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**Pneumonia Disease Prediction**

**from X-ray Images**

**Lecture 01 –**

**Treating Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Deep Learning Problem (using CNN)**

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| **بِسْمِ اللهِ الرَّحْمٰنِ الرَّحِيْم** |

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| **Human Engineering** |

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| **تصحیح نیت** |

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| |  | | --- | | **حضرت محمد صلی اللہ علیہ وسلم نے فرمایا**  اِنَّمَا الْاَعْمَالُ بِالنِّـیَّاتِ  **ترجمہ:**  **اعمال کا دارومدار نیتوں پر ہے** |  * **اگر دنیا میں کسی نے کوئی کام کیا ہے تو آپ بھی کر سکتے ہیں** * **میں دل سے عمل کی نیت کرتا ہوں کہ** * **میری زندگی کا مقصد ہے خوش رہنا اور خوش رکھنا** * **میری زندگی کا مقصد اللہ کو پانا ہے** * **میری زندگی کا مقصد حضرت محمد صلی اللہ علیہ وسلم سے کامل عشق اور آپ صلی اللہ علیہ وسلم کی کامل اتباع ہے** * **میری زندگی کا مقصد اپنے شعبے میں پوری دنیا میں پہلے نمبر پر آنا ہے** * **میری زندگی کا مقصد مخلوق خدا کی بے لوث خدمت ہے** |

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| **زندگی کا مقصد** |

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| * **ہماری زندگی کا مقصد ۔ اللہ کو پانا** * **اللہ کو پانے کا مختصر ترین اورتیز ترین راستہ – مخلوق خدا کی بے لوث خدمت** |

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| **مشاہدہ سے یقین تک کا سفر** |

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| جس شخص نے بھی اللہ کو پایا ہے اس نے مشاہدہ سے یقین تک کا سفر طے کیا ہے  جو شخص مشاہدہ سے یقین کا سفر طے کر لیتا ہے اُس کو اللہ پاك کی رضا نصیب ہو جاتی ہے  مشاہدہ سے یقینتک کا سفر کیسے طے ہو ؟   1. اِس راستے کا مسافر مشاہدہ میں آنے والی ہر مخلوق ( شکل ) کا انکار کرتا چلا جائے 2. اِس شخص کا حال ( کردار) اِس بات کی گواہی دے گا کہ یہ شخص مشاہدہ سے یقین تک کے سفر کا مسافر ہے 3. اِس شخص کا حال ( کردار) ہی تاریخ ہے   حضرت ابراہیم علیہ السلام ہر مخلوق ( شکل) کا انکار فرماتے چلے گئے اور اللہ کو پا گئے ( مشاہدہ سے یقین تك کا سفر طے ہو گیا)  قرآن میں اللہ پاك فرماتے ہیں   |  | | --- | | **آیت مبارکہ**  وَ اِذۡ  قَالَ  اِبۡرٰہِیۡمُ لِاَبِیۡہِ  اٰزَرَ اَتَتَّخِذُ  اَصۡنَامًا  اٰلِہَۃً ۚ اِنِّیۡۤ   اَرٰىکَ وَ قَوۡمَکَ فِیۡ ضَلٰلٍ مُّبِیۡنٍ  کَذٰلِکَ نُرِیۡۤ  اِبۡرٰہِیۡمَ مَلَکُوۡتَ السَّمٰوٰتِ وَ الۡاَرۡضِ وَ لِیَکُوۡنَ مِنَ الۡمُوۡقِنِیۡنَ  فَلَمَّا جَنَّ عَلَیۡہِ الَّیۡلُ  رَاٰ کَوۡکَبًا ۚ قَالَ ہٰذَا  رَبِّیۡ ۚ فَلَمَّاۤ  اَفَلَ  قَالَ لَاۤ  اُحِبُّ  الۡاٰفِلِیۡنَ  فَلَمَّا رَاَ  الۡقَمَرَ بَازِغًا  قَالَ ہٰذَا رَبِّیۡ ۚ فَلَمَّاۤ  اَفَلَ قَالَ  لَئِنۡ  لَّمۡ  یَہۡدِنِیۡ رَبِّیۡ لَاَکُوۡنَنَّ مِنَ  الۡقَوۡمِ  الضَّآلِّیۡنَ  فَلَمَّا رَاَ الشَّمۡسَ بَازِغَۃً  قَالَ ہٰذَا رَبِّیۡ ہٰذَاۤ  اَکۡبَرُ ۚ فَلَمَّاۤ  اَفَلَتۡ قَالَ یٰقَوۡمِ  اِنِّیۡ بَرِیۡٓءٌ  مِّمَّا تُشۡرِکُوۡنَ  اِنِّیۡ وَجَّہۡتُ وَجۡہِیَ لِلَّذِیۡ فَطَرَ السَّمٰوٰتِ وَ الۡاَرۡضَ حَنِیۡفًا وَّ مَاۤ اَنَا مِنَ الۡمُشۡرِکِیۡنَ  وَ حَآجَّہٗ  قَوۡمُہٗ ؕ قَالَ  اَتُحَآجُّوۡٓنِّیۡ  فِی اللّٰہِ وَ قَدۡ ہَدٰىنِ ؕ وَ لَاۤ  اَخَافُ مَا تُشۡرِکُوۡنَ بِہٖۤ  اِلَّاۤ  اَنۡ یَّشَآءَ رَبِّیۡ شَیۡئًا ؕ وَسِعَ رَبِّیۡ کُلَّ شَیۡءٍ عِلۡمًا ؕ اَفَلَا تَتَذَکَّرُوۡنَ  وَ کَیۡفَ اَخَافُ مَاۤ  اَشۡرَکۡتُمۡ وَ لَا  تَخَافُوۡنَ  اَنَّکُمۡ  اَشۡرَکۡتُمۡ بِاللّٰہِ مَا لَمۡ یُنَزِّلۡ بِہٖ عَلَیۡکُمۡ سُلۡطٰنًا ؕ فَاَیُّ الۡفَرِیۡقَیۡنِ  اَحَقُّ  بِالۡاَمۡنِ ۚ اِنۡ  کُنۡتُمۡ  تَعۡلَمُوۡنَ  اَلَّذِیۡنَ اٰمَنُوۡا وَ لَمۡ یَلۡبِسُوۡۤا اِیۡمَانَہُمۡ بِظُلۡمٍ  اُولٰٓئِکَ لَہُمُ الۡاَمۡنُ وَ ہُمۡ مُّہۡتَدُوۡنَ  **ترجمہ**  **اور ( اس وقت کا ذکر سنو ) جب ابراہیم نے اپنے باپ آزر سے کہا تھا کہ :   کیا آپ بتوں کو خدا بنائے بیٹھے ہیں؟ میں دیکھ رہا ہوں کہ آپ اور آپ کی قوم کھلی گمراہی میں مبتلا ہیں ۔**  **اور اسی طرح ہم ابراہیم کو آسمانوں اور زمین کی سلطنت کا نظارہ کراتے تھے ، اور مقصد یہ تھا کہ وہ مکمل یقین رکھنے والوں میں شامل ہوں**  **چنانچہ جب ان پر رات چھائی تو انہوں نے ایک ستارا دیکھا ۔ کہنے لگے : یہ میرا رب ہے**  **پھر جب وہ ڈوب گیا تو انہوں نے کہا : میں ڈوبنے والوں کو پسند نہیں کرتا ۔**  **پھر جب انہوں نے چاند کو چمکتے دیکھا تو کہا کہ : یہ میرا رب ہے ۔ لیکن جب وہ بھی ڈوب گیا تو کہنے لگے : اگر میرا رب مجھے ہدایت نہ دیتا تو میں یقینا گمراہ لوگوں میں شامل ہوجاؤں ۔**  **پھر جب انہوں نے سورج کو چمکتے دیکھا تو کہا : یہ میرا رب ہے ۔ یہ زیادہ بڑا ہے ۔ پھر جب وہ غروب ہوا تو انہوں نے کہا : اے میری قوم ! جن جن چیزوں کو تم اللہ کی خدائی میں شریک قرار دیتے ہو ، میں ان سب سے بیزار ہوں**  **میں نے تو پوری طرح یکسو ہو کر اپنا رخ اس ذات کی طرف کرلیا ہے جس نے آسمانوں اور زمین کو پیدا کیا ہے ، اور میں شرک کرنے والوں میں سے نہیں ہوں ۔**  **اور (پھر یہ ہوا کہ) ان کی قوم نے ان سے حجت شروع کردی ۔ ابراہیم نے (ان سے) کہا : کیا تم مجھ سے اللہ کے بارے میں حجت کرتے ہو جبکہ اس نے مجھے ہدایت دے دی ہے ؟ اور جن چیزوں کو تم اللہ کے ساتھ شریک مانتے ہو ، میں ان سے نہیں ڈرتا ( کہ وہ مجھے کوئی نقصان پہنچا دیں گی ) الا یہ کہ میرا پروردگار ( مجھے ) کچھ ( نقصان پہنچانا ) چاہے ( تو وہ ہر حال میں پہنچے گا ) میرے پروردگار کا علم ہر چیز کا احاطہ کیے ہوئے ہے ۔ کیا تم پھر بھی کوئی نصیحت نہیں مانتے؟**  **اور جن چیزوں کو تم نے اللہ کا شریک بنا رکھا ہے ، میں ان سے کیسے ڈر سکتا ہوں جبکہ تم ان چیزوں کو اللہ کا شریک ماننے سے نہیں ڈرتے جن کے بارے میں اس نے تم پر کوئی دلیل نازل نہیں کی ہے؟ اب اگر تمہارے پاس کوئی علم ہے تو بتاؤ کہ ہم دو فریقوں میں سے کون بے خوف رہنے کا زیادہ مستحق ہے ؟**  **(حقیقت تو یہ ہے کہ) جو لوگ ایمان لے آئے ہیں اور انہوں نے اپنے ایمان کے ساتھ کسی ظلم کا شائبہ بھی آنے نہیں دیا ، امن اور چین تو بس انہی کا حق ہے ، اور وہی ہیں جو صحیح راستے پر پہنچ چکے ہیں ۔**  **Surah**  **Al-Anaam Ayat# 74-82**  **آیت مبارکہ**  اَلَمۡ تَرَ اِلَی الَّذِیۡ حَآجَّ اِبۡرٰہٖمَ فِیۡ رَبِّہٖۤ اَنۡ اٰتٰىہُ اللّٰہُ الۡمُلۡکَ ۘ اِذۡ قَالَ اِبۡرٰہٖمُ رَبِّیَ الَّذِیۡ یُحۡیٖ وَ یُمِیۡتُ ۙ قَالَ اَنَا اُحۡیٖ وَ اُمِیۡتُ ؕ قَالَ اِبۡرٰہٖمُ فَاِنَّ اللّٰہَ یَاۡتِیۡ بِالشَّمۡسِ مِنَ الۡمَشۡرِقِ فَاۡتِ بِہَا مِنَ الۡمَغۡرِبِ فَبُہِتَ الَّذِیۡ کَفَرَ ؕ وَ اللّٰہُ لَا یَہۡدِی الۡقَوۡمَ الظّٰلِمِیۡنَ  **ترجمہ**  **کیا تم نے اس شخص ( کے حال ) پر غور کیا جس کو اللہ نے سلطنت کیا دے دی تھی کہ وہ اپنے پروردگار ( کے وجود ہی ) کے بارے میں ابراہیم سے بحث کرنے لگا؟ جب ابراہیم نے کہا کہ میرا پروردگار وہ ہے جو زندگی بھی دیتا ہے اور موت بھی   تو وہ کہنے لگا کہ :   میں بھی زندگی دیتا ہوں اور موت دیتا ہوں ۔   ابراہیم نے کہا :   اچھا ! اللہ تو سورج کو مشرق سے نکالتا ہے ، تم ذرا اسے مغرب سے تو نکال کر لاؤ ۔   اس پر وہ کافر مبہوت ہو کر رہ گیا ۔ اور اللہ ایسے ظالموں کو ہدایت نہیں دیا کرتا ۔**  **Surah Al-Baqarah Ayat# 258** |   حضرت ابراہیم علیہ السلام کا حال   1. حضرت ابراہیم علیہ السلام کو آگ میں پھینکا جا رہا ہے اور سب سے بڑی نورانی مخلوق (حضرت جبرئیل علیہ السلام ) آپ سے درخواست کر رہے ہیں کہ اِس آگ کو ہم بجھا دیں ؟ آپ علیہ السلام نے اُس حال میں سب سے بڑی نوری مخلوق کا انکار فرما دیا . اور فرمایا **حَسۡبِیَ اللّٰہ** ( اللہ پاك میرے لیے کافی ہے)   قرآن میں اللہ پاك فرماتے ہیں   |  | | --- | | **آیت مبارکہ**  فَاَقۡبَلُوۡۤا اِلَیۡہِ یَزِفُّوۡنَ  قَالَ اَتَعۡبُدُوۡنَ مَا تَنۡحِتُوۡن  وَ اللّٰہُ خَلَقَکُمۡ وَ مَا تَعۡمَلُوۡنَ  قَالُوا ابۡنُوۡا لَہٗ بُنۡیَانًا فَاَلۡقُوۡہُ فِی الۡجَحِیۡمِ  وَ قَالَ اِنِّیۡ ذَاہِبٌ اِلٰی رَبِّیۡ سَیَہۡدِیۡنِ  **ترجمہ**  **اس پر ان کی قوم کے لوگ ان کے پاس دوڑے ہوئے آئے**  **ابراہیم نے کہا :   کیا تم ان ( بتوں ) کو پوجتے ہو جنہیں خود تراشتے ہو؟**  **حالانکہ اللہ نے تمہیں بھی پیدا کیا ہے ، اور جو کچھ تم بناتے ہو ، اس کو بھی ۔**  **ان لوگوں نے کہا : ابراہیم کے لیے ایک عمارت بناؤ ، اور اسے دہکتی ہوئی آگ میں پھینک دو**  **اور ابراہیم نے کہا :   میں اپنے رب کے پاس جارہا ہوں ، وہی میری رہنمائی فرمائے گا ۔**  **Surah Al-** **Saaffaat Ayat# 94-111**  **آیت مبارکہ**  قُلۡنَا یٰنَارُ کُوۡنِیۡ بَرۡدًا وَّ سَلٰمًا عَلٰۤی اِبۡرٰہِیۡمَ  **ترجمہ**  (**چنانچہ انہوں نے ابراہیم کو آگ میں ڈال دیا ، اور ہم نے کہا** ) **اے آگ ٹھندی ہوجا ، اور ابراہیم کے لیے سلامتی بن جا**  **Surah Al-Anbiya Ayat #69** |  1. حضرت ابراہیم علیہ السلام کو اللہ پاك نے حکم فرمایا کہ اپنے بیٹے حضرت اسماعیل علیہ السلام کو اللہ کے راستے میں قربان کر دیں ( یہ بہت ہی مشکل حال ہے ) . آپ علیہ السلام نے ہر حال میں اللہ کی چاہت ( حکم ) کو پورا فرمایا اور اپنے بیٹےکو ذبح کرنے کے لیے چل پڑے   قرآن میں اللہ پاك فرماتے ہیں   |  | | --- | | **آیت مبارکہ**  فَلَمَّا بَلَغَ مَعَہُ  السَّعۡیَ قَالَ یٰبُنَیَّ  اِنِّیۡۤ اَرٰی فِی الۡمَنَامِ اَنِّیۡۤ  اَذۡبَحُکَ فَانۡظُرۡ مَاذَا تَرٰی ؕ قَالَ یٰۤاَبَتِ افۡعَلۡ مَا تُؤۡمَرُ ۫ سَتَجِدُنِیۡۤ  اِنۡ شَآءَ اللّٰہُ مِنَ الصّٰبِرِیۡنَ  **ترجمہ**  **پھر جب وہ لڑکا ابراہیم کے ساتھ چلنے پھرنے کے قابل ہوگیا تو انہوں نے کہا : بیٹے ! میں خواب میں دیکھتا ہوں کہ تمہیں ذبح کر رہا ہوں ، اب سوچ کر بتاؤ ، تمہاری کیا رائے ہے؟ بیٹے نے کہا ابا جان ! آپ وہی کیجیے جس کا آپ کو حکم دیا جارہا ہے ، انشاءاللہ آپ مجھے صبر کرنے والوں میں سے پائیں گے**  **Surah Al-** **Saaffaat Ayat# 102** |  1. حضرت ابراہیم علیہ السلام کو اللہ پاك نے حکم فرمایا کہ اپنے بیٹے اور بیوی کو مکہ چھوڑ آؤ ( جہاں زندگی کے کوئی اسباب نہ تھے ) . حضرت ابراہیم علیہ السلام نے ہر حال میں اللہ کی چاہت ( حکم ) کو پورا فرمایا اور اپنے بیٹے اور بیوی کو مکہ چھوڑ آئے   قرآن میں اللہ پاك فرماتے ہیں   |  | | --- | | **آیت مبارکہ**  **ر**بَّنَاۤ اِنِّیۡۤ اَسۡکَنۡتُ مِنۡ ذُرِّیَّتِیۡ بِوَادٍ غَیۡرِ ذِیۡ زَرۡعٍ عِنۡدَ بَیۡتِکَ الۡمُحَرَّمِ ۙ رَبَّنَا لِیُـقِیۡمُوا الصَّلٰوۃَ فَاجۡعَلۡ اَفۡئِدَۃً مِّنَ النَّاسِ تَہۡوِیۡۤ اِلَیۡہِمۡ وَارۡ زُقۡہُمۡ مِّنَ الثَّمَرٰتِ لَعَلَّہُمۡ یَشۡکُرُوۡنَ  **ترجمہ**  **اے ہمارے پروردگار ! میں نے اپنی کچھ اولاد کو آپ کے حرمت والے گھر کے پاس ایک ایسی وادی میں لا بسایا ہے جس میں کوئی کھیتی نہیں ہوتی ۔ ہمارے پروردگار ! ( یہ میں نے اس لیے کیا ) تاکہ یہ نماز قائم کریں ، لہذا لوگوں کے دلوں میں ان کے لیے کشش پیدا کردیجیے ، اور ان کو پھلوں کا رزق عطا فرمایے ، تاکہ وہ شکر گذار بنیں**  **Surah Al-** **Abraham Ayat# 37** |   حضرت ابراہیم علیہ السلام کا حال ( کردار ) اور تاریخ  حضرت ابراہیم علیہ السلام کا حال ( کردار ) پوری امت مسلمہ کے لیے ( قیامت تک ) نمونہ ہے  قرآن میں اللہ پاك فرماتے ہیں   |  | | --- | | **آیت مبارکہ**  وَ مَنۡ اَحۡسَنُ دِیۡنًا مِّمَّنۡ اَسۡلَمَ  وَجۡہَہٗ لِلّٰہِ وَ ہُوَ مُحۡسِنٌ وَّ اتَّبَعَ مِلَّۃَ اِبۡرٰہِیۡمَ حَنِیۡفًا ؕ وَ اتَّخَذَ اللّٰہُ اِبۡرٰہِیۡمَ خَلِیۡلًا  **ترجمہ**  **اور اس سے بہتر کس کا دین ہوگا جس نے اپنے چہرے ( سمیت سارے وجود ) کو اللہ کے آگے جھکا دیا ہو ، جبکہ وہ نیکی کا خوگر بھی ہو ، اور جس نے سیدھے سچے ابراہیم کے دین کی پیروی کی ہو ۔ اور ( یہ معلوم ہی ہے کہ ) اللہ نے ابراہیم کو اپنا خاص دوست بنا لیا تھا ۔**  **Surah un-Nissa Ayat# 125**  **آیت مبارکہ**  قَدۡ کَانَتۡ لَکُمۡ  اُسۡوَۃٌ  حَسَنَۃٌ  فِیۡۤ اِبۡرٰہِیۡمَ وَ الَّذِیۡنَ مَعَہٗ ۚ ُ  **ترجمہ**  **تمہارے لیے ابراہیم اور ان کے ساتھیوں میں بہترین نمونہ ہے**  **Surah Al-** **Mumtahina Ayat# 4**  **آیت مبارکہ**  قَدۡ کَانَتۡ لَکُمۡ  اُسۡوَۃٌ  حَسَنَۃٌ  فِیۡۤ اِبۡرٰہِیۡمَ وَ الَّذِیۡنَ مَعَہٗ ۚ ُ  **ترجمہ**  **تمہارے لیے ابراہیم اور ان کے ساتھیوں میں بہترین نمونہ ہے ہوئے ہیں**  **Surah Al-** **Mumtahina Ayat# 4**  **آیت مبارکہ**  قُلۡ صَدَقَ اللّٰہُ ۟ فَاتَّبِعُوۡا مِلَّۃَ اِبۡرٰہِیۡمَ حَنِیۡفًا ؕ وَ مَا کَانَ مِنَ الۡمُشۡرِکِیۡنَ  **ترجمہ**  **آپ کہیے کہ اللہ نے سچ کہا ہے ، لہذا تم ابراہیم کے دین کا اتباع کرو جو پوری طرح سیدھے راستے پر تھے ، اور ان لوگوں میں سے نہیں تھے جو اللہ کی خدائی میں کسی کو شریک مانتے ہیں**  **Surah Al-** **Imran Ayat# 95** | |

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| **اللہ پاک نے اپنے ایک حکم سے ساتوں آسمان اور ساتوں زمین بنا دیے**  **اس وقت جو دنیا ہے ساتوں آسمان اور زمین سے فائدہ اٹھانے میں اپنی قوت کو ضائع کر رہی ہے**  **جس اللہ پاک نے بنایا ہے اس پاک ذات سے فائدہ اٹھانے میں نہیں لگی ہوئی**  **اللہ پاک کی ذات سے فائدہ اٹھانا کیا ہے**  **جس وقت وہ اللہ پاک جو چاہتا ہے اس کو ہم نے حضرت محمد صلی اللہ علیہ وسلم کے طریقے سے پورا کرنا ہے**  **سب سے پہلے محنت اس بات پر کرنی پڑے گی**  **اللہ ہے**  **اور اسی کے ہاتھ میں سب کچھ ہے**  **(کسی سے نہیں ہوتا اللہ سے ہوتا ہے)**  **اسے ایک ہے زبان سے کہنا اور ایک ہے دل میں اتارنا**  **ہمارا کام یہ ہے**  **ہرآن ہر گھڑی ہر وقت ہماری یہ سوچ ہو کہ ساری دنیا کے انسان اس بات کو اپنی فکر بنائیں**  **اللہ ہے وہ ہم سے کیا چاہتا ہے**  **اللہ کی چاہت کو ہم نے حضرت محمد صلی اللہ علیہ وسلم کے مبارک طریقے سے پورا کرنا ہے**  **اور ساری دنیا کے انسانوں کو اس کے پورا کرنے پر تیار کرنا ہے** |

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| باتیں کم عمل زیادہ |

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| **حضرت صوفی برکت علی صاحب رح**  **اے نوجوان**  **نہ کہہ نہ لکھ ، نہ کہہ نہ لکھ ، نہ کہہ نہ لکھ**  **بہت کہا جا چکا بہت لکھا جا چکا ،بہت کہا جا چکا بہت لکھا جا چکا ،بہت کہا جا چکا بہت لکھا جا چکا**  **کر کے دکھا ، کر کے دکھا ، کر کے دکھا**  **دنیا تو تیرے** **کئے کو دیکھنا چاہتی ہے** |

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| با ادب با نصیب ، بے ادب بے نصیب |

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| فن   * وہ معلومات جو بغیر **ا**دب کے آتی ہیں . ان كو فنون کہتے ہیں * فنون اجسسام پر محنت کرتے ہیں * جسم مٹی سے بنا ہے ، اِس نے مٹ جانا ہے   علم   * وہ معلومات جو ادب کے راستے سے آتی ہَیں . ان کو علوم کہتے ہَیں * علوم ارواح پر محنت کرتے ہَیں * روح عالم امر سے ہے، اِس لیے کبھی بھی فنا نہیں ہو گی   علم کی حقیقت   * علم کی حقیقت صِرف ایک راستے سے حاصل ہو سکتی ہے ، اور وہ ہے   + ادب * کسی بھی آدمی سے کچھ سیکھنے کے لیے ، آپ کو سب سے پہلے دل سے اُس کا ادب کرنا پَڑے گا   + بغیر ادب کے آپ معلومات تو حاصل کر لیں گے لیکن علم کی حقیقت ( استاد کا فیض ) نہیں ملے گا * جس شخص کو علم کی حقییقت نصیب ہو جاتی ہے ، وہ اللہ کو پا جاتا ہے |

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| **جو کام کریں دل سے کریں** |

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| * **کام کرنا.** * **خوشی خوشی کام کرنا.** * **الله کو ساتھ لے کرخوشی خوشی کام کرنا.** * **آیت :** إِيَّاكَ نَعْبُدُ وإِيَّاكَ نَسْتَعِينُ   **ترجمہ: یا الله ہم تیری ہی عبادت کرتے ہیں. اور تجھ ہی سے مد د مانگتے ہیں** |

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| **نتائج سے بے پروا ہو کر ہمیشہ پاکیزگی کا راستہ اختیار کریں** |

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| **یہ دعا روزانہ پڑھیں**  **دعا:** ٱهْدِنَا ٱلصِّرَٰطَ ٱلْمُسْتَقِيمَ صِرَٰطَ ٱلَّذِينَ أَنْعَمْتَ عَلَيْهِم  **ترجمہ: ہمیں سیدھی راه دکھا ان لوگوں کی راه جن پر تو نے انعام کیا.**  **یا اللہ ہم کچھ نہیں چاہتے ہم وہ چاہتے ہیں جو تو چاہتا ہے**  **(حضرت حاجی عبدالوہاب صاحب رح)** |

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| **دعا ایسی ہو جو اللہ سے فیصلے کروا دے** |

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| * اللَّهُمَّ خِرْ لِيْ وَاخْتَرْ لِي * سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا ۖ   إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ   * رَبِّ اشْرَحْ لِي صَدْرِي وَيَسِّرْ لِي اَمْرِي   وَاحْلُلْ عُقْدَةً مِنْ لِسَانِي يَفْقَهُوا قَوْلِي   * رَّبِّ أَعُوذُ بِكَ مِنْ هَمَزَاتِ الشَّيَاطِينِ ۖ   وَاَعُوْذُبِكَ رَبِّ اَنْ يَّحْضُرُوْنِ |

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| **Commando is a Man of Character** |

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**Five Types of Training**

* **Police**
* **Elite**
* **Rangers**
* **Army**
* **Commando**

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**Main Goal of a Course - Commando Training**

* **Commando**
  + **Commando is a Man of Character and (s)he should Safeguard his Character**

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**Main Qualities of a Commando**

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| * **Live a Balanced and Scheduled Life** * **محنت کبھی نہیں ہارتی.** * **100% Effort with Sincerity** * **دعائیں ہوں تو کھوٹے سکے بھی چل جاتے ہیں.** * **والدین اور اُستاد کی خدمت + ادب** * **Respect and Serve your Parents and Teachers** |

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**Main Qualities of a Commando Cont…**

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| * **Go to bed immediately after عشاء نماز (between 9pm – 10pm)** * **Do اللہ کا ذکر on daily basis (at least 30 minutes)** * قرآن پاک کی تلاوت ہمیشہ تجوید کے ساتھ کریں * **Do brisk walk / running on daily basis (at least 30 minutes)** * **Drink 1-liter milk, eat at least 10 dates and take at least 10 spoons of honey on daily basis** |

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**Main Qualities of a Commando Cont…**

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| * **Commando Passes in Three Big Exams of Life:** * **پیسہ** * **عہدہ** * **عورت ہے تو مرد / مرد ہے تو عورت** |

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**Summary of Qualities in a Commando**

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| **عاجزی** |

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| **Course Focus** |

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| |  | | --- | | * **To Master the Art of Living, mainly get Excellence in two things**   + **Become a Balanced and Characterful Personality**   + **Become an Authority in Machine Learning in the Whole World** | |

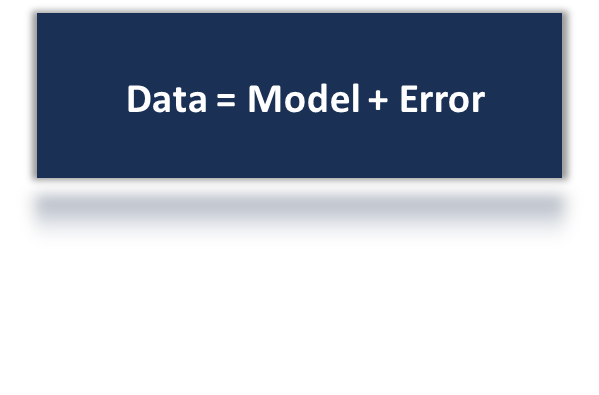
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| **Little Efforts Daily Will Make You the Greatest** |

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**Little Efforts Daily Will Make You the Greatest**

* **To systematically learn and get excellence in any concept / subject**
* **روز کا کام روز کریں**
* **اک مہینے کا کھانا ایک دن میں نہیں کھایا جا سکتا، ایسے ہی ایک مہینے کا کام ایک دن میں نہیں ہو سکتا**
* **Importance of Completing Tasks on Daily Basis**
  + **Main Reasons of Failure in Life**
* **یہ کام کل کریں گے**
* **جو کام کبھی بھی ہو سکتا ہے وہ کبھی نہیں ہوتا**
* **زندگی ایک دن ہے اور وہ ہے آج زندگی میں کل نام کی کوئی چیز نہیں ہے**
* **جو دن آپ کی زندگی سے چلا گیا اب واپس نہیں آئے گا**
* **آج کا کام آج ہی ہوسکتا ہے**
* **جو گزر گیا وہ آنا نہیں ، آنے والے دن کا پتہ نہیں ، آج میدان جما ہے تو اپنے جوہر دکھاؤ**

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| **Machine Learning – Summary** |

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| **Lecture Outline** |

* **Best Teaching and Learning Methodology of the World**
* **Using a Template-based Approach to Systematically Perform a Real-world Task**
* **Lecture Aim**
* **CNN–based Deep Neural Network Architecture**
* **Pneumonia Disease Prediction from X-ray Images**
* **Steps – Treating Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Deep Learning Problem (using CNN)**
* **Stop Complaining! Stop Criticizing! Let’s Start Contributing**
* **Lecture Summary**

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| **Best Teaching and Learning Methodology of the World** |

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**Best Teaching and Learning Methodology of the World**

* **Question**
  + **What is the best Teaching and Learning Methodology of the world?**
* **Answer**
  + **The best Teaching and Learning Methodology of the world is the one, which**
    - **Allah (اللہ) taught us in The Holy Quran and Hazrat Muhammad S.A.W.W. (حضرت محمد صلی اللہ علیہ وسلم) used to teach His Students i.e. Sahaba Karam R.A. (صحابہ کرام رضی اللہ عنھم اجمعین)**
* **Reason**
  + **The Teaching and Learning Methodology of Hazrat Muhammad S.A.W.W. is the best (till the Day of Judgment) because** 
    - **It produced the best Human Beings of the world till the Day of Judgement**
  + **Hazrat Muhammad S.A.W.W. said**

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| **حدیث مبارکہ**  **حَدَّثَنَا آدَمُ ، حَدَّثَنَا شُعْبَةُ ، حَدَّثَنَا أَبُو جَمْرَةَ ، قَالَ : سَمِعْتُ زَهْدَمَ بْنَ مُضَرِّبٍ ، قَالَ : سَمِعْتُ عِمْرَانَ بْنَ حُصَيْنٍ رَضِيَ اللَّهُ عَنْهُمَا ، قَالَ : قَالَ النَّبِيُّ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ : خَيْرُكُمْ قَرْنِي ، ثُمَّ الَّذِينَ يَلُونَهُمْ ، ثُمَّ الَّذِينَ يَلُونَهُمْ . قَالَ عِمْرَانُ : لَا أَدْرِي ، أَذَكَرَ النَّبِيُّ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ بَعْدُ قَرْنَيْنِ أَوْ ثَلَاثَةً ، قَالَ النَّبِيُّ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ : إِنَّ بَعْدَكُمْ قَوْمًا يَخُونُونَ وَلَا يُؤْتَمَنُونَ ، وَيَشْهَدُونَ وَلَا يُسْتَشْهَدُونَ ، وَيَنْذِرُونَ وَلَا يَفُونَ ، وَيَظْهَرُ فِيهِمُ السِّمَنُ**  **ترجمہ**  **رسول اللہ صلی اللہ علیہ وسلم نے فرمایا تم میں سب سے بہتر میرے زمانہ کے لوگ ( صحابہ ) ہیں۔ پھر وہ لوگ جو ان کے بعد آئیں گے ( تابعین ) پھر وہ لوگ جو اس کے بھی بعد آئیں گے ( تبع تابعین ) عمران نے بیان کیا کہ میں نہیں جانتا آپ صلی اللہ علیہ وسلم نے دو زمانوں کا ( اپنے بعد ) ذکر فرمایا یا تین کا پھر آپ صلی اللہ علیہ وسلم نے فرمایا کہ تمہارے بعد ایسے لوگ پیدا ہوں گے جو چور ہوں گے، جن میں دیانت کا نام نہ ہو گا۔ ان سے گواہی دینے کے لیے نہیں کہا جائے گا۔ لیکن وہ گواہیاں دیتے پھریں گے۔ نذریں مانیں گے لیکن پوری نہیں کریں گے۔ مٹاپا ان میں عام ہو گا۔**  **صحیح بخاری 2651** |

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**Best Teaching Methodology and Learning Methodology of the World Cont…**

* **Question**
  + **In what areas Sahaba Karam R.A. mainly achieved Excellence?**
* **Answer** 
  + **Sahaba Karam R.A. mainly achieved Excellence in three areas**
    1. **Excellence in Friendship (تعلق) and Obedience (اطاعت) of Allah**
    2. **Excellence in Love (عشق) and Obedience (اطاعت) of Hazrat Muhammad S.A.W.W.**
    3. **Excellence in their Field of Work**

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**اللہ سے تعلق**

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| * **حضرت فرماتے تھے**   + **اللہ پاك سے کم سے کم اِتْنا تو تعلق ہو کہ آدمی دعا کے لیے ہاتھ اٹھائے اور کام ہو جائے**   + **آج ہم کہتے ہیں کے میرا فلاں سے اِتْنا تعلق ہے کے میرا نام لیا تو کام ہو جائے گا**     - **کیا ہم نے کبھی یہ کہا کے اللہ پاك سے اِتْنا تعلق ہے کہ دعا کی لیے ہاتھ اٹھائے تو کم ہو جائے جا ؟** * **انسان جب قیامت کے دن اللہ پاك کو دیکھے گا تو اس بات کی حسرت اور تمنا کرے گا کے اتنے پیارے اللہ کو میں نے دنیا میں کیوں نہیں پا لیا** |

* **امیر خُسْرَو (رحمتہ اللہ علیہ) کا شعر ہے**

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| **از لذت دیدار است خسرو چیں تواں گفتن**  **سر دادن جاں دادن نہ دیدا رخ یارے** |

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| * + **لوگوں نے اللہ کو دیکھا نہیں ہے اور اللہ کی محبت میں سَر کٹوا دیئے ( جان دے دی ) . جب اللہ کو دیکھیں گے تو کیا ہو گا (اللہ کو دیکھنے کی خوشی لفظوں میں بیان نہیں ہو سکتی(**   + **اللہ سب کا ہے . وہ مُجھ جیسے گناہ گروں کا بھی ہے . اللہ کی رحمت اور فضل سے کبھی بھی ناامید** **نہیں ہونا چاہے**   + **جو سچے دل سے اللہ پاك کو طلب کرے گا . انشا اللہ ، اللہ پاك اپنے فضل سے اسے اپنا عشق اور تعلق ضرور نصیب فرمائیں گے** |

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**حضرت محمد صلی اللہ علیہ وسلم سے عشق**

* **Hazrat Muhammad S.A.W.W. said**

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| **حدیث مبارکہ**  حَدَّثَنَا قُتَيْبَةُ بْنُ سَعِيدٍ حَدَّثَنَا يَعْقُوبُ يَعْنِي ابْنَ عَبْدِ الرَّحْمَنِ عَنْ سُهَيْلٍ عَنْ أَبِيهِ عَنْ أَبِي هُرَيْرَةَ أَنَّ رَسُولَ اللَّهِ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ قَالَ مِنْ أَشَدِّ أُمَّتِي لِي حُبًّا نَاسٌ يَكُونُونَ بَعْدِي يَوَدُّ أَحَدُهُمْ لَوْ رَآنِي بِأَهْلِهِ وَمَالِهِ  **ترجمہ**  **حضرت ابو ہریرہ رضی اللہ تعالیٰ عنہ سے روایت ہے کہ رسول اللہ صلی اللہ علیہ وسلم نے فرمایا میری امت میں میرے ساتھ سب سے زیادہ محبت کرنے والوں میں وہ لوگ ( بھی ) ہیں جو میرے بعد ہوں گے ، ان میں سے ( ہر ) ایک یہ چاہتا ہوگا کہ کاش! اپنے اہل وعیال اور مال کی قربانی دے کرمجھے دیکھ لے ۔**  **7145 مسلم صحیح** |

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| * **حضرت فرماتے تھے**   + **آج بھی ایسے لوگ دُنیا میں موجود ہیں اور قیامت تک رہیں گے**     - **جن کو حضور صلی اللہ علیہ وسلم سے ایسا عشق ہے کہ وہ ایک بار آپ صلی اللہ علیہ وسلم کو دیکھنے کے لیے اپنا سب کچھ قربان کرنے کو تیار ہیں**     - **لیکن سوال یہ ہے کہ**       * **کیا میں ان خوش نصیبوں میں سے ہوں یانہیں ؟** * **ساری دنیا کی ماؤں سے زیادہ حضرت محمد صلی اللہ علیہ وسلم کو اپنے ایک ایک امتی سے محبت ہے** * **اللہ پاك ہمیں**   + **حضرت محمد صلی اللہ علیہ وسلم سے کامل عشق**   + **آپ صلی اللہ علیہ وسلم کی کامل اتباع**   + **اور آپ صلی اللہ علیہ وسلم پر کثرت سے درود شریف پڑھنے کی توفیق عطا فرمائیں آمین** |

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**Example 01 – Excellence Achieved by Sahaba Karam R.A.**

* **Name of Sahabi R.A.**
  + **Hazrat Umar R.A.**
* **Trait 01 - Excellence in Friendship (تعلق) and Obedience (اطاعت) of Allah**
  + **Hazrat Umar R.A. achieved Excellence in the Friendship (تعلق) and Obedience (اطاعت) of Allah and Allah made him Khalifa.tur.Rasool S.A.W.W (خلیفۃ الرسول صلی اللہ علیہ وسلم)**
  + **Allah ordered the world to obey the commands of Hazrat Umar R.A. (اللہ پاک نے دنیا کو حضرت عمر رضی اللہ تعالی عنہ کے لیے مُسَخَّر کر دیا)**
  + **Earth (زمین) Obeying Hazrat Umar R.A.**

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| **مدینہ میں زلزلہ آیا . حضرت عمر رضی اللہ تعالی عنہ نے زمین پر کوڑا مارا اور فرمایا کہ کیا عمر رضی اللہ تعالی عنہ تم پر انصاف نہیں کرتا . تو کیوں ہلتی ہے . زلزلہ رک گیا** |

* + **Air (ہوا) Obeying Hazrat Umar R.A.**

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| **حضرت سریہ رضی اللہ تعالی عنہ مدینہ سے ہزاروں میل دور جنگ لڑ رہے ہیں . پہاڑ کی طرف سے دشمن آ رہا ہے اور حضرت سریہ رضی اللہ تعالی عنہ کو اُس کا پتہ نہیں ہے . حضرت عمر رضی اللہ تعالی عنہ مدینہ سے خطبہ دیتے ہُوئے فرماتے ہیں ، اے سریہ ( رضی اللہ تعالی عنہ) پہاڑ کی طرف دیکھو . ہوا حضرت عمر رضی اللہ تعالی عنہ کا پیغام حضرت سریہ رضی اللہ تعالی عنہ تک پہنچاتی ہے اور حضرت سریہ رضی اللہ تعالی عنہ کو دشمن کا پتہ چل جاتا ہے** |

* + **Water (پانی) Obeying Hazrat Umar R.A.**

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| **دریاۓ نیل خُشک ہو گیا . مشہور یہ تھا کہ کسی نوجوان لڑکی کو دلہن بنا کر دریا میں ڈالا جائے تو پِھر دریا چلتا ہے . یہ بات حضرت عمر رضی اللہ تعالی عنہ تک پہنچی . آپ رضی اللہ تعالی عنہ نے دریا ۓ نیل کو خط لکھا جس کا مفہوم ہے کہ اللہ پاك کے حکم سے چلتا ہے تو چل ، ورنہ ہمیں تیری ضرورت نہیں ہے حضرت عمر رضی اللہ تعالی عنہ کا خط دریا نیل میں ڈالا گیا اور دریاۓ نیل چل پڑا** |

* + **Fire (آگ) Obeying Hazrat Omar R.A.**

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| **مدینہ کے قریب لاوا نکلنے لگا . حضرت عمر رضی اللہ تعالی عنہ نے اپنے ساتھی کو فرمایا ، جا** **ؤ اور لاوا بند کر آ** **ؤ . وہ ساتھی گئے اور اپنے ہاتھ کے اشارے سے لاوا کو دوباہ زمین میں بند کر دیا** |

* **Trait 02 - Excellence in Love (عشق) and Obedience (اطاعت) of Hazrat Muhammad S.A.W.W.**

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| * **حضرت عمر رضی اللہ تعالی عنہ كو کائنات میں ہر چیز سے زیادہ حضرت محمد صلی اللہ علیہ وسلم سے محبت تھی** * **ایک مرتبہ حضرت عمر رضی اللہ تعالی عنہ کے کرتا مبارک کی آسْتِین لمبی ہو گئی . کسی نے قینچی دی کے فالتو کپڑا کاٹ لیں . حضرت عمر رضی اللہ تعالی عنہ نے فرمایا کہ ایک مرتبہ حضور صلی اللہ علیہ وسلم کے کرتا مبارک کی آسْتِین لمبی ہو گئی تھی آپ صلی اللہ علیہ وسلم نے اپنے کرتےمبارک کی آسْتِین کو چھری سے کاٹا تھا . میں بھی اپنے کرتے کی آسْتِین کو چھری سے کاٹوں گا۔** * **صحابہ کرام رضی اللہ تعالی عنہ دنیا اور آخرت میں کامیاب تھے کیونکہ وہ سنت کو سنت سمجھ کر اختیار کرتے تھے**   + **آج ہم مسلمان دنیا میں پریشان ہیں کیوں کہ ہم سنت کو سنت سمجھ کر چھوڑ دیتے ہَیں** |

* **Trait 03 - Excellence in their Field of Work**
  + **Hazrat Umar R.A. achieved Excellence in his Field of Work**
    - **i.e. Establishing and Running a Very Big State**

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| * **حضرت عمر رضی اللہ تعالی عنہ کا دور خلافت صرف 10 سال ہے . اِس مختصر سے وَقت میں مسلمانوں کی حکومت 22.5 لاکھ مربع میل تک پھیل گئی** * **حضرت عمر رضی اللہ تعالی عنہ . نے اتنے تھوڑے وَقت میں ایسی مثالی حکومت قائم کر دی . جسکی مثال تاریخ انسانی میں نہیں ملتی** * **حضرت عمر رضی اللہ تعالی عنہ کے دور میں اتنی خوشحالی تھی کہ لوگ زکوۃ کے پیسے لے کر ضرورت مند ڈھونڈتے تھے لیکن کوئی زکوۃ لینے والا نہیں ملتا تھا** * **حضرت عمر رضی اللہ تعالی عنہ کے دور میں اتنا امن تھا کہ ایک عورت عراق سے مدینہ تنہا سفر کرتی ہے اور اسے کوئی نظر اٹھا کر بھی نہیں دیکھتا** |

* **Conclusion**
  + **The Teaching and Learning Methodology of Hazrat Muhammad S.A.W.W. produced best Human Beings (i.e. Sahaba Karam R.A.) who performed miracles in every field of life**
  + **If we use the Teaching and Learning Methodology of Hazrat Muhammad S.A.W.W**
    - **We can also produce great Human Beings in very short time**

**SLIDE**

**Example 02 – Excellence Achieved by Sahaba Karam R.A.**

* **Name of Sahabi R.A.**
  + **Hazrat Abdur Rehman Bin Auf R.A**
* **Trait 01 - Excellence in Friendship (تعلق) and Obedience (اطاعت) of Allah**
  + **Hazrat Abdur Rehman Bin Auf R.A. is in Ashra Mubashra Sahaba R.A (صحابہ رضی اللہ تعالی عنہ عشرہ مبشرہ)**
* **Question**
  + **Who are Ashra Mubashra (عشرہ مبشرہ) Sahaba Karam R.A.?**
* **Answer**

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| * **عشرہ مبشرہ رضی اللہ تعالی عنہ وہ 10 صحابہ کرام رضی اللہ تعالی عنہ ہَیں جن کو اللہ پاك نے دنیا میں ہی جنت کی بشارت دےدی تھی** * **عشرہ مبشرہ صحابہ کرام کے نام یہ ہَیں** * **Hazrat Abu Bakar Siddiq (R.A.)**   **( حضرت أبو بكر الصديق رضی اللہ تعالی عنہ)**   * **Hazrat Umar Farooq (R.A.)**   **(حضرت عمر بن الخطاب رضی اللہ تعالی عنہ)**   * **Hazrat Usman Ghani (R.A.)**   **(حضرت عثمان بن عفان رضی اللہ تعالی عنہ)**   * **Hazrat Ali (R.A.)**   **(حضرت علي بن ابو طالب رضی اللہ تعالی عنہ)**   * **Hazrat Talha (R.A.)**   **(حضرت طلحةبن عبيدالله رضی اللہ تعالی عنہ)**   * **Hazrat Zubair ibn-e-Awam (R.A.)**   **(حضرت الزبير بن العوام بن خويلد رضی اللہ تعالی عنہ)**   * **Hazrat Abu Obaidaibn-al-Jarah (R.A.)**   **(حضرت ابوعبیدہ بن جراح رضی اللہ تعالی عنہ ‎)**   * **Hazrat Abdul Rehman Ibn-e-Auf (R.A.)**   **(حضرت عبد الرحمن بن عوف رضی اللہ تعالی عنہ ‎)**   * **Hazrat Saad Ibn-e-Abi Waqas (R.A.)**   **(حضرت سعد بن أبي وقاص رضی اللہ تعالی عنہ)**   * **Hazrat Saeed Ibn-e-Zaid (R.A.)**   **(حضرت سعيد بن زيد رضی اللہ تعالی عنہ)** |

* **Trait 02 - Excellence in Love (عشق) and Obedience (اطاعت) of Hazrat Muhammad S.A.W.W.**

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| * + **حضرت عبد الرحمان بن عوف رضی اللہ تعالی عنہ كو کائنات میں ہر چیز سے زیادہ حضرت محمد صلی اللہ علیہ وسلم سے محبت تھی**   + **حضرت عبد الرحمان بن عوف رضی اللہ تعالی عنہ نے اپنی تجارت business)) 100فیصد حضرت محمد صلی اللہ علیہ وسلم کے مبارک طَریقے کے مطابق کِیا** |

* **Trait 03 - Excellence in the Field of Work**
  + **Hazrat Abdur Rehman Bin Auf R.A achieved Excellence in his Field of Work**
    - **i.e. Business**

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| * + **حضرت عبد الرحمان بن عوف رضی اللہ تعالی عنہ کا جب انتقال ہوا تو 3 ارب سے زیادہ اشرفیاں چھوڑیں** |

* **Conclusion**
  + **The Teaching and Learning Methodology of Hazrat Muhammad S.A.W.W. produced best Human Beings (i.e. Sahaba Karam R.A.) who performed miracles in every field of life**
  + **If we use the Teaching and Learning Methodology of Hazrat Muhammad S.A.W.W**
    - **We can also produce great Human Beings in very short time**

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| **حدیث مبارکہ**  حَدَّثَنَا آدَمُ بْنُ أَبِي إِيَاسٍ , حَدَّثَنَا شُعْبَةُ ، عَنْ الْأَعْمَشِ ، قَالَ : سَمِعْتُ ذَكْوَانَ يُحَدِّثُ ، عَنْ أَبِي سَعِيدٍ الْخُدْرِيِّ رَضِيَ اللَّهُ عَنْهُ , قَالَ : قَالَ النَّبِيُّ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ : لَا تَسُبُّوا أَصْحَابِي فَلَوْ أَنَّ أَحَدَكُمْ أَنْفَقَ مِثْلَ أُحُدٍ ذَهَبًا مَا بَلَغَ مُدَّ أَحَدِهِمْ وَلَا نَصِيفَهُ . تَابَعَهُ جَرِيرٌ , وَعَبْدُ اللَّهِ بْنُ دَاوُدَ , وَأَبُو مُعَاوِيَةَ , وَمُحَاضِرٌ ، عَنْ الْأَعْمَشِ  **ترجمہ**  **نبی کریم صلی اللہ علیہ وسلم نے فرمایا میرے اصحاب کو برا بھلا مت کہو۔ اگر کوئی شخص احد پہاڑ کے برابر بھی سونا ( اللہ کی راہ میں ) خرچ کر ڈالے تو ان کے ایک مد غلہ کے برابر بھی نہیں ہو سکتا اور نہ ان کے آدھے مد کے برابر۔ شعبہ کے ساتھ اس حدیث کو جریر، عبداللہ بن داود، ابومعاویہ اور محاضر نے بھی اعمش سے روایت کیا ہے۔**  **3673 صحیح بخاری** |

**SLIDE**

**Example – Teaching and Learning Methodology of The Holy Quran**

* **Order of Allah**
  + **Allah Gave Order (حکم) that Drinking of Wine (شراب) is Haram (حرام)**
* **Allah systematically gave this Order i.e.**
  + **A Simple to Complex (Step by Step) Approach was used**
* **Step 1: Drinking of Wine is Bad**

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| **آیت مبارکہ**  یٰۤاَیُّہَا الَّذِیۡنَ اٰمَنُوۡۤا اِنَّمَا الۡخَمۡرُ وَ الۡمَیۡسِرُ وَ الۡاَنۡصَابُ وَ الۡاَزۡلَامُ رِجۡسٌ مِّنۡ عَمَلِ الشَّیۡطٰنِ فَاجۡتَنِبُوۡہُ لَعَلَّکُمۡ تُفۡلِحُوۡنَ  **ترجمہ**  **اے ایمان والو ! شراب ، جوا ، بتوں کے تھان اور جوئے کے تیر ، ( ٦٢ ) یہ سب ناپاک شیطانی کام ہیں ، لہذا ان سے بچو ، تاکہ تمہیں فلاح حاصل ہو**  **سُورَةُ المائدہ آیت 90** |

* **Step 2: You should not Drunk Wine at the Time of Namaz**

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| **آیت مبارکہ**    یٰۤاَیُّہَا الَّذِیۡنَ اٰمَنُوۡا لَا تَقۡرَبُوا الصَّلٰوۃَ وَ اَنۡتُمۡ سُکٰرٰی حَتّٰی تَعۡلَمُوۡا مَا تَقُوۡلُوۡنَ وَ لَا جُنُبًا اِلَّا عَابِرِیۡ سَبِیۡلٍ حَتّٰی تَغۡتَسِلُوۡا ؕ  **ترجمہ**  **اے ایمان والو ! جب تم نشے کی حالت میں ہو تو اس وقت تک نماز کے قریب بھی نہ جانا جب تک تم جو کچھ کہہ رہے ہو اسے سمجھنے نہ لگو ، ( ٣٢ )**  **سُورَةُ النسا آیت 43** |

* **Step 3: Drinking of Wine is Haram**

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| **آیت مبارکہ**  یَسۡئَلُوۡنَکَ عَنِ الۡخَمۡرِ وَ الۡمَیۡسِرِؕ قُلۡ فِیۡہِمَاۤ اِثۡمٌ کَبِیۡرٌ وَّ مَنَافِعُ لِلنَّاسِ ۫ وَ اِثۡمُہُمَاۤ اَکۡبَرُ مِنۡ نَّفۡعِہِمَا ؕ  **ترجمہ**  **لوگ آپ سے شراب اور جوئے کے بارے میں پوچھتے ہیں ۔ آپ کہہ دیجیے کہ ان دونوں میں بڑا گناہ بھی ہے ، اور لوگوں کے لیے کچھ فائدے بھی ہیں ، اور ان دونوں کا گناہ ان کے فائدے سے زیادہ بڑھا ہوا ہے**  **سُورَةُ البقرہ آیت 219** |

**SLIDE**

**Example – Teaching and Learning Methodology of The Holy Quran Cont…**

* **Outcome of Template-based Approach used in The Holy Quran for Teaching and Learning**
  + **When Sahaba Karam (R.A.) heard the Third Order of Allah about Wine (i.e. Drinking of Wine Is Haram)**
    - **All the Sahaba Karam (R.A.) immediately obeyed the Order of Allah and stopped drinking Wine**
* **Conclusion**
  + **Following The Holy Quran, if we use a Template-based Approach to systematically learn / perform any Real-world Task as Allah has taught us**
    - **We can make Impossible Possible In Sha Allah 😊**

**SLIDE**

**Template-based Approach Learned from the Holy Quran**

* **From the example given (from The Holy Quran) in previous Slides, we may extract the following** 
  + **Teaching and Learning Methodology**
* **To systematically learn / perform any Real-world Task** 
  + **Use a Template-based Approach**
* **To Make a Template, use the**
  + **Divide and Conquer Approach**
* **How Divide and Conquer Approach Works?**
  + **Systematically break a Real-world Task into**
    - **Steps / Sub-steps / Sub-sub-steps**
  + **For each Step / Sub-step / Sub-sub-step, see the** 
    - **Order and Flow i.e.**
      * **Use a Simple to Complex Approach**
    - **Connectivity and Independence i.e.** 
      1. **Each Step / Sub-step / Sub-sub-step must be connected to the previous and next Step / Sub-step / Sub-sub-step**
      2. **Each Step / Sub-step / Sub-sub-step must be independent of every other Step / Sub-step / Sub-sub-step**

**SLIDE**

**Note**

* **In Sha Allah, in the next Slides, I will plan, design, and write my Lecture using the**
  + **Template-based Approach which we learned from The Holy Quran**

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| **Its Story Time** |

**Story No 01**

**Reference: Book Name: Hayat Us Sahaba Part 01, Page Number: 164**

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| **Using a Template-based Approach to Systematically Perform a Real-world Task** |

**SLIDE**

**Steps – Using a Template-based Approach to Systematically Perform a Real-world Task**

* **To systematically perform any Real-world Task, follow the following steps**
  + **Step 1: Completely and correctly understand the Real-world Task**
    - **Write down two main things**
      * **Given**
      * **Task**
  + **Step 2: Understand the Input and Output of the Real-world Task**
    - **Write down two main things**
      * **Input**
      * **Output**
  + **Step 3: Plan and Design a Template-based Approach to perform the Real-world Task**
    - **Step 3.1: Use Divide and Conquer Approach to break the Real-world Task into**
      * **Steps / Sub-steps / Sub-sub-steps**
    - **Step 3.2: For each Steps / Sub-steps / Sub-sub-steps**
      * **Check the Order and Flow between Steps / Sub-steps / Sub-sub-steps**
      * **Check the Connectivity and Independence between Steps / Sub-steps / Sub-sub-steps**
  + **Step 4: Use a Five Step Process to perform the Real-world Task**
    - **Step 4.1: Plan – in Mind**
    - **Step 4.2: Design – on Paper**
    - **Step 4.3: Execute – at Prototype level**
    - **Step 4.4: Execute – at Full Scale**
    - **Step 4.5: Take Feedback from Users / Audience and Domain Experts to further improve the solution of Real-world Task**
  + **Step 5: Document each and every Step, when performing a Real-world Task**

**SLIDE**

**Importance of Documentation**

* **At university, mainly three types of degree programs are offered**
  + **Undergraduate**
  + **MPhil**
  + **PhD**
* **Let’s see the main outcome of these degree programs**
  + **Outcome of an Undergraduate Degree Programs**
    - **Final Year Project Report** 
      * **i.e. A Written Document**
  + **Outcome of a MPhil Degree Programs**
    - **MPhil Thesis** 
      * **i.e. A Written Document**
  + **Outcome of a PhD Degree Programs**
    - **PhD Thesis** 
      * **i.e. A Written Document**
* **Conclusion**
  + **As can be noted from above discussion, that**
    - **A Written Document is the main outcome of all the major degree programs offered at university level**
  + **This clearly highlights the**
    - **Importance of Documentation**

**SLIDE**

**Importance of Documentation Cont…**

* **The best book of the world i.e. the Holy Quran, is also** 
  + **A Written Document**
* **Question**
  + **How to recite The Holy Quran?**
* **Answer**
  + **Recite with Love (عشق)**
* **Situation 01 - Recitation of the Holy Quran** 
  + **A person is reciting Bismillah (اللہِ بِسمِ) and he recites the complete Bismillah (اللہِ بِسمِ) in one go and then starts reciting other Ayats (آیات) of the Holy Quran**

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| **بِسْمِ اللهِ الرَّحْمٰنِ الرَّحِيْم** |

* **Situation 02 - Recitation of The Holy Quran with Love (عشق)**
  + **A person is reciting Bismillah (اللہِ بِسمِ) and he stops at the second word of Bismillah (اللہِ بِسمِ) i.e. Allah (اللہ)**
  + **He kisses the word Allah (اللہ) and starts crying, saying that**
    - **It is the كلام of my beloved Allah (اللہ)**
  + **He repeats the word Allah (اللہ) again and again with Love**
  + **After reading the complete Bismillah (اللہِ بِسمِ), he asks himself a question**
  + **اللہ ملا کہ نہیں ملا؟**
  + **اِس تلاوت کا مقصد تھا اللہ كو پانا ، تو کیا مجھے اللہ ملا کہ نہیں ملا ؟**
* **Conclusion**
  + **Every night When you go to bed for sleep, ask yourself a question**
  + **میں اِس دنیا میں اللہ کو پانے آیا تھا**
  + **اللہ ملا کہ نہیں ملا؟**
  + **جو اللہ کو اللہ سے مانگے گا ، انشا اللہ وہ اللہ کو پا جائے گا**
  + **یا اللہ ، ہم آپ سے آپ کو مانگتے ہَیں ، ہمیں اپنا عشق اور سچا تعلق عطا فرما آمین!**

**SLIDE**

**Example - Steps (Systematically Performing a Real-world Task)**

* **Consider the following Real-world Task**
* **Real-world Task**
  + **Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem Using Train-Test-Split Approach**

**SLIDE**

**Example - Steps (Systematically Performing a Real-world Task) Cont…**

* **Step 1: Completely and correctly understand the Real-world Task**
  + **Given**
    - **Fazal of Allah (اللہ کا فضل)**
    - **Dua (دعا) and Tawajju (توجہ) of Akabir (اکابر)**
    - **Learning Material related to Pneumonia Disease Prediction (From X-ray Image) Problem, Train-Test-Split Approach and Machine Learning**
  + **Task**
    - **Design and develop a self-explanatory and detailed Lecture on**
      * **Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem Using Train-Test-Split Approach**

**SLIDE**

**Example – Steps (Systematically Performing a Real-world Task) Cont…**

* **Step 2: Understand the Input and Output of the Real-world Task**
  + **Input**
    - **Fazal of Allah (اللہ کا فضل)**
    - **Dua (دعا) and Tawajju (توجہ) of Akabir (اکابر)**
    - **Learning Material related to Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem Using Train-Test-Split Approach and Machine Learning**
  + **Output**
    - **Lecture 01 - Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem Using Train-Test-Split Approach**

**SLIDE**

**Example - Steps (Systematically Performing a Real-world Task) Cont…**

* **Step 3: Plan and Design a Template-based Approach to perform the Real-world Task**
  + **Step 3.1: Use Divide and Conquer Approach to break the Real-world Task into**
    - **Steps / Sub-steps / Sub-sub-steps**
* **Using a Template-based Approach, I have divided the Real-world Task into three main Steps**
  + **Step 1: Pneumonia Disease Prediction (From X-ray Image) Problem**
  + **Step 2: Steps – Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem Using Train-Test-Split Approach**
* **Each main Step is further divided into Sub-steps / Sub-sub-steps**
  + **In Sha Allah, I will show you the Sub-steps / Sub-sub-steps in the next Sections of the Lecture**

**SLIDE**

**Example - Steps (Systematically Performing a Real-world Task) Cont…**

* **Step 4: Use a Five Step Process to perform the Real-world Task**
  + **Step 4.1: Plan – in Mind**
  + **Step 4.2: Design – on Paper**
  + **Step 4.3: Execute – at Prototype level**
  + **Step 4.4: Execute – at Full Scale**
  + **Step 4.5: Take Feedback from Users / Audience and Domain Experts to further improve the solution of Real-world Task**
* **Alhumdulilah, with Fazal of Allah (اللہ کے فضل سے), I have performed the Real-world Task (i.e. Treating Pneumonia Disease Prediction (From X-ray Image) Problem as a Machine Learning Problem using Train-Test Split Approach) using the above Five Step Process**
* **Note**
  + **I did multiple iterations of first three Steps i.e. Plan, Design and Execute (Prototype Level)**
  + **I completed the fourth Step i.e. Execute (Full Scale)**
  + **In Sha Allah, I will wait for your valuable Feedback to further improve this Lecture**

**SLIDE**

**Example - Steps (Systematically Performing a Real-world Task) Cont…**

* **Step 5: Document each and every Step, when performing a Real-world Task**
* **Alhumdulilah, with Fazal of Allah (اللہ کے فضل سے) I have documented this Lecture and you are reading it 😊**
* **In Sha Allah, I will wait for your valuable Feedback on the quality of Documentation**

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| **Hadith** |

**Hadith No 01**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 3**

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**Hadith No 02**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 34**

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**Hadith No 03**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 82**

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**Hadith No 04**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 122**

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**Hadith No 05**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 124**

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| **Lecture Aim** |

**SLIDE**

**Lecture Aim**

* **The main aim of this Lecture is to demonstrate how Pneumonia Disease Prediction (from X-ray Image) problem can be treated as a Supervised Deep Learning Problem (using CNN)**

**SLIDE**

**What Will You Need?**

* **To read, understand, analyze and absorb how Pneumonia Disease Prediction (from X-ray Image) problem can be treated as a Supervised Deep Learning Problem (using CNN) and become a balanced and characterful personality, you will need:**
  + **Purity in Intention**
    - **Intention (نیت) to read this Lecture should be to**
      * **Get Marifat (معرفت) of Allah (اللہ کو پانا)**
      * **Become a balanced and characterful personality**
      * **Become an authority in the field of Computer Science in the whole world** 
        + **To serve the humanity for Raza of Allah (اللہ کی رضا)**
  + **Learning Material related to CNN and Machine Learning**
  + **A Laptop / PC with**
    - **Essential Software’s**

**SLIDE**

**What Will You Learn?**

* **After reading, understanding, documenting and absorbing this Lecture, In Sha Allah, you will learn:**
  + **How to systematically perform any Real-world Task using a Template-based Approach?**
  + **How to become a balanced and characterful personality?**
  + **Pneumonia Disease Prediction (from X-ray Image)**
  + **What are the main Steps to treat the Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Deep Learning Problem (using CNN)?**

**SLIDE**

**Best Medicine of the World**

* **The best medicine of the world is**

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| **Love and Respect the Humanity**  **ساری انسانیت سے محبت کریں اور ساری انسانیت کا احترام کریں** |

|  |
| --- |
| **انسانیت کی سب سے بڑی خیر خواہی** **یہ ہے کہ ساری دنیا کے انسان ہمیشہ کی دوزخ سے بچ کر ہمیشہ کی جنّت میں جانے والے بن جائیں**  **ہمارا ایمان ہے کہ حضرت محمدﷺ الله کے آخری نبی اور رسول ہیں آپ ﷺ کے بعد ( قیامت تک ) کوئی نبی اور رسول نہیں آے گا - اس لئے ختم نبوت کے صدقے یہ ہم سب کی ذمداری ہے**  **کہ خود نیک اعمال (الله کی فرمابرداری ) کرتے ہوے ساری دنیا کے انسانوں کو ایمان اور نیک اعمال (الله کی فرمابرداری ) کی دعوت دیں اور خود گناہوں (الله کی نافرمانی ) سے بچتے ہوے ساری دنیا کے انسانوں کو گناہوں (الله کی نافرمانی ) سے بچنے کی دعوت دیں**  **الله پاک قرآن میں فرماتے ہیں :**  **آیت مبارکہ**  کُنۡتُمۡ خَیۡرَ اُمَّۃٍ اُخۡرِجَتۡ لِلنَّاسِ تَاۡمُرُوۡنَ بِالۡمَعۡرُوۡفِ وَ تَنۡہَوۡنَ عَنِ الۡمُنۡکَرِ وَ تُؤۡمِنُوۡنَ بِاللّٰہِ ؕ وَ لَوۡ اٰمَنَ اَہۡلُ  الۡکِتٰبِ لَکَانَ خَیۡرًا لَّہُمۡ ؕ مِنۡہُمُ الۡمُؤۡمِنُوۡنَ وَ اَکۡثَرُہُمُ الۡفٰسِقُوۡنَ  **ترجمہ**  **مسلمانو ! تم وہ بہترین امت ہو جو لوگوں کے فائدے کے لیے وجود میں لائی گئی ہے ۔ تم نیکی کی تلقین کرتے ہو ، برائی سے روکتے ہو اور اللہ پر ایمان رکھتے ہو ۔ اگر اہل کتاب ایمان لے آتے تو یہ ان کے حق میں کہیں بہتر ہوتا ۔ ان میں سے کچھ تو مومن ہیں ، مگر ان کی اکثریت نافرمان ہے ۔**  **Aal-e-Imran, 110** |

**SLIDE**

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| **محبت**   * **کسی کو پا لینا محبت نہیں ہے کسی کے دل میں جگہ بنا لینا محبت ہے** |

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| **کبھی خاموش بیٹھو گے کبھی کچھ گنگناؤ گے**  **میں اتنا یاد آؤں گا مجھے جتنا بھلاؤ گے**  **کوئی جب پوچھ بیٹھے گا خاموشی کا سبب تم سے**  **بہت سمجھانا چاہو گے مگر سمجھا نہ پاؤ گے**  **کبھی دنیا مکمل بن کے آئے گی نگاہوں میں**  **کبھی میری کمی دنیا کی ہر اک شے میں پاؤ گے**  **کہیں پر بھی رہیں ہم تم محبت تھی محبت ہے**  **تمہیں ہم یاد آئیں گے ہمیں تم یاد آو گے** |

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| **CNN-based Deep Neural Network Architecture** |

**SLIDE**

* **Note**
  + **CNN-based Deep Neural Network cannot directly understand the Image Data**
  + **Therefore, we need to convert our Image Data into Numerical Representation (Machine Understandable Format)**
* **There are many possible approaches to convert Image into Numerical Representation (Machine Understandable Format)**
  + **For example**
    - **Pixel Value based approach**
    - **Numpy Array based approach etc.**
* **Note**
  + **In sha Allah, in this Lecture, we will use Numpy Array based approach to convert our Image (Input) into Numerical Representation (Machine Understandable Format)**

**SLIDE**

**CNN-based Deep Neural Network Architecture – Layers**

* **Input Layer**
  + **In Input Layer, following processing is performed in six main Steps**
    - **Step 01: Input Images are resized into specific dimension inorder to keep the dimension of Image consistent.**
    - **Step 02: Images at Step 01 are converted into Grayscale**
    - **Step 03: Resized Grayscale Images are converted into Numerical Representation using Numpy Array.**
    - **Step 04: Pixel Intensity Values of Images in Step 03 are Normalized**
    - **Step 05: Normalized Feature Vectors are reshaped for Deep Learning**
    - **Step 06: Fixed Length Feature Vectors are given as Input to Next Layer**
      * **i.e. CNN Layer**
* **Hidden Layer**
  + **We have used Convolutional and Pooling Layers as**
    - **Hidden Layer in this Deep Neural Network Architecture**

**SLIDE**

**CNN-based Deep Neural Network Architecture – Layers (cont…)**

* **Convolutional Layer**
  + **Convolutional layers are the key component of CNN.**
  + **In Image Classification tasks**
    - **Input to the Convolutional Layers are treated as**
      * **One 2D matrices (or channels)**
      * **More 2D matrices (or channels)**
    - **Output Generates**
      * **Multiple 2D matrices.**
* **Pooling Layer**
  + **Pooling layer plays an important role in CNN for feature dimension reduction.**
  + **Pooling is applied to combine the neighbouring elements in the convolution output matrices.**
  + **Commonly used pooling algorithms are** 
    - **Max Pooling**
    - **Average Pooling**
* **Number of Convolutional Layers**
  + **Example**
    - **Setting num\_layers =2 means**
      * **Stacking Two CNN Layers together to form a stacked CNN**
      * **Second CNN Layer taking in Outputs of the First CNN Layer and computing the final results**
  + **Default Value for Number of Convolutional Layers is**
    - **1**
* **Sequential**
  + **It defines a Sequence of layers in the neural network**
* **Batch Normalization**
  + **It Normalizes Training Instances in Batches**
* **Flatten**
  + **Flatten takes the square images and turn them into a 1 Dimentional Feature Vector**
* **Dense**
  + **Contains Fully Connected Layers of Neurons**
  + **Each layer of neurons need an activation function to tell them what to do.**
* **Activation Function**
  + **Sigmoid**
  + **Tanh**
  + **ReLU (Rectifying Linear Unit)**
  + **Leaky-ReLU**
  + **Softmax**
* **Relu**
  + **In CNN model, the ReLU activation function is used in the Convolutional Layer**
* **Output Layer**
  + **At Output Layer, we have used**
    - **Sigmoid Activation Function**
  + **The Sigmoid Activation Function is used for Binary Classification**
  + **Formula of Sigmoid Activation Function**
    - **σ(S) =**
    - **where S is Weighted sum of Inputs**

**SLIDE**

**CNN-based Deep Neural Network Architecture**

* **The Figure below shows the CNN-based Deep Neural Network Architecture, which I used in this Lecture**

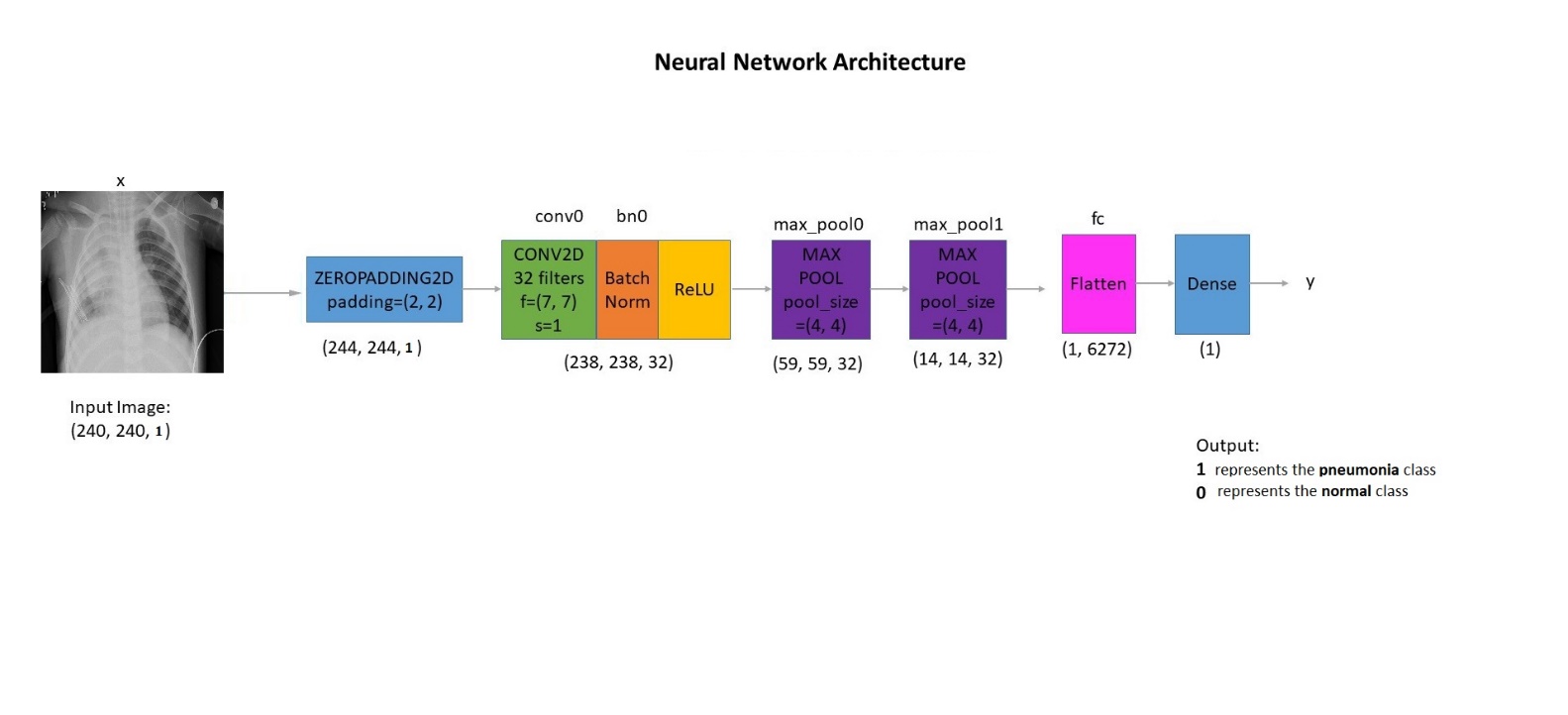


Figure 1: CNN-based Deep Neural Network Architecture

**SLIDE**

**Main Parameters – Generic**

* **Important (Generic) Parameters to consider in designing CNN-based Deep Neural Network are as follows**
  + **No. of Input Units**
  + **No. of Hidden Layers**
    - **No. of Hidden Units at each Hidden Layer**
    - **No. of Convolutional Layer**
    - **No. of Pooling Layer**
    - **No. of Batch Normalization Layer**
  + **No. of Fully Connected Layers**
  + **No. of Output Units**
  + **Activation Function at each Hidden and Output Unit**
  + **Number of Epochs**
  + **Learning Rate**
  + **Optimizer**
  + **Loss Function**

**SLIDE**

**Main Parameters – CNN Layer**

* **For CNN-based Deep Neural Network used in this Lecture, following Parameters were used**
  + **No. of Input Layer = 1**
    - **Input Size = (224 X 224 X 1)**
  + **No. of Hidden Layer = 2**
    - **No. of Convolutional Layer = 1**
    - **No. of Pooling Layer = 2**
    - **No. of Batch Normalization Layer = 1**
    - **Flatten Layer = 1**
  + **No. of Output Layer = 1**
    - **No. of Output Unit = 1**
  + **Activation Function = 1**
    - **Hidden Layer = ReLU**
    - **Output Layer = Sigmoid**
  + **Number of Epochs = 15**
  + **Learning Rate = 0.0001**
  + **Optimizer = Adam**
  + **Loss Function = binary\_crossentropy**

**SLIDE**

**Horrrrrrrraaaaaaayyyyyyyyyyyy**

* **Alhumdulilah, we have understood the CNN-based Deep Neural Network Architecture in detail**
* **Insha Allah, in the next Section, I will try to present the** 
  + **Pneumonia Disease Prediction Problem from X-ray Image**
* **Note**
  + **Always celebrate your achievements**
* **Remember**
  + **There are no such things as**
    - **Big Achievement**
    - **Small Achievement**
  + **Achievement is Achievement**

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| **Its Jokes Time** |

**Joke No 01**

|  |
| --- |
| ایک چھوٹے بچے نے اپنے والد سے پوچھا“ ابو؟کیا ہم ہوائی جہاز کے ذریعے اللہ میاں کے پاس پہنچ سکتے ہیں، ”باپ نے جواب دیا“ ارے اللہ میاں کے پاس تو کار میں بیٹھ کر بھی پہنچا جا سکتا ہے۔ بشرطیکہ کار تمہاری امی ڈرائیو کر رہی ہو۔ |

**Joke No 02**

|  |
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| ایک صاحب ڈاکٹر کے پاس گئے اور بولے۔ ”ڈاکٹر صاحب! مجھے رات کو نیند نہیں آتی۔“ ڈاکٹر نے پوچھا۔ ”کیا کام کرتے ہو؟“ مریض نے کہا۔ ”میں موٹر مکینک ہوں۔“ ڈاکٹر نے کہا۔ ”اچھا‘ تو تم اس میز کے نیچے لیٹ جاوٴ۔ نیند آ جائے گی۔“ |

**Joke No 03**

|  |
| --- |
| نئی نویلی دلہن نے جلا ہوا گوشت شوہر کے سامنے رکھا تو اس نے کھانے سے ہاتھ کھینچ لیا اور کہا۔ ”بیگم! گوشت کا ذائقہ کچھ عجیب سا ہے“۔ بیوی نے پوچھا:”کیوں‘ کیسا ہے؟“۔ شوہر نے جواب دیا:”جیسے جلا ہوا چمڑا ہو“۔ بیوی نے منہ بنا کر جواب دیا:”لَاحَول وَلَا قّوة! آپ نے بھی کیسی کیسی چیزیں چکھ رکھی ہے“۔ |

**Joke No 04**

|  |
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| ایک عورت نے اپنی سہیلی کی بہادری سے متاثر ہو کر کہا: ” تم نے واقعی بہادری دکھائی کہ ایک چور پریوں پل پڑیں کہ وہ بھاگ کھڑا ہوا“۔ عورت نے جواب دیا: ” مجھے کب پتہ تھا کہ وہ چور ہے میں یہ سمجھی تھی کہ میرا شوہر دیر سے گھر آیا ہے“۔ “ |

**Joke No 05**

|  |
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| ستاد نے ایک بچی سے گھر کے کام کی کاپی لی اور اسے دیکھنا شروع کیا‘ اس میں بہت زیادہ غلطیاں تھیں‘ ہنس کر کہنے لگیں ”تم اکیلی نے اتنی ساری غلطیاں کیسے کر لیں؟“ بچی نے معصومیت سے جواب دیا۔ ”مس! بھائی جان نے بھی میری مدد کی تھی۔” |

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| **Pneumonia Disease Prediction from X-ray Image** |

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) Problem**

* **Task**
  + **Develop a Pneumonia Disease Prediction (from X-ray Image) System to predict Pneumonia disease from X-ray Images.**
* **Input** 
  + **X-ray Image**
* **Output**
  + **Prediction of Pneumonia from X-ray Image**
* **Possible Output Values (2 Categories)**
  + **Category 01 = Normal**
  + **Category 02 = Pneumonia**
* **Treated as a**
  + **Supervised Machine Learning Problem**
* **Goal**
  + **Learn an Input-Output Function**
    - **i.e. Learn from Input to predict Output**

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) is a Classification Problem**

* **Pneumonia Disease Prediction (from X-ray Image) is a Classification Problem because** 
  + **Output is Categorical**

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) Problem - Task**

* **Given**

1. **X-ray Image**
2. **Finite set of labels (Normal and Pneumonia)**

* **Task**
  + **Assign a Single Label to the given Image from the pre-defined set of labels**

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) Problem – Input and Output**

* **Input**
  + **An X-ray Image (Unstructured)**
* **Output**
  + **Normal / Pneumonia (Categorical)**

**SLIDE**

**Example 01 – Pneumonia Disease Prediction (from X-ray Image)**

* **Input**

|  |
| --- |
|  |

* **Output**

|  |
| --- |
| **Normal** |

**SLIDE**

**Example 02 – Pneumonia Disease Prediction (from X-ray Image)**

* **Input**

|  |
| --- |
|  |

* **Output**

|  |
| --- |
| **Pneumonia** |

**SLIDE**

**Gender Identification from Image Dataset**

* **The Dataset used in this Lecture is called Pneumonia Disease Prediction from X-ray Image Dataset** 
  + **Total Instances = 100**
    - **Normal instances = 50**
    - **Pneumonia instances = 50**

**SLIDE**

**Pneumonia Disease Prediction from X-ray Image Dataset – Attributes**

* **Pneumonia Disease Prediction from X-ray Image Dataset comprises of Two Attributes**
  + **X-ray Image**
  + **Pneumonia Prediction**
* **Note**
  + **X-ray Image is Input**
  + **Pneumonia Prediction is Output**

**SLIDE**

**Pneumonia Disease Prediction from X-ray Image Dataset – Input Attributes**

* **In this Lecture, an X-ray Image (Input) is represented with 50,176 (224x224) Pixels** 
  + **Each Pixel is an Attribute / Feature**
  + **Therefore, Total Number of Input Attributes / Features will be**
    - **50,176**

**SLIDE**

**Pneumonia Disease Prediction from X-ray Image Dataset – Output Attribute**

* **In Pneumonia Disease Prediction from X-ray Image Dataset, there is One Output Attribute**
  + **Output Attribute – Pneumonia Prediction**
    - **Possible Value 01 = Normal**
    - **Possible Value 02 = Pneumonia**

**SLIDE**

**Pneumonia Disease Prediction from X-ray Image Dataset – Summary (Input and Output)**

* **The following Table summarizes the Input and Output Attributes for Pneumonia Disease Prediction from X-ray Image Dataset**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Attribute No.** | **Attribute Name** | **Represented as** | **Possible Values** | **Data Types** |
| **1** | **X-ray Image** | **50,176 Pixels (Input Attributes)** | **Range of Each Pixel (Attribute) is [0 -255]** | **Numerical** |
| **2** | **Pneumonia Prediction** | **-** | **Normal, Pneumonia** | **Categorical** |

**Table 01: Attributes of Pneumonia Disease Prediction from X-ray Image Dataset**

**SLIDE**

**Research Focus – Pneumonia Disease Prediction (from X-ray Image) System**

* **Research Focus**

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| --- |
| **Develop a Pneumonia Disease Prediction (from X-ray Image) System** |

**SLIDE**

**Horrrrrrrraaaaaaayyyyyyyyyyyy! 🚩**

* **Alhamdulillah, we have understood the Pneumonia Disease Prediction (from X-ray Image) Problem in detail**
* **In Sha Allah, in the next Section, I will try to present the** 
  + **Steps – Treating Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Machine Learning Problem using CNN**
* **Note**
  + **Always celebrate your achievements**
* **Remember**
  + **There are no such things as**
    - **Big Achievement**
    - **Small Achievement**
    - **Achievement is Achievement**

|  |
| --- |
| **Its Ghazal Time** |

**Ghazal No 1**

|  |
| --- |
| کبھی کتابوں میں پھول رکھنا کبھی درختوں پہ نام لکھنا  ہمیں بھی ہے یاد آج تک وہ نظر سے حرف سلام لکھنا  وہ چاند چہرے وہ بہکی باتیں سلگتے دن تھے مہکتی راتیں  وہ چھوٹے چھوٹے سے کاغذوں پر محبتوں کے پیام لکھنا  گلاب چہروں سے دل لگانا وہ چپکے چپکے نظر ملانا  وہ آرزوؤں کے خواب بننا وہ قصۂ ناتمام لکھنا  مرے نگر کی حسیں فضاؤ کہیں جو ان کا نشان پاؤ  تو پوچھنا یہ کہاں بسے وہ کہاں ہے ان کا قیام لکھنا  کھلی فضاؤں میں سانس لینا عبث ہے اب تو گھٹن ہے ایسی  کہ چاروں جانب شجر کھڑے ہیں صلیب صورت تمام لکھنا  گئی رتوں میں حسنؔ ہمارا بس ایک ہی تو یہ مشغلہ تھا  کسی کے چہرے کو صبح کہنا کسی کی زلفوں کو شام لکھنا  )حسن رضوی( |

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| **Steps – Treating Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Machine Learning Problem** **(using CNN)** |

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) Problem**

* **Task**
  + **Develop a Pneumonia Disease Prediction (from X-ray Image) System to predict the occurance of Pneumonia from X-ray Image of Human’s Chest**
* **Input**
* **One Attribute**

|  |
| --- |
| 1. **X-ray Image** |

* + **Representation of Input (Image)**
    - **An Image is represented as a Set of 50,176 (224 X 224) Pixels (Attributes / Features)**
  + **Range of Pixel Value** 
    - **Range of Each Pixel Value is [0 - 255]**
* **Output**
  + **One Attribute**

|  |
| --- |
| **1. Pneumonia Prediction** |

* **Treated as a**
  + **Supervised Machine Learning Problem**
* **Goal**
  + **Learn an Input-Output Function**
    - **i.e. Learn from Input to predict the Output**

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) System is a Classification Problem**

* **Pneumonia Disease Prediction (from X-ray Image) System is a Classification Problem because** 
  + **Output is Categorical**

**SLIDE**

**Pneumonia Disease Prediction (from X-ray Image) System – Input and Output**

* **Input**
  + **Image (Represented as 50,176 Pixels Values)**
* **Output**
  + **Categorical**

**SLIDE**

**Project Focus**

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| **Pneumonia Disease Prediction (from X-ray Image) System** |

**SLIDE**

**Steps – Pneumonia Disease Prediction (from X-ray Image) Problem as a Classification Problem**

* **In Sha Allah (انشاء اللہ), I will follow the following steps to treat the Pneumonia Disease Prediction (from X-ray Image) Problem as a Classification Problem** 
  + **Step 1: Decide the Learning Settings**
  + **Step 2: Obtain Sample Data** 
    - **Step 2.1: Obtain Training Data**
    - **Step 2.2: Obtain Testing Data**
    - **Step 2.3: Obtain Validation Data**
  + **Step 3: Understand and Pre-process Sample Data**
    - **Step 3.1: Understand and Pre-process Training Data**
      * **Step 3.1.1: Resize X-ray Images in Training Data**
      * **Step 3.1.2: Convert Resized RGB X-ray Images in Training Data into Grayscale**
    - **Step 3.2: Understand and Pre-process Testing Data** 
      * **Step 3.2.1: Resize X-ray Images in Testing Data**
      * **Step 3.2.2: Convert Resized RGB X-ray Images in Testing Data into Grayscale**
    - **Step 3.3: Understand and Pre-process Validation Data** 
      * **Step 3.2.1: Resize X-ray Images in Validation Data**
      * **Step 3.2.2: Convert Resized RGB X-ray Images in Validation Data into Grayscale**
  + **Step 4: Represent Sample Data in Machine Understandable Format (Numerical Representation)**
    - **Step 4.1: Represent Training Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.1.1: Convert Resized Grayscale X-ray Images of Training Data into Numpy Array**
      * **Step 4.1.2: Normalize Numpy Arrays of Grayscale X-ray Images in Training Data**
    - **Step 4.2: Represent Testing Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.2.1: Convert Resized Grayscale X-ray Images of Testing Data into Numpy Array**
      * **Step 4.2.2: Normalize Numpy Arrays of Grayscale X-ray Images in Testing Data**
    - **Step 4.3: Represent Validation Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.3.1: Convert Resized Grayscale X-ray Images of Validation Data into Numpy Array**
      * **Step 4.3.2: Normalize Numpy Arrays of Grayscale X-ray Images in Validation Data**
  + **Step 5: Select Suitable Deep Learning Algorithms**
  + **Step 6: Select Suitable Evaluation Measure(s)**
  + **Step 7: Execute First Two Phases of Machine Learning Cycle**
    - **Training Phase**
    - **Testing Phase**
  + **Step 8: Analyze Results**

|  |
| --- |
| **If (Results are Good)**  **Then**  **Move to the Next Step**  **Else**  **Go to Step 1** |

* + **Step 9: Execute 3rd and 4th Phases of Machine Learning Cycle**
    - **Application Phase**
    - **Feedback Phase**
  + **Step 10: Based on Feedback**
    - **Go to Step 1 and Repeat all the Steps**

|  |
| --- |
| **Step 1: Decide the Learning Setting** |

**SLIDE**

**Step 1: Decide the Learning Setting**

* **In Sha Allah (انشاء اللہ), I will treat the Pneumonia Disease Prediction (from X-ray Image) Problem as a** 
  + **Supervised Machine Learning Problem**
* **Since Output is Categorical, it will be treated as a**
  + **Classification Problem**

|  |
| --- |
| **Step 2: Obtain Sample Data** |

**SLIDE**

**Obtain Sample Data**

* **Since I am Treating Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Machine Learning Problem, I will need**
  + **Annotated Data**
* **For more accurate learning, I need**
  1. **Large amount of Annotated Data**
  2. **High-quality Annotated Data**
  3. **Balanced Data**
* **Note**
  + **For simplicity, In Sha Allah (انشاء اللہ) I will use a Dataset of 100 Images**

**SLIDE**

**Obtain Sample Data Cont…**

* **Two Main Choices to Obtain Data**
  + **Use an Existing Corpus / Dataset**
  + **Create your own Corpus / Dataset**
* **Insha Allah, in this Lecture, I will create my own Dataset of 100 Images**
  + **I will download 100 Images from Word Wide Web which are free and publicly available for research purposes**
* **See Sample-Data Folder and in Supporting Material**
* **The Following Table shows Sample Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output**  **(Pneumonia Prediction)** |
| **x1** |  | **Normal** |
| **x2** |  | **Normal** |
| **x3** |  | **Normal** |
| **x4** |  | **Normal** |
| **x5** |  | **Normal** |
| **x6** |  | **Normal** |
| **x7** |  | **Normal** |
| **x8** |  | **Normal** |
| **x9** |  | **Normal** |
| **x10** |  | **Normal** |
| **x11** |  | **Normal** |
| **x12** |  | **Normal** |
| **x13** |  | **Normal** |
| **x14** |  | **Normal** |
| **x15** |  | **Normal** |
| **x16** |  | **Normal** |
| **x17** |  | **Normal** |
| **x18** |  | **Normal** |
| **x19** |  | **Normal** |
| **x20** |  | **Normal** |
| **x21** |  | **Normal** |
| **x22** |  | **Normal** |
| **x23** |  | **Normal** |
| **x24** |  | **Normal** |
| **x25** |  | **Normal** |
| **x26** |  | **Normal** |
| **x27** |  | **Normal** |
| **x28** |  | **Normal** |
| **x29** |  | **Normal** |
| **x30** |  | **Normal** |
| **x31** |  | **Normal** |
| **x32** |  | **Normal** |
| **x33** |  | **Normal** |
| **x34** |  | **Normal** |
| **x35** |  | **Normal** |
| **x36** |  | **Normal** |
| **x37** |  | **Normal** |
| **x38** |  | **Normal** |
| **x39** |  | **Normal** |
| **x40** |  | **Normal** |
| **x41** |  | **Normal** |
| **x42** |  | **Normal** |
| **x43** |  | **Normal** |
| **x44** |  | **Normal** |
| **x45** |  | **Normal** |
| **x46** |  | **Normal** |
| **x47** |  | **Normal** |
| **x48** |  | **Normal** |
| **x49** |  | **Normal** |
| **x50** |  | **Normal** |
| **x51** |  | **Pneumonia** |
| **x52** |  | **Pneumonia** |
| **x53** |  | **Pneumonia** |
| **x54** |  | **Pneumonia** |
| **x55** |  | **Pneumonia** |
| **x56** |  | **Pneumonia** |
| **x57** |  | **Pneumonia** |
| **x58** |  | **Pneumonia** |
| **x59** |  | **Pneumonia** |
| **x60** |  | **Pneumonia** |
| **x61** |  | **Pneumonia** |
| **x62** |  | **Pneumonia** |
| **x63** |  | **Pneumonia** |
| **x64** |  | **Pneumonia** |
| **x65** |  | **Pneumonia** |
| **x66** |  | **Pneumonia** |
| **x67** |  | **Pneumonia** |
| **x68** |  | **Pneumonia** |
| **x69** |  | **Pneumonia** |
| **x70** |  | **Pneumonia** |
| **x71** |  | **Pneumonia** |
| **x72** |  | **Pneumonia** |
| **x73** |  | **Pneumonia** |
| **x74** |  | **Pneumonia** |
| **x75** |  | **Pneumonia** |
| **x76** |  | **Pneumonia** |
| **x77** |  | **Pneumonia** |
| **x78** |  | **Pneumonia** |
| **x79** |  | **Pneumonia** |
| **x80** |  | **Pneumonia** |
| **x81** |  | **Pneumonia** |
| **x82** |  | **Pneumonia** |
| **x83** |  | **Pneumonia** |
| **x84** |  | **Pneumonia** |
| **x85** |  | **Pneumonia** |
| **x86** |  | **Pneumonia** |
| **x87** |  | **Pneumonia** |
| **x88** |  | **Pneumonia** |
| **x89** |  | **Pneumonia** |
| **x90** |  | **Pneumonia** |
| **x91** |  | **Pneumonia** |
| **x92** |  | **Pneumonia** |
| **x93** |  | **Pneumonia** |
| **x94** |  | **Pneumonia** |
| **x95** |  | **Pneumonia** |
| **x96** |  | **Pneumonia** |
| **x97** |  | **Pneumonia** |
| **x98** |  | **Pneumonia** |
| **x99** |  | **Pneumonia** |
| **x100** |  | **Pneumonia** |

**SLIDE**

**Obtain Sample Data Cont…**

* **Total Instances (X-ray Images) in Sample Data = 100**
  + **Normal = 50**
  + **Pneumonia = 50**
* **We split Sample Data in** 
  + **Train-Test- Split Ratio of 80-20**
* **Total Instances in Training Data = 72**
  + **Normal = 36**
  + **Pneumonia = 36**
* **Total Instances in Testing Data = 20**
  + **Normal = 10**
  + **Pneumonia = 10**
* **Total Instances in Validation Data = 20**
  + **Normal = 4**
  + **Pneumonia = 4**

|  |
| --- |
| **Step 2.1: Obtain Training Data** |

**SLIDE**

**Obtain Training Data**

* **We obtained Training Data of 72 X-ray Images (Instances)**
  + **See Sample Data/Training\_Data Folder in Supporting Material**
* **The following Table shows the Training Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output**  **(Pneumonia Prediction)** |
| **x1** |  | **Normal** |
| **x2** |  | **Normal** |
| **x3** |  | **Normal** |
| **x4** |  | **Normal** |
| **x5** |  | **Normal** |
| **x6** |  | **Normal** |
| **x7** |  | **Normal** |
| **x8** |  | **Normal** |
| **x9** |  | **Normal** |
| **x10** |  | **Normal** |
| **x11** |  | **Normal** |
| **x12** |  | **Normal** |
| **x13** |  | **Normal** |
| **x14** |  | **Normal** |
| **x15** |  | **Normal** |
| **x16** |  | **Normal** |
| **x17** |  | **Normal** |
| **x18** |  | **Normal** |
| **x19** |  | **Normal** |
| **x20** |  | **Normal** |
| **x21** |  | **Normal** |
| **x22** |  | **Normal** |
| **x23** |  | **Normal** |
| **x24** |  | **Normal** |
| **x25** |  | **Normal** |
| **x26** |  | **Normal** |
| **x27** |  | **Normal** |
| **x28** |  | **Normal** |
| **x29** |  | **Normal** |
| **x30** |  | **Normal** |
| **x31** |  | **Normal** |
| **x32** |  | **Normal** |
| **x33** |  | **Normal** |
| **x34** |  | **Normal** |
| **x35** |  | **Normal** |
| **x36** |  | **Normal** |
| **x37** |  | **Pneumonia** |
| **x38** |  | **Pneumonia** |
| **x39** |  | **Pneumonia** |
| **x40** |  | **Pneumonia** |
| **x41** |  | **Pneumonia** |
| **x42** |  | **Pneumonia** |
| **x43** |  | **Pneumonia** |
| **x44** |  | **Pneumonia** |
| **x45** |  | **Pneumonia** |
| **x46** |  | **Pneumonia** |
| **x47** |  | **Pneumonia** |
| **x48** |  | **Pneumonia** |
| **x49** |  | **Pneumonia** |
| **x50** |  | **Pneumonia** |
| **x51** |  | **Pneumonia** |
| **x52** |  | **Pneumonia** |
| **x53** |  | **Pneumonia** |
| **x54** |  | **Pneumonia** |
| **x55** |  | **Pneumonia** |
| **x56** |  | **Pneumonia** |
| **x57** |  | **Pneumonia** |
| **x58** |  | **Pneumonia** |
| **x59** |  | **Pneumonia** |
| **x60** |  | **Pneumonia** |
| **x61** |  | **Pneumonia** |
| **x62** |  | **Pneumonia** |
| **x63** |  | **Pneumonia** |
| **x64** |  | **Pneumonia** |
| **x65** |  | **Pneumonia** |
| **x66** |  | **Pneumonia** |
| **x67** |  | **Pneumonia** |
| **x68** |  | **Pneumonia** |
| **x69** |  | **Pneumonia** |
| **x70** |  | **Pneumonia** |
| **x71** |  | **Pneumonia** |
| **x72** |  | **Pneumonia** |

|  |
| --- |
| **Step 2.2: Obtain Testing Data** |

**SLIDE**

**Obtain Testing Data**

* **We obtained Testing Data of 20 X-ray Images (Instances)**
  + **See Sample Data/Testing\_Data Folder in Supporting Material**
* **The following Table shows the Testing Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output**  **(Pneumonia Prediction)** |
| **x1** |  | **Normal** |
| **x2** |  | **Normal** |
| **x3** |  | **Normal** |
| **x4** |  | **Normal** |
| **x5** |  | **Normal** |
| **x6** |  | **Normal** |
| **x7** |  | **Normal** |
| **x8** |  | **Normal** |
| **x9** |  | **Normal** |
| **x10** |  | **Normal** |
| **x11** |  | **Pneumonia** |
| **x12** |  | **Pneumonia** |
| **x13** |  | **Pneumonia** |
| **x14** |  | **Pneumonia** |
| **x15** |  | **Pneumonia** |
| **x16** |  | **Pneumonia** |
| **x17** |  | **Pneumonia** |
| **x18** |  | **Pneumonia** |
| **x19** |  | **Pneumonia** |
| **x20** |  | **Pneumonia** |

|  |
| --- |
| **Step 2.3: Obtain Validation Data** |

**SLIDE**

**Obtain Validation Data**

* **We obtained Validation Data of 8 X-ray Images (Instances)**
  + **See Sample Data/Validation\_Data Folder in Supporting Material**
* **The following Table shows the Validation Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output**  **(Pneumonia Prediction)** |
| **x1** |  | **Normal** |
| **x2** |  | **Normal** |
| **x3** |  | **Normal** |
| **x4** |  | **Normal** |
| **x5** |  | **Pneumonia** |
| **x6** |  | **Pneumonia** |
| **x7** |  | **Pneumonia** |
| **x8** |  | **Pneumonia** |

|  |
| --- |
| **Step 03: Understand and Pre-process Sample Data** |

**SLIDE**

**Step 3: Understand and Pre-process Sample Data**

* **Understanding Data**
  + **The Sample Data contains Two Attributes** 
    - **X-ray Image**
    - **Pneumonia Prediction**
  + **Separating Input from Output**
    - **Input comprises of a Single Attribute**
      * **X-ray Image**
    - **The Output comprises of a Single Attribute**
      * **Pneumonia Prediction**

|  |
| --- |
| **Step 3.1: Understand and Pre-process Training Data** |

**SLIDE**

**Step 3: Understand and Pre-process Training Data**

* **Understanding Data**
  + **The Training Data contains Two Attributes** 
    - **X-ray Image**
    - **Pneumonia Prediction**
  + **Separating Input from Output**
    - **Input comprises of a Single Attribute**
      * **X-ray Image**
    - **The Output comprises of a Single Attribute**
      * **Pneumonia Prediction**
* **Total Instances in Training Data = 72**
  + **Normal = 36**
  + **Pneumonia = 36**

|  |
| --- |
| **Step 3.1.1: Resize X-ray Images in Training Data** |

* **Pre-process Data**
  + **We resized all images to 50,176 pixels i.e. (224 x 224 resolution) to keep the dataset consistent**
  + **See Sample Data/Preprocessed Data/Resized Data/Training\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Training Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Original X-ray Images** | **(Preprocessed)**  **Resized X-ray Images** | **Output (Pneumonia Prediction)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Normal** |
| **x6** |  |  | **Normal** |
| **x7** |  |  | **Normal** |
| **x8** |  |  | **Normal** |
| **x9** |  |  | **Normal** |
| **x10** |  |  | **Normal** |
| **x11** |  |  | **Normal** |
| **x12** |  |  | **Normal** |
| **x13** |  |  | **Normal** |
| **x14** |  |  | **Normal** |
| **x15** |  |  | **Normal** |
| **x16** |  |  | **Normal** |
| **x17** |  |  | **Normal** |
| **x18** |  |  | **Normal** |
| **x19** |  |  | **Normal** |
| **x20** |  |  | **Normal** |
| **x21** |  |  | **Normal** |
| **x22** |  |  | **Normal** |
| **x23** |  |  | **Normal** |
| **x24** |  |  | **Normal** |
| **x25** |  |  | **Normal** |
| **x26** |  |  | **Normal** |
| **x27** |  |  | **Normal** |
| **x28** |  |  | **Normal** |
| **x29** |  |  | **Normal** |
| **x30** |  |  | **Normal** |
| **x31** |  |  | **Normal** |
| **x32** |  |  | **Normal** |
| **x33** |  |  | **Normal** |
| **x34** |  |  | **Normal** |
| **x35** |  |  | **Normal** |
| **x36** |  |  | **Normal** |
| **x37** |  |  | **Pneumonia** |
| **x38** |  |  | **Pneumonia** |
| **x39** |  |  | **Pneumonia** |
| **x40** |  |  | **Pneumonia** |
| **x41** |  |  | **Pneumonia** |
| **x42** |  |  | **Pneumonia** |
| **x43** |  |  | **Pneumonia** |
| **x44** |  |  | **Pneumonia** |
| **x45** |  |  | **Pneumonia** |
| **x46** |  |  | **Pneumonia** |
| **x47** |  |  | **Pneumonia** |
| **x48** |  |  | **Pneumonia** |
| **x49** |  |  | **Pneumonia** |
| **x50** |  |  | **Pneumonia** |
| **x51** |  |  | **Pneumonia** |
| **x52** |  |  | **Pneumonia** |
| **x53** |  |  | **Pneumonia** |
| **x54** |  |  | **Pneumonia** |
| **x55** |  |  | **Pneumonia** |
| **x56** |  |  | **Pneumonia** |
| **x57** |  |  | **Pneumonia** |
| **x58** |  |  | **Pneumonia** |
| **x59** |  |  | **Pneumonia** |
| **x60** |  |  | **Pneumonia** |
| **x61** |  |  | **Pneumonia** |
| **x62** |  |  | **Pneumonia** |
| **x63** |  |  | **Pneumonia** |
| **x64** |  |  | **Pneumonia** |
| **x65** |  |  | **Pneumonia** |
| **x66** |  |  | **Pneumonia** |
| **x67** |  |  | **Pneumonia** |
| **x68** |  |  | **Pneumonia** |
| **x69** |  |  | **Pneumonia** |
| **x70** |  |  | **Pneumonia** |
| **x71** |  |  | **Pneumonia** |
| **x72** |  |  | **Pneumonia** |

**SLIDE**

**Note**

|  |
| --- |
| * **To be successful in life, try to spend most of your time with people**   + **Who are clean from two main diseases?** * **مولانا عبدالرحمن اشرفی رح فرماتے تھے کہ،**   + **قرآن پاک کا خلاصہ 2 باتیں ہیں: (1) بدکلامی اور (2) بد گمانی**     - **بد کلامی سے جسمانی بیماریاں پیدا ہوتی ہیں**     - **بد گمانی سے روحانی بیماریاں پیدا ہوتی ہیں** * **ان دونوں ( بد کلامی اور بد گمانی) کا خلاصہ ہے**   + **عاجزی** * **استاد محترم فرماتے ہیں کہ،**   + **اللہ پاک عاجزی پر ملتے ہیں** |

|  |
| --- |
| **Step 3.1.2: Convert Resized RGB X-ray Images in Training Data into Grayscale** |

**SLIDE**

* **Pre-process Data**
  + **We converted all X-ray images from RGB (Red, Green, Blue) Color Channels to Grayscale.**
  + **See Sample Data/Preprocessed Data/Grayscale Data/Training\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Training Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Resized RGB X-ray Images** | **(Preprocessed)**  **Grayscale X-ray Images** | **Output (Pneumonia Prediction)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Normal** |
| **x6** |  |  | **Normal** |
| **x7** |  |  | **Normal** |
| **x8** |  |  | **Normal** |
| **x9** |  |  | **Normal** |
| **x10** |  |  | **Normal** |
| **x11** |  |  | **Normal** |
| **x12** |  |  | **Normal** |
| **x13** |  |  | **Normal** |
| **x14** |  |  | **Normal** |
| **x15** |  |  | **Normal** |
| **x16** |  |  | **Normal** |
| **x17** |  |  | **Normal** |
| **x18** |  |  | **Normal** |
| **x19** |  |  | **Normal** |
| **x20** |  |  | **Normal** |
| **x21** |  |  | **Normal** |
| **x22** |  |  | **Normal** |
| **x23** |  |  | **Normal** |
| **x24** |  |  | **Normal** |
| **x25** |  |  | **Normal** |
| **x26** |  |  | **Normal** |
| **x27** |  |  | **Normal** |
| **x28** |  |  | **Normal** |
| **x29** |  |  | **Normal** |
| **x30** |  |  | **Normal** |
| **x31** |  |  | **Normal** |
| **x32** |  |  | **Normal** |
| **x33** |  |  | **Normal** |
| **x34** |  |  | **Normal** |
| **x35** |  |  | **Normal** |
| **x36** |  |  | **Normal** |
| **x37** |  |  | **Pneumonia** |
| **x38** |  |  | **Pneumonia** |
| **x39** |  |  | **Pneumonia** |
| **x40** |  |  | **Pneumonia** |
| **x41** |  |  | **Pneumonia** |
| **x42** |  |  | **Pneumonia** |
| **x43** |  |  | **Pneumonia** |
| **x44** |  |  | **Pneumonia** |
| **x45** |  |  | **Pneumonia** |
| **x46** |  |  | **Pneumonia** |
| **x47** |  |  | **Pneumonia** |
| **x48** |  |  | **Pneumonia** |
| **x49** |  |  | **Pneumonia** |
| **x50** |  |  | **Pneumonia** |
| **x51** |  |  | **Pneumonia** |
| **x52** |  |  | **Pneumonia** |
| **x53** |  |  | **Pneumonia** |
| **x54** |  |  | **Pneumonia** |
| **x55** |  |  | **Pneumonia** |
| **x56** |  |  | **Pneumonia** |
| **x57** |  |  | **Pneumonia** |
| **x58** |  |  | **Pneumonia** |
| **x59** |  |  | **Pneumonia** |
| **x60** |  |  | **Pneumonia** |
| **x61** |  |  | **Pneumonia** |
| **x62** |  |  | **Pneumonia** |
| **x63** |  |  | **Pneumonia** |
| **x64** |  |  | **Pneumonia** |
| **x65** |  |  | **Pneumonia** |
| **x66** |  |  | **Pneumonia** |
| **x67** |  |  | **Pneumonia** |
| **x68** |  |  | **Pneumonia** |
| **x69** |  |  | **Pneumonia** |
| **x70** |  |  | **Pneumonia** |
| **x71** |  |  | **Pneumonia** |
| **x72** |  |  | **Pneumonia** |

|  |
| --- |
| **Step 3.2: Understand and Pre-process Testing Data** |

**SLIDE**

**Step 3.2: Understand and Pre-process Testing Data**

* **Understanding Data**
  + **The Testing Data contains Two Attributes** 
    - **X-ray Image**
    - **Pneumonia Prediction**
  + **Separating Input from Output**
    - **Input comprises of a Single Attribute**
      * **X-ray Image**
    - **The Output comprises of a Single Attribute**
      * **Pneumonia Prediction**
* **Total Instances in Testing Data = 20**
  + **Normal = 10**
  + **Pneumonia = 10**

|  |
| --- |
| **Step 3.2.1: Resize X-ray Images in Testing Data** |

**SLIDE**

* **Pre-process Data**
  + **We resized all images to 50,176 pixels i.e. (224 x 224 resolution) to keep the dataset consistent**
  + **See Sample Data/Preprocessed Data/Resized Data/Testing\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Testing Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Original X-ray Images** | **(Preprocessed)**  **Resized X-ray Images** | **Output (Pneumonia Prediction)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Normal** |
| **x6** |  |  | **Normal** |
| **x7** |  |  | **Normal** |
| **x8** |  |  | **Normal** |
| **x9** |  |  | **Normal** |
| **x10** |  |  | **Normal** |
| **x11** |  |  | **Pneumonia** |
| **x12** |  |  | **Pneumonia** |
| **x13** |  |  | **Pneumonia** |
| **x14** |  |  | **Pneumonia** |
| **x15** |  |  | **Pneumonia** |
| **x16** |  |  | **Pneumonia** |
| **x17** |  |  | **Pneumonia** |
| **x18** |  |  | **Pneumonia** |
| **x19** |  |  | **Pneumonia** |
| **x20** |  |  | **Pneumonia** |

|  |
| --- |
| **Step 3.2.2: Convert Resized RGB X-ray Images in Testing Data into Grayscale** |

**SLIDE**

* **Pre-process Data**
  + **We converted all X-ray images from RGB (Red, Green, Blue) Color Channels to Grayscale.**
  + **See Sample Data/Preprocessed Data/Grayscale Data/Testing\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Testing Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Resized RGB X-ray Images** | **(Preprocessed)**  **Grayscale X-ray Images** | **Output (Pneumonia Prediction)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Normal** |
| **x6** |  |  | **Normal** |
| **x7** |  |  | **Normal** |
| **x8** |  |  | **Normal** |
| **x9** |  |  | **Normal** |
| **x10** |  |  | **Normal** |
| **x11** |  |  | **Pneumonia** |
| **x12** |  |  | **Pneumonia** |
| **x13** |  |  | **Pneumonia** |
| **x14** |  |  | **Pneumonia** |
| **x15** |  |  | **Pneumonia** |
| **x16** |  |  | **Pneumonia** |
| **x17** |  |  | **Pneumonia** |
| **x18** |  |  | **Pneumonia** |
| **x19** |  |  | **Pneumonia** |
| **x20** |  |  | **Pneumonia** |

|  |
| --- |
| **Step 3.3: Understand and Pre-process Validation Data** |

**SLIDE**

**Step 3.2: Understand and Pre-process Validation Data**

* **Understanding Data**
  + **The Validation Data contains Two Attributes** 
    - **X-ray Image**
    - **Pneumonia Prediction**
  + **Separating Input from Output**
    - **Input comprises of a Single Attribute**
      * **X-ray Image**
    - **The Output comprises of a Single Attribute**
      * **Pneumonia Prediction**
* **Total Instances in Validation Data = 8**
  + **Normal = 4**
  + **Pneumonia = 4**

|  |
| --- |
| **Step 3.3.1: Resize X-ray Images in Validation Data** |

**SLIDE**

* **Pre-process Data**
  + **We resized all images to 50,176 pixels i.e. (224 x 224 resolution) to keep the dataset consistent**
  + **See Sample Data/Preprocessed Data/Resized Data/Validation\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Testing Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Original X-ray Images** | **(Preprocessed)**  **Resized X-ray Images** | **Output (Gender)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Pneumonia** |
| **x6** |  |  | **Pneumonia** |
| **x7** |  |  | **Pneumonia** |
| **x8** |  |  | **Pneumonia** |

|  |
| --- |
| **Step 3.3.2: Convert Resized RGB X-ray Images in Validation Data into Grayscale** |

* **Pre-process Data**
  + **We converted all X-ray images from RGB (Red, Green, Blue) Color Channels to Grayscale.**
  + **See Sample Data/Preprocessed Data/Grayscale Data/Validation\_Data Folder in Supporting Material**

**SLIDE**

**Original Sample Data Vs Pre-processed Validation Data**

|  |  |  |  |
| --- | --- | --- | --- |
| **Instance No.** | **Resized RGB X-ray Images** | **(Preprocessed)**  **Grayscale X-ray Images** | **Output (Gender)** |
| **x1** |  |  | **Normal** |
| **x2** |  |  | **Normal** |
| **x3** |  |  | **Normal** |
| **x4** |  |  | **Normal** |
| **x5** |  |  | **Pneumonia** |
| **x6** |  |  | **Pneumonia** |
| **x7** |  |  | **Pneumonia** |
| **x8** |  |  | **Pneumonia** |

**SLIDE**

**Note**

* **Alhamdulillah (الحمدللہ), We have Understood and Preprocessed Sample Data**
* **In Sha Allah (انشاء اللہ), in the next Slides, I will try to explain how to Represent Sample Data in Machine Understandable Format (Numerical Representation)**

|  |
| --- |
| **Step 04: Represent Sample Data in Machine Understandable Format (Numerical Representation)** |

**SLIDE**

**Step 4: Represent Sample Data in Machine Understandable Format**

* **Feature-based Classification Algorithms (implemented in Keras) can understand data in** 
  + **Attribute-Value Pair** 
    - **Values of Attributes / Features must be Numeric**
* **Problem**
  + **Our Sample Data is not in Attribute-Value Pair form**
    - **We need to transform our Sample Data into Machine Understandable Format**
* **Solution**
  + **There are many approaches to transform Sample Data into Machine Understandable Format**

**SLIDE**

**Important Note**

* **In this Lecture, we are using Keras implementation of the Convolution Neural Networks (CNN) Machine Learning Algorithm**
* **Scikit-learn can only understand Data in Numerical Representation**
  + **Therefore, we will need to Convert both Input (Image) and Output (Gender) into Numerical Representation**

**SLIDE**

**Transforming Sample Data in Machine Understandable Format**

* **In our Sample Data**
  + **Input is Unstructured (X-ray Image)**
  + **Output is Categorical**
* **Considering Input (X-ray Image) and Output (Pneumonia Prediction), we will need to** 
  + **Transform Input (X-ray Image) into Numerical Representation**
  + **Transform Output (Categorical) into Numerical Representation**

**SLIDE**

**Converting Output into Numerical Representation**

* **A Two-Step Process** 
  + **Step 01: Define an Encoding Scheme**
  + **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Sample Data**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 01: Define an Encoding Scheme**
* **Encoding Scheme for Gender Attribute**
  + **Normal = 0**
  + **Pneumonia = 1**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Sample Data**
* **The Table below shows Pre-processed Sample Data after Encoding Categorical Output Values to Numerical Output Values**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output (Pneumonia Prediction)** |
| **x1** |  | **0** |
| **x2** |  | **0** |
| **x3** |  | **0** |
| **x4** |  | **0** |
| **x5** |  | **0** |
| **x6** |  | **0** |
| **x7** |  | **0** |
| **x8** |  | **0** |
| **x9** |  | **0** |
| **x10** |  | **0** |
| **x11** |  | **0** |
| **x12** |  | **0** |
| **x13** |  | **0** |
| **x14** |  | **0** |
| **x15** |  | **0** |
| **x16** |  | **0** |
| **x17** |  | **0** |
| **x18** |  | **0** |
| **x19** |  | **0** |
| **x20** |  | **0** |
| **x21** |  | **0** |
| **x22** |  | **0** |
| **x23** |  | **0** |
| **x24** |  | **0** |
| **x25** |  | **0** |
| **x26** |  | **0** |
| **x27** |  | **0** |
| **x28** |  | **0** |
| **x29** |  | **0** |
| **x30** |  | **0** |
| **x31** |  | **0** |
| **x32** |  | **0** |
| **x33** |  | **0** |
| **x34** |  | **0** |
| **x35** |  | **0** |
| **x36** |  | **0** |
| **x37** |  | **0** |
| **x38** |  | **0** |
| **x39** |  | **0** |
| **x40** |  | **0** |
| **x41** |  | **0** |
| **x42** |  | **0** |
| **x43** |  | **0** |
| **x44** |  | **0** |
| **x45** |  | **0** |
| **x46** |  | **0** |
| **x47** |  | **0** |
| **x48** |  | **0** |
| **x49** |  | **0** |
| **x50** |  | **0** |
| **x51** |  | **1** |
| **x52** |  | **1** |
| **x53** |  | **1** |
| **x54** |  | **1** |
| **x55** |  | **1** |
| **x56** |  | **1** |
| **x57** |  | **1** |
| **x58** |  | **1** |
| **x59** |  | **1** |
| **x60** |  | **1** |
| **x61** |  | **1** |
| **x62** |  | **1** |
| **x63** |  | **1** |
| **x64** |  | **1** |
| **x65** |  | **1** |
| **x66** |  | **1** |
| **x67** |  | **1** |
| **x68** |  | **1** |
| **x69** |  | **1** |
| **x70** |  | **1** |
| **x71** |  | **1** |
| **x72** |  | **1** |
| **x73** |  | **1** |
| **x74** |  | **1** |
| **x75** |  | **1** |
| **x76** |  | **1** |
| **x77** |  | **1** |
| **x78** |  | **1** |
| **x79** |  | **1** |
| **x80** |  | **1** |
| **x81** |  | **1** |
| **x82** |  | **1** |
| **x83** |  | **1** |
| **x84** |  | **1** |
| **x85** |  | **1** |
| **x86** |  | **1** |
| **x87** |  | **1** |
| **x88** |  | **1** |
| **x89** |  | **1** |
| **x90** |  | **1** |
| **x91** |  | **1** |
| **x92** |  | **1** |
| **x93** |  | **1** |
| **x94** |  | **1** |
| **x95** |  | **1** |
| **x96** |  | **1** |
| **x97** |  | **1** |
| **x98** |  | **1** |
| **x99** |  | **1** |
| **x100** |  | **1** |

**SLIDE**

**Note**

* **Alhamdulillah (الحمدللہ), Output is transformed into Numerical Representation**
* **In Sha Allah (انشاء اللہ), in the next Slides, I will try to explain how to transform Input (Image) into Numerical Representation**

**SLIDE**

**Feature Extraction - Converting Input into Numerical Representation**

* **Considering Feature-based ML Algorithms, an Input can be transformed into Numerical Representation in the following steps**
  + **Step 1: Select a Feature Extraction Method**
  + **Step 2: Extract Features from Input using the Feature Extraction Method selected in Step 1**
  + **Step 3: Normalize the Features Extracted in Step 2**

**SLIDE**

**Feature Extraction - Converting Input into Numerical Representation**

* **Step 1: Select a Feature Extraction Method**
* **Insha Allah (انشاء اللہ), I will use Numpy Array based Feature Extraction Method to transform Sample Data into Numerical Representation (Machine Understandable Format)**
  + **Total Features = 224 X 224 = 50,176**
    - **Feature 01 = Value of Pixel 01**
    - **Feature 02 = Value of Pixel 02**
    - **Feature 03 = Value of Pixel 03**
    - **……..**
    - **Feature 50,175 = Value of Pixel 50,175**
    - **Feature 50,176 = Value of Pixel 50,176**
  + **Feature Value = Value of Pixel between 0 to 255**

**SLIDE**

**Feature Extraction - Converting Input into Numerical Representation**

* **Step 2: Extract Features from Input using the Feature Extraction Method selected in Step 1**
* **Step 3: The Extracted Features in Step 2 are Normalized in pixel Intensity values ranged between (0-1)** 
  + **Original Range of Pixel Intensity Values = 0-255**
  + **Normalized Range of Pixel Intensity Values = 0-1**
* **After Feature Normalization, Input is transformed into Numerical Representation**

**SLIDE**

**Hoooooooorrrrrrrrrraaaaaaaaayyyyyyyyyyy! 🚩**

* **Alhamdulillah (الحمدللہ), both Input and Output are transformed into Numerical Representation**

**SLIDE**

**Recap – Original Sample Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output**  **(Pneumonia Prediction)** |
| **x1** |  | **Normal** |
| **x2** |  | **Normal** |
| **x3** |  | **Normal** |
| **x4** |  | **Normal** |
| **x5** |  | **Normal** |
| **x6** |  | **Normal** |
| **x7** |  | **Normal** |
| **x8** |  | **Normal** |
| **x9** |  | **Normal** |
| **x10** |  | **Normal** |
| **x11** |  | **Normal** |
| **x12** |  | **Normal** |
| **x13** |  | **Normal** |
| **x14** |  | **Normal** |
| **x15** |  | **Normal** |
| **x16** |  | **Normal** |
| **x17** |  | **Normal** |
| **x18** |  | **Normal** |
| **x19** |  | **Normal** |
| **x20** |  | **Normal** |
| **x21** |  | **Normal** |
| **x22** |  | **Normal** |
| **x23** |  | **Normal** |
| **x24** |  | **Normal** |
| **x25** |  | **Normal** |
| **x26** |  | **Normal** |
| **x27** |  | **Normal** |
| **x28** |  | **Normal** |
| **x29** |  | **Normal** |
| **x30** |  | **Normal** |
| **x31** |  | **Normal** |
| **x32** |  | **Normal** |
| **x33** |  | **Normal** |
| **x34** |  | **Normal** |
| **x35** |  | **Normal** |
| **x36** |  | **Normal** |
| **x37** |  | **Normal** |
| **x38** |  | **Normal** |
| **x39** |  | **Normal** |
| **x40** |  | **Normal** |
| **x41** |  | **Normal** |
| **x42** |  | **Normal** |
| **x43** |  | **Normal** |
| **x44** |  | **Normal** |
| **x45** |  | **Normal** |
| **x46** |  | **Normal** |
| **x47** |  | **Normal** |
| **x48** |  | **Normal** |
| **x49** |  | **Normal** |
| **x50** |  | **Normal** |
| **x51** |  | **Pneumonia** |
| **x52** |  | **Pneumonia** |
| **x53** |  | **Pneumonia** |
| **x54** |  | **Pneumonia** |
| **x55** |  | **Pneumonia** |
| **x56** |  | **Pneumonia** |
| **x57** |  | **Pneumonia** |
| **x58** |  | **Pneumonia** |
| **x59** |  | **Pneumonia** |
| **x60** |  | **Pneumonia** |
| **x61** |  | **Pneumonia** |
| **x62** |  | **Pneumonia** |
| **x63** |  | **Pneumonia** |
| **x64** |  | **Pneumonia** |
| **x65** |  | **Pneumonia** |
| **x66** |  | **Pneumonia** |
| **x67** |  | **Pneumonia** |
| **x68** |  | **Pneumonia** |
| **x69** |  | **Pneumonia** |
| **x70** |  | **Pneumonia** |
| **x71** |  | **Pneumonia** |
| **x72** |  | **Pneumonia** |
| **x73** |  | **Pneumonia** |
| **x74** |  | **Pneumonia** |
| **x75** |  | **Pneumonia** |
| **x76** |  | **Pneumonia** |
| **x77** |  | **Pneumonia** |
| **x78** |  | **Pneumonia** |
| **x79** |  | **Pneumonia** |
| **x80** |  | **Pneumonia** |
| **x81** |  | **Pneumonia** |
| **x82** |  | **Pneumonia** |
| **x83** |  | **Pneumonia** |
| **x84** |  | **Pneumonia** |
| **x85** |  | **Pneumonia** |
| **x86** |  | **Pneumonia** |
| **x87** |  | **Pneumonia** |
| **x88** |  | **Pneumonia** |
| **x89** |  | **Pneumonia** |
| **x90** |  | **Pneumonia** |
| **x91** |  | **Pneumonia** |
| **x92** |  | **Pneumonia** |
| **x93** |  | **Pneumonia** |
| **x94** |  | **Pneumonia** |
| **x95** |  | **Pneumonia** |
| **x96** |  | **Pneumonia** |
| **x97** |  | **Pneumonia** |
| **x98** |  | **Pneumonia** |
| **x99** |  | **Pneumonia** |
| **x100** |  | **Pneumonia** |

**SLIDE**

**Original Sample Data in Numerical Representation**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[[141 3 3 ... 17 5 0]**  **[ 1 1 124 ... 15 4 0]**  **[222 3 2 ... 15 1 0]**  **...**  **[ 3 3 3 ... 0 0 3]**  **[ 3 3 3 ... 0 1 3]**  **[ 9 3 3 ... 0 2 3]]** | **0** |
| **x2** | **[[ 74 1 161 ... 71 75 79]**  **[ 3 0 1 ... 74 68 98]**  **[ 33 3 0 ... 76 83 114]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]]** | **0** |
| **x3** | **[[65 76 78 ... 60 60 55]**  **[64 71 76 ... 59 57 54]**  **[64 73 76 ... 59 53 50]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x4** | **[[ 94 94 90 ... 45 38 31]**  **[125 92 95 ... 39 32 25]**  **[138 124 94 ... 37 30 24]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x5** | **[[41 49 55 ... 43 42 35]**  **[39 49 57 ... 41 39 28]**  **[36 44 59 ... 48 37 30]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x6** | **[[ 0 0 0 ... 38 36 31]**  **[ 0 0 0 ... 36 35 36]**  **[ 0 0 0 ... 41 33 35]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x7** | **[[ 0 0 0 ... 33 36 41]**  **[ 0 0 0 ... 35 41 42]**  **[ 0 0 0 ... 34 38 43]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x8** | **[[ 4 1 4 ... 30 27 14]**  **[106 3 1 ... 24 14 5]**  **[ 37 2 1 ... 17 5 3]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 3 0 ... 0 0 0]**  **[ 2 1 0 ... 0 0 0]]** | **0** |
| **x9** | **[[132 156 143 ... 0 0 0]**  **[103 140 156 ... 0 0 0]**  **[ 93 108 147 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x10** | **[[ 0 0 0 ... 37 29 23]**  **[ 0 0 0 ... 38 30 19]**  **[ 0 0 0 ... 35 28 22]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x11** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x12** | **[[145 2 2 ... 42 53 30]**  **[ 3 1 86 ... 41 32 16]**  **[199 0 2 ... 34 27 16]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 4 0 0 ... 0 0 0]]** | **0** |
| **x13** | **[[104 0 11 ... 3 1 0]**  **[ 1 0 6 ... 3 0 0]**  **[ 9 0 8 ... 2 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 4 0 0 ... 0 0 0]]** | **0** |
| **x14** | **[[47 49 50 ... 0 0 0]**  **[48 50 54 ... 0 0 0]**  **[47 49 51 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x15** | **[[ 86 95 104 ... 87 82 76]**  **[ 88 95 100 ... 88 79 75]**  **[ 88 96 103 ... 85 79 70]**  **...**  **[ 1 0 0 ... 0 0 0]**  **[ 1 0 0 ... 0 0 0]**  **[ 1 0 0 ... 0 0 0]]** | **0** |
| **x16** | **[[111 1 202 ... 0 0 0]**  **[ 2 1 1 ... 0 0 0]**  **[157 0 3 ... 0 0 0]**  **...**  **[ 4 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]**  **[ 3 0 0 ... 0 0 0]]** | **0** |
| **x17** | **[[145 1 57 ... 13 16 16]**  **[ 2 1 9 ... 9 15 13]**  **[ 22 1 57 ... 13 8 10]**  **...**  **[199 223 205 ... 46 44 56]**  **[213 182 224 ... 52 49 55]**  **[200 220 196 ... 49 37 59]]** | **0** |
| **x18** | **[[ 87 82 103 ... 90 92 109]**  **[ 86 85 88 ... 90 89 127]**  **[ 91 85 92 ... 90 91 148]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x19** | **[[37 43 48 ... 35 28 20]**  **[35 43 38 ... 34 24 20]**  **[39 41 41 ... 31 27 18]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x20** | **[[107 1 210 ... 199 206 203]**  **[ 2 1 3 ... 194 200 195]**  **[ 89 2 1 ... 201 200 198]**  **...**  **[ 55 97 112 ... 28 28 28]**  **[ 63 76 94 ... 28 28 28]**  **[127 68 77 ... 28 28 28]]** | **0** |
| **x21** | **[[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **...**  **[33 53 60 ... 0 3 4]**  **[32 48 59 ... 2 3 6]**  **[31 46 59 ... 2 4 5]]** | **0** |
| **x22** | **[[18 18 14 ... 0 0 0]**  **[17 21 15 ... 0 0 0]**  **[14 22 14 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x23** | **[[ 43 50 56 ... 82 3 77]**  **[ 41 48 55 ... 0 2 122]**  **[ 37 44 52 ... 148 2 73]**  **...**  **[ 41 36 36 ... 33 31 38]**  **[ 43 37 33 ... 33 31 31]**  **[ 35 28 25 ... 26 24 69]]** | **0** |
| **x24** | **[[ 0 0 0 ... 34 42 39]**  **[ 0 0 0 ... 35 39 38]**  **[ 0 0 0 ... 38 35 36]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 6 0 0 ... 0 0 0]**  **[ 6 0 0 ... 0 0 1]]** | **0** |
| **x25** | **[[110 1 79 ... 12 12 11]**  **[ 6 1 3 ... 14 10 8]**  **[ 1 2 3 ... 13 10 10]**  **...**  **[ 0 0 0 ... 19 17 9]**  **[ 2 1 0 ... 13 17 10]**  **[ 1 1 0 ... 12 5 2]]** | **0** |
| **x26** | **[[ 73 88 97 ... 164 102 99]**  **[ 81 93 93 ... 157 101 101]**  **[ 78 89 96 ... 156 94 93]**  **...**  **[ 0 0 0 ... 0 1 1]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x27** | **[[112 0 136 ... 72 75 79]**  **[ 4 0 2 ... 72 75 77]**  **[ 5 0 2 ... 70 72 78]**  **...**  **[ 48 49 41 ... 48 45 42]**  **[ 61 49 45 ... 44 52 30]**  **[ 43 47 36 ... 39 40 38]]** | **0** |
| **x28** | **[[152 132 137 ... 118 126 124]**  **[148 130 142 ... 124 130 134]**  **[139 139 142 ... 123 126 123]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x29** | **[[35 1 3 ... 30 31 31]**  **[78 4 2 ... 31 32 28]**  **[44 1 1 ... 31 33 30]**  **...**  **[26 24 26 ... 10 10 11]**  **[21 24 20 ... 9 7 10]**  **[19 19 20 ... 9 13 87]]** | **0** |
| **x30** | **[[ 38 40 46 ... 52 74 103]**  **[ 40 39 43 ... 54 73 105]**  **[ 37 39 43 ... 51 70 104]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x31** | **[[255 255 255 ... 60 51 34]**  **[222 222 231 ... 54 47 29]**  **[ 78 86 97 ... 53 44 26]**  **...**  **[ 0 0 0 ... 1 1 1]**  **[ 0 0 0 ... 1 2 2]**  **[ 0 0 0 ... 1 2 2]]** | **0** |
| **x32** | **[[157 1 88 ... 68 73 74]**  **[ 3 2 13 ... 71 70 80]**  **[107 5 213 ... 75 78 80]**  **...**  **[ 16 32 33 ... 36 33 26]**  **[ 23 20 29 ... 35 26 28]**  **[ 23 19 22 ... 26 32 28]]** | **0** |
| **x33** | **[[36 44 54 ... 73 74 87]**  **[34 48 56 ... 66 71 83]**  **[37 43 55 ... 68 67 85]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x34** | **[[41 40 41 ... 43 35 36]**  **[37 37 39 ... 38 32 34]**  **[41 41 43 ... 38 35 33]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x35** | **[[87 1 25 ... 0 0 1]**  **[ 2 0 1 ... 0 0 2]**  **[ 1 0 0 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 2]**  **[ 1 0 0 ... 0 0 1]]** | **0** |
| **x36** | **[[ 0 0 0 ... 53 54 54]**  **[ 0 0 0 ... 60 53 51]**  **[ 0 0 0 ... 59 51 46]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x37** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x38** | **[[ 0 0 0 ... 44 35 17]**  **[ 0 0 0 ... 44 32 23]**  **[ 0 0 0 ... 45 32 14]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x39** | **[[ 86 97 101 ... 43 29 3]**  **[ 90 96 100 ... 44 27 2]**  **[ 92 101 102 ... 43 24 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x40** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x41** | **[[141 131 133 ... 0 0 0]**  **[131 136 137 ... 0 0 0]**  **[136 149 152 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x42** | **[[ 59 68 84 ... 85 92 103]**  **[ 46 44 50 ... 103 107 96]**  **[ 42 46 42 ... 110 93 62]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x43** | **[[ 0 7 18 ... 175 183 189]**  **[ 0 7 21 ... 186 178 162]**  **[ 0 3 15 ... 171 157 167]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x44** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x45** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 2 2 2]**  **[0 0 0 ... 5 5 7]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x46** | **[[ 73 83 90 ... 196 233 254]**  **[ 70 81 90 ... 193 228 254]**  **[ 73 82 89 ... 190 227 255]**  **...**  **[ 0 0 0 ... 0 0 10]**  **[ 0 0 0 ... 0 0 9]**  **[ 0 0 0 ... 0 0 10]]** | **0** |
| **x47** | **[[ 8 14 24 ... 64 60 61]**  **[11 14 32 ... 69 68 65]**  **[11 11 33 ... 70 69 57]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x48** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[2 3 3 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x49** | **[[ 77 1 89 ... 15 16 15]**  **[ 1 2 1 ... 15 15 16]**  **[152 1 1 ... 14 15 15]**  **...**  **[ 34 38 33 ... 30 29 18]**  **[ 51 33 36 ... 31 28 30]**  **[ 67 33 32 ... 29 27 28]]** | **0** |
| **x50** | **[[149 4 183 ... 173 2 2]**  **[ 0 1 0 ... 7 2 0]**  **[112 0 70 ... 5 3 1]**  **...**  **[ 0 0 0 ... 8 8 6]**  **[ 2 0 0 ... 1 2 0]**  **[ 3 0 0 ... 172 2 0]]** | **0** |
| **x51** | **[[31 31 32 ... 14 16 24]**  **[31 32 30 ... 15 21 26]**  **[33 35 36 ... 19 25 34]**  **...**  **[12 12 12 ... 14 13 13]**  **[12 12 12 ... 14 12 13]**  **[12 12 12 ... 12 12 13]]** | **1** |
| **x52** | **[[48 50 57 ... 70 77 75]**  **[50 50 51 ... 75 82 84]**  **[50 49 56 ... 86 86 87]**  **...**  **[11 13 13 ... 8 0 0]**  **[10 11 11 ... 11 0 0]**  **[ 8 11 12 ... 9 1 5]]** | **1** |
| **x53** | **[[ 0 0 254 ... 0 0 0]**  **[ 0 0 254 ... 0 0 0]**  **[ 0 0 254 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x54** | **[[ 2 2 2 ... 37 34 32]**  **[ 2 2 2 ... 34 33 31]**  **[ 2 2 2 ... 33 31 30]**  **...**  **[ 13 13 13 ... 12 10 11]**  **[ 13 14 14 ... 12 10 12]**  **[159 14 14 ... 12 10 160]]** | **1** |
| **x55** | **[[ 9 8 20 ... 3 4 5]**  **[ 4 12 11 ... 1 2 3]**  **[ 9 14 12 ... 0 1 1]**  **...**  **[11 11 10 ... 20 20 20]**  **[11 11 10 ... 20 20 20]**  **[11 11 10 ... 20 20 20]]** | **1** |
| **x56** | **[[ 75 76 81 ... 131 77 60]**  **[ 74 75 73 ... 72 128 76]**  **[ 74 77 88 ... 27 110 120]**  **...**  **[ 26 26 23 ... 28 28 28]**  **[ 25 25 24 ... 28 28 28]**  **[ 25 25 24 ... 28 28 28]]** | **1** |
| **x57** | **[[0 0 0 ... 6 5 4]**  **[0 0 0 ... 6 4 3]**  **[0 0 0 ... 6 4 3]**  **...**  **[0 0 0 ... 0 0 0]**  **[1 0 0 ... 0 0 1]**  **[2 0 0 ... 0 0 2]]** | **1** |
| **x58** | **[[77 77 80 ... 12 12 11]**  **[72 76 78 ... 16 12 12]**  **[66 68 75 ... 16 15 10]**  **...**  **[ 0 8 15 ... 0 0 0]**  **[ 0 7 13 ... 0 0 0]**  **[ 0 8 14 ... 0 0 0]]** | **1** |
| **x59** | **[[29 28 28 ... 6 6 5]**  **[29 28 28 ... 8 8 7]**  **[28 28 27 ... 7 7 9]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x60** | **[[11 11 30 ... 31 33 34]**  **[ 7 24 36 ... 34 32 34]**  **[17 33 43 ... 33 31 33]**  **...**  **[26 26 26 ... 22 21 21]**  **[26 26 26 ... 20 21 21]**  **[26 26 26 ... 18 21 21]]** | **1** |
| **x61** | **[[ 0 0 252 ... 0 0 0]**  **[ 0 0 252 ... 0 0 0]**  **[ 0 0 252 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x62** | **[[ 3 5 7 ... 91 112 111]**  **[ 3 5 6 ... 107 112 104]**  **[ 3 5 5 ... 112 105 104]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 3 3 0 ... 0 3 3]**  **[ 14 9 0 ... 0 9 14]]** | **1** |
| **x63** | **[[ 50 52 51 ... 1 1 1]**  **[ 46 50 50 ... 1 1 1]**  **[ 48 52 50 ... 1 1 1]**  **...**  **[240 1 1 ... 1 1 240]**  **[ 1 1 1 ... 1 1 1]**  **[ 1 1 1 ... 1 1 1]]** | **1** |
| **x64** | **[[21 24 24 ... 29 28 25]**  **[21 22 26 ... 29 28 25]**  **[22 24 24 ... 33 30 27]**  **...**  **[ 5 31 3 ... 2 2 4]**  **[ 5 30 0 ... 2 2 2]**  **[ 4 30 0 ... 2 2 2]]** | **1** |
| **x65** | **[[122 128 127 ... 2 0 1]**  **[128 127 132 ... 0 2 1]**  **[133 132 134 ... 2 2 2]**  **...**  **[ 4 4 4 ... 1 1 2]**  **[ 4 4 4 ... 1 1 2]**  **[ 4 4 4 ... 1 1 2]]** | **1** |
| **x66** | **[[ 8 8 8 ... 9 9 9]**  **[ 8 8 8 ... 9 9 9]**  **[ 8 8 8 ... 9 9 9]**  **...**  **[ 0 35 51 ... 16 15 16]**  **[ 0 34 50 ... 16 16 16]**  **[ 0 33 50 ... 18 18 18]]** | **1** |
| **x67** | **[[ 4 4 5 ... 9 9 9]**  **[ 4 3 3 ... 8 9 9]**  **[ 4 3 2 ... 6 7 7]**  **...**  **[15 14 19 ... 4 4 4]**  **[12 14 18 ... 4 4 4]**  **[53 14 18 ... 4 4 50]]** | **1** |
| **x68** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[4 4 0 ... 0 4 4]**  **[6 3 0 ... 0 3 6]]** | **1** |
| **x69** | **[[13 16 18 ... 1 0 0]**  **[14 17 18 ... 7 0 0]**  **[14 19 18 ... 13 6 0]**  **...**  **[ 6 6 6 ... 8 8 8]**  **[ 6 6 6 ... 8 8 8]**  **[ 6 6 6 ... 8 8 8]]** | **1** |
| **x70** | **[[106 97 96 ... 94 87 81]**  **[ 97 102 94 ... 88 85 86]**  **[ 99 97 99 ... 83 84 87]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x71** | **[[13 14 16 ... 4 4 4]**  **[13 16 17 ... 4 4 4]**  **[15 18 21 ... 4 4 4]**  **...**  **[ 0 0 0 ... 10 10 10]**  **[ 0 0 0 ... 10 10 10]**  **[ 0 0 0 ... 10 10 10]]** | **1** |
| **x72** | **[[12 16 18 ... 0 0 0]**  **[13 18 20 ... 3 0 0]**  **[14 18 21 ... 0 0 0]**  **...**  **[ 8 6 6 ... 1 2 4]**  **[ 8 6 5 ... 2 1 3]**  **[ 8 6 4 ... 3 0 2]]** | **1** |
| **x73** | **[[18 16 15 ... 17 17 18]**  **[17 15 14 ... 15 17 16]**  **[15 14 13 ... 14 17 16]**  **...**  **[13 8 8 ... 11 11 17]**  **[10 8 8 ... 11 11 15]**  **[ 9 8 8 ... 11 11 11]]** | **1** |
| **x74** | **[[48 56 84 ... 19 13 6]**  **[46 54 86 ... 19 13 7]**  **[45 61 86 ... 19 13 6]**  **...**  **[ 1 1 1 ... 6 3 0]**  **[ 1 1 1 ... 0 0 0]**  **[ 1 1 1 ... 0 0 0]]** | **1** |
| **x75** | **[[45 48 52 ... 37 37 33]**  **[43 48 50 ... 36 36 34]**  **[46 48 48 ... 37 38 33]**  **...**  **[26 30 28 ... 46 43 30]**  **[29 29 29 ... 47 39 34]**  **[29 27 27 ... 48 41 28]]** | **1** |
| **x76** | **[[36 43 47 ... 0 0 0]**  **[33 38 42 ... 0 0 0]**  **[29 41 41 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x77** | **[[ 0 0 0 ... 38 38 38]**  **[ 0 0 0 ... 38 40 40]**  **[ 0 0 0 ... 37 39 39]**  **...**  **[13 13 14 ... 6 5 5]**  **[13 15 16 ... 6 5 5]**  **[13 17 18 ... 6 5 5]]** | **1** |
| **x78** | **[[33 37 33 ... 61 62 59]**  **[33 33 37 ... 62 65 59]**  **[33 35 34 ... 57 62 60]**  **...**  **[33 40 53 ... 63 61 62]**  **[38 50 54 ... 68 66 61]**  **[35 36 48 ... 70 58 54]]** | **1** |
| **x79** | **[[22 24 25 ... 30 31 31]**  **[22 23 26 ... 33 30 31]**  **[22 24 27 ... 35 31 32]**  **...**  **[10 10 11 ... 8 10 10]**  **[10 10 11 ... 8 9 10]**  **[10 10 11 ... 8 9 10]]** | **1** |
| **x80** | **[[18 20 22 ... 12 8 8]**  **[20 22 23 ... 13 9 8]**  **[20 19 21 ... 13 9 8]**  **...**  **[ 0 0 0 ... 6 12 10]**  **[ 0 0 0 ... 9 10 11]**  **[ 0 0 0 ... 9 10 10]]** | **1** |
| **x81** | **[[ 6 9 13 ... 0 0 0]**  **[ 6 9 13 ... 0 0 0]**  **[ 6 8 13 ... 0 0 0]**  **...**  **[195 4 0 ... 0 4 195]**  **[ 1 1 0 ... 0 1 1]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x82** | **[[ 42 47 45 ... 26 35 31]**  **[ 45 45 47 ... 30 36 32]**  **[ 40 48 49 ... 45 37 33]**  **...**  **[ 25 41 44 ... 37 40 40]**  **[ 29 41 43 ... 33 32 135]**  **[ 30 36 41 ... 28 109 54]]** | **1** |
| **x83** | **[[12 12 12 ... 5 2 0]**  **[12 12 12 ... 9 4 1]**  **[12 12 12 ... 9 5 0]**  **...**  **[37 36 35 ... 17 17 17]**  **[37 35 34 ... 16 17 17]**  **[36 34 31 ... 16 17 17]]** | **1** |
| **x84** | **[[ 32 30 32 ... 3 3 4]**  **[ 33 32 34 ... 1 1 3]**  **[ 36 35 35 ... 0 1 2]**  **...**  **[ 2 2 0 ... 108 143 153]**  **[ 2 2 0 ... 101 141 162]**  **[ 2 2 0 ... 115 138 154]]** | **1** |
| **x85** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x86** | **[[49 60 70 ... 46 42 36]**  **[61 74 80 ... 44 46 41]**  **[79 73 67 ... 47 46 45]**  **...**  **[ 6 4 2 ... 3 4 10]**  **[ 7 3 2 ... 4 6 7]**  **[ 9 4 2 ... 4 7 11]]** | **1** |
| **x87** | **[[ 0 0 0 ... 247 91 7]**  **[ 0 0 0 ... 6 254 6]**  **[ 0 0 0 ... 11 218 15]**  **...**  **[ 1 0 0 ... 0 0 0]**  **[ 5 250 254 ... 0 0 2]**  **[159 252 8 ... 0 0 157]]** | **1** |
| **x88** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x89** | **[[156 163 168 ... 159 246 122]**  **[156 163 164 ... 159 137 127]**  **[156 163 162 ... 159 50 116]**  **...**  **[ 41 119 102 ... 0 0 2]**  **[ 1 213 132 ... 0 0 0]**  **[ 8 10 7 ... 0 0 0]]** | **1** |
| **x90** | **[[ 1 3 3 ... 250 35 4]**  **[ 1 3 3 ... 9 253 1]**  **[ 0 1 2 ... 12 113 13]**  **...**  **[ 91 39 176 ... 0 0 0]**  **[ 7 232 250 ... 0 1 1]**  **[157 248 5 ... 0 2 158]]** | **1** |
| **x91** | **[[ 20 24 28 ... 17 19 23]**  **[ 21 24 30 ... 16 18 21]**  **[ 21 29 31 ... 14 16 19]**  **...**  **[138 145 150 ... 17 21 20]**  **[139 145 151 ... 17 16 20]**  **[143 149 151 ... 17 17 24]]** | **1** |
| **x92** | **[[ 7 12 16 ... 6 248 7]**  **[ 6 11 15 ... 3 0 0]**  **[ 6 8 13 ... 9 250 4]**  **...**  **[ 0 0 1 ... 0 0 1]**  **[ 6 246 252 ... 0 0 1]**  **[ 1 10 7 ... 0 0 1]]** | **1** |
| **x93** | **[[173 171 167 ... 132 132 137]**  **[176 164 160 ... 132 124 137]**  **[170 169 157 ... 128 118 138]**  **...**  **[ 65 93 117 ... 18 18 18]**  **[ 67 98 120 ... 18 18 18]**  **[ 68 103 122 ... 18 18 18]]** | **1** |
| **x94** | **[[ 59 73 74 ... 133 241 84]**  **[ 62 77 73 ... 100 87 78]**  **[ 58 69 87 ... 108 31 84]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 117 254 ... 0 0 0]**  **[ 9 0 0 ... 0 0 0]]** | **1** |
| **x95** | **[[ 0 0 0 ... 197 95 6]**  **[ 0 0 0 ... 13 22 2]**  **[ 0 0 0 ... 219 249 9]**  **...**  **[ 45 72 104 ... 0 0 0]**  **[ 4 249 245 ... 0 0 7]**  **[159 18 0 ... 0 0 158]]** | **1** |
| **x96** | **[[127 129 130 ... 115 112 113]**  **[147 135 132 ... 113 117 126]**  **[141 142 136 ... 254 39 122]**  **...**  **[ 20 45 63 ... 250 70 1]**  **[ 20 42 62 ... 4 1 0]**  **[ 22 47 65 ... 0 0 0]]** | **1** |
| **x97** | **[[ 0 0 0 ... 40 31 26]**  **[ 0 0 0 ... 38 31 23]**  **[ 0 0 0 ... 36 31 23]**  **...**  **[ 1 1 1 ... 2 2 2]**  **[ 1 1 1 ... 2 2 2]**  **[ 1 1 1 ... 2 2 2]]** | **1** |
| **x98** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x99** | **[[ 0 0 0 ... 6 6 6]**  **[ 0 0 0 ... 6 6 6]**  **[ 0 0 0 ... 6 6 6]**  **...**  **[ 3 8 4 ... 12 14 7]**  **[ 1 7 4 ... 11 9 3]**  **[ 6 2 4 ... 12 5 13]]** | **1** |
| **x100** | **[[65 67 67 ... 98 93 96]**  **[61 60 59 ... 95 94 93]**  **[55 55 55 ... 95 92 92]**  **...**  **[14 37 45 ... 11 8 8]**  **[19 40 51 ... 8 7 11]**  **[25 41 52 ... 7 9 9]]** | **1** |

|  |
| --- |
| **Step 4.1: Represent Training Data in Machine Understandable Format (Numerical Representation)** |

**SLIDE**

**Step 4.1: Represent Training Data in Machine Understandable Format**

* **Feature-based Classification Algorithms (implemented in Keras) can understand data in** 
  + **Attribute-Value Pair** 
    - **Values of Attributes / Features must be Numeric**
* **Problem**
  + **Our Training Data is not in Attribute-Value Pair form**
    - **We need to transform our Training Data into Machine Understandable Format**
* **Solution**
  + **There are many approaches to transform Training Data into Machine Understandable Format**

**SLIDE**

**Important Note**

* **In this Lecture, we are using Keras implementation of the Convolution Neural Networks (CNN) Machine Learning Algorithm**
* **Convolutional Neural Networks (CNN) can only understand Data in Numerical Representation**
  + **Therefore, we will need to Convert both Input (X-ray Image) and Output (Pneumonia Prediction) into Numerical Representation**

**SLIDE**

**Transforming Training Data in Machine Understandable Format**

* **In our Training Data**
  + **Input is Unstructured (X-ray Image)**
  + **Output is Categorical**
* **Considering Input (X-ray Image) and Output (Pneumonia Prediction), we will need to** 
  + **Transform Input (X-ray Image) into Numerical Representation**
  + **Transform Output (Categorical) into Numerical Representation**

**SLIDE**

**Converting Output into Numerical Representation**

* **A Two-Step Process** 
  + **Step 01: Define an Encoding Scheme**
  + **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Training Data**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 01: Define an Encoding Scheme**
* **Encoding Scheme for Gender Attribute**
  + **Normal = 0**
  + **Pneumonia = 1**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Training Data**
* **The Table below shows Pre-processed Training Data after Encoding Categorical Output Values to Numerical Output Values**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output (Pneumonia Prediction)** |
| **x1** |  | **0** |
| **x2** |  | **0** |
| **x3** |  | **0** |
| **x4** |  | **0** |
| **x5** |  | **0** |
| **x6** |  | **0** |
| **x7** |  | **0** |
| **x8** |  | **0** |
| **x9** |  | **0** |
| **x10** |  | **0** |
| **x11** |  | **0** |
| **x12** |  | **0** |
| **x13** |  | **0** |
| **x14** |  | **0** |
| **x15** |  | **0** |
| **x16** |  | **0** |
| **x17** |  | **0** |
| **x18** |  | **0** |
| **x19** |  | **0** |
| **x20** |  | **0** |
| **x21** |  | **0** |
| **x22** |  | **0** |
| **x23** |  | **0** |
| **x24** |  | **0** |
| **x25** |  | **0** |
| **x26** |  | **0** |
| **x27** |  | **0** |
| **x28** |  | **0** |
| **x29** |  | **0** |
| **x30** |  | **0** |
| **x31** |  | **0** |
| **x32** |  | **0** |
| **x33** |  | **0** |
| **x34** |  | **0** |
| **x35** |  | **0** |
| **x36** |  | **0** |
| **x37** |  | **1** |
| **x38** |  | **1** |
| **x39** |  | **1** |
| **x40** |  | **1** |
| **x41** |  | **1** |
| **x42** |  | **1** |
| **x43** |  | **1** |
| **x44** |  | **1** |
| **x45** |  | **1** |
| **x46** |  | **1** |
| **x47** |  | **1** |
| **x48** |  | **1** |
| **x49** |  | **1** |
| **x50** |  | **1** |
| **x51** |  | **1** |
| **x52** |  | **1** |
| **x53** |  | **1** |
| **x54** |  | **1** |
| **x55** |  | **1** |
| **x56** |  | **1** |
| **x57** |  | **1** |
| **x58** |  | **1** |
| **x59** |  | **1** |
| **x60** |  | **1** |
| **x61** |  | **1** |
| **x62** |  | **1** |
| **x63** |  | **1** |
| **x64** |  | **1** |
| **x65** |  | **1** |
| **x66** |  | **1** |
| **x67** |  | **1** |
| **x68** |  | **1** |
| **x69** |  | **1** |
| **x70** |  | **1** |
| **x71** |  | **1** |
| **x72** |  | **1** |

**SLIDE**

**Note**

* **Alhamdulillah (الحمدللہ), Output is transformed into Numerical Representation**
* **In Sha Allah (انشاء اللہ), in the next Slides, I will try to explain how to transform Input (Image) into Numerical Representation**

|  |
| --- |
| **Step 4.1.1 : Convert Resized Grayscale X-ray Images of Training Data into Numpy Array** |

**SLIDE**

**Step 4.1.1 - Convert Resized Grayscale X-ray Images of Training Data into Numpy Array**

* **Considering Feature-based ML Algorithms, an Input can be transformed into Numerical Representation in the following steps**
  + **Step 1: Select a Feature Extraction Method**
  + **Step 2: Extract Features from Input using the Feature Extraction Method selected in Step 1**
  + **Step 3: Normalize the Features Extracted in Step 2**

**SLIDE**

**Convert Resized Grayscale X-ray Images of Training Data into Numpy Array**

* **Step 1: Select a Feature Extraction Method**
* **Insha Allah (انشاء اللہ), I will use Numpy Array based Feature Extraction Method to transform Sample Data into Numerical Representation (Machine Understandable Format)**
  + **Total Features = 224 X 224 = 50,176**
    - **Feature 01 = Value of Pixel 01**
    - **Feature 02 = Value of Pixel 02**
    - **Feature 03 = Value of Pixel 03**
    - **……..**
    - **Feature 50,175 = Value of Pixel 50,175**
    - **Feature 50,176 = Value of Pixel 50,176**
  + **Feature Value = Value of Pixel between 0 to 255**

**SLIDE**

**Resized Grayscale X-ray Images of Training Data into Numpy Array**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[[141 3 3 ... 17 5 0]**  **[ 1 1 124 ... 15 4 0]**  **[222 3 2 ... 15 1 0]**  **...**  **[ 3 3 3 ... 0 0 3]**  **[ 3 3 3 ... 0 1 3]**  **[ 9 3 3 ... 0 2 3]]** | **0** |
| **x2** | **[[ 74 1 161 ... 71 75 79]**  **[ 3 0 1 ... 74 68 98]**  **[ 33 3 0 ... 76 83 114]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]]** | **0** |
| **x3** | **[[65 76 78 ... 60 60 55]**  **[64 71 76 ... 59 57 54]**  **[64 73 76 ... 59 53 50]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x4** | **[[ 94 94 90 ... 45 38 31]**  **[125 92 95 ... 39 32 25]**  **[138 124 94 ... 37 30 24]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x5** | **[[41 49 55 ... 43 42 35]**  **[39 49 57 ... 41 39 28]**  **[36 44 59 ... 48 37 30]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x6** | **[[ 0 0 0 ... 38 36 31]**  **[ 0 0 0 ... 36 35 36]**  **[ 0 0 0 ... 41 33 35]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x7** | **[[ 0 0 0 ... 33 36 41]**  **[ 0 0 0 ... 35 41 42]**  **[ 0 0 0 ... 34 38 43]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x8** | **[[ 4 1 4 ... 30 27 14]**  **[106 3 1 ... 24 14 5]**  **[ 37 2 1 ... 17 5 3]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 3 0 ... 0 0 0]**  **[ 2 1 0 ... 0 0 0]]** | **0** |
| **x9** | **[[132 156 143 ... 0 0 0]**  **[103 140 156 ... 0 0 0]**  **[ 93 108 147 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x10** | **[[ 0 0 0 ... 37 29 23]**  **[ 0 0 0 ... 38 30 19]**  **[ 0 0 0 ... 35 28 22]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x11** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x12** | **[[145 2 2 ... 42 53 30]**  **[ 3 1 86 ... 41 32 16]**  **[199 0 2 ... 34 27 16]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 4 0 0 ... 0 0 0]]** | **0** |
| **x13** | **[[104 0 11 ... 3 1 0]**  **[ 1 0 6 ... 3 0 0]**  **[ 9 0 8 ... 2 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 4 0 0 ... 0 0 0]]** | **0** |
| **x14** | **[[47 49 50 ... 0 0 0]**  **[48 50 54 ... 0 0 0]**  **[47 49 51 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x15** | **[[ 86 95 104 ... 87 82 76]**  **[ 88 95 100 ... 88 79 75]**  **[ 88 96 103 ... 85 79 70]**  **...**  **[ 1 0 0 ... 0 0 0]**  **[ 1 0 0 ... 0 0 0]**  **[ 1 0 0 ... 0 0 0]]** | **0** |
| **x16** | **[[111 1 202 ... 0 0 0]**  **[ 2 1 1 ... 0 0 0]**  **[157 0 3 ... 0 0 0]**  **...**  **[ 4 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 0]**  **[ 3 0 0 ... 0 0 0]]** | **0** |
| **x17** | **[[145 1 57 ... 13 16 16]**  **[ 2 1 9 ... 9 15 13]**  **[ 22 1 57 ... 13 8 10]**  **...**  **[199 223 205 ... 46 44 56]**  **[213 182 224 ... 52 49 55]**  **[200 220 196 ... 49 37 59]]** | **0** |
| **x18** | **[[ 87 82 103 ... 90 92 109]**  **[ 86 85 88 ... 90 89 127]**  **[ 91 85 92 ... 90 91 148]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x19** | **[[37 43 48 ... 35 28 20]**  **[35 43 38 ... 34 24 20]**  **[39 41 41 ... 31 27 18]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x20** | **[[107 1 210 ... 199 206 203]**  **[ 2 1 3 ... 194 200 195]**  **[ 89 2 1 ... 201 200 198]**  **...**  **[ 55 97 112 ... 28 28 28]**  **[ 63 76 94 ... 28 28 28]**  **[127 68 77 ... 28 28 28]]** | **0** |
| **x21** | **[[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **...**  **[33 53 60 ... 0 3 4]**  **[32 48 59 ... 2 3 6]**  **[31 46 59 ... 2 4 5]]** | **0** |
| **x22** | **[[18 18 14 ... 0 0 0]**  **[17 21 15 ... 0 0 0]**  **[14 22 14 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x23** | **[[ 43 50 56 ... 82 3 77]**  **[ 41 48 55 ... 0 2 122]**  **[ 37 44 52 ... 148 2 73]**  **...**  **[ 41 36 36 ... 33 31 38]**  **[ 43 37 33 ... 33 31 31]**  **[ 35 28 25 ... 26 24 69]]** | **0** |
| **x24** | **[[ 0 0 0 ... 34 42 39]**  **[ 0 0 0 ... 35 39 38]**  **[ 0 0 0 ... 38 35 36]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 6 0 0 ... 0 0 0]**  **[ 6 0 0 ... 0 0 1]]** | **0** |
| **x25** | **[[110 1 79 ... 12 12 11]**  **[ 6 1 3 ... 14 10 8]**  **[ 1 2 3 ... 13 10 10]**  **...**  **[ 0 0 0 ... 19 17 9]**  **[ 2 1 0 ... 13 17 10]**  **[ 1 1 0 ... 12 5 2]]** | **0** |
| **x26** | **[[ 73 88 97 ... 164 102 99]**  **[ 81 93 93 ... 157 101 101]**  **[ 78 89 96 ... 156 94 93]**  **...**  **[ 0 0 0 ... 0 1 1]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x27** | **[[112 0 136 ... 72 75 79]**  **[ 4 0 2 ... 72 75 77]**  **[ 5 0 2 ... 70 72 78]**  **...**  **[ 48 49 41 ... 48 45 42]**  **[ 61 49 45 ... 44 52 30]**  **[ 43 47 36 ... 39 40 38]]** | **0** |
| **x28** | **[[152 132 137 ... 118 126 124]**  **[148 130 142 ... 124 130 134]**  **[139 139 142 ... 123 126 123]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x29** | **[[35 1 3 ... 30 31 31]**  **[78 4 2 ... 31 32 28]**  **[44 1 1 ... 31 33 30]**  **...**  **[26 24 26 ... 10 10 11]**  **[21 24 20 ... 9 7 10]**  **[19 19 20 ... 9 13 87]]** | **0** |
| **x30** | **[[ 38 40 46 ... 52 74 103]**  **[ 40 39 43 ... 54 73 105]**  **[ 37 39 43 ... 51 70 104]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x31** | **[[255 255 255 ... 60 51 34]**  **[222 222 231 ... 54 47 29]**  **[ 78 86 97 ... 53 44 26]**  **...**  **[ 0 0 0 ... 1 1 1]**  **[ 0 0 0 ... 1 2 2]**  **[ 0 0 0 ... 1 2 2]]** | **0** |
| **x32** | **[[157 1 88 ... 68 73 74]**  **[ 3 2 13 ... 71 70 80]**  **[107 5 213 ... 75 78 80]**  **...**  **[ 16 32 33 ... 36 33 26]**  **[ 23 20 29 ... 35 26 28]**  **[ 23 19 22 ... 26 32 28]]** | **0** |
| **x33** | **[[36 44 54 ... 73 74 87]**  **[34 48 56 ... 66 71 83]**  **[37 43 55 ... 68 67 85]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x34** | **[[41 40 41 ... 43 35 36]**  **[37 37 39 ... 38 32 34]**  **[41 41 43 ... 38 35 33]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x35** | **[[87 1 25 ... 0 0 1]**  **[ 2 0 1 ... 0 0 2]**  **[ 1 0 0 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 0 0 ... 0 0 2]**  **[ 1 0 0 ... 0 0 1]]** | **0** |
| **x36** | **[[ 0 0 0 ... 53 54 54]**  **[ 0 0 0 ... 60 53 51]**  **[ 0 0 0 ... 59 51 46]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x37** | **[[31 31 32 ... 14 16 24]**  **[31 32 30 ... 15 21 26]**  **[33 35 36 ... 19 25 34]**  **...**  **[12 12 12 ... 14 13 13]**  **[12 12 12 ... 14 12 13]**  **[12 12 12 ... 12 12 13]]** | **1** |
| **x38** | **[[48 50 57 ... 70 77 75]**  **[50 50 51 ... 75 82 84]**  **[50 49 56 ... 86 86 87]**  **...**  **[11 13 13 ... 8 0 0]**  **[10 11 11 ... 11 0 0]**  **[ 8 11 12 ... 9 1 5]]** | **1** |
| **x39** | **[[ 0 0 254 ... 0 0 0]**  **[ 0 0 254 ... 0 0 0]**  **[ 0 0 254 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x40** | **[[ 2 2 2 ... 37 34 32]**  **[ 2 2 2 ... 34 33 31]**  **[ 2 2 2 ... 33 31 30]**  **...**  **[ 13 13 13 ... 12 10 11]**  **[ 13 14 14 ... 12 10 12]**  **[159 14 14 ... 12 10 160]]** | **1** |
| **x41** | **[[ 9 8 20 ... 3 4 5]**  **[ 4 12 11 ... 1 2 3]**  **[ 9 14 12 ... 0 1 1]**  **...**  **[11 11 10 ... 20 20 20]**  **[11 11 10 ... 20 20 20]**  **[11 11 10 ... 20 20 20]]** | **1** |
| **x42** | **[[ 75 76 81 ... 131 77 60]**  **[ 74 75 73 ... 72 128 76]**  **[ 74 77 88 ... 27 110 120]**  **...**  **[ 26 26 23 ... 28 28 28]**  **[ 25 25 24 ... 28 28 28]**  **[ 25 25 24 ... 28 28 28]]** | **1** |
| **x43** | **[[0 0 0 ... 6 5 4]**  **[0 0 0 ... 6 4 3]**  **[0 0 0 ... 6 4 3]**  **...**  **[0 0 0 ... 0 0 0]**  **[1 0 0 ... 0 0 1]**  **[2 0 0 ... 0 0 2]]** | **1** |
| **x44** | **[[77 77 80 ... 12 12 11]**  **[72 76 78 ... 16 12 12]**  **[66 68 75 ... 16 15 10]**  **...**  **[ 0 8 15 ... 0 0 0]**  **[ 0 7 13 ... 0 0 0]**  **[ 0 8 14 ... 0 0 0]]** | **1** |
| **x45** | **[[29 28 28 ... 6 6 5]**  **[29 28 28 ... 8 8 7]**  **[28 28 27 ... 7 7 9]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x46** | **[[11 11 30 ... 31 33 34]**  **[ 7 24 36 ... 34 32 34]**  **[17 33 43 ... 33 31 33]**  **...**  **[26 26 26 ... 22 21 21]**  **[26 26 26 ... 20 21 21]**  **[26 26 26 ... 18 21 21]]** | **1** |
| **x47** | **[[ 0 0 252 ... 0 0 0]**  **[ 0 0 252 ... 0 0 0]**  **[ 0 0 252 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x48** | **[[ 3 5 7 ... 91 112 111]**  **[ 3 5 6 ... 107 112 104]**  **[ 3 5 5 ... 112 105 104]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 3 3 0 ... 0 3 3]**  **[ 14 9 0 ... 0 9 14]]** | **1** |
| **x49** | **[[ 50 52 51 ... 1 1 1]**  **[ 46 50 50 ... 1 1 1]**  **[ 48 52 50 ... 1 1 1]**  **...**  **[240 1 1 ... 1 1 240]**  **[ 1 1 1 ... 1 1 1]**  **[ 1 1 1 ... 1 1 1]]** | **1** |
| **x50** | **[[21 24 24 ... 29 28 25]**  **[21 22 26 ... 29 28 25]**  **[22 24 24 ... 33 30 27]**  **...**  **[ 5 31 3 ... 2 2 4]**  **[ 5 30 0 ... 2 2 2]**  **[ 4 30 0 ... 2 2 2]]** | **1** |
| **x51** | **[[122 128 127 ... 2 0 1]**  **[128 127 132 ... 0 2 1]**  **[133 132 134 ... 2 2 2]**  **...**  **[ 4 4 4 ... 1 1 2]**  **[ 4 4 4 ... 1 1 2]**  **[ 4 4 4 ... 1 1 2]]** | **1** |
| **x52** | **[[ 8 8 8 ... 9 9 9]**  **[ 8 8 8 ... 9 9 9]**  **[ 8 8 8 ... 9 9 9]**  **...**  **[ 0 35 51 ... 16 15 16]**  **[ 0 34 50 ... 16 16 16]**  **[ 0 33 50 ... 18 18 18]]** | **1** |
| **x53** | **[[ 4 4 5 ... 9 9 9]**  **[ 4 3 3 ... 8 9 9]**  **[ 4 3 2 ... 6 7 7]**  **...**  **[15 14 19 ... 4 4 4]**  **[12 14 18 ... 4 4 4]**  **[53 14 18 ... 4 4 50]]** | **1** |
| **x54** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[4 4 0 ... 0 4 4]**  **[6 3 0 ... 0 3 6]]** | **1** |
| **x55** | **[[13 16 18 ... 1 0 0]**  **[14 17 18 ... 7 0 0]**  **[14 19 18 ... 13 6 0]**  **...**  **[ 6 6 6 ... 8 8 8]**  **[ 6 6 6 ... 8 8 8]**  **[ 6 6 6 ... 8 8 8]]** | **1** |
| **x56** | **[[106 97 96 ... 94 87 81]**  **[ 97 102 94 ... 88 85 86]**  **[ 99 97 99 ... 83 84 87]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x57** | **[[13 14 16 ... 4 4 4]**  **[13 16 17 ... 4 4 4]**  **[15 18 21 ... 4 4 4]**  **...**  **[ 0 0 0 ... 10 10 10]**  **[ 0 0 0 ... 10 10 10]**  **[ 0 0 0 ... 10 10 10]]** | **1** |
| **x58** | **[[12 16 18 ... 0 0 0]**  **[13 18 20 ... 3 0 0]**  **[14 18 21 ... 0 0 0]**  **...**  **[ 8 6 6 ... 1 2 4]**  **[ 8 6 5 ... 2 1 3]**  **[ 8 6 4 ... 3 0 2]]** | **1** |
| **x59** | **[[18 16 15 ... 17 17 18]**  **[17 15 14 ... 15 17 16]**  **[15 14 13 ... 14 17 16]**  **...**  **[13 8 8 ... 11 11 17]**  **[10 8 8 ... 11 11 15]**  **[ 9 8 8 ... 11 11 11]]** | **1** |
| **x60** | **[[48 56 84 ... 19 13 6]**  **[46 54 86 ... 19 13 7]**  **[45 61 86 ... 19 13 6]**  **...**  **[ 1 1 1 ... 6 3 0]**  **[ 1 1 1 ... 0 0 0]**  **[ 1 1 1 ... 0 0 0]]** | **1** |
| **x61** | **[[45 48 52 ... 37 37 33]**  **[43 48 50 ... 36 36 34]**  **[46 48 48 ... 37 38 33]**  **...**  **[26 30 28 ... 46 43 30]**  **[29 29 29 ... 47 39 34]**  **[29 27 27 ... 48 41 28]]** | **1** |
| **x62** | **[[36 43 47 ... 0 0 0]**  **[33 38 42 ... 0 0 0]**  **[29 41 41 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x63** | **[[ 0 0 0 ... 38 38 38]**  **[ 0 0 0 ... 38 40 40]**  **[ 0 0 0 ... 37 39 39]**  **...**  **[13 13 14 ... 6 5 5]**  **[13 15 16 ... 6 5 5]**  **[13 17 18 ... 6 5 5]]** | **1** |
| **x64** | **[[33 37 33 ... 61 62 59]**  **[33 33 37 ... 62 65 59]**  **[33 35 34 ... 57 62 60]**  **...**  **[33 40 53 ... 63 61 62]**  **[38 50 54 ... 68 66 61]**  **[35 36 48 ... 70 58 54]]** | **1** |
| **x65** | **[[22 24 25 ... 30 31 31]**  **[22 23 26 ... 33 30 31]**  **[22 24 27 ... 35 31 32]**  **...**  **[10 10 11 ... 8 10 10]**  **[10 10 11 ... 8 9 10]**  **[10 10 11 ... 8 9 10]]** | **1** |
| **x66** | **[[18 20 22 ... 12 8 8]**  **[20 22 23 ... 13 9 8]**  **[20 19 21 ... 13 9 8]**  **...**  **[ 0 0 0 ... 6 12 10]**  **[ 0 0 0 ... 9 10 11]**  **[ 0 0 0 ... 9 10 10]]** | **1** |
| **x67** | **[[ 6 9 13 ... 0 0 0]**  **[ 6 9 13 ... 0 0 0]**  **[ 6 8 13 ... 0 0 0]**  **...**  **[195 4 0 ... 0 4 195]**  **[ 1 1 0 ... 0 1 1]**  **[ 0 0 0 ... 0 0 0]]** | **1** |
| **x68** | **[[ 42 47 45 ... 26 35 31]**  **[ 45 45 47 ... 30 36 32]**  **[ 40 48 49 ... 45 37 33]**  **...**  **[ 25 41 44 ... 37 40 40]**  **[ 29 41 43 ... 33 32 135]**  **[ 30 36 41 ... 28 109 54]]** | **1** |
| **x69** | **[[12 12 12 ... 5 2 0]**  **[12 12 12 ... 9 4 1]**  **[12 12 12 ... 9 5 0]**  **...**  **[37 36 35 ... 17 17 17]**  **[37 35 34 ... 16 17 17]**  **[36 34 31 ... 16 17 17]]** | **1** |
| **x70** | **[[ 32 30 32 ... 3 3 4]**  **[ 33 32 34 ... 1 1 3]**  **[ 36 35 35 ... 0 1 2]**  **...**  **[ 2 2 0 ... 108 143 153]**  **[ 2 2 0 ... 101 141 162]**  **[ 2 2 0 ... 115 138 154]]** | **1** |
| **x71** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x72** | **[[49 60 70 ... 46 42 36]**  **[61 74 80 ... 44 46 41]**  **[79 73 67 ... 47 46 45]**  **...**  **[ 6 4 2 ... 3 4 10]**  **[ 7 3 2 ... 4 6 7]**  **[ 9 4 2 ... 4 7 11]]** | **1** |

|  |
| --- |
| **Step 4.1.2: Normalize Numpy Array of Grayscale X-ray Images in Training Data** |

**SLIDE**

**Step 4.1.2: Normalize Numpy Array of Grayscale X-ray Images in Training Data**

* **Step 1: Extract Features from Input using the Feature Extraction Method selected in Step 4.1.1**
* **Step 3: The Extracted Features in Step 1 are Normalized in pixel Intensity values ranged between (0-1)** 
  + **Original Range of Pixel Intensity Values = 0-255**
  + **Normalized Range of Pixel Intensity Values = 0-1**
* **After Feature Normalization, Input is transformed into Numerical Representation**

**SLIDE**

**Normalize Numpy Array of Grayscale X-ray Images in Training Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(Normalized 50,176 Pixel Values)** | **Output (Gender)** |
| **x1** | **[0.5529412 0.01176471 0.01176471 … 0.08235294 0.06666667**  **0.01960784]** | **0** |
| **x2** | **[0.2901961 0.00392157 0.6313726 … 0.2784314**  **0.29411766 0.30980393]** | **0** |
| **x3** | **[0.25490198 0.29803923 0.30588236 … 0.23529412**  **0.23529412 0.21568628]** | **0** |
| **x4** | **[0.36862746 0.36862746 0.3529412 … 0.1764706**  **0.14901961 0.12156863]** | **0** |
| **x5** | **[0.16078432 0.19215687 0.21568628 … 0.16862746**  **0.16470589 0.13725491]** | **0** |
| **x6** | **[0. 0. 0. … 0.14901961**  **0.14117648 0.12156863]** | **0** |
| **x7** | **[0. 0. 0. … 0.12941177**  **0.14117648 0.16078432]** | **0** |
| **x8** | **[0.01568628 0.00392157 0.01568628 … 0.11764706**  **0.10588235 0.05490196]** | **0** |
| **x9** | **[0.5176471 0.6117647 0.56078434 … 0. 0. 0.]** | **0** |
| **x10** | **[0. 0. 0. … 0.14509805**  **0.11372549 0.09019608 ]** | **0** |
| **x11** | **[0. 0. 0. … 0. 0.**  **0. ]** | **0** |
| **x12** | **[0.5686275 0.00784314 0.00784314 … 0.16470589**  **0.20784314 0.11764706]** | **0** |
| **x13** | **[[0.40784314 0. 0.04313726 … 0.01176471**  **0.00392157 0. ]** | **0** |
| **x14** | **[0.18431373 0.19215687 0.19607843 … 0.**  **0. 0. ]** | **0** |
| **x15** | **[0.3372549 0.37254903 0.40784314 … 0.34117648**  **0.32156864 0.29803923]** | **0** |
| **x16** | **[0.43529412 0.00392157 0.7921569 … 0.**  **0. 0.]** | **0** |
| **x17** | **[0.5686275 0.00392157 0.22352941 … 0.05098039**  **0.0627451 0.0627451]** | **0** |
| **x18** | **[0.34117648 0.32156864 0.40392157 … 0.3529412**  **0.36078432 0.42745098]** | **0** |
| **x19** | **[0.14509805 0.16862746 0.1882353 … 0.13725491**  **0.10980392 0.07843138]** | **0** |
| **x20** | **[0.41960785 0.00392157 0.8235294 … 0.78039217**  **0.80784315 0.79607844]** | **0** |
| **x21** | **[0. 0. 0. … 0. 0. 0.]** | **0** |
| **x22** | **[0.07058824 0.07058824 0.05490196 … 0.**  **0. 0.]** | **0** |
| **x23** | **[0.16862746 0.19607843 0.21960784 … 0.32156864**  **0.01176471 0.3019608]** | **0** |
| **x24** | **[0. 0. 0. … 0.13333334**  **0.16470589 0.15294118]** | **0** |
| **x25** | **[0.43137255 0.00392157 0.30980393 … 0.04705882**  **0.04705882 0.04313726]** | **0** |
| **x26** | **[0.28627452 0.34509805 0.38039216 … 0.6431373**  **0.4 0.3882353]** | **0** |
| **x27** | **[0.4392157 0. 0.53333336 … 0.28235295**  **0.29411766 0.30980393]** | **0** |
| **x28** | **[0.59607846 0.5176471 0.5372549 … 0.4627451**  **0.49411765 0.4862745]** | **0** |
| **x29** | **[0.13725491 0.00392157 0.01176471 … 0.11764706**  **0.12156863 0.12156863]** | **0** |
| **x30** | **[0.14901961 0.15686275 0.18039216 … 0.20392157**  **0.2901961 0.40392157]** | **0** |
| **x31** | **[1. 1. 1. … 0.23529412**  **0.2 0.13333334]** | **0** |
| **x32** | **[0.6156863 0.00392157 0.34509805 … 0.26666668**  **0.28627452 0.2901961]** | **0** |
| **x33** | **[0.14117648 0.17254902 0.21176471 … 0.28627452**  **0.2901961 0.34117648]** | **0** |
| **x34** | **[0.16078432 0.15686275 0.16078432 … 0.16862746**  **0.13725491 0.14117648]** | **0** |
| **x35** | **[0.34117648 0.00392157 0.09803922 … 0.**  **0. 0.00392157]** | **0** |
| **x36** | **[0. 0. 0. … 0.20784314**  **0.21176471 0.21176471]** | **0** |
| **x37** | **[0.12156863 0.12156863 0.1254902 … 0.05490196**  **0.0627451 0.09411765]** | **1** |
| **x38** | **[0.1882353 0.19607843 0.22352941 … 0.27450982**  **0.3019608 0.29411766]** | **1** |
| **x39** | **[0. 0. 0.99607843 … 0. 0.**  **0. ]** | **1** |
| **x40** | **[0.00784314 0.00784314 0.00784314 … 0.14509805**  **0.13333334 0.1254902 ]** | **1** |
| **x41** | **[0.03529412 0.03137255 0.07843138 … 0.01176471**  **0.01568628 0.01960784]** | **1** |
| **x42** | **[0.29411766 0.29803923 0.31764707 … 0.5137255**  **0.3019608 0.23529412]** | **1** |
| **x43** | **[0. 0. 0. … 0.02352941**  **0.01960784 0.01568628]** | **1** |
| **x44** | **[0.3019608 0.3019608 0.3137255 … 0.04705882**  **0.04705882 0.04313726]** | **1** |
| **x45** | **[0.11372549 0.10980392 0.10980392 … 0.02352941**  **0.02352941 0.01960784]** | **1** |
| **x46** | **[0.04313726 0.04313726 0.11764706 … 0.12156863**  **0.12941177 0.13333334]** | **1** |
| **x47** | **[0. 0. 0.9882353 … 0.**  **0. 0. ]** | **1** |
| **x48** | **[0.01176471 0.01960784 0.02745098 … 0.35686275**  **0.4392157 0.43529412]** | **1** |
| **x49** | **[0.19607843 0.20392157 0.2 … 0.00392157**  **0.00392157 0.00392157]** | **1** |
| **x50** | **[0.08235294 0.09411765 0.09411765 … 0.11372549**  **0.10980392 0.09803922]** | **1** |
| **x51** | **[0.47843137 0.5019608 0.49803922 … 0.00784314**  **0. 0.00392157]** | **1** |
| **x52** | **[0.03137255 0.03137255 0.03137255 … 0.03529412**  **0.03529412 0.03529412]** | **1** |
| **x53** | **[0.01568628 0.01568628 0.01960784 … 0.03529412**  **0.03529412 0.03529412]** | **1** |
| **x54** | **[0. 0. 0. … 0.**  **0. 0. ]** | **1** |
| **x55** | **[0.05098039 0.0627451 0.07058824 … 0.00392157**  **0. 0. ]** | **1** |
| **x56** | **[0.41568628 0.38039216 0.3764706 … 0.36862746**  **0.34117648 0.31764707]** | **1** |
| **x57** | **[0.05098039 0.05490196 0.0627451 … 0.01568628**  **0.01568628 0.01568628]** | **1** |
| **x58** | **[0.04705882 0.0627451 0.07058824 … 0.**  **0. 0. ]** | **1** |
| **x59** | **[0.07058824 0.0627451 0.05882353 … 0.06666667**  **0.06666667 0.07058824]** | **1** |
| **x60** | **[0.1882353 0.21960784 0.32941177 … 0.07450981**  **0.05098039 0.02352941]** | **1** |
| **x61** | **[0.1764706 0.1882353 0.20392157 … 0.14509805**  **0.14509805 0.12941177]** | **1** |
| **x62** | **[0.14117648 0.16862746 0.18431373 …** | **1** |
| **x63** | **0.**  **0. 0. ]** | **1** |
| **x64** | **[0. 0. 0. … 0.14901961**  **0.14901961 0.14901961]** | **1** |
| **x65** | **[0.12941177 0.14509805 0.12941177 … 0.23921569**  **0.24313726 0.23137255]** | **1** |
| **x66** | **[0.08627451 0.09411765 0.09803922 … 0.11764706**  **0.12156863 0.12156863]** | **1** |
| **x67** | **[0.07058824 0.07843138 0.08627451 … 0.04705882**  **0.03137255 0.03137255]** | **1** |
| **x68** | **[0.02352941 0.03529412 0.05098039 … 0.**  **0. 0. ]** | **1** |
| **x69** | **[0.16470589 0.18431373 0.1764706 … 0.10196079**  **0.13725491 0.12156863]** | **1** |
| **x70** | **[0.04705882 0.04705882 0.04705882 … 0.01960784**  **0.00784314 0. ]** | **1** |
| **x71** | **[0.1254902 0.11764706 0.1254902 … 0.01176471**  **0.01176471 0.01568628]** | **1** |
| **x72** | **[0.19215687 0.23529412 0.27450982 … 0.18039216**  **0.16470589 0.14117648]** | **1** |

**SLIDE**

**Hoooooooorrrrrrrrrraaaaaaaaayyyyyyyyyyy! 🚩**

* **Alhamdulillah (الحمدللہ), both Input and Output in Training Data are transformed into Numerical Representation**

|  |
| --- |
| **Step 4.2: Represent Testing Data in Machine Understandable Format (Numerical Representation)** |

**SLIDE**

**Step 4.2: Represent Testing Data in Machine Understandable Format**

* **Feature-based Classification Algorithms (implemented in Keras) can understand data in** 
  + **Attribute-Value Pair** 
    - **Values of Attributes / Features must be Numeric**
* **Problem**
  + **Our Testing Data is not in Attribute-Value Pair form**
    - **We need to transform our Testing Data into Machine Understandable Format**
* **Solution**
  + **There are many approaches to transform Testing Data into Machine Understandable Format**

**SLIDE**

**Important Note**

* **In this Lecture, we are using Keras implementation of the Convolution Neural Networks (CNN) Machine Learning Algorithm**
* **Convolutional Neural Networks (CNN) can only understand Data in Numerical Representation**
  + **Therefore, we will need to Convert both Input (X-ray Image) and Output (Pneumonia Prediction) into Numerical Representation**

**SLIDE**

**Transforming Testing Data in Machine Understandable Format**

* **In our Testing Data**
  + **Input is Unstructured (X-ray Image)**
  + **Output is Categorical**
* **Considering Input (X-ray Image) and Output (Pneumonia Prediction), we will need to** 
  + **Transform Input (X-ray Image) into Numerical Representation**
  + **Transform Output (Categorical) into Numerical Representation**

**SLIDE**

**Converting Output into Numerical Representation**

* **A Two-Step Process** 
  + **Step 01: Define an Encoding Scheme**
  + **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Testing Data**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 01: Define an Encoding Scheme**
* **Encoding Scheme for Gender Attribute**
  + **Normal = 0**
  + **Pneumonia = 1**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Testing Data**
* **The Table below shows Pre-processed Testing Data after Encoding Categorical Output Values to Numerical Output Values**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output (Pneumonia Prediction)** |
| **x1** |  | **0** |
| **x2** |  | **0** |
| **x3** |  | **0** |
| **x4** |  | **0** |
| **x5** |  | **0** |
| **x6** |  | **0** |
| **x7** |  | **0** |
| **x8** |  | **0** |
| **x9** |  | **0** |
| **x10** |  | **0** |
| **x11** |  | **1** |
| **x12** |  | **1** |
| **x13** |  | **1** |
| **x14** |  | **1** |
| **x15** |  | **1** |
| **x16** |  | **1** |
| **x17** |  | **1** |
| **x18** |  | **1** |
| **x19** |  | **1** |
| **x20** |  | **1** |

**SLIDE**

**Note**

* **Alhamdulillah (الحمدللہ), Output is transformed into Numerical Representation**
* **In Sha Allah (انشاء اللہ), in the next Slides, I will try to explain how to transform Input (Image) into Numerical Representation**

|  |
| --- |
| **Step 4.2.1 : Convert Resized Grayscale X-ray Images of Testing Data into Numpy Array** |

**SLIDE**

**Step 4.2.1 - Convert Resized Grayscale X-ray Images of Testing Data into Numpy Array**

* **Considering Feature-based ML Algorithms, an Input can be transformed into Numerical Representation in the following steps**
  + **Step 1: Select a Feature Extraction Method**
  + **Step 2: Extract Features from Input using the Feature Extraction Method selected in Step 1**
  + **Step 3: Normalize the Features Extracted in Step 2**

**SLIDE**

**Convert Resized Grayscale X-ray Images of Testing Data into Numpy Array**

* **Step 1: Select a Feature Extraction Method**
* **Insha Allah (انشاء اللہ), I will use Numpy Array based Feature Extraction Method to transform Sample Data into Numerical Representation (Machine Understandable Format)**
  + **Total Features = 224 X 224 = 50,176**
    - **Feature 01 = Value of Pixel 01**
    - **Feature 02 = Value of Pixel 02**
    - **Feature 03 = Value of Pixel 03**
    - **……..**
    - **Feature 50,175 = Value of Pixel 50,175**
    - **Feature 50,176 = Value of Pixel 50,176**
  + **Feature Value = Value of Pixel between 0 to 255**

**SLIDE**

**Resized Grayscale X-ray Images of Testing Data into Numpy Array**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x2** | **[[ 0 0 0 ... 44 35 17]**  **[ 0 0 0 ... 44 32 23]**  **[ 0 0 0 ... 45 32 14]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x3** | **[[ 86 97 101 ... 43 29 3]**  **[ 90 96 100 ... 44 27 2]**  **[ 92 101 102 ... 43 24 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x4** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x5** | **[[141 131 133 ... 0 0 0]**  **[131 136 137 ... 0 0 0]**  **[136 149 152 ... 0 0 0]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x6** | **[[ 59 68 84 ... 85 92 103]**  **[ 46 44 50 ... 103 107 96]**  **[ 42 46 42 ... 110 93 62]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x7** | **[[ 0 7 18 ... 175 183 189]**  **[ 0 7 21 ... 186 178 162]**  **[ 0 3 15 ... 171 157 167]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x8** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x9** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 2 2 2]**  **[0 0 0 ... 5 5 7]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x10** | **[[ 73 83 90 ... 196 233 254]**  **[ 70 81 90 ... 193 228 254]**  **[ 73 82 89 ... 190 227 255]**  **...**  **[ 0 0 0 ... 0 0 10]**  **[ 0 0 0 ... 0 0 9]**  **[ 0 0 0 ... 0 0 10]]** | **0** |
| **x11** | **[[ 0 0 0 ... 247 91 7]**  **[ 0 0 0 ... 6 254 6]**  **[ 0 0 0 ... 11 218 15]**  **...**  **[ 1 0 0 ... 0 0 0]**  **[ 5 250 254 ... 0 0 2]**  **[159 252 8 ... 0 0 157]]** | **1** |
| **x12** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x13** | **[[156 163 168 ... 159 246 122]**  **[156 163 164 ... 159 137 127]**  **[156 163 162 ... 159 50 116]**  **...**  **[ 41 119 102 ... 0 0 2]**  **[ 1 213 132 ... 0 0 0]**  **[ 8 10 7 ... 0 0 0]]** | **1** |
| **x14** | **[[ 1 3 3 ... 250 35 4]**  **[ 1 3 3 ... 9 253 1]**  **[ 0 1 2 ... 12 113 13]**  **...**  **[ 91 39 176 ... 0 0 0]**  **[ 7 232 250 ... 0 1 1]**  **[157 248 5 ... 0 2 158]]** | **1** |
| **x15** | **[[ 20 24 28 ... 17 19 23]**  **[ 21 24 30 ... 16 18 21]**  **[ 21 29 31 ... 14 16 19]**  **...**  **[138 145 150 ... 17 21 20]**  **[139 145 151 ... 17 16 20]**  **[143 149 151 ... 17 17 24]]** | **1** |
| **x16** | **[[ 7 12 16 ... 6 248 7]**  **[ 6 11 15 ... 3 0 0]**  **[ 6 8 13 ... 9 250 4]**  **...**  **[ 0 0 1 ... 0 0 1]**  **[ 6 246 252 ... 0 0 1]**  **[ 1 10 7 ... 0 0 1]]** | **1** |
| **x17** | **[[173 171 167 ... 132 132 137]**  **[176 164 160 ... 132 124 137]**  **[170 169 157 ... 128 118 138]**  **...**  **[ 65 93 117 ... 18 18 18]**  **[ 67 98 120 ... 18 18 18]**  **[ 68 103 122 ... 18 18 18]]** | **1** |
| **x18** | **[[ 59 73 74 ... 133 241 84]**  **[ 62 77 73 ... 100 87 78]**  **[ 58 69 87 ... 108 31 84]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 2 117 254 ... 0 0 0]**  **[ 9 0 0 ... 0 0 0]]** | **1** |
| **x19** | **[[ 0 0 0 ... 197 95 6]**  **[ 0 0 0 ... 13 22 2]**  **[ 0 0 0 ... 219 249 9]**  **...**  **[ 45 72 104 ... 0 0 0]**  **[ 4 249 245 ... 0 0 7]**  **[159 18 0 ... 0 0 158]]** | **1** |
| **x20** | **[[127 129 130 ... 115 112 113]**  **[147 135 132 ... 113 117 126]**  **[141 142 136 ... 254 39 122]**  **...**  **[ 20 45 63 ... 250 70 1]**  **[ 20 42 62 ... 4 1 0]**  **[ 22 47 65 ... 0 0 0]]** | **1** |

|  |
| --- |
| **Step 4.2.2: Normalize Numpy Array of Grayscale X-ray Images in Testing Data** |

**SLIDE**

**Step 4.2.2: Normalize Numpy Array of Grayscale X-ray Images in Testing Data**

* **Step 1: Extract Features from Input using the Feature Extraction Method selected in Step 4.2.1**
* **Step 3: The Extracted Features in Step 1 are Normalized in pixel Intensity values ranged between (0-1)** 
  + **Original Range of Pixel Intensity Values = 0-255**
  + **Normalized Range of Pixel Intensity Values = 0-1**
* **After Feature Normalization, Input is transformed into Numerical Representation**

**SLIDE**

**Normalize Numpy Array of Grayscale X-ray Images in Testing Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(Normalized 50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[0. 0. 0. … 0.**  **0. 0. ]** | **0** |
| **x2** | **[0. 0. 0. … 0.17254902**  **0.13725491 0.06666667]** | **0** |
| **x3** | **[0.3372549 0.38039216 0.39607844 … 0.16862746**  **0.11372549 0.01176471]** | **0** |
| **x4** | **[0. 0. 0. … 0.**  **0. 0. ]** | **0** |
| **x5** | **[0.5529412 0.5137255 0.52156866 … 0.**  **0. 0. ]** | **0** |
| **x6** | **[0.23137255 0.26666668 0.32941177 … 0.33333334**  **0.36078432 0.40392157]** | **0** |
| **x7** | **[0. 0.02745098 0.07058824 … 0.6862745**  **0.7176471 0.7411765]** | **0** |
| **x8** | **[0. 0. 0. … 0.**  **0. 0.]** | **0** |
| **x9** | **[0. 0. 0. … 0. 0. 0.]** | **0** |
| **x10** | **[0.28627452 0.3254902 0.3529412 … 0.76862746**  **0.9137255 0.99607843]** | **0** |
| **x11** | **[0. 0. 0. … 0.96862745**  **0.35686275 0.02745098 ]** | **1** |
| **x12** | **[0. 0. 0. … 0.**  **0. 0.]** | **1** |
| **x13** | **[0.6117647 0.6392157 0.65882355 … 0.62352943**  **0.9647059 0.47843137 ]** | **1** |
| **x14** | **[0.00392157 0.01176471 0.01176471 … 0.98039216**  **0.13725491 0.01568628]** | **1** |
| **x15** | **[0.07843138 0.09411765 0.10980392 … 0.06666667**  **0.07450981 0.09019608]** | **1** |
| **x16** | **[[0.02745098 0.04705882 0.0627451 … 0.02352941**  **0.972549 0.02745098]** | **1** |
| **x17** | **[0.6784314 0.67058825 0.654902 … 0.5176471**  **0.5176471 0.5372549]** | **1** |
| **x18** | **[0.23137255 0.28627452 0.2901961 … 0.52156866**  **0.94509804 0.32941177]** | **1** |
| **x19** | **[0. 0. 0. … 0.77254903**  **0.37254903 0.02352941]** | **1** |
| **x20** | **[0.49803922 0.5058824 0.50980395 … 0.4509804**  **0.4392157 0.44313726]** | **1** |

**SLIDE**

**Hoooooooorrrrrrrrrraaaaaaaaayyyyyyyyyyy! 🚩**

* **Alhamdulillah (الحمدللہ), both Input and Output in Testing Data are transformed into Numerical Representation**

|  |
| --- |
| **Step 4.3: Represent Validation Data in Machine Understandable Format (Numerical Representation)** |

**SLIDE**

**Step 4.3: Represent Validation Data in Machine Understandable Format**

* **Feature-based Classification Algorithms (implemented in Keras) can understand data in** 
  + **Attribute-Value Pair** 
    - **Values of Attributes / Features must be Numeric**
* **Problem**
  + **Our Testing Data is not in Attribute-Value Pair form**
    - **We need to transform our Testing Data into Machine Understandable Format**
* **Solution**
  + **There are many approaches to transform Validation Data into Machine Understandable Format**

**SLIDE**

**Important Note**

* **In this Lecture, we are using Keras implementation of the Convolution Neural Networks (CNN) Machine Learning Algorithm**
* **Convolutional Neural Networks (CNN) can only understand Data in Numerical Representation**
  + **Therefore, we will need to Convert both Input (X-ray Image) and Output (Pneumonia Prediction) into Numerical Representation**

**SLIDE**

**Transforming Testing Data in Machine Understandable Format**

* **In our Testing Data**
  + **Input is Unstructured (X-ray Image)**
  + **Output is Categorical**
* **Considering Input (X-ray Image) and Output (Pneumonia Prediction), we will need to** 
  + **Transform Input (X-ray Image) into Numerical Representation**
  + **Transform Output (Categorical) into Numerical Representation**

**SLIDE**

**Converting Output into Numerical Representation**

* **A Two-Step Process** 
  + **Step 01: Define an Encoding Scheme**
  + **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Testing Data**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 01: Define an Encoding Scheme**
* **Encoding Scheme for Gender Attribute**
  + **Normal = 0**
  + **Pneumonia = 1**

**SLIDE**

**Converting Output into Numerical Representation Cont…**

* **Step 02: Use Encoding Scheme defined in Step 01, to convert Categorical Output Values to Numerical Output Values for all instances in the Validation Data**
* **The Table below shows Pre-processed Testing Data after Encoding Categorical Output Values to Numerical Output Values**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(X-ray Image)** | **Output (Pneumonia Prediction)** |
| **x1** |  | **0** |
| **x2** |  | **0** |
| **x3** |  | **0** |
| **x4** |  | **0** |
| **x5** |  | **1** |
| **x6** |  | **1** |
| **x7** |  | **1** |
| **x8** |  | **1** |

**SLIDE**

**Note**

* **Alhamdulillah (الحمدللہ), Output is transformed into Numerical Representation**
* **In Sha Allah (انشاء اللہ), in the next Slides, I will try to explain how to transform Input (Image) into Numerical Representation**

|  |
| --- |
| **Step 4.3.1 : Convert Resized Grayscale X-ray Images of Validation Data into Numpy Array** |

**SLIDE**

**Step 4.2.1 - Convert Resized Grayscale X-ray Images of Validation Data into Numpy Array**

* **Considering Feature-based ML Algorithms, an Input can be transformed into Numerical Representation in the following steps**
  + **Step 1: Select a Feature Extraction Method**
  + **Step 2: Extract Features from Input using the Feature Extraction Method selected in Step 1**
  + **Step 3: Normalize the Features Extracted in Step 2**

**SLIDE**

**Convert Resized Grayscale X-ray Images of Validation Data into Numpy Array**

* **Step 1: Select a Feature Extraction Method**
* **Insha Allah (انشاء اللہ), I will use Numpy Array based Feature Extraction Method to transform Sample Data into Numerical Representation (Machine Understandable Format)**
  + **Total Features = 224 X 224 = 50,176**
    - **Feature 01 = Value of Pixel 01**
    - **Feature 02 = Value of Pixel 02**
    - **Feature 03 = Value of Pixel 03**
    - **……..**
    - **Feature 50,175 = Value of Pixel 50,175**
    - **Feature 50,176 = Value of Pixel 50,176**
  + **Feature Value = Value of Pixel between 0 to 255**

**SLIDE**

**Resized Grayscale X-ray Images of Validation Data into Numpy Array**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[[ 8 14 24 ... 64 60 61]**  **[11 14 32 ... 69 68 65]**  **[11 11 33 ... 70 69 57]**  **...**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]**  **[ 0 0 0 ... 0 0 0]]** | **0** |
| **x2** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[2 3 3 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **0** |
| **x3** | **[[ 77 1 89 ... 15 16 15]**  **[ 1 2 1 ... 15 15 16]**  **[152 1 1 ... 14 15 15]**  **...**  **[ 34 38 33 ... 30 29 18]**  **[ 51 33 36 ... 31 28 30]**  **[ 67 33 32 ... 29 27 28]]** | **0** |
| **x4** | **[[149 4 183 ... 173 2 2]**  **[ 0 1 0 ... 7 2 0]**  **[112 0 70 ... 5 3 1]**  **...**  **[ 0 0 0 ... 8 8 6]**  **[ 2 0 0 ... 1 2 0]**  **[ 3 0 0 ... 172 2 0]]** | **0** |
| **x5** | **[[ 0 0 0 ... 40 31 26]**  **[ 0 0 0 ... 38 31 23]**  **[ 0 0 0 ... 36 31 23]**  **...**  **[ 1 1 1 ... 2 2 2]**  **[ 1 1 1 ... 2 2 2]**  **[ 1 1 1 ... 2 2 2]]** | **1** |
| **x6** | **[[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **...**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]**  **[0 0 0 ... 0 0 0]]** | **1** |
| **x7** | **[[ 0 0 0 ... 6 6 6]**  **[ 0 0 0 ... 6 6 6]**  **[ 0 0 0 ... 6 6 6]**  **...**  **[ 3 8 4 ... 12 14 7]**  **[ 1 7 4 ... 11 9 3]**  **[ 6 2 4 ... 12 5 13]]** | **1** |
| **x8** | **[[65 67 67 ... 98 93 96]**  **[61 60 59 ... 95 94 93]**  **[55 55 55 ... 95 92 92]**  **...**  **[14 37 45 ... 11 8 8]**  **[19 40 51 ... 8 7 11]**  **[25 41 52 ... 7 9 9]]** | **1** |

|  |
| --- |
| **Step 4.3.2: Normalize Numpy Array of Grayscale X-ray Images in Validation Data** |

**SLIDE**

**Step 4.3.2: Normalize Numpy Array of Grayscale X-ray Images in Validation Data**

* **Step 1: Extract Features from Input using the Feature Extraction Method selected in Step 4.3.1**
* **Step 3: The Extracted Features in Step 1 are Normalized in pixel Intensity values ranged between (0-1)** 
  + **Original Range of Pixel Intensity Values = 0-255**
  + **Normalized Range of Pixel Intensity Values = 0-1**
* **After Feature Normalization, Input is transformed into Numerical Representation**

**SLIDE**

**Normalize Numpy Array of Grayscale X-ray Images in Validation Data**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input**  **(Normalized 50,176 Pixel Values)** | **Output (Pneumonia Prediction)** |
| **x1** | **[0.03137255 0.05490196 0.09411765 … 0.2509804**  **0.23529412 0.23921569 ]** | **0** |
| **x2** | **[0. 0. 0. … 0. 0. 0. ]** | **0** |
| **x3** | **[0.3019608 0.00392157 0.34901962 … 0.05882353**  **0.0627451 0.05882353]** | **0** |
| **x4** | **[0.58431375 0.01568628 0.7176471 … 0.6784314**  **0.00784314 0.00784314]** | **0** |
| **x5** | **[0. 0. 0. … 0.15686275**  **0.12156863 0.10196079]** | **1** |
| **x6** | **[0. 0. 0. … 0. 0. 0. ]** | **1** |
| **x7** | **[0. 0. 0. … 0.02352941**  **0.02352941 0.02352941]** | **1** |
| **x8** | **[0.25490198 0.2627451 0.2627451 … 0.38431373**  **0.3647059 0.3764706]** | **1** |

**SLIDE**

**Hoooooooorrrrrrrrrraaaaaaaaayyyyyyyyyyy! 🚩**

* **Alhamdulillah (الحمدللہ), both Input and Output in Validation Data are transformed into Numerical Representation**

|  |
| --- |
| **Step 05: Select Suitable Deep Learning Algorithms** |

**SLIDE**

**Step 05: Select Suitable Deep Learning Algorithms**

* **Previous studies have shown that Good Starting Points for Classification Problems are**
  + **RNN**
  + **LSTM**
  + **Bi-LSTM**
  + **GRU**
  + **Bi-GRU**
  + **CNN**

**SLIDE**

**Lecture Focus**

* **In Sha Allah, in this Lecture, we will use**

|  |
| --- |
| **CNN-based Deep Neural Networks** |

|  |
| --- |
| **Step 06: Select Suitable Evaluation Measure(s)** |

**SLIDE**

**Step 07: Select Suitable Evaluation Measure(s)**

* **I will use the Accuracy Evaluation Measure to evaluate the performance of the Model**
* **Accuracy**
  + **Accuracy is defined as the proportion of correctly classified Test Instances**

|  |
| --- |
|  |

* **Note**
  + **Error = 1 - Accuracy**

|  |
| --- |
| **Step 07: Execute First Two Phases of Machine Learning Cycle** |

**SLIDE**

**Step 7: Execute First Two Phases of Machine Learning Cycle**

* **Recall the Equation**

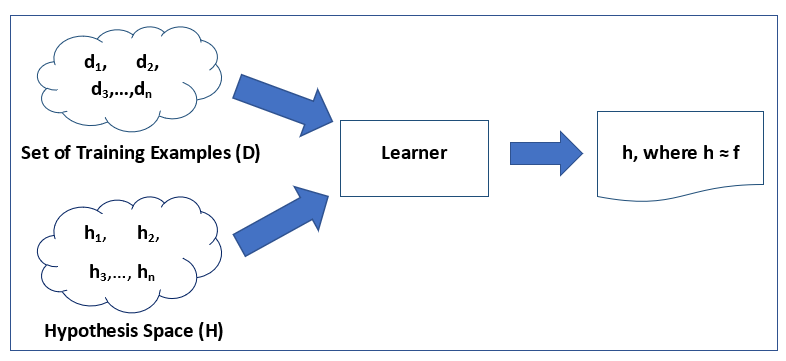
|  |
| --- |
|  |

* **Training Phase**
  + **Use Training Data to build the Model**
  + **Use Validation Data to check** 
    - **Whether the Model is Overfitting during the Training Phase or Not?**
* **Testing Phase**
  + **Use Testing Data to evaluate the performance of the Model**
* **Note that we aim to**
  + **Learn an Input-Output Function**

**SLIDE**

**General Settings - Learning Input-Output Function**

* **Recall – Our goal is to** 
  + **Learn an Input-Output Function**



**Figure 2: General Settings – Input and Output**

**SLIDE**

**Training Phase**

**h1, h2,**

**h3,….., hn**

**h, Where h ≈ f**

**Learner**

**Training Phase**

|  |  |
| --- | --- |
| **[0.5529412 0.01176471 …**  **0.01960784]** | **0** |
| **[0.2901961 0.00392157 … 0.30980393]** | **0** |
| **[0.25490198 0.29803923 …**  **0.21568628]** | **0** |
| **[0.36862746 0.36862746 …**  **0.12156863]** | **0** |
| **[0.16078432 0.19215687 …**  **0.13725491]** | **0** |
| **[0.12156863 0.12156863 …**  **0.09411765]** | **1** |
| **[0.1882353 0.19607843 …**  **0.29411766]** | **1** |
| **[0. 0. … 0. ]** | **1** |
| **[0.00784314 0.00784314 …**  **0.1254902 ]** | **1** |
| **[0.03529412 0.03137255 …**  **0.01960784]** | **1** |

**Set of Training Examples ( D )**

**Hypothesis Space (H)**

**SLIDE**

* **Apply Model on the Testing Data**

**Testing Phase**

|  |
| --- |
| **[0. 0. … 0. ]** |
| **[0. 0. … 0.06666667]** |
| **[0.3372549 0.38039216 … 0.01176471]** |
| **[0. 0. … 0. ]** |
| **[0.5529412 0.5137255 …**  **0. ]** |

**Set of Testing Examples ( D )**

**Model (h)**

**Predictions**

**SLIDE**

**Testing Phase Cont…**

* **The following Table shows the Predictions Returned by the Model (h)**

|  |  |  |
| --- | --- | --- |
| **Instance No.** | **Input** | **Output** |
| **Pixels** | **Predictions** |
| **x1** | **[0. 0. 0. … 0.**  **0. 0. ]** | **0** |
| **x2** | **[0. 0. 0. … 0.17254902**  **0.13725491 0.06666667]** | **0** |
| **x3** | **[0.3372549 0.38039216 0.39607844 … 0.16862746**  **0.11372549 0.01176471]** | **0** |
| **x4** | **[0. 0. 0. … 0.**  **0. 0. ]** | **0** |
| **x5** | **[0.5529412 0.5137255 0.52156866 … 0.**  **0. 0. ]** | **0** |
| **x6** | **[0.23137255 0.26666668 0.32941177 … 0.33333334**  **0.36078432 0.40392157]** | **0** |
| **x7** | **[0. 0.02745098 0.07058824 … 0.6862745**  **0.7176471 0.7411765]** | **0** |
| **x8** | **[0. 0. 0. … 0.**  **0. 0.]** | **0** |
| **x9** | **[0. 0. 0. … 0. 0. 0.]** | **0** |
| **x10** | **[0.28627452 0.3254902 0.3529412 … 0.76862746**  **0.9137255 0.99607843]** | **0** |
| **x11** | **[0. 0. 0. … 0.96862745**  **0.35686275 0.02745098 ]** | **0** |
| **x12** | **[0. 0. 0. … 0.**  **0. 0.]** | **0** |
| **x13** | **[0.6117647 0.6392157 0.65882355 … 0.62352943**  **0.9647059 0.47843137 ]** | **0** |
| **x14** | **[0.00392157 0.01176471 0.01176471 … 0.98039216**  **0.13725491 0.01568628]** | **0** |
| **x15** | **[0.07843138 0.09411765 0.10980392 … 0.06666667**  **0.07450981 0.09019608]** | **0** |
| **x16** | **[[0.02745098 0.04705882 0.0627451 … 0.02352941**  **0.972549 0.02745098]** | **0** |
| **x17** | **[0.6784314 0.67058825 0.654902 … 0.5176471**  **0.5176471 0.5372549]** | **0** |
| **x18** | **[0.23137255 0.28627452 0.2901961 … 0.52156866**  **0.94509804 0.32941177]** | **0** |
| **x19** | **[0. 0. 0. … 0.77254903**  **0.37254903 0.02352941]** | **0** |
| **x20** | **[0.49803922 0.5058824 0.50980395 … 0.4509804**  **0.4392157 0.44313726]** | **0** |

**SLIDE**

**Testing Phase, Continue**

* **Calculating Accuracy** 
  + **To calculate Accuracy, we will compare** 
    - **Actual Values with Predicted Values**
* **Note**
  + **To explain calculations more clearly, I have converted Numerical Predicted Values to Categorical Predicted Values**

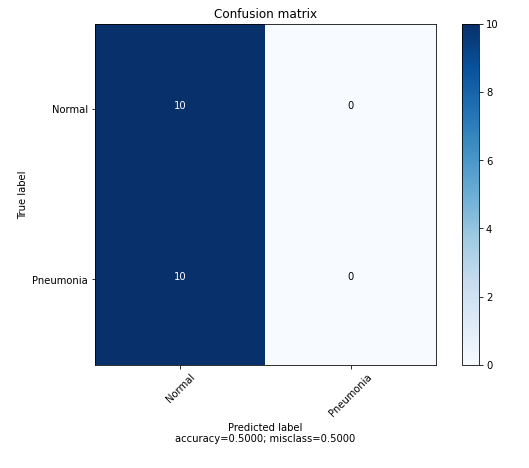
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Instance No. | Input  PRE-PORCESSD IMAGES | Output | | |
| **Actual Value** | **Predicted Values** | **Score** |
| x1 |  | **Normal** | **Normal** | **1** |
| x2 |  | **Normal** | **Normal** | **1** |
| x3 |  | **Normal** | **Normal** | **1** |
| x4 |  | **Normal** | **Normal** | **1** |
| x5 |  | **Normal** | **Normal** | **1** |
| x6 |  | **Normal** | **Normal** | **1** |
| x7 |  | **Normal** | **Normal** | **1** |
| x8 |  | **Normal** | **Normal** | **1** |
| x9 |  | **Normal** | **Normal** | **1** |
| x10 |  | **Normal** | **Normal** | **1** |
| x11 |  | **Peumonia** | **Normal** | **0** |
| x12 |  | **Peumonia** | **Normal** | **0** |
| x13 |  | **Peumonia** | **Normal** | **0** |
| x14 |  | **Peumonia** | **Normal** | **0** |
| x15 |  | **Peumonia** | **Normal** | **0** |
| x16 |  | **Peumonia** | **Normal** | **0** |
| x17 |  | **Peumonia** | **Normal** | **0** |
| x18 |  | **Peumonia** | **Normal** | **0** |
| x19 |  | **Peumonia** | **Normal** | **0** |
| x20 |  | **Peumonia** | **Normal** | **0** |

|  |
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|  |

**SLIDE**

**Confusion Matrix**

* **We will draw Confusion Matrix** 
  + **To get more Insight on the Performance of Trained Model on the Test Data**

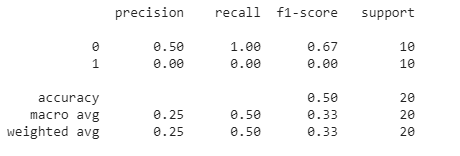
****

**Figure 3: Confusion Matrix**

**SLIDE**

**Classification Report**

* **To Evaluate the Performance of Trained Model on Test Data we will calculate other Evaluation Measures** 
  + **Evaluation Measures**
    - **Precision**
    - **Recall**
    - **Accuracy**
    - **F1 Score etc.**

****

**Figure 4: Classification Report**

|  |
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| **Step 08: Analyze Results** |

**SLIDE**

**Step 8: Analyze Results**

* **The assumption for this Example**
  + **Here, I am assuming that the Model** 
    - **performed well on large Test Data and we can apply it in the real-world 😊**

|  |
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| **Step 09: Execute 3rd and 4th Phases of Machine Learning Cycle** |

**SLIDE**

**Step 9: Execute 3rd and 4th Phases of Machine Learning Cycle**

* **Application Phase**
  + **Model is deployed in Real-world to make predictions on Real-time Data**
* **Steps – Make Predictions on Real-time Data**
  + **Step 1: Take Input (X-ray Image) from User**
  + **Step 2: Resize the Input Image (Exactly Same as Images of Training Data Testing Data and Validation Data)**
  + **Step 3: Convert User Input into Feature Vector** 
    - **Same as Feature Vectors of Training Data Testing Data and Validation Data (using Numpy Array based Feature Extraction Method)**
  + **Step 4: Apply Model on the Feature Vector of the unseen instance**
  + **Step 5: Return Prediction to the User**

**SLIDE**

**Example – Making Predictions on Real-time Data**

* **Step 1: Take Input (X-ray Image) from User**
  + **User Input**

|  |
| --- |
| **Please input an Image:** |

* **Step 2: Preprocess image (Resize Image to 224 x 224 resolution):**

|  |
| --- |
| **Resized image:** |

* **Step 3: Preprocess image (Convert Resized RGB Image into Grayscale):**

|  |
| --- |
| **Grayscale image:** |

* **Step 4: Convert User Input into Numpy Array**
  + **Numpy Array**

|  |
| --- |
| **<[[26 32 30 ... 19 30 42]**  **[ 21 34 37 ... 26 28 42]**  **[108 33 40 ... 27 31 40]**  **...**  **[ 19 19 18 ... 32 33 33]**  **[ 19 19 18 ... 32 32 33]**  **[ 19 19 18 ... 32 32 31]]>** |

* **Step 5: Normalize User Input**
  + **Normalized Array**

|  |
| --- |
| **<[[0.10196079 0.1254902 0.11764706…**  **0.1254902 0.1254902 0.12156863]]>** |

* **Step 6: Apply Model on the Normalized Pixels of unseen instance**

**Model (h) is applied on <[[0.10196079 0.1254902 0.11764706…**

**0.1254902 0.1254902 0.12156863]]>**

* **Step 7: Return Prediction to the User**
  + **1 (Pneumonia)**

**SLIDE**

**Application Phase**

**Application Phase**

**Prediction**

**Model (h)**

|  |
| --- |
| **[0.10196079 0.1254902 0.11764706…**  **0.1254902 0.1254902 0.12156863]** |

**SLIDE**

**Feedback Phase**

* **A Two-Step Process**
* **Step 1: After some time, take Feedback from**
* **Domain Experts and Users on Deployed Pneumonia Disease Prediction (from X-ray Image) System**
* **Step 2: Make a List of Possible Improvements based on Feedback receive**

|  |
| --- |
| **Step 10: Improve Pneumonia Disease Prediction (from X-ray Image) System based on Feedback** |

**SLIDE**

**Step 10: Improve Pneumonia Disease Prediction (from X-ray Image) System based on Feedback**

* **Go to Step 1 and improve the Improve Pneumonia Disease Prediction (from X-ray Image) System based on** 
  + **List of Possible Improvements made in Step 9**

|  |
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| **TODO and Your Turn** |

**SLIDE**

**TODO**

* **Task**
  + **Consider the Sample Data of 50 instances for the BrainTumor Identification Problem and answer the questions given below**
  + **The Brain Tumor Identification Problem is a Binary Classification Problem**
  + **The aim of Brain Tumor Identification is to discriminate between two classes: (1) Benign and (2) Malignant**
* **See Brain Tumor Sample Data File in Supporting Material**
* **Split the Sample Data as follows**
  + **Training Data = 80% (36 Instances)**
  + **Testing Data = 20% (10 Instances)**
  + **Validation Data = 10% of Training Data (4 Instances)**
* **Note**
  + **Your answer should be**
    - **Well Justified**
* **Questions**
  + **Write Input and Output for the Brain Tumor Identification Problem?**
  + **Follow the Steps mentioned in this Lecture and show** 
    - **How will you treat the Brain Tumor Identification Problem as a Supervised Deep Learning Problem (using CNN)?**

**SLIDE**

**Your Turn**

* **Task**
  + **Select a Machine Learning Problem (similar to Brain Tumor Identification Problem given in TODO Task) and answer the questions given below.**
* **Questions**
  + **Write Input and Output for the Selected Machine Learning Problem?**
  + **Follow the Steps mentioned in this Lecture and show** 
    - **How will you treat the Selected Machine Learning Problem as a Supervised Deep Learning Problem (using CNN)?**

|  |
| --- |
| **Its Story Time** |

**Story No 02**

**Reference: Book Name: Hayat Us Sahaba Part 01, Page Number: 176**

|  |
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|  |

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| --- |
| **Stop Complaining! Stop Criticizing! Let’s Start Contributing** |

**SLIDE**

**A True Story**

* **Here I am writing a true story of one of my Respected Teachers**

**(Prof. Dr. Yaseen Iqbal Department of Physics, University of Peshawar, Pakistan)**

**SLIDE**

**Story**

* **In 1996, I was a Ph.D. student at the University of Sheffield, England. One day, I was having a walk with my friends. We saw an Old Lady picking up French Fries (potato chips) from the Foot Path. One of my friends said to the Old Lady**
  + **Mam! Why are you picking these? It is a crowded place and you may get hurt.**
* **Old Lady replied**
  + **Gentleman! This is MY Country. If it is dirty. I feel dirty.**
* **Remember** 
  + **There is nothing like**
    - **Big Contribution or**
    - **Small Contribution**
  + **Contribution is Contribution 😊**
* **Let’s Strat Contributing from Today**
  + **To make this Beautiful World, more Beautiful 😊**

|  |
| --- |
| **Hadith** |

**Hadith No 01**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 140**

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|  |

**Hadith No 02**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 159**

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**Hadith No 03**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 180**

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**Hadith No 04**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 191**

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|  |

**Hadith No 05**

**Reference: Book Name: Muntakhab Ahadith, Page Number: 193**

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| **Lecture Summary** |

**SLIDE**

**Lecture Summary**

* **To systematically perform any Real-world Task using a Template-based Approach, follow the following steps**
  + **Step 1: Completely and correctly understand the Real-world Task**
    - **Write down two main things**
      * **Given**
      * **Task**
  + **Step 2: Understand the Input and Output of the Real-world Task**
    - **Write down two main things**
      * **Input**
      * **Output**
  + **Step 3: Plan and Design a Template-based Approach to perform the Real-world Task**
    - **Step 3.1: Use the Divide and Conquer Approach to break the Real-world Task into**
      * **Steps / Sub-steps / Sub-sub-steps**
    - **Step 3.2: For each Steps / Sub-steps / Sub-sub-steps**
      * **Check the Order and Flow between Steps / Sub-steps / Sub-sub-steps**
      * **Check the Connectivity and Independence between Steps / Sub-steps / Sub-sub-steps**
  + **Step 4: Use a Five-Step Process to perform the Real-world Task**
    - **Step 4.1: Plan – in Mind**
    - **Step 4.2: Design – on Paper**
    - **Step 4.3: Execute – at Prototype level**
    - **Step 4.4: Execute – at Full Scale**
    - **Step 4.5: Take Feedback from Users / Audience and Domain Expert to further improve the solution of Real-world Task**
  + **Step 5: Document each Step, when performing a Real-world Task**
* **CNN-based Deep Neural Network Architecture**
  + **CNN-based Deep Neural Network cannot directly understand the Image Data**
  + **Therefore, we need to convert our Image Data into Numerical Representation (Machine Understandable Format)**
* **There are many possible approaches to convert Image into Numerical Representation (Machine Understandable Format)**
  + **For example**
    - **Pixel Value based approach**
    - **Numpy Array based approach etc.**
* **CNN-based Deep Neural Network Architecture – Layers**
* **Input Layer**
  + **In Input Layer, following processing is performed in six main Steps**
    - **Step 01: Input Images are resized into specific dimension inorder to keep the dimension of Image consistent.**
    - **Step 02: Images at Step 01 are converted into Grayscale**
    - **Step 03: Resized Grayscale Images are converted into Numerical Representation using Numpy Array.**
    - **Step 04: Pixel Intensity Values of Images in Step 03 are Normalized**
    - **Step 05: Normalized Feature Vectors are reshaped for Deep Learning**
    - **Step 06: Fixed Length Feature Vectors are given as Input to Next Layer**
      * **i.e. CNN Layer**
* **Hidden Layer**
  + **We have used Convolutional and Pooling Layers as**
    - **Hidden Layer in this Deep Neural Network Architecture**
* **Convolutional Layer**
  + **Convolutional layers are the key component of CNN.**
  + **In Image Classification tasks**
    - **Input to the Convolutional Layers are treated as**
      * **One 2D matrices (or channels)**
      * **More 2D matrices (or channels)**
    - **Output Generates**
      * **Multiple 2D matrices.**
* **Pooling Layer**
  + **Pooling layer plays an important role in CNN for feature dimension reduction.**
  + **Pooling is applied to combine the neighbouring elements in the convolution output matrices.**
  + **Commonly used pooling algorithms are** 
    - **Max Pooling**
    - **Average Pooling**
* **Number of Convolutional Layers**
  + **Example**
    - **Setting num\_layers =2 means**
      * **Stacking Two CNN Layers together to form a stacked CNN**
      * **Second CNN Layer taking in Outputs of the First CNN Layer and computing the final results**
  + **Default Value for Number of Convolutional Layers is**
    - **1**
* **Sequential**
  + **It defines a Sequence of layers in the neural network**
* **Batch Normalization**
  + **It Normalizes Training Instances in Batches**
* **Flatten**
  + **Flatten takes the square images and turn them into a 1 Dimentional Feature Vector**
* **Dense**
  + **Contains Fully Connected Layers of Neurons**
  + **Each layer of neurons need an activation function to tell them what to do**
* **Activation Function**
  + **Sigmoid**
  + **Tanh**
  + **ReLU (Rectifying Linear Unit)**
  + **Leaky-ReLU**
  + **Softmax**
* **Relu**
  + **In CNN model, the ReLU activation function is used in the Convolutional Layer**
* **Output Layer**
  + **At Output Layer, we have used**
    - **Sigmoid Activation Function**
  + **The Sigmoid Activation Function is used for Binary Classification**
  + **Formula of Sigmoid Activation Function**
    - **σ(S) =**
    - **where S is Weighted sum of Inputs**
* **Important (Generic) Parameters to consider in designing CNN-based Deep Neural Network are as follows**
  + **No. of Input Units**
  + **No. of Hidden Layers**
    - **No. of Hidden Units at each Hidden Layer**
    - **No. of Convolutional Layer**
    - **No. of Pooling Layer**
    - **No. of Batch Normalization Layer**
  + **No. of Fully Connected Layers**
  + **No. of Output Units**
  + **Activation Function at each Hidden and Output Unit**
  + **Number of Epochs**
  + **Learning Rate**
  + **Optimizer**
  + **Loss Function**
* **For CNN-based Deep Neural Network used in this Lecture, following Parameters were used**
  + **No. of Input Layer = 1**
    - **Input Size = (224 X 224 X 1)**
  + **No. of Hidden Layer = 2**
    - **No. of Convolutional Layer = 1**
    - **No. of Pooling Layer = 2**
    - **Batch Normalization Layer = 1**
    - **Flatten Layer = 1**
  + **No. of Outpur Layer = 1**
    - **No. of Output Unit = 1**
  + **Activation Function = 1**
    - **Hidden Layer = ReLU**
    - **Output Layer = Sigmoid**
  + **Number of Epochs = 15**
  + **Learning Rate = 0.0001**
  + **Optimizer = Adam**
  + **Loss Function = binary\_crossentropy**
* **Pneumonia Disease Prediction (from X-ray Image)– Task**
  + **Given**
    - **An X-ray Image (Represented as Set of Attributes)**
  + **Task**
    - **Automatically predict the person has Pneumonia or Not**
* **Pneumonia Disease Prediction (from X-ray Image)– Input and Output**
  + **Input** 
    - **An X-ray Image**
  + **Output**
    - **Normal / Pneumonia**
* **The Problem of Pneumonia Disease Prediction (from X-ray Image) is treated as a**
  + **Supervised Machine Learning Task**
* **The main goal of Pneumonia Disease Prediction (from X-ray Image) Problem is to**
  + **Learn an Input-Output Function** 
    - **i.e. Learn from Input to predict the Output**
* **Learning Input-Output Function – General Settings** 
  + **Input to Learner**
    - **Set of Training Examples (D)**
    - **Set of Hypothesis (a.k.a. Hypothesis Space (H))**
  + **Job of Learner**
    - **The main job of a Learner is to search the Hypothesis Space (H) using the Set of Training Examples (D) to find out a Hypothesis (h) from Hypothesis Space (H), which best fits the Set of Training Examples (D)**
  + **Output of Learner**
    - **A Learner outputs a Hypothesis (h) from Hypothesis Space (H), which best fits the Set of Training Examples (D)**
* **Steps to treat the Pneumonia Disease Prediction (from X-ray Image) Problem as a Classification Problem** 
  + **Step 1: Decide the Learning Settings**
  + **Step 2: Obtain Sample Data** 
    - **Step 2.1: Obtain Training Data**
    - **Step 2.2: Obtain Testing Data**
    - **Step 2.3: Obtain Validation Data**
  + **Step 3: Understand and Pre-process Sample Data**
    - **Step 3.1: Understand and Pre-process Training Data**
      * **Step 3.1.1: Resize X-ray Images in Training Data**
      * **Step 3.1.2: Convert Resized RGB X-ray Images in Training Data into Grayscale**
    - **Step 3.2: Understand and Pre-process Testing Data** 
      * **Step 3.2.1: Resize X-ray Images in Testing Data**
      * **Step 3.2.2: Convert Resized RGB X-ray Images in Testing Data into Grayscale**
    - **Step 3.3: Understand and Pre-process Validation Data** 
      * **Step 3.2.1: Resize X-ray Images in Validation Data**
      * **Step 3.2.2: Convert Resized RGB X-ray Images in Validation Data into Grayscale**
  + **Step 4: Represent Sample Data in Machine Understandable Format (Numerical Representation)**
    - **Step 4.1: Represent Training Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.1.1: Convert Resized Grayscale X-ray Images of Training Data into Numpy Array**
      * **Step 4.1.2: Normalize Numpy Arrays of Grayscale X-ray Images in Training Data**
    - **Step 4.2: Represent Testing Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.2.1: Convert Resized Grayscale X-ray Images of Testing Data into Numpy Array**
      * **Step 4.2.2: Normalize Numpy Arrays of Grayscale X-ray Images in Testing Data**
    - **Step 4.3: Represent Validation Data in Machine Understandable Format (Numerical Representation)**
      * **Step 4.3.1: Convert Resized Grayscale X-ray Images of Validation Data into Numpy Array**
      * **Step 4.3.2: Normalize Numpy Arrays of Grayscale X-ray Images in Validation Data**
  + **Step 5: Select Suitable Deep Learning Algorithms**
  + **Step 6: Select Suitable Evaluation Measure(s)**
  + **Step 7: Execute First Two Phases of Machine Learning Cycle**
    - **Training Phase**
    - **Testing Phase**
  + **Step 8: Analyze Results**

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| **If (Results are Good)**  **Then**  **Move to the Next Step**  **Else**  **Go to Step 1** |

* + **Step 9: Execute 3rd and 4th Phases of Machine Learning Cycle**
    - **Application Phase**
    - **Feedback Phase**
  + **Step 10: Based on Feedback**
    - **Go to Step 1 and Repeat all the Steps**
* **Alhamdulillah, in this Lecture we systematically learned (using a Template-based Approach) how to**
  + **Use the Best Teaching and Learning Methodology of the World to systematically perform any Real-world Task using a Template-based Approach**
  + **CNN-based Deep Neural Network Architecture**
  + **Pneumonia Disease Prediction (from X-ray Image)**
  + **Steps – Pneumonia Disease Prediction (from X-ray Image) Problem as a Supervised Machine Learning Problem**
  + **Start Contributing from Today 😊**

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| **جزاك اللهُ خيرًا** |