start with, more satellite symbolism from various infrared groups, microwave groups, areas, and evening time periods, as well as TC best track information, ground, marine, and journey perceptions ought to be in every way considered to expand the model's preparation tests to work on the strength of the model. Second, on the grounds that the TC power is impacted by its size and design as well as by surrounding thermodynamic circumstances and actual variables , future work ought to consider more boundaries, for example, surface temperature, water fume, ocean level strain, vertical breeze shear, guiding stream, and so on. Third, the proposed design is handled as an element extraction and relapse task expected for TC power assessment. More DL designs (e.g., Conv LSTM) can be gone after for spatial-worldly series relapse assignments in TC tracks or precipitation now casting later on.

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