PROJECT REPORT ON

"3D PRINTER MATERIAL PREDICTION USING WATSON AUTO AI"

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1. INTRODUCTION

1.1 Overview

Advances in technology have led to new developments in the fabrication of industrial products. One such development is the production of parts using 3D printers which are now being increasingly used in prototype fabrication, reverse engineering, and small run batch manufacturing. Rapid prototyping provides for quick and inexpensive fabrication of parts used in such areas as the production of industrial machine parts, motorized vehicles, medical applications, tooth implants, food processing, and consumer hobby applications. Rapid prototyping can shape such raw materials as ceramic, metal and plastic, as well as cells and tissues. The methods used for rapid prototyping include Fused Deposition Modeling (FDM), Stereolithography (STL), Selective Laser Sintering (SLS), and Laminated Object Manufacturing (LOM).

1.1.1. 3D Printer

3D printing is a way of creating three dimensional (3D) solid objects. 3D printing is done by building up the object layer by layer. Usually, 3D printers use plastic, because it is easier to use and cheaper. Some 3D printers can 3D print with other materials, like metals and ceramics, but they cost too much money for most people.

3D printers are useful because they can make new objects very fast, and are good at making them very detailed. This means an engineer can test a lot of new designs and not have to wait for someone else to make them. They are also useful for fixing parts made of plastic, and for making toys, figures, and models. There are a lot of people who print 3D objects at home.

The first step in 3D printing something is to make it on a computer. People do this with CAD (Computer Aided Design) software or a 3D scanner. To design models in CAD, people start with basic shapes, and build from that point. 3D scanners are machines that take lots of measurements of the object and automatically make a model on the computer. They can be very fast, but are also more expensive.

In FDM, an extrusion nozzle is used to heat and melt the material that is then deposited in layers. As each layer forms its specified geometry, the next layer is deposited on top of the other to continue the production process. It is noted that FDM parts have lower mechanical properties compared to those produced by mold and machining methods.

The decrease in mechanical properties is because of the molten thermoplastic material fibers adhering to the previously deposited cold layers. In the FDM method, as polymer chains are aligned in the direction of the flow upon exiting the nozzle, an anisotropic structure is formed in the resulting fabricated part. Additionally, anisotropic structures may also occur because of weak adhesion between layers and presence of porous areas that form as a result of raster orientation. In the early phases of the evolution of 3D printers, the parts fabricated through FDM were frequently used for prototyping, and the mechanical strength of the fabricated parts was not of primary concern. However, in recent years, the increase in the number of home hobby users and the elimination of the costs related to mold creation for small run batch production have led to employing FDM for production run purposes as well. Accordingly, mechanical strength has emerged as an important aspect in the application of the FDM method, and the proper specification of the related process parameters is now essential. Thus, a variety of materials are being investigated to improve on mechanical properties. For example, plastic filaments of polylactic acid (PLA) are widely used for FDM. Polyethylene glycol (PEG) compound is mixed into PLA-based plastic products concentrations of 5%, 10%, and 20% for facilitating manufacturing at low temperatures and for improved solubility. However, the use of high concentrations of PEG has been observed to result in structural and surface changes in products.

1.1.2 MATERIALS

Top 10 materials used for 3D printing are:

1. Nylon
2. ABS
3. Resin
4. PLA (Polylactic Acid)
5. Gold and Silver
6. Stainless Steel
7. Titanium
8. Ceramics
9. PET/PETG
10. HIPS (High Impact Polystyrene)

The two materials used in this project are:

1. ABS :

ABS (Acrylonitrile Butadiene Styrene) is a thermoplastic that is commonly used as a 3D printer filament. It is also a material generally used in personal or household 3D printing and is a go-to material for most 3D printers.

Distinct Characteristics:

- It is one of the most accessible and cheap materials for 3D printing.
- ABS is highly available and has a wide variety of colours.
- This material has a longer lifespan compared to Nylon.
- It is also mechanically strong.
- This material is not suitable for hobbyists. It is only used for manufacturers and engineers who are looking for high-quality prototype production.

Disadvantages:

- It requires heated bed when printing.
- Since ABS materials have high melting point, it has a tendency to experience warping if cooled while printing.
- This type of filament is a non-biodegradable toxic material that releases toxic fumes with awful smell at high temperature.

2. PLA (Polylactic Acid) :

PLA or Polylactic Acid are made from renewable resources such as sugarcane or cornstarch. It is also called “green plastic”. It is mostly used in primary and secondary schools since it is safe to use and easy to print with. It is also used in FDM desktop printing.

Distinct characteristics:

- PLA is easy to print since it has low warping.
- It can also be printed on a cold surface.
- It can print with sharper corners and features compared to ABS material.
- This material is available in different colours.

Disadvantages:

- PLA materials are not very sturdy and can deform when exposed to extreme heat.
- This type of material is less sturdy.

1.1.3. Types of 3D Printers

- Large production 3D printers are well-suited for demanding jobs such as low-volume, custom parts, and large builds. Because of their capacity and precise designs, these printers are most commonly used in the aerospace, automotive, industrial, and consumer goods industries.
- – Desktop printers are smaller 3D printer models used to work on product designs, prototypes and models. They are ideal for office settings.
- – Dental 3D printers are made specifically for the dental industry and used in everything from small dental practices to large labs.
- – Metal 3D printers create quality metal parts. Whether you want a printer for office use or mass production, there is a metal 3D printer model available.

1.2. PURPOSE

3D printing has become increasingly democratized in the past few years. The invention of 3D printing targets 2 things: reduce time to get the first version of a product and emancipate many constraints that are not possible with traditional production methods. For example, with 3D printing, it is possible to print complex geometric shapes and interlocking parts that require no assembly. It is also possible to produce single objects, in small quantities, at low cost and fast delivery. This technology also helps in the reduction of production-related material loss. For more information on the benefits of 3D printing compared to plastic molding and other manufacturing processes, you can refer to our comparison page between 3D printing and traditional manufacturing methods.

3D Printing can produce different objects without creating specific tooling or even using several tools. This is how 3D Printing helps increasing flexibility in the production flow and helps reducing industrial expenses. Since there’s no need to build a dedicated production line, it helps also to significantly save time: 3D Printing enables us to innovate faster and mechanize faster. Since 3D Printing makes a replica of the 3D files one by one, so economies of scale can't be realized when the same file is produced several times: this is clearly different from series manufacturing methods that aims to produce millions of units of the same objects. On the contrary, 3D Printing is the perfect method for on-demand and customization needs. There are a lot of other good reasons to choose 3D Printing instead of other manufacturing methods.

Having for a long time been restricted to professionals and industrial prototyping, 3D Printing now allows printing of parts and finished products and has become accessible to the general public.

3D Printers are usually divided into 2 categories: home 3D printers and professionnal 3D printers. This distinction is not always true: some companies own home 3D printers for the very early stages of a prototype and the general public can have access to professional-grade 3D printers in FabLabs or with online 3D printing services such as Sculpteo.

However, be aware that the 3D printing technology is significantly different between professional printer and 3D printer available for the general public. Most 3D printers for the general public use filament deposition method (FDM) and produce almost exclusively objects in ABS or PLA plastic, professional 3D printers can print many materials with a higher level of precision.

Beyond the awesome stories that come in the media spotlight, 3D printing has already made a shift in the manufacturing process of various industries such as dental and hear-aiding, aerospace, civil and military aeronautics, jewelry etc.

Sculpteo is a 3D printing service online. Our printing centers are exclusively equipped with high-performance professional 3D printers.

2. LITERATURE SURVEY

2.1. EXISTING PROBLEM

3D Printing gives us the ability to handle any level of complexity and ensures pinpoint accuracy. The things we can make are limited only by our imaginations. And it delivers the promise of mass customization. But this technology was supposed to revolutionize manufacturing. Putting creativity in everyone's hands, disrupts the production model.

1. Output/Quality Problems with 3D Printing.

In some ways, this is the most basic thing, but there are many quality-related problems with 3D printing today:

- Fragile, delaminated FDM (fused deposition modeling) parts
- Low-resolution output
- Materials

Now, to be fair, the materials are defined by what can be extruded, squirted, or melted, but this is not based on their application or final use. And even though there are some examples of multimaterials, it's typically only two at a time. So we're constraining ourselves.

2. The Process Is Unreliable.

The complexity of just getting the process to work is often daunting, and it involves too much fiddling with formats, parameters, and mechanical adjustments.

3. The Workflow.

The workflow is old and outdated, and it’s still based on the classic linear approach:

- Human: Design
- Computer: Document and Analyze

The 3D-printing workflow usually doesn’t take advantage of generative design or other recent breakthroughs. The problem with the current workflow is that, first, designers are drawing stuff, and then the robot is drawing stuff again in the 3D printer.

4. The Target: It’s Wrong.

The fourth lamentation is that people have been aiming at the wrong target with their 3D-printing efforts.

They’ve been happy creating prototypes, replacement parts, and trinkets; but what they should be focused on are final parts and creating novel solutions to higher-level problems.

In order to reach this new target, it’s important to look at 3D printing holistically, through four facets of additive manufacturing: parts, system, materials, and process.

5: The Market: It’s Prematurely Mature.

My last 3D-printing lamentation is that 3D-printer manufacturers seem to be prematurely solidifying standards and stifling innovation. Today, 3D-printing’s problem is that the market remains “prematurely mature.”

Manufacturers are unfortunately mistaking that smaller, earlier chasm for the bigger one ahead. Customers are the enthusiasts, not the majority. Yet manufacturers are using business models meant to optimize later phases as if there were already a printer in every home.

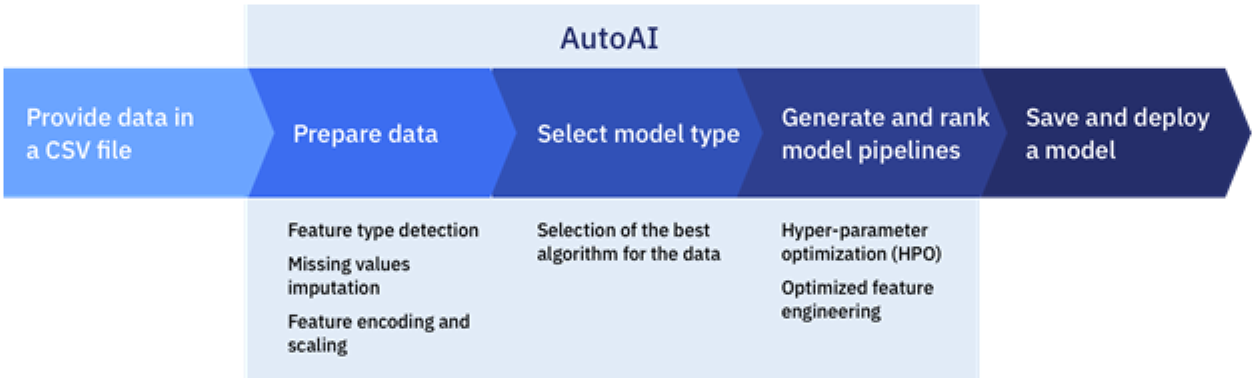
2.2. PROPOSED SOLUTION

This project prevents the people from choosing false material for 3D Printing. The model gets the appropriate data from the predictions done. After that we want to process those data using a suitable algorithm, then our model display which material to be used. To predict the appropriate material we are applying various machine learning algorithms.

Decision Tree Algorithm : Decision tree is considered as the powerful solution to the classification problems and it is applied in many real world applications. Many data mining techniques are used for weather forecasting in the present scenario, with various levels of accuracy. From the Above literature it reveals that there are works which are carried out considering Rule-based Methods, Neural Networks, and Memory based reasoning, Naïve Bayes, Bayesian Belief Networks, and Support Vector Machines. But none of them have attempted identify for Decision tree using data sets hence in this work an attempt is made to predict future weather forecast. A decision tree is a decision support tool that uses a tree-like model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. It is one way to display an algorithm that only contains conditional control statements. Decision trees are commonly used in operations research, specifically in decision analysis, to help identify a strategy most likely to reach a goal, but are also a popular tool in machine learning. A decision tree is a flowchart-like structure in which each internal node represents a "test" on an attribute (e.g. whether a coin flip comes up heads or tails), each branch represents the outcome of the test, and each leaf node represents a class label (decision taken after computing all attributes). The paths from root to leaf represent classification rules. In decision analysis, a decision tree and the closely related influence diagram are used as a visual and analytical decision support tool, where the expected values (or expected utility) of competing alternatives are calculated. A decision tree consists of three types of nodes: Decision nodes – typically represented by squares Chance nodes – typically represented by circles End nodes – typically represented by triangles Decision trees are commonly used in operations research and operations management. If, in practice, decisions have to be taken online with no recall under incomplete knowledge, a decision tree should be paralleled by a probability model as a best choice model or online selection model algorithm. Another use of decision trees is as a descriptive means for calculating conditional probabilities. Decision trees, influence diagrams, utility functions, and other decision analysis tools and methods are taught to undergraduate students.

3. THEORITICAL ANALYSIS

3.1 Block Diagram



3.2 Hardware/Software Design

After creating an account on IBM cloud following steps have to be performed to create the model and the application:

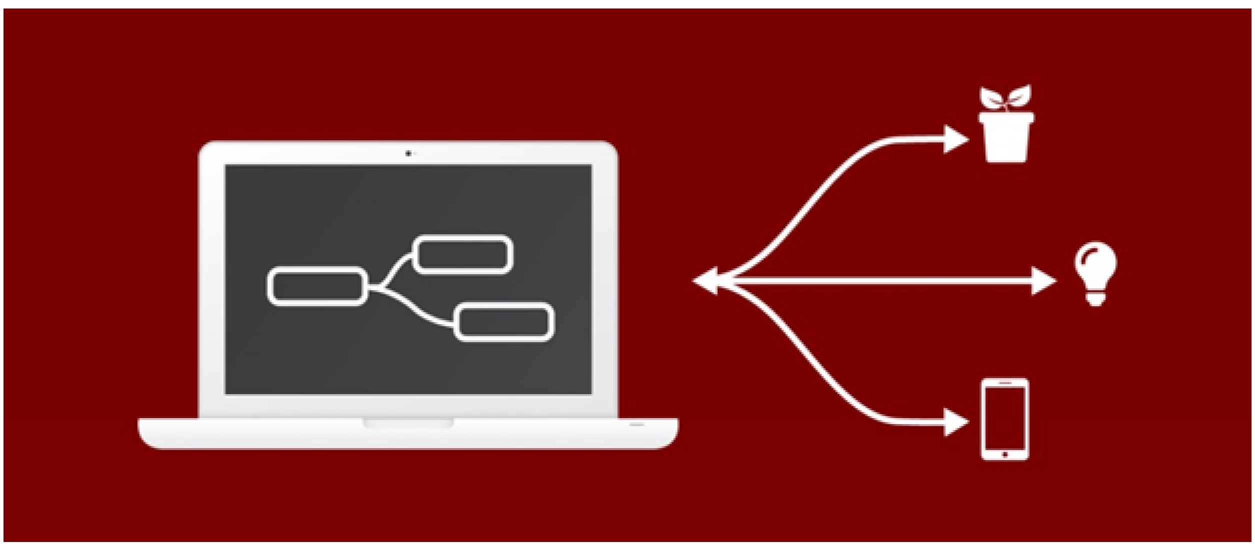
<u>MODEL</u>

The model is built using IBM Watson Studio

1. Create project in Watson Studio
2. Auto AI Experiment in Add Project
3. Setting Up an AUTO AI Environment
4. Import Dataset
5. Run The Model
6. Selection of Auto AI Pipeline
7. Deploy and Test the model in Watson Studio

APPLICATION BUILDING

1. Create NODE RED service
    1. Go To Manage Palette & Install Dashboard Nodes
    2. Build UI with NODE RED

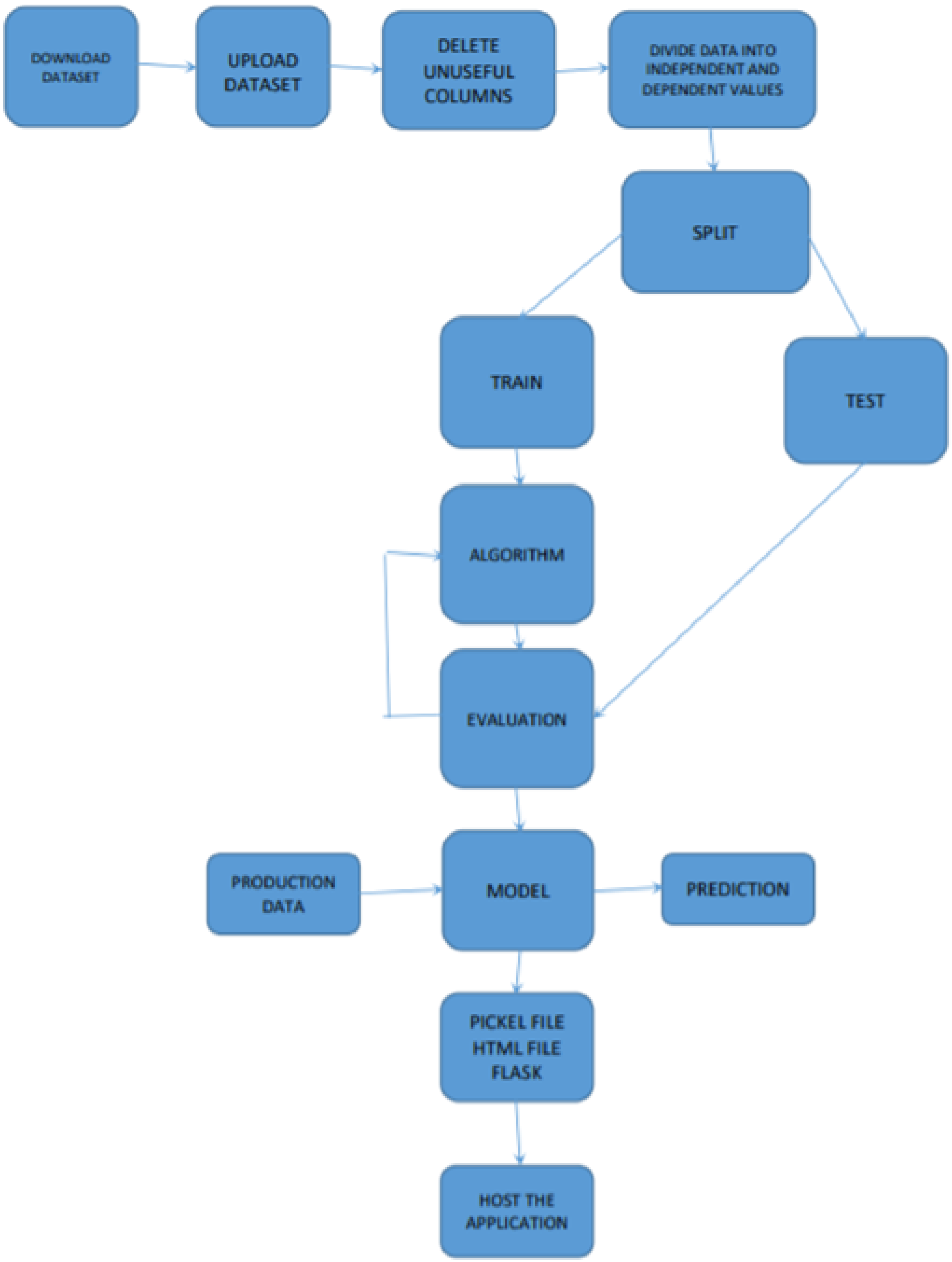


4 EXPERIMENTAL INVESTIGATIONS

PARAMETERS

1. layer height
2. wall thickness
3. infill density
4. infill pattern
5. nozzle temperature
6. bed temperature
7. print speed
8. material
9. fan speed
10. roughness
11. tension strength
12. elongation

5. FLOWCHART


DOWNLOAD DATASET
UPLOAD DATASET
DELETE UNUSEFUL COLUMNS
DIVIDE DATA INTO INDEPENDENT AND DEPENDENT VALUES
SPLIT
TRAIN
TEST
ALGORITHM
EVALUATION
PRODUCTION DATA
MODEL
PREDICTION
PICKEL FILE
HTML FILE
FLASK
HOST THE APPLICATION

6. RESULT

The model is able to predict appropriate material with good accuracy for provided parameters.

7. ADVANTAGES AND DISADVANTAGES

Advantages

1. Speed: One of the biggest advantages of 3D printing technology is Rapid Prototyping.
2. Cost: For small production runs and applications, 3D printing is the most cost-effective manufacturing process.
3. Flexibility.
4. Competitive Advantage
5. Tangible Design and Product Testing.
6. Quality.
7. Consistency.
8. Risk Reduction.

Disadvantages

- User should have the idea on all the parameters and units of each parameter.

8. APPLICATIONS

A growing range of 3D printer and 3D printing material options has widened the potential applications of 3D printing significantly. From 3D printed airplane parts to medical devices, 3D printing has made it easier than ever to create lighter, more effective parts at a faster rate (and a lower cost) than traditional methods.

Industries using 3D printing include:

- – Aerospace
- – Automotive
- – Medical
- – Dental
- – Consumer Goods
- – Manufacturing

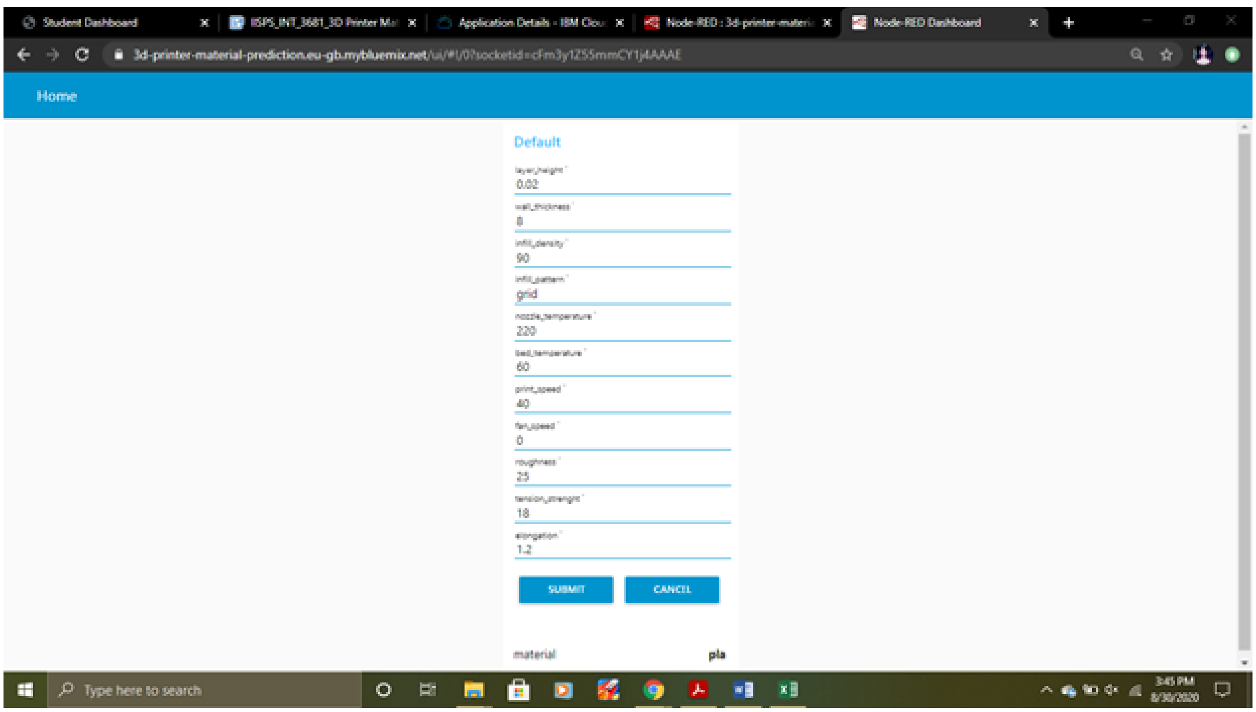
Common applications for 3D printing include:

- – Rapid prototyping
- – Modeling
- – Low-volume, custom parts
- – Production parts
- – Jigs and fixtures

9. CONCLUSIONS

In this project we used IBM Auto AI Service for prediction of material for 3D printer. Various parameters were considered to get the result. The results show how these parameters have influenced the observations in this data. Given enough data the observed trend over time could be studied and important deviations which show changes in parameters identified. Decision trees prove as an effective method of Decision making in Material prediction. This work is important to disaster management studies because the variation in terms of thickness, temperature, elongation, etc. can be studied using this service.

The UI output of the project is as follows:



The URL for project :-
https://3d-printer-material-prediction.eu-gb.mybluemix.net/ui/

10. FUTURE SCOPE

While the fundamentals of its function may remain the same, we can expect to see more accurate machines, complex materials, and exciting applications come from 3D printing in the future.

11. BIBLIOGRAPHY

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