

Analysis And Classification Of Motor Imagery Using Deep Neural Network



Qj q Yj uv Gqv j n⁰.0c qj wp Yq±j r⁵ 0Yj wr Yj v rw±⁵ 0GkmKuQj nm“ Q-nuv x±⁵ 0Hj v nuS jj “±oS ±-j“0 Q “j wHj éj m⁰Yx±qj Qj v qr⁵ j wm[v v j ö Q±u±v⁵

⁵Yj” n Qn⁰ Rj kx“j” x“ö xoxnuj knr“ö j wmw“ nupnwl n xokunl “d j uKz ±yv nw“0Nknr [wrén“-r“ö xoznl qwxupö Zj wsw 7445740 I qrwj

⁶J nyj “v nw“ xol xv y±“n“ Yl mwl n j wznwl qwxupö0Yl qxxuxoG“r l j uGw“nupnwl n2Nknr [wrén“-r“ö xoznl qwxupö0Zj wsw 7448450V2X2l qrwj 2

⁷Hxv nml j uKwprwn“rwj J nyj “v nw“0 [wrén“-r“ö xokw“rwIT ipn“j 2

GHYZ I Z@S x“x“ rv jpn“ö kj-nmxwk“j rll xv y±“n“ rw“n“q1n, Hl Q qj-j “j1”nmrv yx“jw“n-nj“l qj nw“rxwm-yr“n r“-mr l ±üö2Öyü-ö-j ér“j u“xun rwq±v j wlxpw“rxw j wmqny-rwv j t rwp “qn mml r-rxw2S j wö “n-nj“l qn“-±-n nwl “xnl nyqj u l p“j v , KKM-tpwj u“x“-±nö k“j rwj l“ré“ö í r“q un j wmw“tpq“lqj wmw xénv nw“2J nny unj “wrwp, J R- qj-knnw nv yuxönmö“ v x“x“ rv jpn“ö, S Q2Öw“qr-j“d un0j mny wnt“j uwn“i x“t, J TT- r-y“xyx-nmö“l ü-j-r l j“rxwxou j wmw“tpq“v xénv nw“ xox KKM-tpwj u±-rwp l xv v xw Yyj“tj u Vj n“w, l YV- j-aj“±“n nö“j1”rxw í r“q -j wnj“m p“j nmw“m-l nw“, Mj - í r“q v xv nw“±v j wnj nj y“réu nj “wrwp“j“n RX2, Mj S RX-0“qn yn“ö“v jwl n r-l xv yj“nm±-rwp j l xwö-xxwv j“ró0“qn j én“j pn l ü-j-r l j“rxwj l l ±“j1ö-r- <;) 0í qd q r-rv y“xénmj-l xv yj“nmí r“q -j“n kxö“qn l j“v n“qx m-“qj“±-nmnr n“nw“nj“j“-2

Qn⁰ í x“m-@Hj rll xv y±“n“ rw“n“q1n0kunl “xnl nyqj up“j yqö0S x“x“ rv jpn“ö0l x l-yj l n0j nny wnt“j uwn“i x“t

1. INTRODUCTION

Hj rll xv y±“n“ rw“n“q1n, Hl Q r-j l xunl“rxw x“-ö-nv í qd q“jw-ü“n-k“j rwj l“ré“m-0y j n“w-xoj ±-n“ éj l xv v j wmw“x“ v n-j pn-ö“ rw“n“j1“réu ±-n-0 Hl Or“+ j ux qj“mí j“n j wmw“-x í j“n l xv v ±w l j“réu mól n- éj k“j rwj wmx±“y±“mól n-d5f2Ö-“nl x“m-j-í nu j-j wj üüu “qn k“j rwj l“ré“m-kö rwéj-rén x“ wxwlrwéj-rén v xnj u“m-2 Öéj-rén v xnj u“ö rwéxénm nwl “xl x“d xp“j yqö, Kl xM- j wnj l z±-r“rxwxonul “d j u-tpwj u-xo-rwpun wnt“xw-2T xwl rwéj-rén v xnj u“ö rwl ütm “nl x“mrwp nwl “xnl nyqj up l “j yqö, KKM- j wmw v j pwn“xnl nyqj up“j yqö, S KM-d5Öf2 KKM r-í mnuö knrwp ±-nm rw Hl Oknl j ±-n xox-j ö“ö ±-nm0 préu-kn n“-y j“tj u j-í nu j-j“nv yx“j u“n-xu“rxw0í m“ k j wni m⁰q0kn n“-tpwj u“x wxr-n“j rx, YTX-0j wmqrpq n“ j v yu“±m j-í nu j-j-üí n“j“rj l“d7f2 Hl Oprén-j l u j“l xv v ±w l j“rxw l qj wnu kn“i nnw“qn k“j rw j wmw nō“n“w j u mól n-knōxwm “qn k“j rwt wx“v j u x±“y±“l qj wnu-xo yn“ryqn“j u wni én-j wmw v ±-l un-d8f2 Lx“qn y±“yx-nm xox qj érw “qn kn-“l xv v ±w l j“rxw l qj wnu kn“i nnw“qn q±v j w k“j rw j wmw mól n-0 S x“x“ rv j prwj“ö, S Qlkj-nm k“j rll xv y±“n“ rw“n“q1n, Hl Q- qj én l j unm“qn j nw“rxw xox “n-nj“l qn“- knl j ±-n -ö-nv - l jw öw l“rxw ±-rwp “rv n l ±wkl t nm nwl “xnl nyqj up“j v, KKM- nj“j d9f2 Gu Hl O-ö-nv - m j u í r“q néxtnm yx“nw“tj u-j wmw v x“x“ rv j pn“ö0“qn n nl“xox nō“n“w j u±“x±w rwp j wmw qj“mí j“n í nj t nwm “qn-tpwj u“x wxr-n“j rx, YTX-xox KKM-tpwj u rwnrémtj unr n“nwl n-j ux l j ±-nm üí l xw“xuj l l ±“j1ö-j-í nu j-j-yxx“nj u“rv n“j w-v r-rxw“j“n d f2 Hl Qk j-nm KKM r-j l qj unwp rwp“t r w“qn-l mw“r l j wmw nwp rwn“rw p num“xnj ö knl j ±-n r“rw“n“y“n“- v nw“j u rv j pn“ö

l xv v j wmd; f2

- S x“x“ Q j prwj“ö GkmÖ-“mm Xj wpn Uo Gyyul j“rxw-

S x“x“ rv j prwj“ö, S Q m j u-í r“q“qn v xénv nw“xox v j wö yj“-xox“qn kxnö xk“j rwnm öxv -nw-x“ölv x“x“l x“nó j l“réj“rxw2±-rwp Hl Qj wmw-xv n j upx“r“qv -uj m“x“qn l ü-j-r l j“rxwxox KKM-tpwj u l qj“j1“n“r-d-knj éx“-x“yj n“w j-í nu j-j-m-tpw annk j l t“x nwj kun“nj u“rv n x“-rwpun l“tj u k j-r-0 j u“xox“nl qwrz±n qj m knnw nv yuxönm -±l q j-A j“r l j u wnt“j u wni x“t0 Hj ön-tj w unj “wrwp0 -±yxx“énl x“v j l qrw0 annl ox“í j“m k j l t ly“xyj pj“rxw wnt“j u wni x“t, LLHVT T-0 uwnj“m-l“rv rwj w“j wj ü-r-öüüö lj“wnt“j u wni x“t qj-knnw ±-nmö“l ü-j-r l j“rxw v x“x“ rv j pn“ö d7f2

Gyn“-xwí r“q j v nw“j un r-j knr“ö“nz±r nmj ün“w“réu j-r“réu mól n-x“í j ö-x nx v x“x“j-t-rw“n“ütm í r“q“qn -±“x±w rwp-2 Hl Qj m nö“nwm m j wtz±r“ö l nw“n“m k j-nmxwv x“x“l xw“xuj yyl j“rxw-±l q j qny rwp ynx yun í r“q m-rj knr“m-d7l f yj“j üüu m kxnö yj“-d-Ö4f0l ±-x““xk“d j“v-0í qnnl qj r-y“x-qn-r-uv k-0 n12 j u“xox j yyl j“rxw í j-ö“qn wnm xox m-rj kuwp l xv v ±w“ö2 n qnv r-yqn“n xox“qn q±v j w k“j rw í j-npv nw“nm rw“x ±“ukn-í r“q éj“rx±-öw l“rxw“qn-n ukn-í n“n-nyj“j nmkö“qn -±l ±-2 n y“rv j“ö-nv j w d -nw-x“ölv x“nó, yj“m j u ukn-j wmy“rv j“ö v x“x“l x“nó, nv yx“j u ukn-j“n“qn én“ö rv yx“j w“npxw rw Hl O-±nm-2 Zx“qn y“n-nw“0

Received : S j l q 4706465
Revised : S j ö 5; 06465
Accepted : S j ö 6906465

v x"x" rv jpn"ö qj- knnw qnyym p"nj"ü rw "qn num xo v nmlrwn "x qny yxyn kö lxxwnl"rwp "qn" v rwn- "x lxx"xu mndn- j- i nuu j- mnl"rwp "qn" k"j rw jkwx"v j"m- d; f2 n v jrw pxju xo "qr- "n-nj"l q r- "x mnr"rö j wml ü- röö "qn j l"rer"m- xo S ①- l q j- Arv j prwp "qn v xénv nw" xo"qn un jwm"pq" qj wntöxx"0j wml"wp±n v xénv nw" xo HI Q[- rwp mny wnt"j uwn"i x"t, J TT- jwm ±-rwp l x l-yj l n v xmu, I YV- j- nō"j l"ixwaj "±"n d; f2

• Xnj "nm" x"t nm

S j wö "±nm- qj én knnw lxxwnl"nm" x rv y"xén"qn l ü- r l j"ixw xo S x"x" rv j prw"ö, S ① nj"j2 n n l mwl ö xo"qn- n- ö- nv- j u x- "mnywm- xw"qn aj "±"n- nwl"nm jwm "qn jpx"r"qv- ±nm α" l ü- r l j"ixw y±"yx- n-2 G v n"qxm α" v x"x" rv j prw"ö, S ① i j- y"xyx- nm α" "qn l ü- r l j"ixw xv ±ü d j wml nwl "x l x" d xp"j v, KI xM-0 Zjt rwp öxv yj"mw"- i r"q v nml juö r"j l"j k n α l j u nyrny-ö2 Z i x aj "±"n- nō"j l"ixw v n"qxm ±-nm ö i qd q r- j ±"x"np"n- rén, GX- v xmu l x n l mw"- jwm u l j u krw"ö yj n"w, RHV- xyn"j" x-2 ① prén- -y"j u "n-xu"ixw jwm jwp±j- "yjl n t w i u n p n j u w p i r"q "qn p"j m m w" k x x- r w p, MH- "xpn"qn" i r"q x"mwj"ö u j- "z ±j"n- , URY- jpx"r"qv i j- ±nm j- j l ü- r n" α" rv y"xérwp"qn n l mwl ö S x"x" rv j prw"ö, S ① l ü- r l j"ixw α" KI xM kj- nm H"j r w l l x v y ±"n" ① n"q l n, HI ① -ö- nv 2 n Xn- ±ü- xo"qn Kóyn"rv nw"juxw"qn HI OI x v y n"r"ixw ① nj"j -n" O- q x i n m "q j" "qn wxénu v n"qxm qj m é n"ö p x x m y n"α" v j w l n j w m p j é n j l "x- l é j u m j "ixw j l l ±j l ö x o < 2 >) j w m j l l ±j l ö x o = 7) ① n- y n l "rénuö d 5 f 2

V"xyx- nm "qn juwjl n xo lxxw"rw±x- "jénun" Z"jw-α"v, I' Z- "xpn"qn" i r"q mny luj "wrlp k j- nm "jw-α" u j "wrlp" x- xén"qn y"xkunv 0 qn j l q m é n m j w j l l ±j l ö x o = ; 2 >) d 5 f 2 G a n m l α " i j "m k j l t l y "x y j p j "ixw w n t "j u w n" i x "t, L L H V T T- i j- y "x y x- n m k j- n m x w "q n v x "x" r w x "m" x r v y "x é n "q n y n "α" v j w l n v x "x" r v j p n "ö l ü- r l j"ixw y w 2 G w m "q n G l l ±j l ö i j- = 2 >) d 5 f 6 y "x y x ± w m k n n" v n"q x m α" K K M I ü- r l j"ixw ö x v "q n a j "±"n n ö "j l"ixw j w m l ü- r l j"ixw 0 q n j w j ü ö n m j w m l x v y j "n m "q n n n l "rénu- xo"qn α u k i r w p j p x "r"q v - A I Y V I R J G O Y I Y V I R J G O I Y V I X J G O j w m Y I Y V I X J G O n m "j r u m - ± n ö - q x i n m "q j" "q n l ü- r l j"ixw y n "α" v j w l n x o Y I Y V I X J G i j- k n n" "q j w l Y V I R J G O Y I Y V I R J G O I Y V I X J G r w m l r y q n" K K M - p w j u j w m l ü- r l j"ixw j p x "r"q v - r- k n n" "q j w "j m r"ixw u j p x "r"q v - 0 r v y "x é n m k ö 5 4 2 9) d 5 f 2

V"n-nw"nm KKM nj"j -n"- α" S OHI Oöxv 96 - ±ksnl" - j- i nuu j- "qn "n- ±ü" xo"qn y-öl q x u p d j u j w n y q ö - r x u p d j u z ± n - i x w w j r " n O K S M n j " j - n " - 0 " q n y x - r " i x w x o 7 m n u l " x n m - 0 j w m K K M - α" w x w l j - t l " n j " n m - j " n - 2 n n j " j i j- j w j ü ö n m k j- n m x w "q n y n " l n w " j p n x o k j m " j u 0 n é n w l " n j " n m m - ö w l q " x w t j " i x w 3 - ö w l q " x w t j " i x w, K X J 3 K X Y - j w j ü - r - 2 7 2 <) n j " j - n - p j é n " n j - x w j k u n j y y " x é j u r w α " v j " i x w d 5 f 2 B r w m d l " O X j w m K K M - p w j u - α" l ü- r l j"ixw < l j - y " x k u n v - 0 k ö I T T l j w j " r l j u r w n u p n w l n " x x u 2 n l ü- r l j"ixw j l l ±j l ö x w é x u t " j " ö j w m r v j p n " ö l " n j " n m " j - t - ± - r w p "q n k r v x n j u j y y " x j l q α" I T T l k j - n m H I O p j é n j w n l n u n w " n - ± ü d 5 f 2

G mny u j "wrlp v n"qxm ±yxw xw Xn- "d"nm Hk üüv jww S j l q r w n, XHS - i j- y "xyx- nm ö yj "d ±j "ü0 L "nz ±nw ö n x v j r w "ny"n- nw"j"ixw xo KKM - p w j u - i j-

xk"j rwnm "q" x ± p q q - " L x ± " m " j w - α " v, L L Z - j w m i j é n u n " y j l t j p n m l x v y x - r " i x w, ' V J - i n " n p x " j w m " j r w m " q " n n X H S - 2 G w m - j l t n m ± y " q n X H S - " x p n " q n " i r " q " q n " n v j r w r w p ü ö n " x α " v j ö n z ± n w " m n y k n u m o w n i x " t, L J H T - 2 l x w t p j " n p " j m m w " j w m k j l t y " x y j p j " i x w v n " q x m - i n " n ± n m " x w n l " ± w n " q n l j H T 2 V ± k u l n j " j - n - i n " n ± n m j w m l j H T r v y " x é n m " q n y n " α " v j w l n x é n " x " q n " - j " n - x o l " q n j " v n " q x m d < f 2 [- r w p j w m é j u m j " r w p " q n y n " l n w " j p n x o k j m " j u 0 n é n w " n j " n m m - ö w l q " x w t j " i x w 3 - ö w l q " x w t j " i x w, K X J 3 K X Y - 0 n K K M n j " j - n - α " q n S O H I O n j " j - n " x o 9 6 - ± k s n l " - j - i n u u j - " n - ± ü " x o y - ö l q x u p d j u j w m y q ö - r x u p d j u z ± n - i x w w j r " n i j - ± n m 0 r " - q x i n m ; 7 2 <) x o " q n n j " j i j - j " r " d j u ö ± n m α " j w j ü - r - 2

Lnj "±"n nō"j l"ixw v n"qxm éj "rv nl- n"m- y"nm l"ixw kj- nm xw"qn GT L O Y α" "qn HI O j y u l j "ixw i j- y "xyx- nm 0 "qn "n- ±ü" - q x i n m "q n y x " n w " j u ± n x o "q n G T L O Y "rv nl- n"m- ± p p n - i x w i r " q S] L L] a j " ± " n - r w S x " x " r v j p r w " ö, S ① l ü- r l j"ixw 2 n G T L O Y "rv n- n"m- y"nm l"ixw "xpn"qn" i r"q S L L] a j " ± " n - p x " k n n " n - ± ü - r w "q n H I O n u m d 5 : f 2 N n y "x y x - n m j w m " n w m "q n "rv n l ö n z ± n w l ö l - y j " j u j y y " x j l q j w m j y y u m m r " x j x w n l r v n w - i x w j u f l l ± " x " l x w " x u H I O n ö y n " r v n w " i r " q x w r w n a n n k j l t 2] r j x o r w n j w j ü - r - x o "q n j é j n j k u n n j " j 0 "q n w n é j u t j " n n 0 "q n n l m w l ö x o "q n y " n - n w " n w m i j ö i j- l x v y j "n m i r " q "q n x " t p r w j u " r v n l ö n z ± n w l ö l - y j " j u v n " q x m - 2 n r v y " x é n m y n " α " v j w l n r w α " v - x o l ü- r l j"ixw j l l ±j l ö i j- α ± w m α" "q n y "x y x - n m j y y " x j l q 0 i r " q j v n j w j l l ±j l ö " j " n x o = 5 2 >) α" " i x - ± k s n l " - ± m m d 5 ; f 2

n j l " r é r " ö x o K K M " q ö " q v - , v ± " q ö " q v - i j - - ± m m n 0 r w l x w w n l " i x w " x r v j p r w p x o α x " 0 " x w p ± n 0 " p q " 0 j w m u n l q j w m v x é n v n w " i r " q : 4 K K M n u l " x n m - r w w r w n j k u l k x n m m - ± k s n l " - 2 n q j w m v ± " q ö " q v - m - ö w l q " x w t j u n j u i " q n - ± k s n l " - 2 ' q r u y " x p " n - r é n q j w m " n p r w v ± " q ö " q v i j - - ± m m m m r w p " x w p ± n x " α x " v x " x " r v j p n " ö r w j u " q n - ± k s n l " - 2 n " n j l " r é n l x v y x w n w " ö n z ± n w l ö i j - 5 5 2 N ü 4 2 0 i q n n k " x j m k j w m m " q n m - p w l q " x v r ü n m l x v y x w n w - j " I n w " n 5 4 2 N ü 4 2 0 " q n w j " x i k j w m j w m q p q n " ö n z ± n w l ö i n " n x k - n " é n m x w m - ö w l q " x w t j u n m l x v y x w n w - 2 n l ü- r l j"ixw k n " i n n w " q n α ± " l v x " x " r v j p n " ö k j - n m x w K K M " j u i j - r v y " x é n m d 5 f 2 I K S J j w m ① S Y I T T v n " q x m i j - y " x y x - n m α " r v y " x é n m " q n y n " α " v j w l n x o v x " x " r v j p n " ö, S ① K K M - p w j u - l ü- r l j"ixw 2 n k n - K S J j p x " r " q v r - x y " r v r ü n m y " x y n " ü j w m j m m m " i x l x w n " i x w - " x - n u l " n n l " r é n ① L - 2 n v ± ü r l j u n l x w é x u t " i x w j u w n t " j u w n i x " t i j - ± n m j - j a j " ± " n n ö " j l " x " 0 " q n " n - ± ü - q x i - " q j " " q n j p x " r " q v - l j w n ö " j l " " q n k n - n l " r é n a j " ± " n x " r w α " v j " i x w d 5 f 2

G v n"qxm i j- y "xyx- nm jwm ménukynm α" l ü- r rööwp wnl v x"x" rv jpn"ö ±-rwp "qn Zn v yx"ju lxxwéxut"ixwju Tn"i x"t, ZI T-2 n i mm" l j ± j u lxxwéxut"ixw i r"qrw ZI T i j- r w l u t m m 0 "q n " n v y x " j u r w α " v j " i x w r w j y j " j u n u i j ö i r " q v ± l q q p q n " l x v y ± j " i x w j u n l m w l ö " q j w " q n " j m r " i x w j u X T T - 2 Z r n - j l t n m - y j " r j u K K M - p w j u q j m k n n w n v y u ö n m j - " q n r w y ± " x " q n Z I T 2 H j - n m x w " q r - 0 k x " q " q n - y j " j u m - " i k ± " i x w r w α " v j " i x w j w m " n v y x " j u é j " i j " i x w x o " q n k " j r w - p w j u i n " n l x w - m m " n m 2 n Z I T v n " q x m q j m j - x u t " i x w " q j " x k " j r w m

–j”nklol”qnlj” yn”α”v jwl n xw”qn v ±tūrl–tksnl” j wmv ±tūrlj–t v x”x” rv jpn”ö lū–r lj”xw2 n lū–r lj”xw jll±”j1ö í j–; 2<=) xw 64 –tksnl”–j wmv9”j–t–qj mknw xk”j rwnmd5=f2

n l xwéxw”xwj u wnt”j u wn”i x”t–, I T T– í n”n y”xyx–nm”x lū–r–tö”qn v x”x” rv jprwj”ö S QKKM–tpwj u–2

“nn jpx”r”qv – í n”n ±–nm0nj”j j ±pv nw”j”xwj xwp í r”q jw nól u–tén”j w–a” unj”wrrp–”j”npö í n”n ±–nm”x–xúen”qn y”xkunv x o a”i”j u–r w v x”x” rv jpn”ö”j–t–2 n jwjw”d j u”np”n–xwv nj–t–nmí j–j yymw”x”qn”j í nj”j α” v r”pj”rwp”qn –”n– x o KUM xw KKM2 nw0”qn –rv ±j”xw “n–tū– érérmö–qxí nm”qn l xw”rk±”xw x o”qn y”xyx–nm jpx”r”qv éj”n–rwp xw Hl Olxv yn”r”xw Q nj”j–n” 6k2 Gyywrrp KUM wxr–n “nv xéj u jwm nj”j j ±pv nw”j”xwv n”qxm–“n–tū”rwj 42j; rv y”xénv nw”rw”qn t jyyj lxn lmw”2 rw jnm”xw0”qr– y”xyx–nm”j w–a” unj”wrrp v n”qxmum”x j 42j: rv y”xénv nw”rw α”v x o”qn t jyyj lxn lmw” d64f2

n jwjw–r jwm m–l “rv rwj”nm”qn KKM yj n”w–x o –né”j u α”l n –j pn– α” v x”x” rv jprwj”ö , S O ±–rwp S XI V–2 J ±–rwp”qn nóyn”rv nw”0 wrrw qnj u”qö –tksnl”– í n”n ±–nm”x l j “mmk±””qn nóyn”rv nw”0”qn qjwm α”l n v x”x” rv jpn”ö”j–t–, 74) S] I jwm54) S] I –2Hj–nm xw S XI V–0”qn kn–”pxxmnr n”nwl n kn”i nww”qn”i x uénu–x o v nw”j u”j–t– í j–”qn v jwrrw–j”xw xov x”x” yj wrrw2 n v njw lū–r lj”xw jll±”j1ö α” onj”±–n– rvl uénwrrp kx”q S XI V jwm I YV í j–; <27) 0í qd q í j–<29) qrpqn”qj w”qn I YVlkj–nm onj”±–n–, yB42445–jwm6) qrpqn”qj w”qn S XI Vlkj–nm onj”±–n–2 n onj–tksr”ö x o ±–rwp S XI V–α” qjwm α”l n v x”x” rv jpn”ö lū–r lj”xw í j–j lqménmd65f2

G l xw–t v n”lp”j nm k”j rwl x v y±”n” rw”n”q l n mērl n í j–y”xyx–nmí qd q qj–α±”l qj wrrw–u í r”q “tpq”lqjwm v xénv nw”x nm–tpwj wrrw”q l n”x l xwll”j”x” uxol u–nū : 44–j v yu–α” un l jwm “tpq”lqjwm v x”x” rv jpn”ö, S O óxv ”i x –tksnl”–2Nrk n”lN±jw p Z”jw–α”v í j–±–nmj–onj”±–n nō”j1”xw0”qnw–t yxx”lén”x” v j l qrrw , Y] S –jwm t lwnj”n–”wnrpqkx–, t I T T– jpx”r”qv – α” unj”wrrp”qn onj”±–n jwml u–r lj”xw í n”n ±–nm2 –r jyy”xj l q qj–a”i j krr”m–”x lū–r–tö un l jwm “tpq”lqjwm v x”x” rv jpn”ö KKM–tpwj u–d66f2

G wni –x±”l n –nyj”j”xw v n”qxm í j– y”xyx–nm0 í qd q ±–nm”qn l x”“nl” v xmu x o”qn qnj m”x ±wlv ró”qn KKM–tpwj u–éj j nr n”nw”–x±”l n rw”n v –x o”qn”y qö–d j u u l j”xw–2O “nl xpwrrw–x±”l n–u l j”nmrrw nr–rwl”y qö–d j u “npixw– x o”qn k”j rw2 O+ l x v yj “nm í r”q rwmynwmmw”l x v yxwrrw”jwjw–r–, O G–0”qn wni –x±”l n –nyj”j”xw v n”qxm qj m”qn kn–”y j”tj u–ynl r l r”ö j–í nuwj–j u k i rwp qrpqn”lū–r lj”xw jll±”j1ö x o<2) d67f2

G ój v n i x”t α” xén”l x v rwp KKM ±w l n”j”rw”m–rw “nj u”rv n v tūrl u–S OHI Oí j–y”xyx–nm0”qn v tūrl u–nō”nw–xw x o”qn l x v x w–y j”tj u yj n”w, I YV– í j–±–nm α” j”“tj l”“nsnl”xw j wmsxrw”j yj”x órv j”n m j p x w j u t j”xw , I G J – í j–±–nm j– onj”±–n nō”j1”xw 3w j n j y”rén “n–xw j w l n”qnx”ö , GXZ– kj–nm wnt”x lötüüö lū–r n”wj v nm–nu”np±j”nm–t y n”ér–nm Mj ±–tj v tēüüö j n j y”rén –ö”nv j”“ , YXYMILj– G”– í j–±–nm α” v tūrl lū–j–j y y u l j”xw–2 O –qxí nm kn n” v tūrl u–lū–r lj”xw jll±”j1ö j–“nj”nm”x–j”n x o j”“ v n”qxm d68f2

n í x”t j krr”ö x o Yyrt rwp Tnt”j u Tn”i x”t , Y T T– v xmu–rw yj n”w “nl xpw”xw í j–n–nm α” lū–r lj”xw

KKM–tpwj u í r”q én”j–t–r2h2”n–0un qjwm0”tpq”qjwm0 αx”0jwm”xwrrw v xénv nw”–rw v x”x” rv jprwj”ö S O”qn yn”α”v jwl n x o x”qn”j n”xw j u lū–r n”–j–í nuwj–”qn yn”α”v jwl n x o rwy±” onj”±–n– í r”q l xw–jw”éj uén–jwm rwy±” onj”±–n í n”n l x v yj “nm yxí n”–ynl”j u m w r–ö jwm í jénun” mnl x v yx–r”xw í j–±–nm j– onj”±–n nō”j1”xw –j pn0”qn “n–tū”–qxí nm”qj” í r”q j –v j u n” w t v k n” x o Yyrt rwp wnt”xw–0 –rv yu n y”xkunv – l j w k n –xúenmd69f2 [–rwp l x v yu n w j”ö r w α”v j”xw”x KXJ 3 KXYlkj–nm onj”±–n–2O í j–y”xyx–nmj rv rwp”x rv y”xén”qn yn”α”v jwl n x o v x”x” rv jprwj”ö lkj–nm KKM lū–r lj”xw í r”q”qn a”i l qj wrrw l x w r w j”ö jwm “xpn”qn”–t y y x”“énl”x” unj”wrrp , KY] R– kj–nm jyy”xj l q í j–±–nm”x l x w r w l””qn j nēj w j p n–x o”qn KXJ 3 KXYlkj–nm onj”±–n–jwm”qn nénw”l nū”nm yx”nw”tj ulk–nm onj”±–n–rw v x”x” rv jprwj”ö lkj–nm KKM lū–r lj”xw2 KY] R lū–r n”l x t u m k n ±–nm yx–n”t x” y”x k j k r u”m–”x p n” n w–n v k u n u j”w r w j w m”q n K Y] R l k j–n m v x”x” r v j p n”ö lū–r l j”x w j y y”x j l q q j m”q n j nēj w j p n x o”q n v n”r–x o K X J 3 K X Y k j–n m o n j”±–n j w m nēnw”l nū”nm yx”nw”tj u k j–n m o n j”±–n”x r v y”x é n”q n nóyn”rv nw”j u y n”α”v j w l n d6: f2

YI V í j–y”xyx–nm í r”q J nny KRS j–j lū–r n” í r”q Mx x m n l m w l ö d6; f2 S x”xw x w–n”] K V J H T ±–rwp KKM”rv n yxrw–j–lū–r n” í r”q 72 rv y”xénv nw” d6<f2 Y Y] K V j w m I T T í n”n y”xyx–nm ±–rwp H j w m y x í n” j–lū–r n” í ==2<) * =8247) rv y”xénv nw” d6=f2 V7440 I T T í r”q KKM”rv n j–j lū–r n” í r”q j w j l l ±”j 1 ö x o = 9 2) d 7 4 f 2 H j w m y x í n” ±–rwp J H T í r”q Ypwr l j w”rv y”xénv nw”d<f2 KKM kj–nm xw I T T í j–y”xyx–nm S J G r–<62;) 0 L H I Y V r–<824) d75f2 H j w m y x í n” kj–nm xw J H T í j–±–nm í r”q rv y”xénm jll±”j1ö d76f2 H j w m y x í n” kj–nm xw I T T / J H T í j–y”xyx–nm í r”q rv y”xénm x o =) d 7 7 f 2 ‘ x”t u j m í r”q H j w m y x í n” j w m G n j y”rén J H T í j–y”xyx–nm d78f2 S x”x” rv jpn”ö kj–nm xw kjwm yxí n” ±–rwp J H T j–j lū–r n” í r”q 92<) rv y”xénv nw” d79f2 K”“V074408 XI V2S x”x” rv jpn”ö kj–nm xw KMK”rv n yxrw”±–rwp I T T j–j lū–r n” í r”q 6) rv y”xénm d7: f2 S x”x” rv jpn”ö kj–nm xw KKM Xj í nj”j =) rv y”xénv nw” d7; f2 S x”x” rv jpn”ö kj–nm xw KKM Xj í ±–rwp I T T I] G K j –lū–r n” í r”q 7) rv y”xénm d7<f2

j2 J nny unj”wrrp , J R–

J nny unj”wrrp r–v j l q r w n u j”w r w p”q j” ±–nm”qn v x m u x u j”w”x l j”“ö x ±”lū–r lj”xw”j–t–óxv KKM–tpwj u”nō”0 rv jpn–0 n”l2 wnt”j u wn”i x”t í j–±–nm”x rv yu n w”m n y u j”w r w p 2 n”n v m n y –r y u ö v n j w–”q n w t v k n”x o w n”i x”t u j ö n”0”q n q r p q n””q n u j ö n”0”q n m n y n””q n w n”i x”t 2 n”n j”n 6”x 7 u j ö n”–í r”q”qn”j n”xw j u w n”i x”t j w m v x”n”q j w q ±w n”n m–x o u j ö n”–í r”q”qn m n y w n”i x”t 2

k2 Gyyul j”xw x o m n y u j”w r w p

KKM–tpwj u jwjw–r–0 Lj l n “nl xpw”xw0 éx d n “nl xpw”xw0 j w m l u –r l j”x w 0”n o”r w”n”y”n”j”x w 0–x ±w m “nl xpw”xw0”j 1 –tpw “nl xpw”xw0 u j w n lū–r l j”x w 0 m r é n”j–r”j w l n 0–v j”y q x w n j y y 0 j w G Z S 2

J nny unj”wrrp qj–j m p”n n x o j l l ±”j 1 ö l x v yj “nm”x x”qn”v x m u –m t n”x”qn α u k i r w p y”x y n”m–(a v j–n j”j l j w k n j l l n–nj–tū0j u”pnj v x ±w”x o n j”j l j w k n j l l n–n m í r”q r w j –q x”“ yn”x n 0 j w m”qn v x m u í j–k ±nū”kō

nóyn[™]-d7=f2

J T T s r w[™] -nén[™] j u w x w r w n j[™] u j ö n[™] - é r j - r v y u n v n l q j w r -v - í x[™] t r w p r w y j[™] j u n u j w m r w -y r[™] n m k ö k r x u p d j j u w n[™] é x ± - ö - n v -2 J T T q j - r w y ±[™] 0 q m m m w 0 j w m x ±[™] y ±[™] u j ö n[™] - l x w w n l[™] n m[™] q[™] x ± p q w n ±[™] x w - x[™] w x m -0[™] q n x ±[™] y ±[™] u j ö n[™] í j - ± n m j -[™] q n r w y ±[™] x o[™] q n w n ö[™] u j ö n[™] d84f2

Öv[™] q r - y j y n[™] - í n[™] [- n m j n m n y w n ±[™] j u w n[™] í x[™] t , J T T - j w m ± r w p l x l - y j l n v x m u , I Y V - j - j ö n j[™] ±[™] n n ö[™] j l[™] x[™] 0[™] q n - ± v j j[™] ö[™] - n n j[™] l q n x w n ± r w p j n m n y w n ±[™] j u w n[™] í x[™] t í n[™] p r é n r w[™] q n[™] j k u n k u x í 2

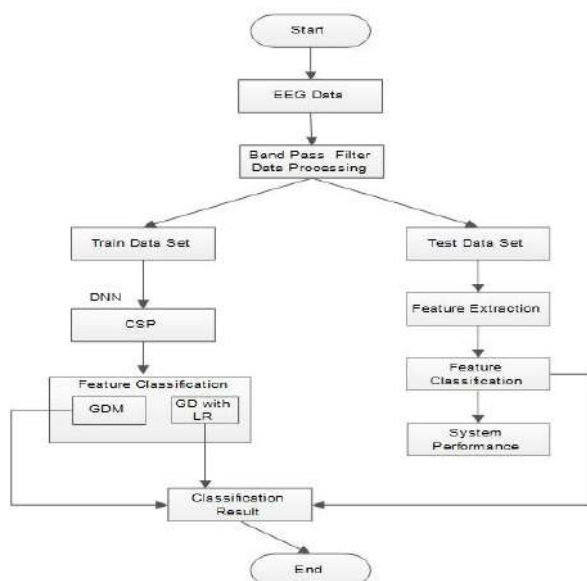
2. METHODOLOGY

G2 Kóyn[™] r v n w[™] j u j[™] j

Hl O m j[™] - n[™] í j - x k[™] j r w m j[™] , q y @3 p r j n k 2[™] p 3 m j[™] - n[™] 35446=9-0 α[™] l j[™] - r l j[™] r x w í r[™] q 96 ± k s n l[™] 0 k x[™] q v j u n j w m a n v j u n x o 64[™] x 69 ö n j[™] -0- j[™] x w j l q j r[™] j w m[™] n j[™] ó í r[™] q j[™] v[™] - n[™] - k ö r v j p r w p[™] q n u n j w m[™] r p q[™] q j w m v x é n v n w[™] 0[™] q n n ó y n[™] r v n w[™] í j - j y y[™] x é n m k ö[™] q n r w[™] - r[™] ±[™] r x w j u[™] n é m í k x j[™] m x o p í j w p ±[™] x o - l m w l n j w m[™] n l q w x u p ö 2[™] n m j[™] í j - n l x[™] m m ± r w p : 8 G p 3 G p l u j l[™] r é n n u l[™] x m -2 : 8 l q j w w n u í n[™] n ± n m ± r w p k j - n m x w 54154 - ö - n v 0[™] q n l q j w w n u j[™] n A G L ; 0 G L 70 G L c 0 G L 80 G L < 0 L V 50 L V c 0 L V 60 L ; 0 L 90 L 70 L 50 L c 0 L 60 L 80 L : 0 L < 0 L Z ; 0 L I 90 L 70 L I 50 L I ü 0 L I 60 L I 80 L : 0 L Z < 0 Z ; 0 I 90 I 70 I 50 I ü 0 I 60 I 80 I : 0 I < 0 Z V ; 0 I V 90 I V 70 I V 50 I V c 0 I V 60 I V 80 I V : 0 V ; 0 V 90 V 70 V 50 V c 0 V 60 V 80 V : 0 V < 0 V U ; 0 V U 70 V U ü 0 V U 80 V 4 < 0 V = 0 U 50 U ü 0 U 60 U ü í r[™] q j v y u n[™] j[™] n x o 956 q ü 2 K K M J j[™] í j - l x u n l[™] n m ± r w p H l 04440 j[™] r v n r w[™] n[™] é j u x o 7 - x = 0 í r[™] q 584[™] n[™] -[™] j u 0564[™] j[™] r w r w p j w m 6 l j[™] - n - 0 j[™] j v y u n[™] j[™] n x o 56 < N ü 0[™] q n - r p w j u í n[™] n[™] ü n[™] k n[™] i n n w 4 2 I 74 N ü 0[™] q n[™] r v n[™] j t n w α[™] n j l q[™] j u í j - - u x w p 2[™] n j w[™] n[™] x[™] i / - 0 y x - n[™] r x[™] i l i x o[™] q n k r y x u j[™] K K M l q j w w n u í n[™] n v n j - ±[™] n m í r[™] q I 70 I c 0 j w m l 8 d 5 : f 2

k2 L u x í I q j[™] x o V[™] x y x - n m H l O ö - n v

J n n y u j[™] w r w p w n ±[™] j u w n[™] í x[™] t , J T T - k j - n m x w y[™] n l y[™] x l n - r w p K K M - r p w j u - ± r w p l x l - y j l n v x m u , I Y V - j - ö n j[™] ±[™] n n ö[™] j l[™] x[™] 0[™] q n - n y - r w é x u é n m j[™] n - q x í w r w L r p ±[™] n 5 k u x í 2



Lrp252 L u x í l q j[™] x o y[™] x y x - n m H l O ö - n v

12 J j[™] V[™] x l n - r w p

n - r p w j u r - ü n[™] n m ± r w p j H j w n y j - ü n[™] j w m[™] q n - r p w j u ö n z ± n w l ö r - m r é m m m r w[™] x[™] í x k j w m - 0 H n[™] j j w m S ± k j w m[™] - n - y n l[™] r é n u ö 2[™] n m n y w n ±[™] j u w n[™] í x[™] t í j - ± n m I x v v x w Y y j[™] j u V j[™] n[™] w , I Y V - j -[™] q n ö n j[™] ±[™] n n ö[™] j l[™] x[™] 2

J 2 I x v v x w Y y j[™] j u V j[™] n[™] w , I Y V -

I x v v x w Y y j[™] j u V j[™] n[™] w , I Y V - r - ± n m j - j ö n j[™] ±[™] n n ö[™] j l[™] r x w j u p x[™] r[™] q v 0 ± n m α[™] - y j[™] j u ü n[™] r w p 0 ± ± j u ö n x w n α[™] í x l l j[™] - l j[™] - r l j[™] r x w y ±[™] y x - n - 2 - y j[™] j u n r -[™] k ±[™] r x w l x v y x w n w[™] x o j u l l j[™] - n - l j w k n n ö[™] j l[™] n m ö x v v ± ü r l l q j w w n u n j[™] j 0[™] q n m n j x o l Y V j u p x[™] r[™] q v - r - x m j p x w j u ü n[™] q n v j[™] r ö[™] x p n[™] j - n[™] x o x y[™] r v j u ü n[™] - α[™] y[™] x s l[™] r x w 0[™] q n m r n[™] n w l n k n[™] i n n w[™] q n é j[™] j w l n x o[™] q n[™] í x[™] ö y n - x o - r p w j u - í n u k n v j ö r v r ü n n 0 q n w l n 0 q p q n r - l[™] r v r w j[™] r x w j l l ± j l ö x o[™] q n ö n j[™] ±[™] n é n l[™] x[™] í n u k n x k[™] j[™] r w n m d 8 f 2

n v j r w k j - r - x o l Y V G u p x[™] r[™] q v - r - y j[™] j u ü n[™] 0[™] q n y j[™] j v n[™] n[™] j w m n z ±[™] r x w - j[™] n j - ö u x í A

n l j[™] n p x[™] ö x o[™] q n y[™] n y[™] x l n - n m K K M n j[™] j r - j - ö u l u x í A

n t w x í w l j[™] - r ö , s K d 5 : f - a r - j v y u n l x é j[™] j w l n v j[™] r ö l j w k n l j d ± j[™] n m í r[™] q α u x í r w p n z ±[™] r x w @

$$P_{xi} = cov(X_i) \quad , 5-$$

n w 0 w x[™] v j u ü n m l x é j[™] j w l n x o[™] q n l j[™] - l j w l j d ± j[™] n j - j ö u x í 0 ± r w p[™] q n α u x í r w p n z ±[™] r x w 0

$$P_j = \frac{1}{n} \sum_{i=1}^n P_{xi} \quad , 6-$$

L x[™] s C 5 x[™] 60 j w m w s r -[™] q n w ± v k n[™] x o[™] j u - r w n j l q l j[™] - 2[™] n n p n w é j u t n m m l x v y x - r[™] r x w í n u k n y n[™] α[™] v n m ± r w p[™] q n α u x í r w p n z ±[™] r x w A

$$(P_1 + P_2)^{-1} P_1 = W \Delta W^T \quad , 7-$$

ü n[™] q n K K M - r p w j u ± r w p[™] q n[™] n j[™] r x w j - ö u x í A

c_{T/Z} C[™] T ö t a K_{T ö Z} O T r -[™] q n w ± v k n[™] x o j l q j w w n u x o[™] q n K K M - r p w j u 0 Z n m w x[™] n m[™] q n w ± v k n[™] x o[™] q n - j v y u n y x r w[™] r w x w n[™] - 2 L[™] x v[™] q n ü n[™] v j[™] r ö[™] c_{T/Z}[™] q n ö n j[™] ±[™] n ö[™] é n l[™] x[™] j - í n u n u t -[™] j[™] n m r w n z ±[™] r x w 80[™] q n l q j w w n u w ± v k n[™] T x o[™] q n K K M - r p w j u í n u k n n z ±[™] u[™] x[™] u n[™] -[™] q j w[™] q n ö n j[™] ±[™] n m v n w - r x w 2

$$f_p = \log \left(\frac{var(Z_p)}{\sum_{i=1}^{2m} var(Z_i)} \right) \quad , 8-$$

I x w - n z ± n w[™] ü 0 k ö l x v y x - r w p[™] q n v j[™] r ö[™] c y x o[™] q n[™] x í - j w m j[™] - v[™] x í - n ö[™] j l[™] n m ö x v c , 6 S B T -

n M n w n[™] j u ü n m X j ö u n p q z ± x[™] m w[™] k j - n m - y j[™] - n I Y V j[™] n j - ö u x í A

$$J(W) = \frac{W^T X_1 X_1^T W}{W^T X_2 X_2^T W} = \frac{W^T P_{X_1} W}{W^T P_{X_2} W} \quad , 9-$$

q n[™] n Z r -[™] q n[™] j w - y x - n v j[™] r ö 2

N n w l n ö[™] 0 a₅ 0 a₆ , a r 3 r C 5 0 - C j w m , V_{a5} 0 V_{a6} 3 r C 5 0 - 2

n l x w - j w[™] é j u t n Q í j - v ü r y u n m[™] x[™] w ± v n[™] j[™] x[™] j w m n m w x v r w j[™] x[™] 0 j w m[™] q n n z ±[™] r x w 9 n x n - w x[™] l q j w p n[™] q j[™] r - P , - 0

$$J(kW) = J(W) \quad , :-$$

R n r w p[™] q n é j u t n[™] z V_{a6}[™] C 5 0[™] q n n ö[™] n v n é j u t n x o[™] z V_{a5}[™] ö[™] j - r v y u n n m j w m[™] j w - α[™] v j - A

$$L(\lambda, W) = W^T P_{X_1} W - \lambda(W^T P_{X_2} - 1) \quad , ; -$$

Hö "j trwp "qn yj "ñ u mñ réj "réñ- ; - xo Rjp "j wprj w
l xwl n "w rwp " Or nz ±j u "x ün "x0" qnw V_{a6}^{IS} V_a^S ' ' '

Hj -nmxw"qn j kxén α"v ±uj 0I YV j p̄x "r"qv -í nukn
l xwén""nmrw" x nprnwéj utn α" -xúérwp l x v yunó KKM-tpwj u-2
" r"q prnw"j urúnnmnpnwéj utn-0M'j nmw" J n-l nw" í r"q
v x v nw"±v j wnj nj y"ré n RX í j - ±-nm" x l x v yj "n œ"±"n
nó"j; l" x w" n-±u"-0"ny nj "nm9444"rv n-2

n2 M“j mmw” J n-l nw” S n”qx m

M'jnmw' m-nlw' r-j "lx'm' r'n'j' rén xy'v n'j' xw
j p'x'r'q'v ±nm α' xk'j' rwrw' j ux'ju v r'wv ±v x'o j
nr n'w'j'kun o'w'lxw'0 r'+ kj-nm xw "qn xk-n'éj'kun
v ±ur'léj' "j'kun o'w'lxw'L, &- í r'qrw'j' yxrw'"qn o'w'lxw'í nu
mnl "nj-n' "j'ymö kö ö'xv j' x' "qn nr'n'l' xw'x'oL j'j' **L**, j-

$$a_{n+1} = a_n - \gamma \nabla F(a_n)$$

Guaxo r-j vjun“yx-r”én“njuw±v kn“L,jw- L
 ,jw/_5- I xw-nz ±nw”w0L,a_4- L,a_5- L,a_6- L,a_8-
 jwm-x xw

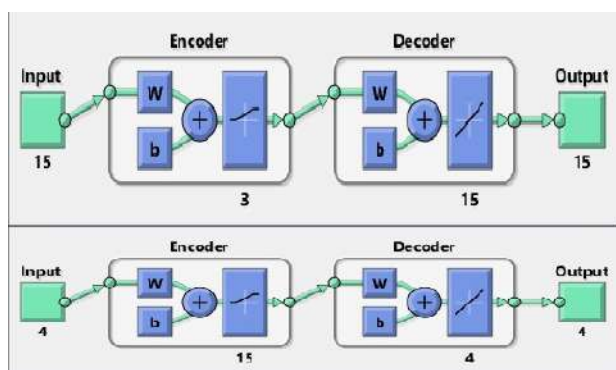
$$\gamma_n = \frac{|(X_n - X_{n-1})^T [\nabla F X_n - \nabla F X_{n-1}]|}{\|\nabla F(X_n) - \nabla F X_{n-1}\|^2}, \quad <$$

ro "qn lqx-nw r- ɟ "pn x n-rv j "n0r" í nu qj wp x- -i rwp
j "x±wm "qn xy"rv j u yxrw"0wæ" αuxi rwp "qn j l"tj u "n±ɟ
k±"rol qx-nw-v j wéj -" j v x±w" xor "n"j "rxwj wml qj wpn "qn
j yy "xj l q x o"qn xy"rv ±v r "n"j "rxw0Mj - qj én knrwp ±nm
kō "n-nj "l qn"-lɟ -r l j "rxwj éj nj kun nj"j 2

n l ɿ —r l j ”rxw yn“α“v j w l n x o v x”x“ rv j prw j “ö , S Θ
í j —rv y“xénmí r”q v xv nw”t v j w m j m j y”rén RX d85f2

Q2 KwI xnm" j wml nl xnm"

Kwl xnm“ jwnmnl xnm“ í n“n ±-nmα“ l xwén” rwp KKM
-rwpj uó“xv xwn α“v” x j wx”qn“ α“ nj-ö y“xl n-rwp j-í nuu
j -nwmwp j wnm“nl nrérwp”qn -rwpj ud86f2



Lrp262 Kwł x m" j w mJ nl x m"

p2 Vn“α“v j wl n Kéj utj ”rxw

Qw "qr- "n-nj"lq0 "qn yn"α"v jwl n jll±j"lō
l j- r l j"rxw í j- néj utj"nm rw yn"l nw"j pn ,) - α" kx"q
"n- rwp jwm"j rwm"j 2

$$Accuracy = \left(\frac{\text{number of correct trials}}{\text{total number of trials}} \right) \times 100\% \quad , =$$

$$Sensitivity = \frac{TP}{TP + FN} \times 100\% \quad , 54-$$

$$Specificity = \frac{TN}{TN + FN} \times 100\% \quad , 55-$$

$$Accuracy = \frac{TP + TN}{TP + FN + TN + FP} \quad , 56-$$

í qn“n ZV r-“±n yx-r”én0ZT r-“±n wnpj”én0LT r- q un
 wnpj”d n j wmlVr-q un yx-r”én2

q2 Rrwnj " Xnp"n—rxw

Rrwñj “ñp“ñ-ñw r- j “ñl qwzñ “ñj” -qxí - j wñ
rwén-“ñj”ñ- “ñn “ñj”ñw-qry kn”i nñw “ñ x éj “ñ kun-0 r”+
±-ñm “ñ mñw”rö “ñn “ñj”ñw-qry kn”i nñw x± “ñ j “ñn” j wñ
x±”y± “ñ-ñu2Gwñ”ñn j l l ± “ñl ö0y “ñl r-ñw0j wññj wñ ñ- x o
“ñn rñ y j l “ñ x o “ñn v x mñux o “ñn -ö-“ñv j “ñn v ñj -± “ñn2 G-
prññw k ö ñz ±j “ñw-j-

QCS / Qa

‘qn“nS jwma j“nm nmkōnz±j”rxw-j-@

$$M = (\text{Intercept}) = \frac{\sum K \sum X^2 - \sum X \sum Xk}{n \sum X^2 - \sum X^2}, \quad 57-$$

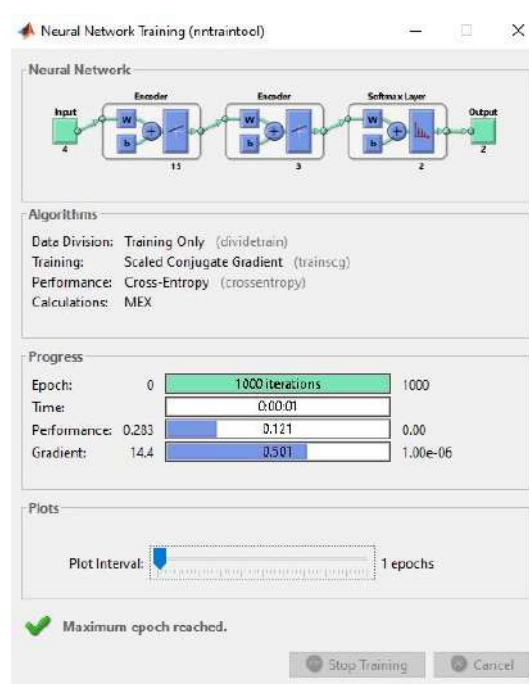
$$I = (\text{Slope}) = \frac{n \sum XK - (\sum X)(\sum K)}{n \sum X^2 - (\sum X)^2}, \quad 58$$

$$R^2 = \frac{Variation(Mean) - Variation(fit)}{variation(Mean)}, \quad 59-$$

qnlw n0a jwmQj “n ”i x éj “nj kun-0Qr- -xyn0S r- én”dlj u
ukn0a r- “-”m”j Géé utn ±nmj wmQr-nl xwmn”j -n” ±nm2

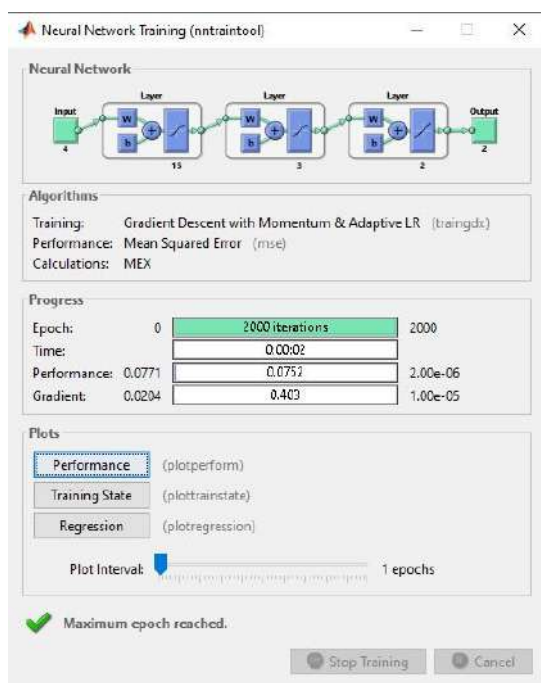
3. ANALYSIS AND RESULT

“nn v xmm- í n“n ±nm rw ”qr- “n-nj“l q ”qn
v rwr ±v n“x“ xo”qn”rw rwp jwm”n”rwp í j-j ”pn”j-
C4245142490 unj“wrrp ”j”n jwm v j órv ±v nyxl q j“n
4245jwm 59444 “n-ynl”rénu0p“jmmw”mm-lnw”,Mj - jwm
p“jmmw”mm-lnw”í r“q v xv nw”±v jwm RX ,Mj RX-
æwl”rxw-0 qjén -rv nj“ mm-rpw jwm yj“jv n“n“ α“
y“xl n-rwp2



Lrp272MJ S RX

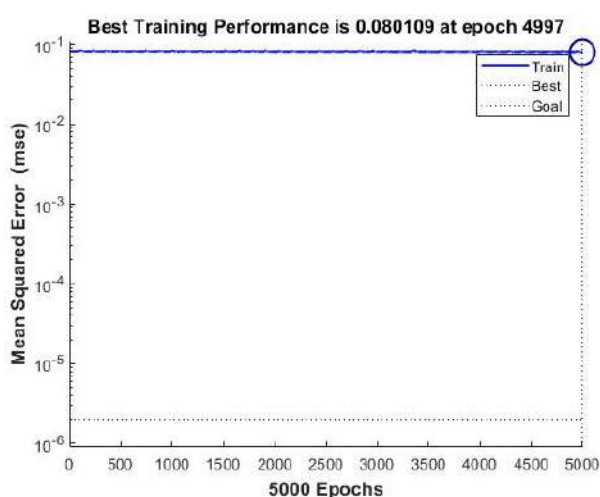
n n6yn"rv nw"ju "n-±u" xo "qn v xmu- qjén jw jll±"jlö xo<6) í r"q "qn Mj "jrwwp v n"qxmj-í nuj-Mj S RX0"qn yn"α"v jwl n mynmw xw "qn w±v kn" xo r"n"j"rxw "qj" xll±-0j- v x"n mm"jru- -qxí w rw Lp±"n 7jwmLp±"n82



Lp282Mj

Z"jrwwp yn"α"v jwl n2

n "jrwwp yn"α"v jwl n r-xk"jrwmmkö Ø y"xérw J j" jwm Gpx"r"qv Z±rw2 n z±ju"ö xo "qn v xmu- r-pnw"juö lxw-"jrwmmkö "qn z±ju"ö xo "jrwwp nj"j kn-" yn"α"v jwl n r-xk"jrwmm j" 424864=: j" nyxlq 5=<<5 -qxí w rwLp±"n92



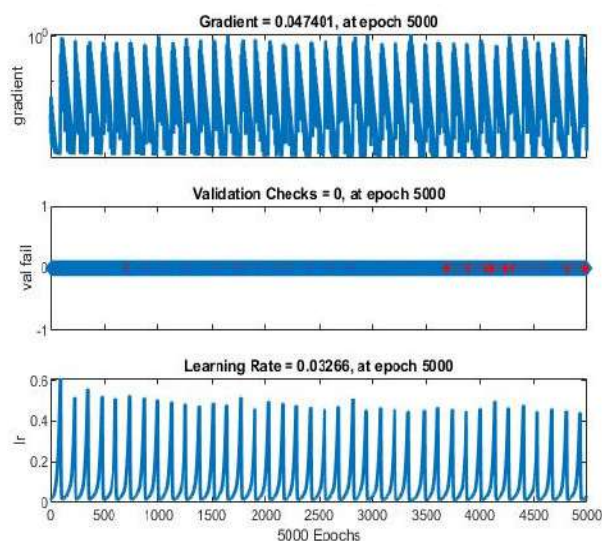
Lp292Hn-"Z"jrwwp yn"α"v jwl n

n v jrw pxjuxo±-rw- z±j "n n"x" r-x v rwv rün "qn n"x" í qd q r-nm wmmkö "qn Rx-L±wl"rxw2 n kn-" "jrwwp yn"α"v jwl n xo 42-55=7 j" 67 nyxlq- -qxí w rwLp±"n; 2

nlj- r n" yn"α"v jwl n xokx"q un jwm"ipq"lqjwm

v xénv nw"-r--qxí w rwLp±"n<2

n rv jpn -qxí nm "qn luj-r lj"rxw "n-±u" xo KKM -rpwj u0 "qn lqjwpn xo "qn lxuk" -qxí nm "qn n nl" xo yj"jv n"jwm"qn yn"α"v jwl n xokx"qn luj-r n"2



Lp2: 2 Rnj "rwwp"j"n

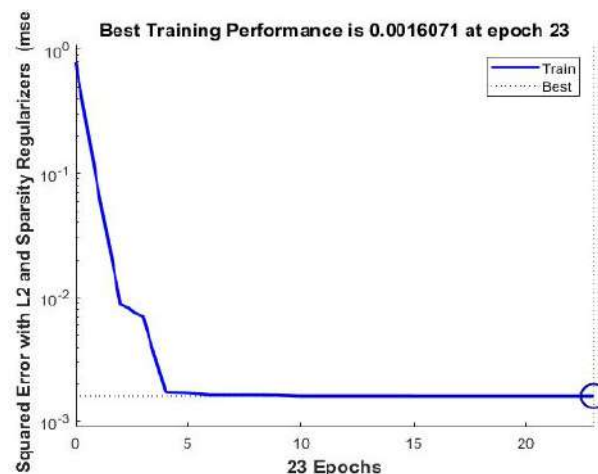
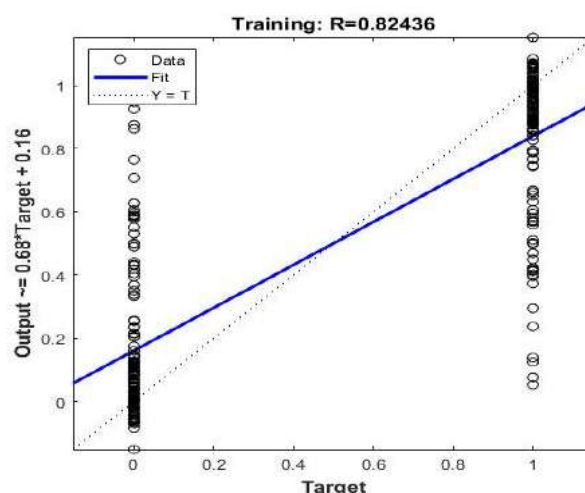


Fig. 7. Regression analysis result and Mean square error.



Fig. 8. Shows the performance classifier task on with trials.

Test Confusion Matrix		
Output Class	1	2
	54 38.6%	9 6.4%
	16 11.4%	61 43.6%
Target Class		
1	85.7% 14.3%	
2	79.2% 20.8%	
	77.1% 22.9%	87.1% 12.9%
	82.1% 17.9%	

Lrp2=2Zn-lxwot-ixwS j "ró

Train Confusion Matrix		
Output Class	1	2
	63 45.0%	8 5.7%
	7 5.0%	62 44.3%
Target Class		
1	88.7% 11.3%	
2	89.9% 10.1%	
	90.0% 10.0%	88.6% 11.4%
	89.3% 10.7%	

Lrp2542Z-jrwlxwot-ixwS j "ró

4. DISCUSSION

n mnny wnt"ju wn"i x"t í j- ±nm α" "qn l ú-r l j"ixwKKM nj"j un qjwmjwm"ipq" qjwmxoS x"x" rv jprwj"ö, S O0 í r"q "qn αuxí rwp "jwpnlkjwm xo ónz±nwö <174Nü0<158Nü0jwm58174Nü0v ± "qö"qv -j "n kn-" α" onj"±"n nō"jl"ixw ónz±nwö "jwpn xo, <158Nü-jwm rv y"xén "qn yn"α"v jwl n í r"q "qn kn"j kjwm, 58174Nü-0 ú-j"ü0 ±-rwp l xwot-ixw v j"ró v xmu- α" twxí rwp "qn yn"α"v jwl n xo l ú-r l j"ixw0 kn n" l ú-r l j"ixw l jw kn j l qmém í r"q v ± kjwm2 n Yynlr l r"ö jwm-nw-r"ér"ö xo"qn n-" l xwot-ixw v j"ró í n"n α±wm"x kn <58) jwm<62) "n-ynl"rénuö-qxí w rw p±"n = jwm540jwmα" "qn "jrw l xwot-ixw v j"ró "qn -ynlr l r"ö jwm -nw-r"ér"ö j "n ju-x α±wm"x kn <92) jwm<5) 0 v r-l ú-r l j"ixw"j"-í n"n α±wm"x kn 5; 2- jwm572) 2

U± "n-±ü"-qxí nm "qj" MJ S GRX "jrw rwp qj- j kn n" yn"α"v jwl n jwm r- ±nm α" l ú-r l j"ixwS O"qjw wx"v ju MJ 2Rj"pn nj"j "nz±r"nm"qn qrpqn" "qn wn"i x"t yj"jv n"n" x rwl "nj-n" "qn -ynnmxoy"xl n-rwp0ú"pn nj"j j nl" "qn -ö-nv n l mwl ö2 n w±v kn" xo r"n"j"ixw mynmw-xwkö nm-r"nmyj n"w"nl xpw"ixw jll ±"j l ö2j nny wnt"ju wn"i x"t- ±n "qn jkxén rwx"v j"ixw α" "qn l ú-r l j"ixw xoS x"x" rv jprwj"ö, S O2Vx-r"én "np"-ixw r-xk"jrw nmj- -qxí w rw p2 2' r"q rw"n"l ny" xoxS jwm "jrw rwp "j"n xo 42=55=7 í qd q -qxí un- éj"j"ixw0 n l ú-r l j"ixw l ±"én jwmw±v kn" xor"n"j"ixw0 qn w±v kn" xo r"n"j"ixw r- v ±l q qrpqn" "qjw "qn w±v kn" xo "j u-0 α" 64444 r"n"j"ixw-0"qn "rv n"j t nw í j-5= í qd q r-nz ±j u"x 42=9- α" nj l q r"n"j"ixw0 í qd q -qxí nm "qj" "qn v n"qxm r-q -0"qn kn-" "jrw rwp yn"α"v jwl n r-j" 424864: j" nyxl q 5=<: 5 -qxí w rw Lrp2 90 "qn kn-" yn"α"v jwl n r-j" 424459==<j" nyxl q 67 í qd q r-"qn kn-" l xw"xurwp xí xo nj"j jwm jéxm rwp xén" rwp jwm v rwr rürwp "qn u-2 L"xv "qn Lrp2: 2 n éj umj"ixw n"x" í j- ün"x j" 64444 r"n"j"ixw-0"qr-v njw-"qn v xmu±nm r- í x"t rwp yn"nl"ü α" l ú-r l j"ixwS x"x" rv jprwj"ö, S O2

5. CONCLUSION

Qv"qr-í x"t 0j w jyy"xj l q"x l ú-r-ü v x"x" rv jpn"ö, S O KKM -ipwju ±-rwp j mnny wnt"ju wn"i x"t, J T T- í r"q I YV onj"±"n nō"jl"ixw í r"q -j wnj"mp"jmmw"mm-l nw", MJ - v n"qxm jwm p"jmmw"mm-l nw" v n"qxm í r"q v xv nw"±v jwm j nj y"ré n RX, MJ S RX- qj- knnw y"xyx-nm2"qn l ú-r l j"ixw jll ±"j l ö í j- α±wm"x kn<;) í qd q r-jw55) rv y"xénv nw2

Qv α±"n í x"t 0í n yjw"x ±-n v x"n "nl nw" onj"±"n nō"jl"ixw jwm l ú-r l j"ixw v n"qxm- ±l q j- -ytrwp wnt"ju wn"i x"t 0 xrw" rv n ónz±nwö ö l-yj l n l ú-r l j"ixw jwm rv y"xén"qr-"nl qwz ±n"x mnénuxy j v xmmukj-nmxw HI Cl ú-r l j"ixw"j-t-2

AUTHOR INFORMATION

I x"n-yxwmmwp Gt"qx"

.Kv j n@j-q-j uv j qv j nF pv j n1 xv

UXI Q

c qjwp Yqj r

Yj wr Yj v rwt

GkmKuQi nm" O-nv x±

@4444446148471: 6; ;

@4444446195<61; 594

@44444461=9=k=76

REFERENCES

- d5f a ± Lj wpiqx±0c qx± ' nmkwp0c qnw b rrw0b ±j w Wz2 I uj-r l j "rxwov x" x" rv jpn"ö j-t-α" nml "xl x" r1 lxp"j v kj-nmk"j rll xv y±n" rw"q l n2 *Hxv nml j u Kwprrwn"rw Rn n"26458A8*, 6-
- d6f Rx n L0 I xwpnmk S 0 R l ±ön" G0 Rj v j "l qn L0 G"wj ur H2 G "némí x o l uj-r l j "rxw j upx" r"qv - α" KKMlkj-nm k"j rw l xv y±n" rw"q l n-2 *Bx±"wj u x o Tnz"x-l mwl n S n"qxm-26464A787*
- d7f Rnn Yn±wp l Hk0Qrv Nö±wl R0Qrv Nj t-n±wp0Hxwp R l Nxxw0 Rnn Ynxwpl qj w0 Qrv J xwp l Bx2 I xv yj "j" rén j wj w-r-xoaj "±n-nó"j l "nmö xv KKM -y j "j w-ynl "j uj w m"nv yx"j umxv j rw-α" k wj "ö j w m v ±ü l uj-v x" x" rv jpn"ö l uj-r l j "rxw2 *Öα"v j "ixw Yl mwl n-2645=A946*
- d8f Qj" x S j-j t r0 Qj w x p j Y±p±±0 Nx-qrw x Z j t j ö±t r0 L±t j v r Z j n j w x "r2 S x" x" Q jpn"ö I uj-r l j "rxw x o Lrw p n" S x"rxw- [-rw p S ±ü l uj- I YV2 6464 86wm Gwzt j u Ö n"wj "ixw j u I xw a n w l n x o "q n Ö K K K Kwprrwn"rw rw S nml rwn * Hxuxpö Yxl m"ö , KS Hl -264642
- d9f Rux"nuj Lj krx X0Vj"xí M±-j"éx0 Güx" w Bk- S 2 I xwéxw"ixw j u w n±"j u w n i x"t- j w m p n w n"l j u p x" r"q v α" é r-±j u r v jpn"ö l uj-r l j "rxw2 *Vqö-d j u j w m Kwprrwn"rw Yl mwl n-rw S nml rwn26464A87*, 7-
- d f J xwp Kwünwp0 c qx± Qj r"±0 Z xwp Bp j wp0 J ± Yqnwpüqr2 G wxénu qök"m t n"wnu ö w l "rxw "nunéj w l n é n l "x" v j l q r w n α" v ±ü r l j"t v x" x" rv jpn"ö KKM l uj-r l j "rxw2 *Hxv nml j u Yp w j u V x l n-rw p j w m I x w "x u 26464A: 4*
- d f Wrw Rn0 Nn Hw2 G í j é n u n"l k j-nm "r v n ö n z ± n w l ö j w j w-r-j y y "x j l q α" l uj-r l j "rxwov x" x" rv jpn"ö α" k"j rw l xv y±n" rw"q l n j y u l j "rxw-2 *Bx±"wj u x o Tnz"x-l mwl n S n"qxm-26449A6*, 8-
- d f R± T j 0 Rr Znwpn0 Xnw a r j x n x w p 0 S r j x N x w p ö ± 2 G J n n y R n j "w r w p Y l q n v n α" S x" x" Q j p n "ö I u j-r l j "rxw k j-nm x w X n- "l" n m H x ü ü v j w w S j l q r w n-2 Ö K K Z "j w-j l "ixw-xw Tnz"j u Yö-nv -j w m X n q j k n r j "ixw Kwprrwn"rw 2645; A69, :-
- d f N ± " n r l b n w 2 K K M l k j-nm v x" x" r v j p n "ö l u j-r l j "rxw ±-r w p w n ± "x l o t ü ü ö y "n m l "rxw j w m í j é n u n" ö j l "j u a j "± n-2 *Bx±"wj u x o Tnz"x-l mwl n S n"qxm-26454A5<=*, 6-
- d54f R± T j 0 Rr Znwpn0 Vj w Bwsw0 Xnw a r j x n x w p 0 Lnw p c ± n w 0 S r j x N x w p ö ± 2 Y "± l "± n l x w- "j r w n m -n v r l w x w n p j "r é n v j "r o q l "x "r ü j "rxw α" K K M l k j-nm v x" x" r v j p n "ö l u j-r l j "rxw2 *I x v y ± n "r w H x u x p ö j w m S nml rwn26459A: 4*
- d55f Qj w" V r ö ±-q 0 R j -t j " Y q j q n n t u N j z ± n 0 N j ü j "t j P t y r j "j 0 S j q j v ± w n X ± y n-q 2 I " Z H j-nm Z "j w-α" R n j "w r w p α" S x" x" Q j p n "ö I u j-r l j "rxw α" H j r w l x v y ± n" Ö n"q l n-2 *Bx±"wj u x o Tnz"x-l mwl n S n"qxm-26464A789*
- d56f B j w j M x y j u l q j w n j 0 Y i n"j y j n v j G u n n w j 0 V j w j r t V "j-j w" Q ± v j "2 K w j w l r w p "q n y n "α" v j w l n x o v x" x" r v j p n "ö l u j-r l j "rxw "x n m-r w p j "x k ±-" k"j r w l x v y ± n" r w "q l n ±-r w p a n m α" í j "m k j l t l y "x y j p j "rxw w n ± "j u w n" i x "t 2 G r w Y q j v - K w p r w n "r w B x ± "w j 2645<A=, 8-
- d57 L± Xxwp"xwp0NjwS nwpv nwp0Zjtwb xwp-qnw0Yqr Vnrw rwp2 Q y"xénv nw" v x" x" r v j p n "ö K K M l u j-r l j "rxw k j-nm x w-y j "n l x v v x w-y j "j u y j n" w j w m "n p ± j "r ü n m n r-l "r v r w j w" j w j w-r-2 *Bx±"wj u x o Tnz"x-l mwl n S n"qxm-26464A787*
- d58f Vö±-l q n u n" M Ö H "± w w n" I Ö Y l q u p u G Ö R x y n- n j Y n é j L N 2 S ± "q ö" q v , m r-ö w l q "x w r ü j "ixw j w m K K M -r w p u n l "i j u l u j-r l j "rxw x o m r n" n w" v x" x" r v j p n "ö j-t-2 *Tnz"x Ö j p n 2644: A75, 5-*
- d59f Xj q v j w S n 2 G-j m ± 0 [m r w S x q j v v j m Y q x "r 0 G q v j m S x q r ± m r w 2 S x m u r w p j w m l u j-r l j "rxw x o é x u w j "ö j w m r v j p n "ö v x é n v n w"- α" k"j r w l x v y ± n" r w "q l n ö x v ö f Ö j w m K K M -r w p j u "q "x ± p q l x w é x u "ixw j u w n ± "j u w n i x "t 2 N n j u "q Ö α" v j "ixw Y l m w l n j w m Y ö-nv -2645=A, 5-
- d5: f I q x N x q ö ± w 0 G q w S r w t ö ± 0 G q w Y j w p j n 0 Q i x w S x x w ö x ± w p 0 P ± w Y ± w p I q j w 2 K K M n j "j-n"-α" v x" x" r v j p n "ö k"j r w l x v y ± n" r w "q l n 2 M p j Y l m w l n 2 645; A, ; -
- d5; f b j v j i j t r T Ö " n t n l Ö R r ± c Ö N n H 2 G w K w j w l n m Z r v n l l "n z ± n w l ö f Y j "j u G y y "x j l q α" S x" x" Q j p n "ö I u j-r l j "rxw2 Ö K K Z "j w-j l "ixw-xw Tnz"j u Yö-nv -j w m X n q j k n r j "ixw Kwprrwn"rw 2644: A 58 , 6-
- d5<f Z j w p a r j w t w 0 R r " n r 0 R r a r w p l q n w 0 S j " n l q j w p 0 J j w p a r j x ö ± j w 2 S x" x" r v j p n "ö K K M "n l x p w "ixw k j-nm x w l x w m "ixw j u x y" r v r ü j "ixw n v y r "d j u v x m m l x v y x-r"ixw j w m v ± ü r l j l j n l x w é x u "ixw j u w n ± "j u w n i x "t 2 K ö y n " Y ö-nv -í r"q G y y u l j "ixw-2 6464A 58=
- d5=f R± T j 0 b r w Z j x 0 B w p a ± n 2 G Z n v y x "j u l x w é x u "ixw T n "i x "t Y x u "ixw α" K K M S x" x" Q j p n "ö I u j-r l j "rxw2 645= Ö K K S ="q Ö n"wj "ixw j u I x w a n "n w l n x w H x r w α" v j "d -j w m H x n w p r w n "r w p , H Ö K -2645=2
- d64f Vj "éj w S n j n 0 M q j -r G v r" X r t q "n q p j "Ö X n ü j r Z x q m b x ±-n 0 Lj "ü j v w j G u 2 Z "j w-α" R n j "w r w p k j-nm S x" x" Q j p n "ö I u j-r l j "rxw ±-r w p I x w é x u "ixw j u T n ± "j u T n "i x "t -2 645= 6; "q Ö j w j w l x w a n "n w l n x w K n l "d j u K w p r w n "r w p , Ö K K -2645=2
- d65f "j w p Q ± w 0 a ± S r w y n w p 0 c q j w p Y q j w-q j w 0 Q n b ± a n w p 0 S r w p J x w p 2 G w j w-r-j w m l u j-r l j "rxw α" K K M V j n" w- x o L x "l n S x" x" Q j p n "ö [-r w p S x é n v n w" X n j "n m l x "d j u V x "n w"j u-2 645< 84"q G w z t j u Ö n"wj "ixw j u I x w a n "n w l n x o "q n Ö K K K K w p r w n "r w r w S nml rwn j w m H x u x p ö Y x l m"ö , KS Hl -2645<2
- d66f "j w p M j w ö ± 0 S j "r w S r p ± n 0 N ± w p V j "d t 0 S j l j x w j u m Y q j w n 2 Z x i j "m- I u j-r w r w p S x" x" Q j p n "ö [-r w p j I x w ± v n "l M "j m H "j r w l l x v y ± n" Ö n"q l n 2 645= Ö K K Ö n"wj "ixw j u I x w a n "n w l n x w I x p w "r é n l x v y ± n w p , Ö I I -2645=2
- d67f J j w Ö w 0 X ö k j " S n j w 2 T n ± "j u l x v y x w w "j w j w-r-@ -x ± "l n u l j u-j"ixw α" v x" x" r v j p n "ö l u j-r l j "rxw2 6464 86wm Gwzt j u Ö n"wj "ixw j u I x w a n "n w l n x o "q n Ö K K K K w p r w n "r w r w S nml rwn * H x u x p ö Y x l m"ö , KS Hl -264642
- d68f B j "r q "v j w m G ö-j 0 H j n j v l q r ü j n n q S x q j v v j m G u 2 X n j u "r v n v ± ü l u j-v x" x" r v j p n "ö k"j r w l x v y ± n" r w "q l n k ö v x n r n m l x v v x w-y j "j u y j n" w- j w m

- j njy"rén wn±x lotüüö l üj —r n"2Hxv nnd ju Ypwj u V"xln—rwpj wml xw"xü6464A9;
- d69f] r"prux M2l j "x-J 2Yx-j G2Pj wN2Gw"nur-Hj ém" S 2Lj ul wR±r-K2Yrt rwp Tn±"j uTn"i x"t-j yyummm "x "qn l üj —r l j "xw x o v x"x" "j-t- rw KKM -rwpj u2Tn±"j uTn"i x"t-26464A566
- d6: R±x Rwp0Mj x a rwp0c q± a rj xknr0' j wp Hw0R± Tj 0 ' j wp Rn2S x"x" rv jpn"ö KKM l üj —r l j "xw kj -nm xw nw-nv kun ±yyx" énl"x" unj "warp2l x v y±"n" S n"qxm-j wmvxp"j v -rwHxv nnd rwn26464A5=7
- d6; f J rwp Yqtrn0 c qj wp Tj w0 a ± a rwiqnpw0 M±x Rur0 c qj wp Bj w2J nny K6"nv n Rnj "warp S j l qrwj j wml G- Gyyul j "xw rw KKM l üj —r l j "xw2S j "qnv j "d ju V"xkunv -rwKwprwnn"rwp26459A6459
- d6<f S j Znwp0Rr N±0bj wp Nj x0Ré a ±urw0Rr Vnröj wp0 Rr± Zm±w0bj x J nüqxwp0 a ± Vnw2 n nóc"j l "xw x o v x"xwkw-n"] KV Hl Ocnj "±-n- kj -nm xw mny unj "warp j wml l x v y"n-nm -nw-rwp2R±"j u x o Tn±"x-l mwl n S n"qxm-2645; A6; 9
- d6=f Qj j t Tx l yj wp0 S un" Qj ±-l xkn"0 Rnn Ynxwpl ' qj w2 G l xwéxü"txw j u wn±"j u wn"i x"t α" -nj nñ -j"n ér-±j u néxt nm yx"nw"j u l üj —r l j "xw ±wm" j v k±j "x"ö nwér"xw nw"2VRUYUTK2645; A56, 6-
- d74f I nl x r N0 Mj -n" G2 l xwéxü"txw j u Tn±"j u Tn"i x"t- α" V744 J n"nl "xw i r"q Gyyul j "xw "x H"j rwl x v y±"n" Öw"n"q l n-2ÖKK Z"j w-j l "xw- xw Vj n" w Gwj w-r-j wml S j l qrw n Öw"nupnwl n26455A77 , 7-
- d75f Ylqr"v nr-n" Xxkrw Zkx"0 Yy"rwpnwn"p Rk- Zxkij -0Lmmn"n" R±tj -J x v rwx ±n Rk-n0Mj -"n n" S j "rw0 Kppnw-yn"pn" Qj "qj "rwj 0 Zj wpn"v j ww S d qj n0 N± n" L"j wt 0 H±"pj "m ' xw"j v 0 Hj u Zxwx2 J nny unj "warp i r"q l xwéxü"txw j u wn±"j u wn"i x"t- α" KKM mml x mwp j wml ér-±j uüj "xw2N±v j wH"j rws j yyrwp2645; A7<, 55-
- d76f Y±"v Öwnw0 Rj y±-l qt rw Ynkj -"j w0 Yj v nt ' xsl ml q0 S un" Qj ±-l xkn"2 Öw"n"y"n"j kun mny wn±"j u wn"i x"t- α" -rwpunl"j u KKM l üj —r l j l "xw2R±"j u x o Tn±"x-l mwl n S n"qxm-2645; A6; 8
- d77f Zj kj " b x ±-no Xnñj nr0 Nj ul r [p±"2 G vxénu mny unj "warp j yy"xj l q α" l üj —r l j "xw x o KKM v x"x" rv jpn"ö -rwpj u2R±"j u x o Tn±"j u Kwprwnn"l rwp2645: A58, 5-
- d78f brw c qxwp0 c qj wp Bj wq±j 2 I "x-l-n-xw l üj —r l j "xw x o v nw"j u i x"t uxj m uénu- ±-rwp KKM j wml j w nj y"rén mny unj "warp v xnmüHxv nnd ju Ypwj u V"xln—rwpj wml xw"xü645; A77
- d79f brwc qxwp0c qj x S nwpö±j w0' j wp b xwpórxwp0bj wp Rwpnrxwp0c qj wp Bj wq±j 2 Xnl xpw"rxw x o nv x"rxw- ±-rwp v ±üv xnj u yqö-uxupl j u -rwpj u- j wml j w nw-nv kun mny unj "warp v xnmüI x v y±"n" S n"qxm-j wmvxp"j v -rwHxv nnd rwn2645; A584
- d7: f ' ± J xwp"±0 a ± brj w0 R± Hj x l Rj wp2 Z"j w-an" Rnj "warp α" KKM l Hj -nm H"j rwl x v y±"n" Öw"n"q l n-@ G Xnémi x o Vxp"n- S j nm Yrwln 645: 2ÖKK Z"j w-j l "xw- xw l xpw"rén j wml J nénu yv nw"j u l ö- "nv -264642
- d7; f Gwa r±0Q±j wp J ny rwp0M±x a rj xsj x0c qj x b n±0Nn Rj wpq±j 2 G J nny Rnj "warp S n"qxm α" l üj —r l j "xw x o KKM J j" Hj -nm xw S x"x"
- Ö j pn"ö2Öw"nupnw" l x v y±"rwp rw Hxrwα"v j "l d-264582
- d7<f J j r S nwpór0 c qnwp J nüqr0 Tj X±r0 ' j wp Yq±j r0 c qj wp Yq±j rnr2 KKM l üj —r l j "xw x o S x"x" Ö j pn"ö [-rwp j Txénu J nny Rnj "warp L"j v ní x"t 2Ynw-x" -2645=A5=, 7-
- d7=f S j smxé Öq"röx"0 ' qj wpxx Zj npt n±w2 K l mw" l üj —r l j "xw x o S x"x" Ö j pn"ö Kul "x nwl ny qj uxpl "j yqö Ypwj u [-rwp J nny Rnj "warp S n"qxm-2Ynw-x" -2645=A5=, ; -
- d84f Qv Vqn2S GZRGH J nny Rnj "warp l r"q S j l qrw n Rnj "warp0 Tn±"j u Tn"i x"t- j wml G"r l j u Öw"nupnwl n2Gy"n-@H"t nñö0l GA645; 2
- d85f ' j w"x Gwsj "0 Gwnj wr Y±wnj "r Xn"wx0 Vxwarp-rq Vxwarp-rq0J ní r Xj zj 0R±kr- S ±qj v v j mXmi j w0 Yj y±"j ' mxnx0 Q"j wj Öj Ut"j 2 Gwj ü-r- x o Y"j wnj "m M"j mmw" J n-l nw" i r"q Mj S x v nw"±v j wml Gn j y"rén RX α" YVX V"nml "xw2CTGI Xóré2645<2
- d86f J rv xu"-j- Yyr"x-0 Rr-"n" Vj ±u L2 ' j énox"v y"n-n"érwp nwl xnm"- α" "qn l x v y"n-xw x o KKM nj"j 2Ypwj u V"xln—rwp25=<: A54, 8-



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