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Near Real Time Online Flow-based Internet Traffic Classification Using Machine Learning (C4.5)

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Abstract

Offering reliable novel service in modern heterogeneous networks is a key challenge and an important prospective income source for many network operators and providers. Providing reliable future service in a cost effective scalable manner requires efficient use of networking and computing resources. This can be done by making the network more self enabled, i.e. making it capable of making distributed local decisions regarding the utilization of the available resources. However such decisions must be correlated in order to achieve the global overall goal (maximizing the performance and minimizing the cost)

Since network administrators are always worried about making fast decisions to monitor and regulate the Internet traffic, a novel approach for online flow-based network traffic classification is proposed. This proposal is based on Machine learning algorithm C4.5 and a custom built network traffic data set captured from a university campus environment. Furthermore the aim of this effort is to build a complete online flow based traffic classification and control system.

Validation on the proposed system is done from accuracy and time points of views. Firstly, an offline training and testing data sets are applied to Weka's C4.5 and our system. And their corresponding accuracy has been compared. Our experimental results show that the accuracy is the exactly the same. Secondly, the received UDP NetFlow packets have been send to our system and to a basic packet sniffing program and the number of NetFlow packets has been counted in each. The comparison result show that no packet overwriting due to race condition.

Keywords: NetFlow, machine learning, C4.5, online classification, accuracy, traffic control, P2P.

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1. INTRODUCTION

The evolution of the current Internet into a large complex service-based network has generate a tremendous challenges and difficulties for network monitoring and control in terms of how to collect the large amount of data in the recent very fast speed wires. Furthermore how to accurately classify the Internet traffic with the exultance of new emerging applications such as peer to peer, video streaming and online gaming. These applications are considered as bandwidth hungry applications and they affect the performance of the network especially in a limited bandwidth networks such as university campuses causing performance deterioration of mission critical applications. Most of These applications use port hopping and payload encryption to avoid detection. Hence the need of online accurate detection approaches.

Traffic classification at application level is critical for protocol research, abnormity detection, accounting, network security, and network operation [1]. Internet traffic identification and classification is vital to the areas of network management and security monitoring, network planning, and QoS provision. Traditional approaches such as port-based and payload-based identification are becoming increasingly difficult with many new applications (e.g. P2P) using dynamic port numbers, masquerading techniques, and encryption to avoid detection [2].

Real-time Internet traffic classification has the potential to solve difficult network management problems for Internet service providers (ISPs) and their equipment vendors. Especially in today's high speed wires, network operators need to know what is flowing over their networks accurately so that they can react quickly in support of their various business goals [3]. Early classification is essential to allow automatic blocking, filtering, or recording of specific applications [4].

This paper proposes a novel near real time online flow based Internet traffic classification [NOFITC]. An open source code of C4.5 algorithm has been customized to work for online Internet traffic classification. Then the performance of the system has been checked from accuracy and time points of views.

Section 2 explores related work, section 3 shows the methodology, section 4 explains the experimental result, and finally section 5 concludes our work and points for future work.

2. Internet Traffic Classification – An Overview

Although a lot of respective research literatures addresses Internet traffic classification and architectural related topics, relatively little work have been done on developing solution methodologies directly related to near real time Internet traffic measurement and control.

There has been a lot of research in the area of network traffic classification by application types and several classifiers have been suggested. Although statistical based Internet traffic classification shows promising results, however relatively few work has been done related to online Internet traffic classification.

2.1 Port Number Based Classification:

This approach classifies the application type using the official Internet Assigned Numbers Authority (IANA) [5] list. Initially it was considered to be simple and easy to implement port-based online in real time. However, nowadays it has lower accuracies (50% - 70%) [6]. Many other studies [7, 8, 9, and10] claimed that mapping traffic to applications based on port numbers is now ineffective.

Alok Madhukar et. Al. [9] focus on network traffic measurement of peer to peer P2P applications on the Internet. The paper compared three methods to classify P2P applications i.e. port-based analysis, application-layer signature, and transport layer heuristics. They collected their traffic trace from University Calgary Internet connection for a period of two years (2004-2005) .Their results show that classic port- based analysis is ineffective, and has been so for quite some time. The proportion of "unknown" traffic increased from 10-30% in 2003 to 30-70% in 2004-2005. While application-layer signatures are accurate, this technique requires examination of user-payload, which may not always be possible.

2.3Signature Based Payload Classification

To address the aforementioned drawbacks of port-based classification, several payload-based analysis techniques have been proposed [6, 9, 11, 12, 13, and 14]. In this approach, packet payloads are examined to search for exact signatures of known applications. Studies show that these approaches work very well for the current Internet traffic including many of P2P traffic. These approaches are accepted by some commercial packet shaping tools.

However, P2P applications such as BitTorrent are beginning to elude this technique by using payload encryption, variable-length padding, and/or encryption. In addition, there are some other disadvantages. First, these techniques only identify traffic for which signatures are available and are unable to classify any other traffic. Second, payload analysis consumes computational power [15, 16] because it analyzes the full payload. Third, these techniques typically require increased processing and storage capacity. [17]

Finally, the privacy laws [16, 18] may not allow administrators to inspect the payload

Liu Bin, et al. [19] presented a flexible and efficient BitTorrent measurement system using application signature analysis which has been implemented with standard hardware and Netfilter extension. They demonstrated the feasibility of this approach in a real network environment and showed that the performance is sufficient to accurately measure high volume traffic on high speed links in real-time. They claim that although the measurement system is currently geared towards BitTorrent protocols, it can be easily extended to measure other protocols running over TCP as well.

2.4 Protocol Behavior or Heuristics Based Classification

Transport-layer heuristics offer a novel method that classifies the P2P traffic based on connection-level patterns. This approach is based on observing and identifying patterns of host behavior at the transport layer. The main advantage of this method is that there is no need for packet payload access.

BLINC [13] introduces a new approach for Internet traffic classification. It associates Internet hosts with applications. It looks at all flows (TCP and UDP) generated by specific hosts. BLINC is able to accurately associate hosts with the applications they provide or use (application server, web client, etc.). However BLINC has to gather information from several flows for each host before it can decide on the role of a host. These requirements prevent the use of these methods for online traffic classification. In contrast, our approach relies only on the first few packets of a TCP flow. This early classification is essential to allow automatic blocking, filtering, or recording of specific applications. It also limits the amount of memory required to store information associated with each flow.

2.5 Statistical Analysis Based Classification:

This approach treats the problem of application classification as a statistical problem. It develops its discriminating criteria based on various statistical features of the flow of packets. Machine learning is always used to build the classification model. The advantage of this approach is that there is no packet payload inspection involved.

Nigel Williams et. al. [20] compared five-widely used machine learning classification algorithms to classify Internet traffic. Their work was a good first attempt to create discussion and inspire future research in the implementation of machine learning techniques for Internet traffic classification. The authors evaluated the classification accuracy and computational performance of C4.5, Bayes Network, Naïve Bayes and Naïve Bayes Tree algorithms using 22 features and with two additional reduced feature sets. They found that the feature reduction techniques were able to greatly reduce the feature space, while only minimally impacting classification accuracy and at the same time significantly increasing computation performance. They also found that the majority of algorithms achieved similar levels of classification accuracy given their feature space and dataset. Also they discovered it was difficult making differentiation between them using standard evaluation metrics such as accuracy, recall and precision.

They found that better differentiation of algorithms can be obtained by examining computational performance metrics such as build time and classification speed. In comparing the classification speed, they found that C4.5 is able to identify network flows faster than the remaining algorithms. Also they found that NBK has the slowest classification speed followed by NBTree, Bayes Net, NBD and C4.5. Build time found NBTree to be slowest by a considerable margin. Our work extends this idea while providing an online Internet traffic classification by customizing the source code of C4.5 algorithm.

Jiang, et al. [21] showed by experiments, that NetFlow records can be usefully employed for application classification. The machine learning used in their study was able to provide an identification accuracy to about 91%. The authors used data collected by the high performance monitor (full packet capturing system) and then NetFlow record was generated by utilizing nPrope (a software implementation of Cisco NetFlow).

Erman, et al. [22] considered the traffic classification in the core network. The authors deployed a framework that can classify a flow using only unidirectional flow information, and they found that flow statistics from the server to client direction of TCP connection provides greater classification accuracy than flow statistics from client-to-server direction. The authors used unsupervised machine learning called clustering.

3. Methodology

In this paper, a novel online near real time flow-based Internet traffic classification [NOFITC] system has been implemented. This system is considered as a building block toward near real time Internet traffic control and bandwidth optimization.

Based on the work of [20]. An open source code of C4.5 written by the author of the algorithm [23] has been downloaded, modified, compiled, and customized to produce our novel system for an online Internet traffic classification.

The above mentioned open source code consists of two main classification module. One module works for offline classification using C4.5. The other works in an interactive mode called consult. It has the ability to receive the features from the keyboard Our [NOFITC] system is build by modifying and customizing the interactive mode module.

The customized open source code is enhanced with several new functions to achieve our goal, (e.g. online NetFlow collection, online NetFlow preprocessing and modified online user interface to adapt the classification functions to work online).

The following diagram (see figure 3-1) - represents the layering structure of the proposed system and at the same time summarizes our customized two modules (online and offline Internet traffic classification modules).

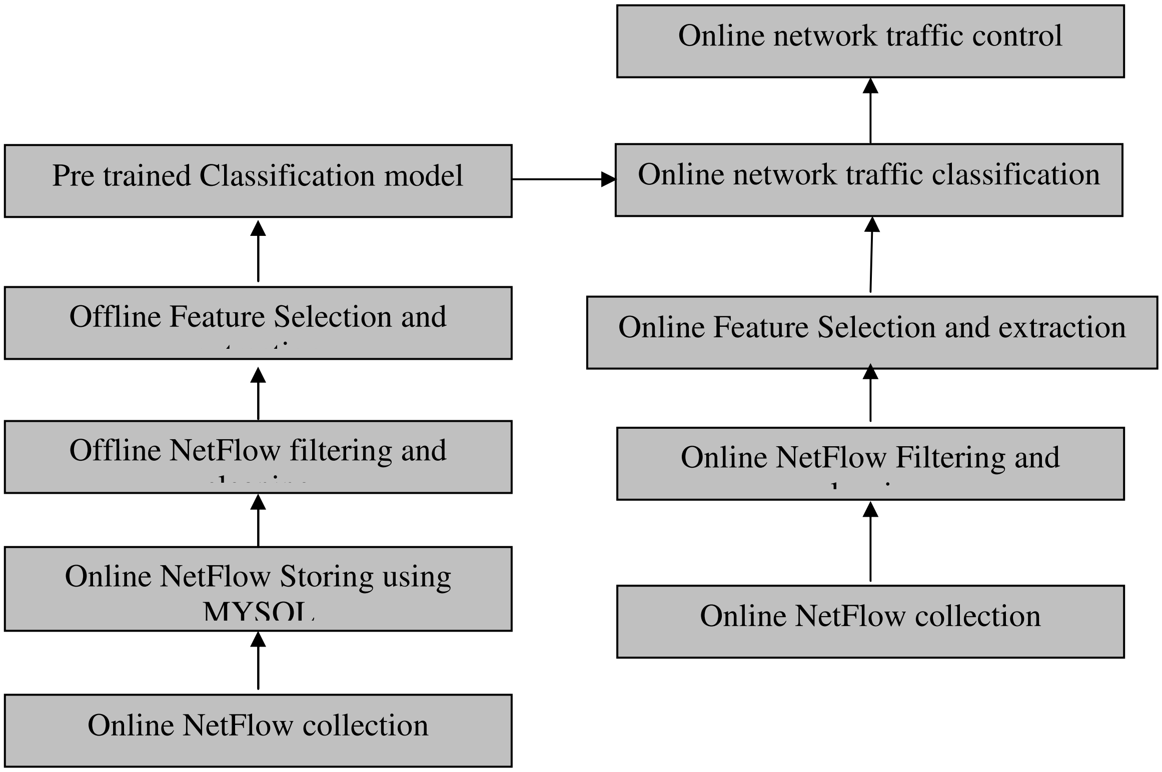

FIGURE (3-1) Layering Model For online traffic classification and Control System

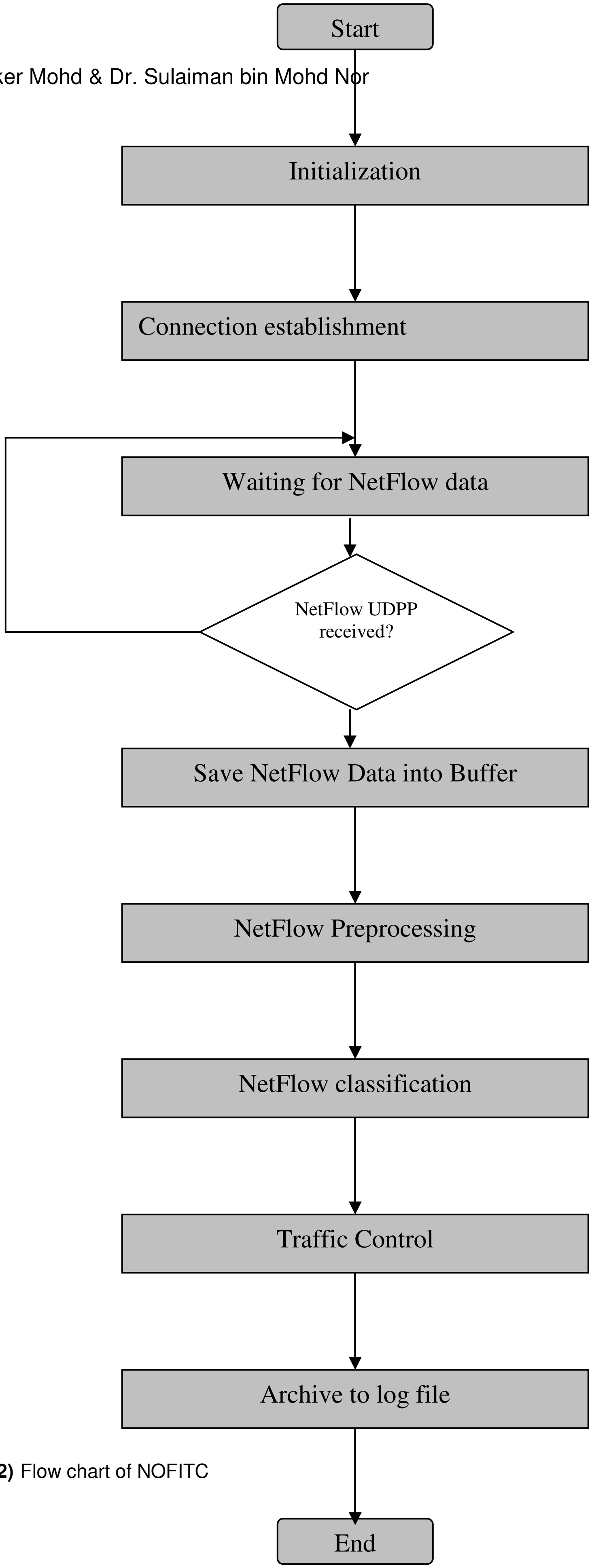

FIGURE (3-2) Flow chart of NOFITC

In this paper we will focus on the online module because the offline one has been discussed in details via our previous work [24, 25].
The following flow chart (see figure 3-2) explains the customized online traffic classification system using C4.5 algorithm.
To obtain our goal successfully and accurately, a validation process has been done according to accuracy and time points of view; firstly, offline training and testing data sets are applied to Weka's C4.5 [26] and our system [NOFITC]. The accuracy obtained by each is compared according to the training data sets.
Secondly, since our target goal is towards near real time traffic classification and control system, in this work the time factor has been considered and the performance of the proposed system examined. This was done by sending the received UDP NetFlow packets simultaneously with one copy to NOFITC and another copy to a basic packet sniffing program. Comparison between the number of received UDP NetFlow packets by the sniffer and the number of received, preprocessed and classified UDP NetFlow packets by NOFITC was done in a fixed time interval (see figure 3-3).

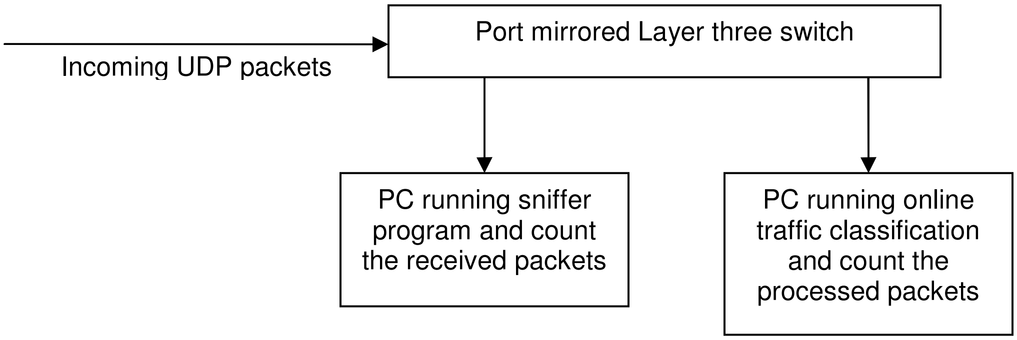

FIGURE [3-3] Performance comparison and the port mirrored switch

3.1 Online NetFlow collection, filtering preprocessing and classification:

The main difference between this work and our previous classification work [24, 25] is that the NetFlow collection filter, preprocessing and classification are done in an online manner rather than offline.
Here, to speed up the processing time, the data collection module (see figure [3-4]) has been implemented with a different approach. Furthermore the design of this module considers the time restriction so that instead of storing the NetFlow records into secondary storage device using MYSQL, the collected NetFlow records is stored into a buffer for further online processes. The collection module has the capability of receiving NetFlow UDP packet from the NetFlow exporter and deliver it to an online preprocessing, which will clean, filter, select basic features, extract derived features and calculate their corresponding values and finally it reformat the NetFlow record so as to make it ready to be classified by the online classification module.
Finally the ready NetFlow record will be send to the classification module and the classification result will be issued accordingly using the customized C4.5 source code.

4. Results

As intended in this paper, the validation of the NOFITC will be scrutinized from and accuracy and time perspectives. The following sections describe this in details.

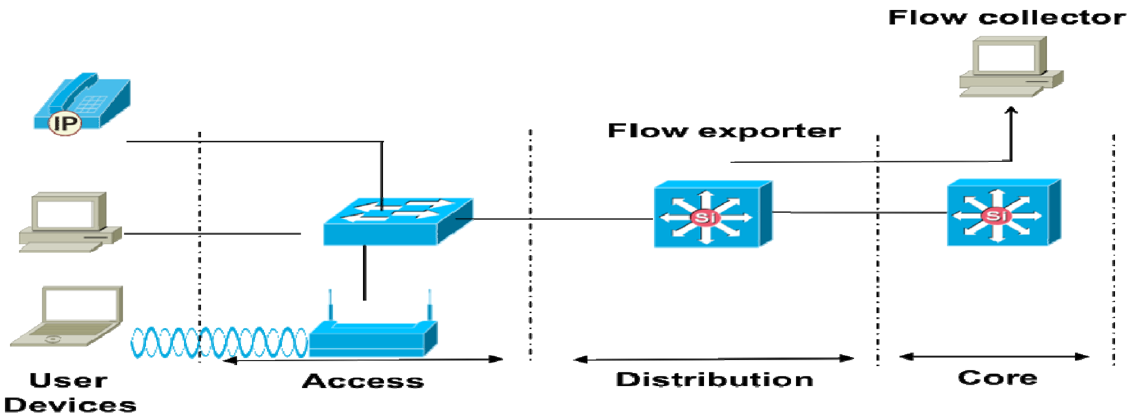

FIGURE [3-4] typical setup in a faculty with NetFlow exporter and collector

4.1 Accuracy:

Experimentally, we validated the offline classification module C4.5 with a custom build network traffic collected from the UTM campus network. Furthermore the accuracy of the open source code is compared with the accuracy of Weka's C4.5 [26]. The result of the comparison according to different training data sets is recorded in table [4-1].

As can be seen form figure [4-1] and table [4-1]The over all accuracy of the implemented system is approximately equal to the accuracy of C4.5 in Weka toolkits, and there are a little bit variation due to the differences in the pruning process which effects the tree size.

4.2 Time:

Since network administrators are always worried about making fast decisions to monitor and regulate the Internet traffic, our results show that the time for online preprocessing and classification is very small compared to the inter arrival of UDP flow packets. From performance point of view our system works perfectly with no UDP NetFlow overwriting. In other words, every UDP NetFlow packets are accounted for and analyzed with any drop in packets. To prove that, we executed the online classification system concurrently with a simple packet sniffing and filtering NOFITC program and counting simultaneously received packets and processed packets respectively from each program for a fixed time interval. More than 10,000 UDP flows were inspected and the results shows that all UDP flow packets were processed by NOFITC with any drop or over riding in packets.

This promising result is an important step in implementing our near real time online network traffic control system model.

Number of instances	Using J.Ross open source code				Using Weka's C4.5	
	Before Pruning		After Pruning			
	size	Errors %	size	Errors %	size	Errors %
76830	361	3.6	205	3.7	205	3.7069
76700	357	3.6	197	3.7	227	3.6741
76528	383	3.6	225	3.7	245	3.6549
76356	385	3.6	251	3.6	243	3.6487
76227	351	3.6	209	3.7	211	96.3176
76055	375	3.6	209	3.7	209	3.6947
75926	353	3.7	157	3.8	157	3.776
75797	359	3.7	157	3.8	157	3.7785
75668	363	3.7	215	3.7	195	3.7017
75496	359	3.6	171	3.7	189	3.7115
75367	357	3.6	175	3.7	189	3.7085
73511	345	3.6	189	3.7	201	3.658
72605	317	3.6	161	3.7	161	3.7008
71646	323	3.7	157	3.7	177	3.7099
69702	299	3.6	135	3.7	137	3.6613
67758	311	3.4	185	3.4	195	3.4372
65814	353	3.3	177	3.4	189	3.3625
63811	277	3.3	129	3.4	133	3.3803
61219	293	3.1	169	3.2	167	3.1902
58627	265	2.9	147	3	147	2.9679
56034	221	2.8	153	2.9	153	2.8572
54306	227	2.9	141	2.9	141	2.9094
49986	303	2.5	223	2.6	219	2.5967
45710	235	2.6	171	2.7	169	2.6843
41477	209	2.7	135	2.8	135	2.7582
37245	235	2.4	133	2.5	135	2.4997
32839	123	1.8	97	1.9	93	1.8575
28606	123	2.1	97	2.1	93	2.1324
24555	123	2.4	97	2.5	93	2.4842
20279	75	1.1	69	1.1	69	1.1391
16003	25	0.3	11	0.3	11	0.3249
11726	25	0.4	11	0.4	11	0.4435
7404	39	0.6	11	0.7	11	0.7023
3384	21	1.2	19	1.2	19	1.2116
2563	35	0.9	35	0.9	35	0.9364
1699	35	1.3	35	1.3	35	1.2949
396	29	4	25	4.5	25	4.5455
250	21	5.6	17	6.4	17	6.4
76	15	5.3	15	5.3	15	5.2632

TABLE [4-1] accuracy comparison between Weka's C4.5 and the proposed system

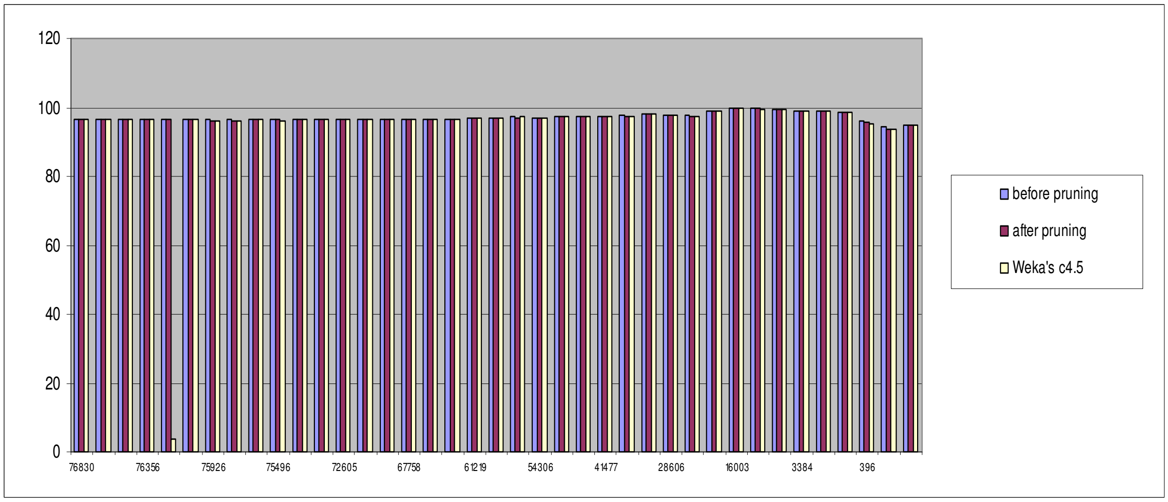

FIGURE [4.1] accuracy comparison between Weka's C4.5 and the proposed system

5. Conclusion and Future work

In this paper we customized and modified the C4.5 source code for the purpose of building a complete near real time online flow-based network traffic classification system [NOFITC].

This effort reflects three contributions. First a novel building and implementation of near real time online flow based traffic classification system [NOFITC], secondly the validation of the accuracy of the proposed system compared with Weka's C4.5. And finally the performance test that proves the system can work in real time flow-based without packet overwriting or dropping.

Although our system reported an excellent performance according to the current configuration, more testing will considered in future to check the reliability of the proposed system with different traffic rates. The proposed system is considered as a building block toward an online flow-based traffic control system, so future work will discuss online traffic control. The outcome of this effort can be directed to a policy enforcement point so as to make decision regarding bandwidth optimization by mission critical application.

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Optimum Tolerance Synthesis for Complex Assembly with Alternative Process Selection Using Bottom Curve Follower Approach

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Abstract

Components cannot be manufactured according to the required nominal dimensions due to inherent variations in workmanship, materials and machine tools. Tolerance specification of part dimensions affects the performance, quality and cost of a product. The proper distribution of tolerance, known as tolerance allocation, reduces the manufacturing cost of a product. Thus, researchers in this field are keenly interested in tolerance allocation. The choice of alternative processes for tolerance allocation also plays a vital role in reducing manufacturing costs. Near-optimal allocated tolerances are obtained using non-traditional optimization techniques, in which solutions are randomly achieved. However, there is the possibility that a better allocation process will not be discovered because the randomness of the results of successive runs will not yield consistent results. In this work, an attempt has been made to solve the above problem using the Lagrange multiplier (LM) method for complex assembly and the bottom curve follower approach. The methodology has been demonstrated on a wheel mounting assembly. Compared to Singh's method [14], a 1.95% savings in manufacturing cost was achieved after implementing the proposed method. The present method was 30 times faster than the existing methods.

Keywords: Tolerance allocation, optimization techniques, alternative process selection, Lagrange's multiplier method, bottom curve follower approach.

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1. INTRODUCTION

A manufacturer cannot survive in the global market if he fails to supply customers with high-quality, maintenance-free products that are attractively priced. On the engineering design side, the specification of tolerance affects the fit and performance of the final product. On the manufacturing side, it affects the selection of machines, tooling and fixtures, operator skill levels, setup costs, the precision of inspection instruments, gauging, the amount of scrap and the amount of rework needed. Generally speaking, the smaller the tolerance, the higher the manufacturing costs and the greater the tolerance, the lower the manufacturing costs. Overall manufacturing costs can be reduced without a great deal of overhead by properly allocating tolerances among the components of an assembly.

Moy introduced simultaneous selection of optimal tolerances by considering discrete cost functions and their manufacturing processes [1]. Loosli developed several methods for tolerance allocation of simple assemblies, which greatly increases the likelihood of finding the absolute minimum cost. The author concluded that the exhaustive search method is the only method that results in global minimal assembly tolerance costs. When this occurs, computing resources are unlimited. If the combination of process exceeds 50, the univariate search method will give the best result. The author also recommended developing a better method to determine the optimum cost when upper and lower process tolerance constraints are applied. He also proposed using the simulated annealing method to solve combinatorial problems [2]. Lee and Woo worked on branch and bound algorithms and reported the selection of optimal tolerances by incorporating a discrete cost function for both linear and nonlinear assemblies with process limits and interrelated dimension chains [3]. Chase et al. presented their results using an exhaustive search, a univariate search and sequential quadratic programming methods to allocate tolerances optimally with the help of a discrete and continuous cost function [4]. Zhang and Wang developed an analytical model for simultaneously allocating design and machining tolerances based on the least manufacturing cost criterion, and formulated tolerance allocation as a nonlinear optimization model based on the cost tolerance relationship in which the author employed a simulated annealing algorithm [5]. Vasseur et al. attempted to determine statistical tolerances by formulating a continuous cost function using a simulated annealing algorithm, taking into account manufacturing costs and quality loss.

Tolerance allocation is the design tool for reducing overall manufacturing costs by systematically redistributing the tolerance budget within an assembly, tightening tolerances on less expensive processes and loosening the tolerance on costly processes [6]. Wu and Tang computed average quality losses of batch products in a different manner, according to the distribution of functional characteristics. They presented a design method for allocating dimensional tolerances of products with asymmetric quality losses [7]. Chase described a detailed algorithm for automatically performing tolerance allocation (loosening tolerance on costlier processes and tightening tolerance on less costly processes) based on an optimization technique [8]. He assumed that the cost versus tolerance data available for each dimension and also each component has an alternative manufacturing process. The author compared discrete and continuous optimization to an exhaustive search based on CPU time and the number of combinations required to find a global optimum. The author concluded that the exhaustive search method is the most reliable procedure to find the global minimum when large computing facilities are available. The zero-one method is too inefficient from practical value. A branch and bound algorithm is more efficient, but requires several discrete points, as closed as for each cost tolerance curve. Sequential quadratic programming (SQP) is capable of treating the multiple loop assembly function, but cannot guarantee the global minimum. The univariate search method is the most efficient of the processes tested by a wide margin and requires a special procedure for handling process limits [9]. Ji et al. described a new approach based on fuzzy comprehensive evaluation and a genetic algorithm to obtain a rational tolerance allocation for the parts. In the tolerance allocation, the machinability, which depends on the fuzzy comprehensive evaluation and the function sensitivity factor, is considered. Design ideas for assembly and manufacturing are also included.

Tolerance allocation affects product design, manufacturing and quality [10]. Ye constructed a nonlinear optimization model to implement a new concurrent engineering method for tolerance allocation. His method produced the best result and is well suited to engineering environments where either high-quality or low-cost products are designed and manufactured. Statistical tolerance synthesis eliminates the need for various intermediate results, thus improving computability and making it easier for design and manufacturing engineers to understand a model.

Conventional tolerance allocation is based on solutions derived from common practice or previous experience [11]. Carfagni et al. presented a methodology to allow automatic tolerance allocation capable of minimizing the manufacturing costs of parts. The authors used a Monte Carlo simulation to compute the statistical distribution of control measurement and employed a genetic algorithm as an optimization technique. Their method allows a global approach to tolerance allocation problems. The authors proved that the methodology is a powerful tool for automatically optimizing a user-defined tolerance set. Assigning a dimension tolerance either in drawings or in CAD models has an enormous impact on cost and quality [12]. Diplaris and Sfantsikopoulos formulated a new analytical cost tolerance model that produces results closer to industrial practice based on available industrial knowledge and earlier published data [13]. Singh et al. introduced a genetic algorithm to obtain a global optimal solution to the advanced tolerance synthesis problem by considering the continuous cost function [14]. Prabhaharan et al. used a genetic algorithm for optimal tolerance allocation to help design and manufacturing engineers overcome the shortcomings in the conventional tolerance stack analysis and allocation system [15]. They introduced a continuous ant colony algorithm, a kind of meta-heuristic approach, as an optimization tool for minimizing the critical dimension deviation and allocating cost-based optimal tolerances [16]. Huang and Shiau obtained the optimized tolerance allocation of a sliding vane rotary compressor’s components for required reliability with minimal cost and quality loss [17]. Siva Kumar et al. constructed closed-form equations for optimum tolerance allocation of simple assemblies [18]. Siva Kumar et al. developed a hybrid algorithm (Heuristics + Tabu search) for optimum tolerance allocation of complex assemblies with alternative processes selection [19].To the best of our knowledge, there is no literature available to obtain the optimum allocated tolerance of complex assemblies with alternative process selection using the Lagrange multiplier (LM) method with bottom curve follower approach. The manufacturers are looking for a noval method to reduce the manufacturing cost inturn to earn more profit from their products. The objective of this paper is to develop a noval method to reduce the manufacturing cost. This is achieved by introducing bottom curve follower method for the best process selection and LM method to obtain the optimum allocated tolerance of the components of a complex assembly.

2. THE PROBLEM

The customer (not the manufacturer) fixes the cost of a product based on heavy competition in the international market. The cost of a product is nothing but the sum of the manufacturing cost and the manufacturer’s profit. To get more profit, the manufacturer has to reduce manufacturing costs. Manufacturers desperately need methods that result in products with minimal manufacturing costs. Tolerance specifications play a major role in manufacturing costs because lower tolerance results in lower manufacturing costs and higher tolerance results in higher manufacturing costs. Proper allocation of tolerance among the components of a mechanical assembly will significantly reduce manufacturing costs. The global optimum allocated tolerances of components are obtained using the LM method in simple assemblies without alternative process selection. Non-traditional optimization techniques have been used to obtain near-optimal allocated tolerance of components in complex assemblies with alternative process selection, in which the results/solutions are obtained randomly via a number of trials/iterations. With these techniques, there is a possibility of omit a better process for optimum tolerance allocation.

3. METHODOLOGY

To achieve the global optimum allocated tolerance for the components of a complex assembly (interrelated dimensional chain product) with an alternative process selection, the bottom curve follower approach is introduced to select the best process. The LM method is used as an optimization technique. The methodology is demonstrated using a wheel mounting assembly (Singh et al.).

3.1 Lagrange's multiplier method

This is the best efficient method for allocating the tolerances for single process optimization problem. This method eliminates the need for multiple-parameter iterative solutions and allows alternative cost-tolerance models. It can handle either worst case or statistical assembly models. The designer must check the resulting component tolerances to make ensure they are within the process tolerance range. An exponential constant cost model gives results closer to the real values when calculating manufacturing cost for given tolerance values.

$$\frac{\partial}{\partial t_i}[tc\_fun] + \lambda \frac{\partial}{\partial t_i}[asy\_cont] = 0 \tag{1}$$

where

tc_fun	- Tolerance cost function
asy_cont	- Assembly constraint

3.1.1 Mathematical model for tolerance cost computation

Exponential cost function model (Singh et al.) is considered for calculating the tolerance cost. An individual component's tolerance cost (MC_i) and the total manufacturing cost / tolerance cost ($Cost_{asm}$) of the product are estimated using the expressions (2) and (3).

$$MC_i = C0_i \times \exp(-C1_i \times t_i) + C2_i \tag{2}$$

$$Cost_{asm} = \sum_{i=1}^{n} MC_i \tag{3}$$

where

C0,C1 & C2	- Exponential cost model constants
t	- Tolerance in mm
i	- Component index
n	- Number of components in an assembly

3.1.2 Mathematical model for tolerance estimation

Allocating tolerance to components of a complex assembly worst case model is considered in this work. Assembly tolerance (t_{asm}) and the individual component's tolerance (detailed derivation is shown in section A.1 - Appendix A) are determined using equations (4) and (5).

$$t_{asm} = \sum_{i=1}^{n} t_i \tag{4}$$

$$t_{i+1} = \frac{\log\left[\dfrac{C0_{i+1} \times C1_{i+1} \times \exp(C1_i \times t_i)}{C0_i \times C1_i}\right]}{C1_{i+1}} \tag{5}$$

3.1.3 Constraints

Two constraints to be obtaining the optimum tolerance allocation are given in expressions (6) and (7). The expression (6) represents that the sum of allocated tolerance of the components must be less than or equal to assembly tolerance value. Expression (7) implies that the allocated tolerance must lie between the upper (t_U) and lower process tolerance limit (t_L) of the component.

$$t_{asm} >= \sum_{i=1}^{n} t_i \tag{6}$$

$$t_{Li} \le t_i \le t_{U\,i} \tag{7}$$

3.2 Bottom curve follower approach

Figure 1 represents the concept of the bottom curve follower approach. For the tolerance tA, the process number P3 has less tolerance cost, since P3 is in the bottom position. Similarly, for the tolerance tB, the process number P1 has less tolerance cost. Compared with nontraditional optimization techniques, this method will yield results quickly. Any one of the alternative processes is randomly selected for each component. The optimum allocated tolerances are then obtained using the LM method. The manufacturing cost of the components is computed for each component, each with its alternative process. The least-cost alternative process is selected for each component and the optimum allocation of tolerance is carried out again. The procedure is repeated again and again until there is no change in the alternative process of each component. The least-cost processes are selected for the manufacturing of components. The detailed algorithm is presented in the next section and the flow chart is shown in Figure A.1 (Appendix A).

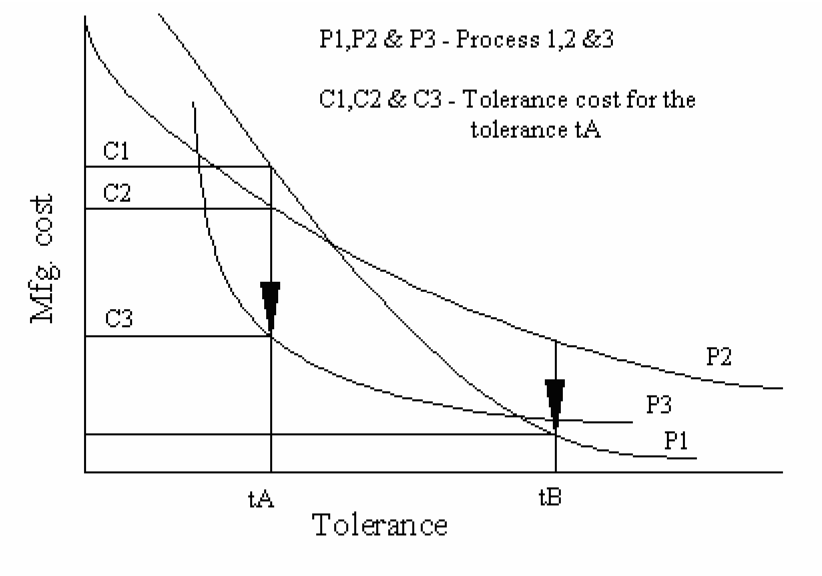

FIGURE 1: Bottom curve follower approach.

3.2.1 Algorithm - bottom curve follower approach

```
Step 1  : Read number of components (n) and assembly tolerances ($t_{asm1}$and $t_{asm2}$)
Step 2  : Set i = 1
Step 3  : Read number of process for each component (nop[i] )
Step 4  : Increment i by 1
Step 5  : If (i<=n)
              Go to step 3
Step 6  : Set i = 1
Step 7  : Set j = 1
Step 8  : Read C0[i][j],C1[i][j],C2[i][j],$t_{min}$[i][j]  and $t_{max}$[i][j]
Step 9  : Increment j by 1
Step 10: If (j<=nop[i])
```

```
            Go to step 8
Step 11: Increment i by 1
Step 12: If (i <= n)
            Go to step 7
Step 13: Set i = 1
Step 14: Generate a random number (pno[i]) within nop[i]
Step 15: Increment i by 1
Step 16: If (i <= n)
            Go to step 14
Step 17: Initialize $t_s$ = max($t_{min}$[][])
Step 18: Initialize i = 1 and t [i][pno[i]] =$t_s$
Step 19: Compute t[i+1][pno[i+1]] using
    $t[i+1][pno[i+1]] = \frac{\log\left[\frac{C0[i+1][pno[i+1]] \times C1[i+1][pno[i+1]] \times \exp(C1[i][pno[i]] \times t[i][pno[i]])}{C0[i][pno[i]] \times C1[i][pno[i]]}\right]}{C1[i+1][pno[i+1]]}$
Step 20: If ((t[i+1][pno[i+1]]) <$t_{min}$[i+1][pno[i+1]]) OR (t[i+1]>$t_{max}$[i+1][pno[i+1]]))
      Go to step 29
Step 21: Increment i by 1
Step 22: If (i<=n-1) then
            Go to step 19
Step 23: Set i=1 and $t_{casm}$=0
Step 24: $t_{casm}$=$t_{casm}$ + t[i][pno[i]]
Step 25: Increment i by 1
Step 26: If ( i < n-1)
            Go to step 24
Step 27: diff=100 x abs($t_{casm}$-$t_{asm1}$)/$t_{casm}$
Step 28: If (diff <= 0.000001 )
            Go to step 30
Step 29: $t_s$ = $t_s$ + 0.00001 and Go to step 18
Step 30: Determine t[n][pno[n]] using t[n] [pno[n]]=$t_{asm2}$ -  t[n-1][pno[n-1]]
Step 31: Initialize i = 1, and cost = 0
Step 32: $MC[i][pno[i]] = C0[i][pno[i]] \times \exp(-C1[i][pno[i]] \times t[i][pno[i]]) + C2[i][pno[i]]$
Step 33: Compute cost = cost + MC[i][pno[i]]
Step 34: Display allocated tolerance t[i][pno[i]] and its manufacturing cost MC[i][pno[i]]
Step 35: Increment i by 1
Step 36: If (i<=n)
            Go to step 32
Step 37: Display t[][],MC[][] and cost of the product.
Step 38: Set i = 1,k=0, itr=1 and tcost [itr]= 0
Step 39: Set j=1
Step 40: Compute cst[i][j]=C0[i][j] x exp(-t [i][pno[i]] x C1[i][j])+C2[i][j]
Step 41: mcst=cst[i][j] and mpno[i]=j
Step 42: Increment j by 1
Step 43: Compute cst[i][j]=C0[i][j] x exp(-t[i][pno[i]] x C1[i][j])+C2[i][j]
Step 44: If (mcst <=cst[i][j])
            mcst=mcst and mpno[i]=mpno[i]
        Else
            mcst=cst[i][j] and mpno[i]=j
Step 45: If (j<=nop[i])
            Go to Step 42
Step 46: tcost[itr]= tcost[itr] + mcst
Step 47: If (pno[i]!=mpno[i])
            k=k+1 and pno[i]=mpno[i]
Step 48: Increment i by 1
```

```
Step 49: If (i<=n)
                Go to step 39
Step 50: If (k=0)
                Go to step 51
        Else
                Go to step 17
Step 51: Display min(tcost[]) and its corresponding ta[][],pno[]
```

4. CASE STUDY

The wheel mounting assembly shown in Figure 2 is an example demonstrating the proposed methodology. The components of the complex assembly are manufactured with alternative processes. The bottom curve follower approach is used to determine the best alternative process for manufacturing the components and the LM method is used to allocate tolerance optimally to the components. The complex assembly consists of two interrelated dimensional chains, to which the component X2 is common. It is assumed that the cost model constants (C0, C1 and C2) of all the processes are available before starting the allocation process. The global optimum allocated tolerances are obtained using a Pentium IV personal computer and C programming language. The exhaustive LM search method is compared with the proposed method's results.

4.1 Wheel mounting assembly

The component and its dimension details of the wheel mounting assembly are shown in Figure 2. The exponential cost function constants of the part dimensions with alternative processes are listed in Table 1. The dimensions of Y1 and Y2 are computed from equations (8) and (9). The tolerance on dimension Y1 and Y2 are expressed in expressions (10) and (11).

$$Y1 = X2 - X4 \quad (8)$$

$$Y2 = X5 - X1 - X2 - X3 \quad (9)$$

$$t_{Y1} \leq 0.11 \geq t[X2][pno[X2]] + t[X4][pno[X4]] \quad (10)$$

$$t_{Y2} \leq 0.24 \geq t[X1][pno[X1]] + t[X2][pno[X2]] + t[X3][pno[X3]] \quad + t[X5][pno[X5]] \quad (11)$$

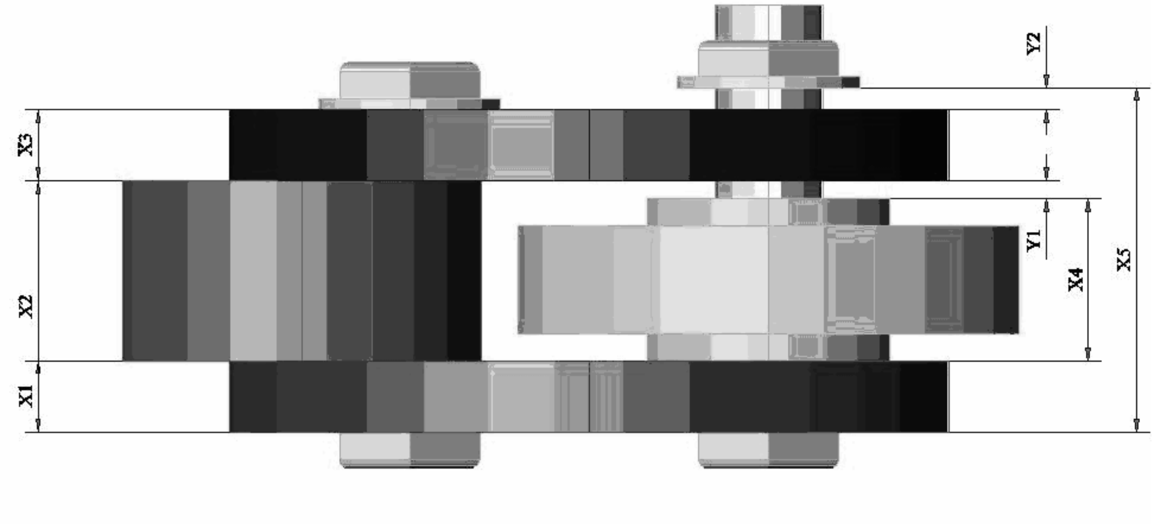

Figure 2: Wheel mounting assembly.

4.2 Numerical illustration - bottom curve follower approach

For demonstration purpose, the components X1, X2, X3, X4 and X5 are manufactured from process number 1,1,1,1 and 1 respectively. The cost function constants are listed in Table 2.

$$t_{asm1} = t[X1][1] + t[X2][1] + t[X3][1] + t[X5][1] \leq 0.24 \quad (12)$$

$$t_{asm2} = t[X2][1] + t[X4][1] \leq 0.11 \quad (13)$$

Part dimension (i)	Process number (j)	Cost model constants			Precision limits (mm)	
		C0[i][j]	C1[i][j]	C2[i][j]	t_{min}[i][j]	t_{max}[i][j]
X1, X2 & X3	1	241.00	55.80	28.20	0.006	0.080
	2	260.00	52.00	29.80	0.006	0.080
	3	286.40	59.50	25.82	0.006	0.080
	4	271.50	57.64	23.00	0.006	0.080
X4	1	312.84	105.66	42.20	0.002	0.060
	2	352.43	92.70	35.00	0.002	0.060
X5	1	208.25	62.45	22.50	0.010	0.100
	2	240.43	66.70	20.20	0.010	0.100
	3	211.42	40.05	25.05	0.010	0.100
	4	214.16	58.82	300.00	0.010	0.100

Table 1: Exponential cost function constants of wheel mounting assembly (Singh et al.,).

*Note: All component's tolerance are in mm; the manufacturing cost is in $

Component (i)	Process No (j)	C0[i][j]	C1[i][j]	C2[i][j]	t_{min}[i][j]	t_{max}[i][j]
X1	1	241.00	55.80	28.2	0.006	0.08
X2	1	241.00	55.80	28.2	0.006	0.08
X3	1	241.00	55.80	28.2	0.006	0.08
X4	1	312.84	105.66	42.2	0.002	0.06
X5	1	208.25	62.45	22.5	0.010	0.10

Table 2: Cost function constant for initial calculation.

For simplification, the components are arranged in the order of X1, X3, X5, X2 &X4 instead of X1, X2, X3, X4 & X5.

Step 1: Initially, t_s is assumed as max(t_{min}[][]) i.e from the above table
t_s=max(t_{min}[][])=max(0.006,0.006,0.006,0.002,0.01)
t_s=0.01 and hence t[X1][1]=0.01.
For demonstration purpose, ts is assumed as 0.05

Step 2: Substitute the values of C0[][],C1[][] and C2[][] in the following expression in which the values are read from the Table 2.

$$t\ [X3][1]=\frac{\ln\left[\dfrac{C0[X3][1]\times C1[X3][1]\times \exp(C1[X1][1]\times t\ \ [X1][1])}{C0[X1][1]\times c1[X1][1]}\right]}{C1[X3][1]}$$

$$t\ [X3][1]=\frac{\ln\left[\dfrac{241\times 55.8\times \exp(55.8\times 0.05)}{241\times 55.8}\right]}{55.8}=0.05$$

Step 3: It is necessary to check that the allocated tolerance t[X3][1] must lie between its process tolerance limits (t_{min}[X3][1] and t_{max}[X3][1]). In this case, it is true. If not, the t_s value is increased and the step 2 is again repeated.

$$t_{\min}[X3][1]\le t[X3][1]\le t_{\max}[X3][1]$$
$$0.006\le 0.05\le 0.08$$

Step 4: Similarly the value of t[X5][1] can be determined and checked as follows

$$t\ [X5][1]=\frac{\ln\left[\dfrac{208.25\times 62.45\times \exp(55.8\times 0.05)}{241\times 55.8}\right]}{62.45}=0.04414$$
$$t_{\min}[X5][1]\le t[X5][1]\le t_{\max}[X5][1]$$
$$0.010\le 0.04414\le 0.10$$

Step 5: Similarly the value of t[X2][1] can be determined as follows

$$t\ [X2][1]=\frac{\ln\left[\dfrac{241\times 55.8\times \exp(62.45\times 0.04414)}{208.25\times 62.45}\right]}{55.8}=0.05$$
$$t_{\min}[X2][1]\le t[X2][1]\le t_{\max}[X2][1]$$
$$0.006\le 0.05\le 0.08$$

Step 6: The value of assembly tolerance is determined from the expression (11) by substituting allocated tolerance of components X1, X2, X3 and X5.

t_{casm} =0.05 + 0.05 + 0.05 + 0.004414 = 0.19414

Step 7: The % difference between calculated and the required assembly tolerance is determined using the following equation

diff = 100x(t_{casm}-t_{asm1})/t_{casm}
= 100xabs(0.19414-0.24)/0.19414
diff = 23.62

Step 8: Since, the % difference is > 0.00001, the value of ts is incremented by 0.0001 and then the steps staring from 1 to 7 are carried out until the value of difference becomes <=0.00001.

Step 9: The optimum allocated tolerance of components after the above steps are t[X1][1]=0.061761;t[X2][1]=0.06176;t[X3][1]=0.061761;t[X5][1]=0.054649;

t_{casm1}=0.239932

The value of t[X4][1] is determined by substituting the value of t[X2][1] in the expression (12).

t_{asm2}=0.11= t[X2][1] + t[X4][1]
t[X4][1] = 0.11 – 0.06176 = 0.04824

Step 10: The manufacturing cost of the components are computed using the following expression.
The manufacturing cost of the component X1 will be

$$MC[X1][pno[X1]] = C0[X1][pno[X1]] \times \exp(-C1[X1][pno[X1]] \times t\ [X1][pno[X1]]) + C2[X1][pno[X1]]$$

$$MC[X1][1] = 241 \times \exp(-55.8 \times 0.061761) + 28.2 = 35.87934$$

Similarly, the manufacturing cost of the component X2, X3, X4 and X5 are

$$MC[X2][1] = 241 \times \exp(-55.8 \times 0.061761) + 28.2 = 35.87934$$

$$MC[X3][1] = 241 \times \exp(-55.8 \times 0.061761) + 28.2 = 35.87934$$

$$MC[X4][1] = 312.84 \times \exp(-105.66 \times 0.04824) + 42.2 = 44.11317$$

$$MC[X5][1] = 208.25 \times \exp(-62.45 \times 0.054649) + 22.5 = 29.36138$$

Step 11: Total cost of the product is determined using expression (3).

$$Cost_{asm} = \sum_{i=1}^{n} MC[i][1]$$

$$= 35.87934 + 35.87934 + 35.87934 + 44.11317 + 29.36138 = 181.1126$$

Step 12: The manufacturing cost of t[X1] []for other alternative process 2,3 and 4 are calculated as follows in which C0[][],C1[][] & C2[][] values are read from the table .

$$MC[X1][2] = 260 \times \exp(-52 \times 0.061761) + 29.8 = 40.27624$$

$$MC[X1][3] = 286.4 \times \exp(-59.5 \times 0.061761) + 25.82 = 33.08167$$

$$MC[X1][4] = 271.5 \times \exp(-57.64 \times 0.061761) + 23 = 30.72188$$

The minimum manufacturing cost of component X1 is obtained in process number 4. Hence, the component X1 is manufactured in process number 4 with the allocated tolerance value of 0.061761.

Step 13: The allocated tolerance of components X2 (t[X2][1]=0.061761) and X3 (t[X3][1]=0.061761) are same as X1, hence, the manufacturing processes are also same with X1. Hence, the components X2 and X3 are also manufactured in process number 4.

$$MC[X2][4] = 271.5 \times \exp(-57.64 \times 0.061761) + 23 = 30.72188$$

$$MC[X3][4] = 271.5 \times \exp(-57.64 \times 0.061761) + 23 = 30.72188$$

Step 14: In similar way, the manufacturing cost of component X4 is

$$MC[X4][2] = 352.43 \times \exp(-92.7 \times 0.04824) + 35 = 39.0273$$

Since, MC[X4][1] is more than the MC[X4][2], hence, the component X4 is manufactured in process number 2 with the allocated tolerance of 0.04824.

Step 15: The manufacturing cost of component X5 for different alternative processes 2,3 and 4 are

$$MC[X5][2] = 240.43 \times \exp(-66.7 \times 0.054649) + 20.2 = 26.47982$$

$$MC[X5][3] = 211.42 \times \exp(-40.05 \times 0.054649) + 25.05 = 48.7424$$

$$MC[X5][1] = 214.16 \times \exp(-58.82 \times 0.054649) + 300 = 308.6044$$

MC[X5][2] is less compared with other manufacturing cost MC[X5][1], MC[X5][3] and MC[X5][4], hence, the component X5 is manufactured in process number 2 with the allocated tolerance of 0.054649.

Step 16: The revised total cost of the product after implementation of bottom curve follower approach is

$$Cost_{asm} = MC[X1][4] + MC[X2][4] + MC[X3][4] + MC[X4][2] + MC[X5][2]$$

$$Cost_{asm} = 30.72188 + 30.72188 + 30.72188 + 39.0273 + 26.47982 = 157.6728$$

Step 17: Now, the process number of components X1, X2, X3, X4 and X5 is assumed as 4,4,4,2 and 2. The step 1 to step 15 are repeated again and again, when there is no change in the process number of the components.

For all combinations of processes (exhaustive search), the above steps are executed. The results are presented in Table B.1 (Appendix B), in which the allocated tolerances are shown in four-decimal accuracy and the tolerance cost is shown in single-decimal accuracy for the sake of simplicity. However, the actual calculation was carried out up to six-decimal accuracy. The process number based on the bottom curve follower approach for the components/dimensions X1, X2, X3, X4 and X5 are 4, 4, 4, 2 and 2 respectively.

5. RESULTS

The allocated tolerance and its manufacturing cost based on the LM method using the bottom curve follower method (proposed method) and Singh's [14] method for wheel mounting assembly are presented in Table 3. The percentage deviation of manufacturing cost for the wheel mounting assembly between Singh's method and the proposed method is estimated as,

$$Deviation = \frac{(159.998 - 156.875) \times 100}{159.998} = 1.95\%$$

	Singh Method			**Bottom Curve Follower Approach**		
Part Dimension	**Process No.**	**Tolerance (mm)**	**Cost ($)**	**Process No.**	**Tolerance (mm)**	**Cost ($)**
X1	4	0.0633	30.0664	4	0.06322	30.09864
X2	4	0.055	34.4017	4	0.05882	32.14838
X3	4	0.0612	30.9757	4	0.06322	30.09864
X4	2	0.0546	37.2332	2	0.05118	38.06628
X5	1	0.0603	27.3211	2	0.05469	26.46350
t_{Y1}		0.2398			0.23995	
t_{Y2}		0.1096			0.11	
Total Cost			159.9981			156.87545

Table 3: Comparison between Singh [14] and the proposed method.

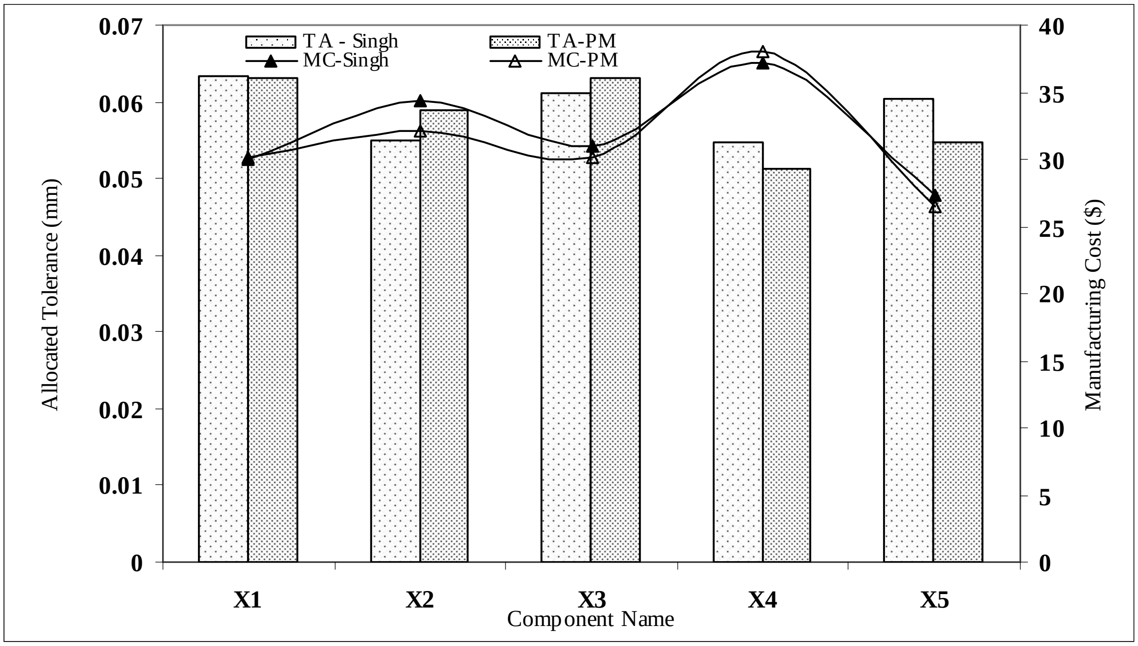

FIGURE 3: Optimum allocated tolerance and manufacturing cost comparison
TA- Optimum allocated tolerance; MC – Manufacturing cost; PM – Proposed method

6. CONCLUSION

Tolerance distribution among the components of an assembly affects manufacturing costs. The solutions obtained using nontraditional optimization techniques were not consistent and were randomly generated for each trial/run. There was also the possibility of omit the best process for optimum tolerance allocation. An attempt was made in this work to obtain the optimum allocated tolerance for interrelated dimensional chains products using the LM method with the bottom curve follower approach. The results of the exhaustive search method and the proposed method were compared. It was interesting to note that the proposed method yielded better results than both the exhaustive search method and Singh's [14] method. Once implemented in complex assembly, the proposed method resulted in 1.95% savings in the manufacturing cost of a product compared to Singh's method. The computation time in terms of CPU time is compared with the existing method in Table 4. It is understood from the Table 4 that the proposed method is approximately 30 times faster than the existing method in allocating tolerance optimally to the components of a complex assembly.

Method	Process combinations	CPU Time (sec)
Singh [14]	44421	5.37
Siva Kumar [19]	44422	5.26
Proposed method	44421	0.18

Table 4: CPU Time for the proposed method.

Appendix - A

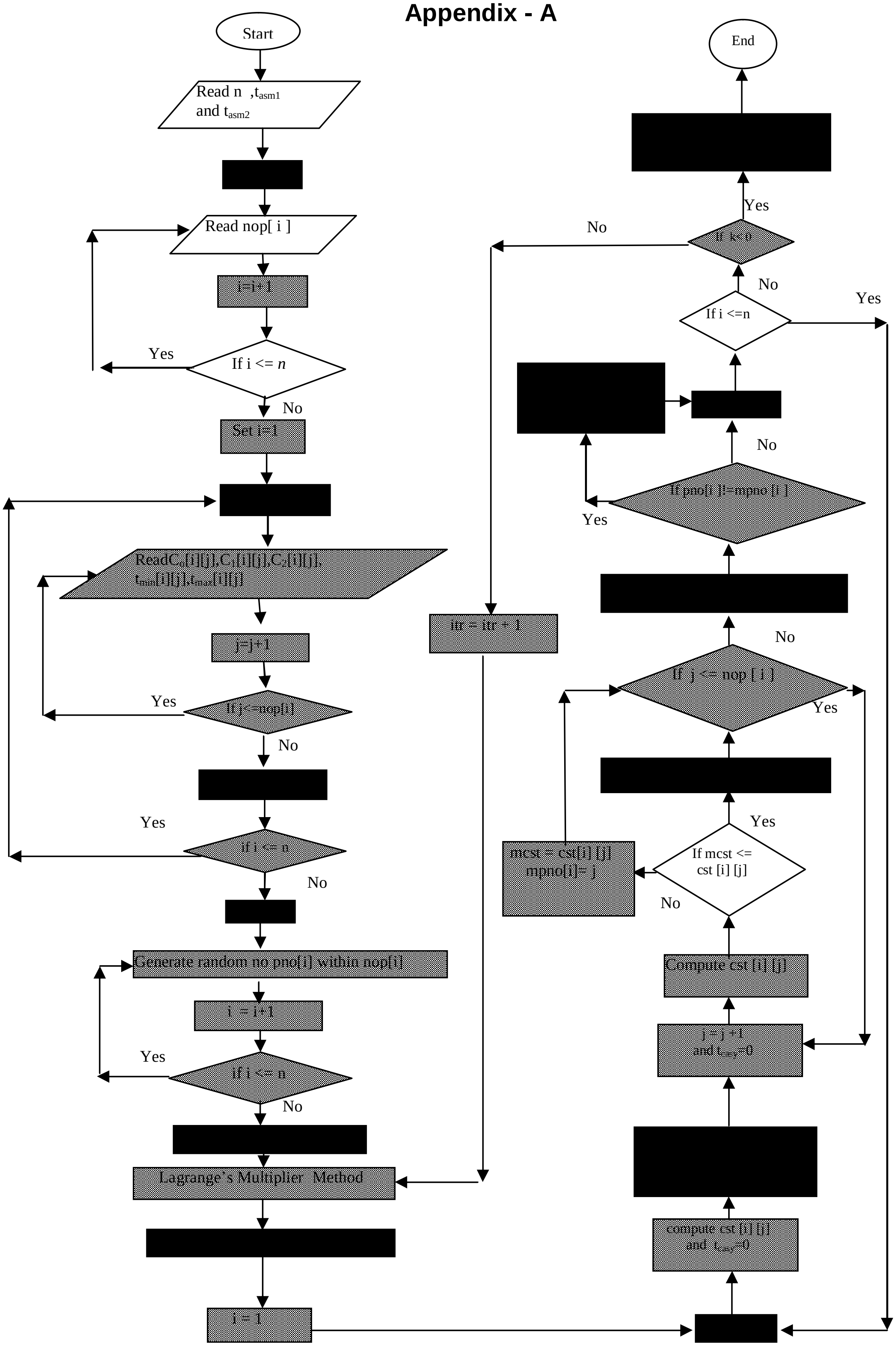

FIGURE A: 1 Flow chart of bottom curve follower approach.

A. 1 Lagrange's multiplier method for worst-case criteria

$$\frac{\partial}{\partial T_i}[mc\_fun] + \lambda \frac{\partial}{\partial t_i}[asy\_cont] = 0 \tag{A.1}$$

$$mc\_fun = C0 \times \exp(-C1 \times t) + C2 \tag{A.2}$$

$$asy\_cont = t - t_{asm} \tag{A.3}$$

After substitution of equations (A.2) and (A.3) in equation (A.1), we get

$$\frac{\partial}{\partial t_i}[C0 \times \exp(-C1 \times t) + C2] + \lambda \frac{\partial}{\partial t_i}[t - t_{asm}] = 0$$

$$-C0 \times C1 \times \exp(-C1 \times t) + \lambda = 0$$

$$\lambda = \frac{C0 \times C1}{\exp(C1 \times t)} = \frac{C0_1 \times C1_1}{\exp(C1_1 \times t_1)} = \frac{C0_2 \times C1_2}{\exp(C1_2 \times t_2)} \tag{A.4}$$

$$t_2 = \frac{\ln\left[\dfrac{C0_2 \times C1_2 \times \exp(C1_1 \times t_1)}{C0_1 \times C1_1}\right]}{C1_2} \tag{A.5}$$

General representation of equation (A.5) is

$$t_{i+1} = \frac{\ln\left[\dfrac{C0_{i+1} \times C1_{i+1} \times \exp(C1_i \times t_i)}{C0_i \times C1_i}\right]}{C1_{i+1}} \tag{A.6}$$

Appendix – B

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11111	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0482	44.1	39.0	0.0546	29.4	26.5	181.1	157.7	0.24	0.11
11112	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0482	39.0	39.0	0.0546	29.4	26.5	176.0	157.7	0.24	0.11
11121	0.0619	35.8	30.7	0.0619	35.8	30.7	0.0619	35.8	30.7	0.0481	44.1	39.1	0.0544	26.6	26.6	178.2	157.7	0.24	0.11
11122	0.0619	35.8	30.7	0.0619	35.8	30.7	0.0619	35.8	30.7	0.0481	39.1	39.1	0.0544	26.6	26.6	173.2	157.7	0.24	0.11
11131	0.0572	38.1	33.0	0.0572	38.1	33.0	0.0572	38.1	33.0	0.0528	43.4	37.6	0.0682	38.8	22.7	196.5	159.5	0.24	0.11
11132	0.0572	38.1	33.0	0.0572	38.1	33.0	0.0572	38.1	33.0	0.0528	37.6	37.6	0.0682	38.8	22.7	190.7	159.5	0.24	0.11
11141	0.0611	36.2	31.0	0.0611	36.2	31.0	0.0611	36.2	31.0	0.0489	44.0	38.8	0.0568	307.6	25.6	460.1	157.5	0.24	0.11
11142	0.0611	36.2	31.0	0.0611	36.2	31.0	0.0611	36.2	31.0	0.0489	38.8	38.8	0.0568	307.6	25.6	454.9	157.5	0.24	0.11
11211	0.0606	36.4	31.3	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0494	43.9	38.6	0.0536	29.8	26.9	185.1	157.4	0.24	0.11
11212	0.0606	36.4	31.3	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0494	38.6	38.6	0.0536	29.8	26.9	179.8	157.4	0.24	0.11
11221	0.0607	36.4	31.2	0.0607	36.4	31.2	0.0652	38.6	29.3	0.0493	43.9	38.6	0.0534	27.0	27.0	182.2	157.4	0.24	0.11
11222	0.0607	36.4	31.2	0.0607	36.4	31.2	0.0652	38.6	29.3	0.0493	38.6	38.6	0.0534	27.0	27.0	176.9	157.4	0.24	0.11
11231	0.0563	38.6	33.6	0.0563	38.6	33.6	0.0605	41.0	31.3	0.0537	43.3	37.4	0.0669	39.6	23.0	201.1	158.9	0.24	0.11
11232	0.0563	38.6	33.6	0.0563	38.6	33.6	0.0605	41.0	31.3	0.0537	37.4	37.4	0.0669	39.6	23.0	195.2	158.9	0.24	0.11
11241	0.0599	36.7	31.6	0.0599	36.7	31.6	0.0644	38.9	29.6	0.0501	43.8	38.4	0.0557	308.1	26.0	464.2	157.2	0.24	0.11
11242	0.0599	36.7	31.6	0.0599	36.7	31.6	0.0644	38.9	29.6	0.0501	38.4	38.4	0.0557	308.1	26.0	458.8	157.2	0.24	0.11
11311	0.0617	35.9	30.7	0.0617	35.9	30.7	0.0619	33.0	30.7	0.0483	44.1	39.0	0.0546	29.4	26.5	178.3	157.6	0.24	0.11
11312	0.0617	35.9	30.7	0.0617	35.9	30.7	0.0619	33.0	30.7	0.0483	39.0	39.0	0.0546	29.4	26.5	173.2	157.6	0.24	0.11
11321	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0620	33.0	30.6	0.0482	44.1	39.0	0.0544	26.6	26.6	175.4	157.7	0.24	0.11
11322	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0620	33.0	30.6	0.0482	39.0	39.0	0.0544	26.6	26.6	170.4	157.7	0.24	0.11
11331	0.0572	38.1	33.1	0.0572	38.1	33.1	0.0576	35.1	32.8	0.0528	43.4	37.6	0.0681	38.9	22.8	193.6	159.3	0.24	0.11
11332	0.0572	38.1	33.1	0.0572	38.1	33.1	0.0576	35.1	32.8	0.0528	37.6	37.6	0.0681	38.9	22.8	187.9	159.3	0.24	0.11
11341	0.0610	36.2	31.1	0.0610	36.2	31.1	0.0612	33.3	31.0	0.0490	44.0	38.8	0.0568	307.6	25.7	457.3	157.5	0.24	0.11
11342	0.0610	36.2	31.1	0.0610	36.2	31.1	0.0612	33.3	31.0	0.0490	38.8	38.8	0.0568	307.6	25.7	452.1	157.5	0.24	0.11
11411	0.0616	35.9	30.8	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0484	44.1	39.0	0.0545	29.4	26.5	175.9	157.6	0.24	0.11
11412	0.0616	35.9	30.8	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0484	39.0	39.0	0.0545	29.4	26.5	170.8	157.6	0.24	0.11
11421	0.0617	35.9	30.8	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0483	44.1	39.0	0.0542	26.7	26.7	173.0	157.6	0.24	0.11
11422	0.0617	35.9	30.8	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0483	39.0	39.0	0.0542	26.7	26.7	167.9	157.6	0.24	0.11
11431	0.0571	38.2	33.1	0.0571	38.2	33.1	0.0579	32.7	32.7	0.0529	43.4	37.6	0.0680	39.0	22.8	191.3	159.3	0.24	0.11
11432	0.0571	38.2	33.1	0.0571	38.2	33.1	0.0579	32.7	32.7	0.0529	37.6	37.6	0.0680	39.0	22.8	185.6	159.3	0.24	0.11
11441	0.0609	36.3	31.1	0.0609	36.3	31.1	0.0616	30.8	30.8	0.0491	43.9	38.7	0.0566	307.7	25.7	454.9	157.5	0.24	0.11
11442	0.0609	36.3	31.1	0.0609	36.3	31.1	0.0616	30.8	30.8	0.0491	38.7	38.7	0.0566	307.7	25.7	449.7	157.5	0.24	0.11
12111	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0449	44.9	40.5	0.0536	29.8	26.9	186.1	159.3	0.24	0.11
12112	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0449	40.5	40.5	0.0536	29.8	26.9	181.7	159.3	0.24	0.11
12121	0.0607	36.4	31.2	0.0652	38.6	29.3	0.0607	36.4	31.2	0.0448	45.0	40.5	0.0534	27.0	27.0	183.2	159.3	0.24	0.11
12122	0.0607	36.4	31.2	0.0652	38.6	29.3	0.0607	36.4	31.2	0.0448	40.5	40.5	0.0534	27.0	27.0	178.8	159.3	0.24	0.11
12131	0.0563	38.6	33.6	0.0605	41.0	31.3	0.0563	38.6	33.6	0.0495	43.9	38.6	0.0669	39.6	23.0	201.7	160.0	0.24	0.11
12132	0.0563	38.6	33.6	0.0605	41.0	31.3	0.0563	38.6	33.6	0.0495	38.6	38.6	0.0669	39.6	23.0	196.4	160.0	0.24	0.11
12141	0.0599	36.7	31.6	0.0644	38.9	29.6	0.0599	36.7	31.6	0.0456	44.7	40.1	0.0557	308.1	26.0	465.2	159.0	0.24	0.11
12142	0.0599	36.7	31.6	0.0644	38.9	29.6	0.0599	36.7	31.6	0.0456	40.1	40.1	0.0557	308.1	26.0	460.6	159.0	0.24	0.11
12211	0.0595	36.9	31.8	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	44.6	39.9	0.0526	30.3	27.4	190.1	158.8	0.24	0.11
12212	0.0595	36.9	31.8	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	39.9	39.9	0.0526	30.3	27.4	185.5	158.8	0.24	0.11
12221	0.0595	36.9	31.8	0.0640	39.1	29.8	0.0640	39.1	29.8	0.0460	44.6	40.0	0.0525	27.5	27.5	187.2	158.8	0.24	0.11
12222	0.0595	36.9	31.8	0.0640	39.1	29.8	0.0640	39.1	29.8	0.0460	40.0	40.0	0.0525	27.5	27.5	182.6	158.8	0.24	0.11
12231	0.0554	39.2	34.2	0.0595	41.6	31.8	0.0595	41.6	31.8	0.0505	43.7	38.3	0.0656	40.3	23.2	206.4	159.2	0.24	0.11
12232	0.0554	39.2	34.2	0.0595	41.6	31.8	0.0595	41.6	31.8	0.0505	38.3	38.3	0.0656	40.3	23.2	200.9	159.2	0.24	0.11
12241	0.0588	37.2	32.1	0.0632	39.5	30.1	0.0632	39.5	30.1	0.0468	44.4	39.6	0.0547	308.6	26.5	469.3	158.4	0.24	0.11
12242	0.0588	37.2	32.1	0.0632	39.5	30.1	0.0632	39.5	30.1	0.0468	39.6	39.6	0.0547	308.6	26.5	464.5	158.4	0.24	0.11
12311	0.0605	36.4	31.3	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0449	44.9	40.5	0.0536	29.8	27.0	183.3	159.3	0.24	0.11
12312	0.0605	36.4	31.3	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0449	40.5	40.5	0.0536	29.8	27.0	178.9	159.3	0.24	0.11
12321	0.0606	36.4	31.2	0.0652	38.6	29.4	0.0608	33.5	31.1	0.0448	44.9	40.5	0.0534	27.0	27.0	180.4	159.3	0.24	0.11
12322	0.0606	36.4	31.2	0.0652	38.6	29.4	0.0608	33.5	31.1	0.0448	40.5	40.5	0.0534	27.0	27.0	176.0	159.3	0.24	0.11
12331	0.0562	38.7	33.7	0.0604	41.1	31.4	0.0567	35.7	33.4	0.0496	43.9	38.5	0.0667	39.7	23.0	198.9	159.9	0.24	0.11
12332	0.0562	38.7	33.7	0.0604	41.1	31.4	0.0567	35.7	33.4	0.0496	38.5	38.5	0.0667	39.7	23.0	193.6	159.9	0.24	0.11
12341	0.0599	36.7	31.6	0.0643	39.0	29.7	0.0601	33.8	31.5	0.0457	44.7	40.1	0.0557	308.1	26.1	462.3	158.9	0.24	0.11
12342	0.0599	36.7	31.6	0.0643	39.0	29.7	0.0601	33.8	31.5	0.0457	40.1	40.1	0.0557	308.1	26.1	457.7	158.9	0.24	0.11
12411	0.0604	36.5	31.3	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0451	44.9	40.4	0.0535	29.9	27.0	180.9	159.2	0.24	0.11
12412	0.0604	36.5	31.3	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0451	40.4	40.4	0.0535	29.9	27.0	176.5	159.2	0.24	0.11
12421	0.0605	36.4	31.3	0.0650	38.6	29.4	0.0612	31.0	31.0	0.0450	44.9	40.5	0.0533	27.1	27.1	178.0	159.2	0.24	0.11
12422	0.0605	36.4	31.3	0.0650	38.6	29.4	0.0612	31.0	31.0	0.0450	40.5	40.5	0.0533	27.1	27.1	173.6	159.2	0.24	0.11
12431	0.0561	38.7	33.7	0.0603	41.1	31.4	0.0569	33.2	33.2	0.0497	43.8	38.5	0.0666	39.7	23.0	196.6	159.8	0.24	0.11
12432	0.0561	38.7	33.7	0.0603	41.1	31.4	0.0569	33.2	33.2	0.0497	38.5	38.5	0.0666	39.7	23.0	191.3	159.8	0.24	0.11
12441	0.0597	36.8	31.7	0.0642	39.0	29.7	0.0605	31.3	31.3	0.0458	44.7	40.1	0.0556	308.2	26.1	460.0	158.9	0.24	0.11
12442	0.0597	36.8	31.7	0.0642	39.0	29.7	0.0605	31.3	31.3	0.0458	40.1	40.1	0.0556	308.2	26.1	455.3	158.9	0.24	0.11
13111	0.0617	35.9	30.7	0.0619	33.0	30.7	0.0617	35.9	30.7	0.0481	44.1	39.1	0.0546	29.4	26.5	178.3	157.7	0.24	0.11
13112	0.0617	35.9	30.7	0.0619	33.0	30.7	0.0617	35.9	30.7	0.0481	39.1	39.1	0.0546	29.4	26.5	173.2	157.7	0.24	0.11
13121	0.0618	35.9	30.7	0.0620	33.0	30.6	0.0618	35.9	30.7	0.0480	44.2	39.1	0.0544	26.6	26.6	175.5	157.7	0.24	0.11
13122	0.0618	35.9	30.7	0.0620	33.0	30.6	0.0618	35.9	30.7	0.0480	39.1	39.1	0.0544	26.6	26.6	170.4	157.7	0.24	0.11
13131	0.0572	38.1	33.1	0.0576	35.1	32.8	0.0572	38.1	33.1	0.0524	43.4	37.7	0.0681	38.9	22.8	193.7	159.5	0.24	0.11
13132	0.0572	38.1	33.1	0.0576	35.1	32.8	0.0572	38.1	33.1	0.0524	37.7	37.7	0.0681	38.9	22.8	188.0	159.5	0.24	0.11
13141	0.0610	36.2	31.1	0.0612	33.3	31.0	0.0610	36.2	31.1	0.0488	44.0	38.8	0.0568	307.6	25.7	457.4	157.6	0.24	0.11

13142	0.0610	36.2	31.1	0.0612	33.3	31.0	0.0610	36.2	31.1	0.0488	38.8	38.8	0.0568	307.6	25.7	452.2	157.6	0.24	0.11
13211	0.0605	36.4	31.3	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0492	43.9	38.7	0.0536	29.8	27.0	182.3	157.5	0.24	0.11
13212	0.0605	36.4	31.3	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0492	38.7	38.7	0.0536	29.8	27.0	177.1	157.5	0.24	0.11
13221	0.0606	36.4	31.2	0.0608	33.5	31.1	0.0652	38.6	29.4	0.0492	43.9	38.7	0.0534	27.0	27.0	179.4	157.5	0.24	0.11
13222	0.0606	36.4	31.2	0.0608	33.5	31.1	0.0652	38.6	29.4	0.0492	38.7	38.7	0.0534	27.0	27.0	174.2	157.5	0.24	0.11
13231	0.0562	38.7	33.7	0.0567	35.7	33.4	0.0604	41.1	31.4	0.0533	43.3	37.5	0.0667	39.7	23.0	198.4	158.9	0.24	0.11
13232	0.0562	38.7	33.7	0.0567	35.7	33.4	0.0604	41.1	31.4	0.0533	37.5	37.5	0.0667	39.7	23.0	192.6	158.9	0.24	0.11
13241	0.0599	36.7	31.6	0.0601	33.8	31.5	0.0643	39.0	29.7	0.0499	43.8	38.5	0.0557	308.1	26.1	461.4	157.3	0.24	0.11
13242	0.0599	36.7	31.6	0.0601	33.8	31.5	0.0643	39.0	29.7	0.0499	38.5	38.5	0.0557	308.1	26.1	456.1	157.3	0.24	0.11
13311	0.0617	35.9	30.7	0.0618	33.0	30.7	0.0618	33.0	30.7	0.0482	44.1	39.1	0.0546	29.4	26.5	175.5	157.7	0.24	0.11
13312	0.0617	35.9	30.7	0.0618	33.0	30.7	0.0618	33.0	30.7	0.0482	39.1	39.1	0.0546	29.4	26.5	170.4	157.7	0.24	0.11
13321	0.0618	35.9	30.7	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0481	44.1	39.1	0.0543	26.6	26.6	172.7	157.7	0.24	0.11
13322	0.0618	35.9	30.7	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0481	39.1	39.1	0.0543	26.6	26.6	167.6	157.7	0.24	0.11
13331	0.0571	38.2	33.1	0.0575	35.2	32.9	0.0575	35.2	32.9	0.0525	43.4	37.7	0.0680	39.0	22.8	190.9	159.4	0.24	0.11
13332	0.0571	38.2	33.1	0.0575	35.2	32.9	0.0575	35.2	32.9	0.0525	37.7	37.7	0.0680	39.0	22.8	185.2	159.4	0.24	0.11
13341	0.0610	36.2	31.1	0.0612	33.4	31.0	0.0612	33.4	31.0	0.0489	44.0	38.8	0.0567	307.6	25.7	454.5	157.6	0.24	0.11
13342	0.0610	36.2	31.1	0.0612	33.4	31.0	0.0612	33.4	31.0	0.0489	38.8	38.8	0.0567	307.6	25.7	449.4	157.6	0.24	0.11
13411	0.0616	36.0	30.8	0.0617	33.1	30.7	0.0622	30.5	30.5	0.0483	44.1	39.0	0.0545	29.4	26.6	173.1	157.6	0.24	0.11
13412	0.0616	36.0	30.8	0.0617	33.1	30.7	0.0622	30.5	30.5	0.0483	39.0	39.0	0.0545	29.4	26.6	168.0	157.6	0.24	0.11
13421	0.0616	35.9	30.8	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0482	44.1	39.0	0.0542	26.7	26.7	170.3	157.7	0.24	0.11
13422	0.0616	35.9	30.8	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0482	39.0	39.0	0.0542	26.7	26.7	165.2	157.7	0.24	0.11
13431	0.0570	38.2	33.2	0.0574	35.2	32.9	0.0578	32.7	32.7	0.0526	43.4	37.7	0.0678	39.0	22.8	188.6	159.3	0.24	0.11
13432	0.0570	38.2	33.2	0.0574	35.2	32.9	0.0578	32.7	32.7	0.0526	37.7	37.7	0.0678	39.0	22.8	182.9	159.3	0.24	0.11
13441	0.0608	36.3	31.2	0.0610	33.4	31.1	0.0615	30.8	30.8	0.0490	44.0	38.8	0.0566	307.7	25.7	452.2	157.5	0.24	0.11
13442	0.0608	36.3	31.2	0.0610	33.4	31.1	0.0615	30.8	30.8	0.0490	38.8	38.8	0.0566	307.7	25.7	447.0	157.5	0.24	0.11
14111	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0477	44.2	39.2	0.0545	29.4	26.5	176.0	157.8	0.24	0.11
14112	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0477	39.2	39.2	0.0545	29.4	26.5	171.0	157.8	0.24	0.11
14121	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0477	44.2	39.3	0.0542	26.7	26.7	173.2	157.9	0.24	0.11
14122	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0477	39.3	39.3	0.0542	26.7	26.7	168.2	157.9	0.24	0.11
14131	0.0571	38.2	33.1	0.0579	32.7	32.7	0.0571	38.2	33.1	0.0521	43.5	37.8	0.0680	39.0	22.8	191.5	159.5	0.24	0.11
14132	0.0571	38.2	33.1	0.0579	32.7	32.7	0.0571	38.2	33.1	0.0521	37.8	37.8	0.0680	39.0	22.8	185.8	159.5	0.24	0.11
14141	0.0609	36.3	31.1	0.0616	30.8	30.8	0.0609	36.3	31.1	0.0484	44.1	39.0	0.0566	307.7	25.7	455.1	157.7	0.24	0.11
14142	0.0609	36.3	31.1	0.0616	30.8	30.8	0.0609	36.3	31.1	0.0484	39.0	39.0	0.0566	307.7	25.7	449.9	157.7	0.24	0.11
14211	0.0604	36.5	31.3	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0489	44.0	38.8	0.0535	29.9	27.0	180.0	157.6	0.24	0.11
14212	0.0604	36.5	31.3	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0489	38.8	38.8	0.0535	29.9	27.0	174.9	157.6	0.24	0.11
14221	0.0605	36.4	31.3	0.0612	31.0	31.0	0.0650	38.6	29.4	0.0488	44.0	38.8	0.0533	27.1	27.1	177.2	157.6	0.24	0.11
14222	0.0605	36.4	31.3	0.0612	31.0	31.0	0.0650	38.6	29.4	0.0488	38.8	38.8	0.0533	27.1	27.1	172.0	157.6	0.24	0.11
14231	0.0561	38.7	33.7	0.0569	33.2	33.2	0.0603	41.1	31.4	0.0531	43.3	37.6	0.0666	39.7	23.0	196.1	158.9	0.24	0.11
14232	0.0561	38.7	33.7	0.0569	33.2	33.2	0.0603	41.1	31.4	0.0531	37.6	37.6	0.0666	39.7	23.0	190.3	158.9	0.24	0.11
14241	0.0597	36.8	31.7	0.0605	31.3	31.3	0.0642	39.0	29.7	0.0495	43.9	38.6	0.0556	308.2	26.1	459.2	157.4	0.24	0.11
14242	0.0597	36.8	31.7	0.0605	31.3	31.3	0.0642	39.0	29.7	0.0495	38.6	38.6	0.0556	308.2	26.1	453.9	157.4	0.24	0.11
14311	0.0616	36.0	30.8	0.0622	30.5	30.5	0.0617	33.1	30.7	0.0478	44.2	39.2	0.0545	29.4	26.6	173.2	157.8	0.24	0.11
14312	0.0616	36.0	30.8	0.0622	30.5	30.5	0.0617	33.1	30.7	0.0478	39.2	39.2	0.0545	29.4	26.6	168.2	157.8	0.24	0.11
14321	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0477	44.2	39.2	0.0542	26.7	26.7	170.4	157.9	0.24	0.11
14322	0.0616	35.9	30.8	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0477	39.2	39.2	0.0542	26.7	26.7	165.4	157.9	0.24	0.11
14331	0.0570	38.2	33.2	0.0578	32.7	32.7	0.0574	35.2	32.9	0.0522	43.5	37.8	0.0678	39.0	22.8	188.7	159.4	0.24	0.11
14332	0.0570	38.2	33.2	0.0578	32.7	32.7	0.0574	35.2	32.9	0.0522	37.8	37.8	0.0678	39.0	22.8	183.0	159.4	0.24	0.11
14341	0.0608	36.3	31.2	0.0615	30.8	30.8	0.0610	33.4	31.1	0.0485	44.1	38.9	0.0566	307.7	25.7	452.3	157.7	0.24	0.11
14342	0.0608	36.3	31.2	0.0615	30.8	30.8	0.0610	33.4	31.1	0.0485	38.9	38.9	0.0566	307.7	25.7	447.1	157.7	0.24	0.11
14411	0.0614	36.0	30.9	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0479	44.2	39.2	0.0543	29.5	26.6	170.9	157.8	0.24	0.11
14412	0.0614	36.0	30.9	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0479	39.2	39.2	0.0543	29.5	26.6	165.8	157.8	0.24	0.11
14421	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0622	30.5	30.5	0.0478	44.2	39.2	0.0541	26.7	26.7	168.0	157.8	0.24	0.11
14422	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0622	30.5	30.5	0.0478	39.2	39.2	0.0541	26.7	26.7	163.0	157.8	0.24	0.11
14431	0.0569	38.3	33.2	0.0577	32.8	32.8	0.0577	32.8	32.8	0.0523	43.4	37.8	0.0677	39.1	22.8	186.3	159.3	0.24	0.11
14432	0.0569	38.3	33.2	0.0577	32.8	32.8	0.0577	32.8	32.8	0.0523	37.8	37.8	0.0677	39.1	22.8	180.7	159.3	0.24	0.11
14441	0.0607	36.3	31.2	0.0614	30.9	30.9	0.0614	30.9	30.9	0.0486	44.0	38.9	0.0565	307.7	25.8	449.9	157.6	0.24	0.11
14442	0.0607	36.3	31.2	0.0614	30.9	30.9	0.0614	30.9	30.9	0.0486	38.9	38.9	0.0565	307.7	25.8	444.7	157.6	0.24	0.11
21111	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0606	36.4	31.3	0.0494	43.9	38.6	0.0536	29.8	26.9	185.1	157.4	0.24	0.11
21112	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0606	36.4	31.3	0.0494	38.6	38.6	0.0536	29.8	26.9	179.8	157.4	0.24	0.11
21121	0.0652	38.6	29.3	0.0607	36.4	31.2	0.0607	36.4	31.2	0.0493	43.9	38.6	0.0534	27.0	27.0	182.2	157.4	0.24	0.11
21122	0.0652	38.6	29.3	0.0607	36.4	31.2	0.0607	36.4	31.2	0.0493	38.6	38.6	0.0534	27.0	27.0	176.9	157.4	0.24	0.11
21131	0.0605	41.0	31.3	0.0563	38.6	33.6	0.0563	38.6	33.6	0.0537	43.3	37.4	0.0669	39.6	23.0	201.1	158.9	0.24	0.11
21132	0.0605	41.0	31.3	0.0563	38.6	33.6	0.0563	38.6	33.6	0.0537	37.4	37.4	0.0669	39.6	23.0	195.2	158.9	0.24	0.11
21141	0.0644	38.9	29.6	0.0599	36.7	31.6	0.0599	36.7	31.6	0.0501	43.8	38.4	0.0557	308.1	26.0	464.2	157.2	0.24	0.11
21142	0.0644	38.9	29.6	0.0599	36.7	31.6	0.0599	36.7	31.6	0.0501	38.4	38.4	0.0557	308.1	26.0	458.8	157.2	0.24	0.11
21211	0.0639	39.2	29.8	0.0595	36.9	31.8	0.0639	39.2	29.8	0.0505	43.7	38.3	0.0526	30.3	27.4	189.2	157.1	0.24	0.11
21212	0.0639	39.2	29.8	0.0595	36.9	31.8	0.0639	39.2	29.8	0.0505	38.3	38.3	0.0526	30.3	27.4	183.8	157.1	0.24	0.11
21221	0.0640	39.1	29.8	0.0595	36.9	31.8	0.0640	39.1	29.8	0.0505	43.7	38.3	0.0524	27.5	27.5	186.4	157.1	0.24	0.11
21222	0.0640	39.1	29.8	0.0595	36.9	31.8	0.0640	39.1	29.8	0.0505	38.3	38.3	0.0524	27.5	27.5	180.9	157.1	0.24	0.11
21231	0.0595	41.6	31.8	0.0554	39.2	34.2	0.0595	41.6	31.8	0.0546	43.2	37.2	0.0656	40.3	23.2	205.9	158.2	0.24	0.11
21232	0.0595	41.6	31.8	0.0554	39.2	34.2	0.0595	41.6	31.8	0.0546	37.2	37.2	0.0656	40.3	23.2	199.9	158.2	0.24	0.11
21241	0.0632	39.5	30.1	0.0588	37.2	32.1	0.0632	39.5	30.1	0.0512	43.6	38.1	0.0547	308.6	26.5	468.5	156.9	0.24	0.11
21242	0.0632	39.5	30.1	0.0588	37.2	32.1	0.0632	39.5	30.1	0.0512	38.1	38.1	0.0547	308.6	26.5	462.9	156.9	0.24	0.11
21311	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0608	33.5	31.2	0.0494	43.9	38.6	0.0536	29.8	26.9	182.3	157.4	0.24	0.11

21312	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0608	33.5	31.2	0.0494	38.6	38.6	0.0536	29.8	26.9	177.0	157.4	0.24	0.11
21321	0.0652	38.6	29.3	0.0606	36.4	31.2	0.0608	33.5	31.1	0.0494	43.9	38.6	0.0534	27.0	27.0	179.4	157.4	0.24	0.11
21322	0.0652	38.6	29.3	0.0606	36.4	31.2	0.0608	33.5	31.1	0.0494	38.6	38.6	0.0534	27.0	27.0	174.1	157.4	0.24	0.11
21331	0.0604	41.1	31.4	0.0562	38.7	33.7	0.0567	35.7	33.4	0.0538	43.3	37.4	0.0667	39.7	23.0	198.3	158.8	0.24	0.11
21332	0.0604	41.1	31.4	0.0562	38.7	33.7	0.0567	35.7	33.4	0.0538	37.4	37.4	0.0667	39.7	23.0	192.5	158.8	0.24	0.11
21341	0.0643	39.0	29.7	0.0598	36.7	31.6	0.0601	33.8	31.5	0.0502	43.8	38.4	0.0557	308.1	26.1	461.4	157.2	0.24	0.11
21342	0.0643	39.0	29.7	0.0598	36.7	31.6	0.0601	33.8	31.5	0.0502	38.4	38.4	0.0557	308.1	26.1	456.0	157.2	0.24	0.11
21411	0.0649	38.7	29.4	0.0604	36.5	31.3	0.0611	31.0	31.0	0.0496	43.9	38.6	0.0535	29.9	27.0	179.9	157.3	0.24	0.11
21412	0.0649	38.7	29.4	0.0604	36.5	31.3	0.0611	31.0	31.0	0.0496	38.6	38.6	0.0535	29.9	27.0	174.6	157.3	0.24	0.11
21421	0.0650	38.6	29.4	0.0605	36.4	31.3	0.0612	31.0	31.0	0.0495	43.9	38.6	0.0533	27.1	27.1	177.0	157.4	0.24	0.11
21422	0.0650	38.6	29.4	0.0605	36.4	31.3	0.0612	31.0	31.0	0.0495	38.6	38.6	0.0533	27.1	27.1	171.7	157.4	0.24	0.11
21431	0.0603	41.1	31.4	0.0561	38.7	33.7	0.0569	33.2	33.2	0.0539	43.3	37.4	0.0666	39.7	23.0	196.0	158.7	0.24	0.11
21432	0.0603	41.1	31.4	0.0561	38.7	33.7	0.0569	33.2	33.2	0.0539	37.4	37.4	0.0666	39.7	23.0	190.1	158.7	0.24	0.11
21441	0.0642	39.0	29.7	0.0597	36.8	31.7	0.0605	31.3	31.3	0.0503	43.7	38.3	0.0556	308.2	26.1	459.1	157.2	0.24	0.11
21442	0.0642	39.0	29.7	0.0597	36.8	31.7	0.0605	31.3	31.3	0.0503	38.3	38.3	0.0556	308.2	26.1	453.6	157.2	0.24	0.11
22111	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0595	36.9	31.8	0.0461	44.6	39.9	0.0526	30.3	27.4	190.1	158.7	0.24	0.11
22112	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0595	36.9	31.8	0.0461	39.9	39.9	0.0526	30.3	27.4	185.4	158.7	0.24	0.11
22121	0.0640	39.1	29.8	0.0640	39.1	29.8	0.0595	36.9	31.8	0.0460	44.6	39.9	0.0524	27.5	27.5	187.3	158.8	0.24	0.11
22122	0.0640	39.1	29.8	0.0640	39.1	29.8	0.0595	36.9	31.8	0.0460	39.9	39.9	0.0524	27.5	27.5	182.6	158.8	0.24	0.11
22131	0.0595	41.6	31.8	0.0595	41.6	31.8	0.0554	39.2	34.2	0.0505	43.7	38.3	0.0656	40.3	23.2	206.4	159.3	0.24	0.11
22132	0.0595	41.6	31.8	0.0595	41.6	31.8	0.0554	39.2	34.2	0.0505	38.3	38.3	0.0656	40.3	23.2	201.0	159.3	0.24	0.11
22141	0.0632	39.5	30.1	0.0632	39.5	30.1	0.0588	37.2	32.1	0.0468	44.4	39.6	0.0547	308.6	26.5	469.3	158.4	0.24	0.11
22142	0.0632	39.5	30.1	0.0632	39.5	30.1	0.0588	37.2	32.1	0.0468	39.6	39.6	0.0547	308.6	26.5	464.5	158.4	0.24	0.11
22211	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0472	44.3	39.4	0.0517	30.8	27.9	194.3	158.1	0.24	0.11
22212	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0472	39.4	39.4	0.0517	30.8	27.9	189.4	158.1	0.24	0.11
22221	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0472	44.3	39.4	0.0515	27.9	27.9	191.4	158.2	0.24	0.11
22222	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0628	39.7	30.3	0.0472	39.4	39.4	0.0515	27.9	27.9	186.5	158.2	0.24	0.11
22231	0.0585	42.2	32.3	0.0585	42.2	32.3	0.0585	42.2	32.3	0.0515	43.6	38.0	0.0643	41.1	23.5	211.3	158.4	0.24	0.11
22232	0.0585	42.2	32.3	0.0585	42.2	32.3	0.0585	42.2	32.3	0.0515	38.0	38.0	0.0643	41.1	23.5	205.7	158.4	0.24	0.11
22241	0.0621	40.1	30.6	0.0621	40.1	30.6	0.0621	40.1	30.6	0.0479	44.2	39.1	0.0537	309.1	26.9	473.6	157.8	0.24	0.11
22242	0.0621	40.1	30.6	0.0621	40.1	30.6	0.0621	40.1	30.6	0.0479	39.1	39.1	0.0537	309.1	26.9	468.6	157.8	0.24	0.11
22311	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0597	34.0	31.7	0.0461	44.6	39.9	0.0526	30.3	27.4	187.3	158.7	0.24	0.11
22312	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0597	34.0	31.7	0.0461	39.9	39.9	0.0526	30.3	27.4	182.6	158.7	0.24	0.11
22321	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0598	34.0	31.7	0.0461	44.6	39.9	0.0524	27.5	27.5	184.4	158.7	0.24	0.11
22322	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0598	34.0	31.7	0.0461	39.9	39.9	0.0524	27.5	27.5	179.7	158.7	0.24	0.11
22331	0.0594	41.7	31.9	0.0594	41.7	31.9	0.0558	36.2	33.9	0.0506	43.7	38.2	0.0654	40.4	23.3	203.6	159.1	0.24	0.11
22332	0.0594	41.7	31.9	0.0594	41.7	31.9	0.0558	36.2	33.9	0.0506	38.2	38.2	0.0654	40.4	23.3	198.2	159.1	0.24	0.11
22341	0.0631	39.6	30.1	0.0631	39.6	30.1	0.0591	34.3	32.0	0.0469	44.4	39.6	0.0546	308.6	26.5	466.5	158.3	0.24	0.11
22342	0.0631	39.6	30.1	0.0631	39.6	30.1	0.0591	34.3	32.0	0.0469	39.6	39.6	0.0546	308.6	26.5	461.6	158.3	0.24	0.11
22411	0.0637	39.3	29.9	0.0637	39.3	29.9	0.0600	31.5	31.5	0.0463	44.6	39.8	0.0525	30.4	27.5	185.0	158.6	0.24	0.11
22412	0.0637	39.3	29.9	0.0637	39.3	29.9	0.0600	31.5	31.5	0.0463	39.8	39.8	0.0525	30.4	27.5	180.2	158.6	0.24	0.11
22421	0.0638	39.2	29.9	0.0638	39.2	29.9	0.0601	31.5	31.5	0.0462	44.6	39.9	0.0523	27.5	27.5	182.1	158.6	0.24	0.11
22422	0.0638	39.2	29.9	0.0638	39.2	29.9	0.0601	31.5	31.5	0.0462	39.9	39.9	0.0523	27.5	27.5	177.4	158.6	0.24	0.11
22431	0.0593	41.7	31.9	0.0593	41.7	31.9	0.0560	33.7	33.7	0.0507	43.7	38.2	0.0653	40.5	23.3	201.3	159.0	0.24	0.11
22432	0.0593	41.7	31.9	0.0593	41.7	31.9	0.0560	33.7	33.7	0.0507	38.2	38.2	0.0653	40.5	23.3	195.9	159.0	0.24	0.11
22441	0.0630	39.6	30.2	0.0630	39.6	30.2	0.0594	31.9	31.9	0.0470	44.4	39.5	0.0545	308.7	26.5	464.1	158.3	0.24	0.11
22442	0.0630	39.6	30.2	0.0630	39.6	30.2	0.0594	31.9	31.9	0.0470	39.5	39.5	0.0545	308.7	26.5	459.3	158.3	0.24	0.11
23111	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0606	36.4	31.3	0.0492	43.9	38.7	0.0536	29.8	26.9	182.3	157.5	0.24	0.11
23112	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0606	36.4	31.3	0.0492	38.7	38.7	0.0536	29.8	26.9	177.1	157.5	0.24	0.11
23121	0.0652	38.6	29.3	0.0608	33.5	31.1	0.0606	36.4	31.2	0.0492	43.9	38.7	0.0534	27.0	27.0	179.4	157.5	0.24	0.11
23122	0.0652	38.6	29.3	0.0608	33.5	31.1	0.0606	36.4	31.2	0.0492	38.7	38.7	0.0534	27.0	27.0	174.2	157.5	0.24	0.11
23131	0.0604	41.1	31.4	0.0567	35.7	33.4	0.0562	38.7	33.7	0.0533	43.3	37.5	0.0667	39.7	23.0	198.4	158.9	0.24	0.11
23132	0.0604	41.1	31.4	0.0567	35.7	33.4	0.0562	38.7	33.7	0.0533	37.5	37.5	0.0667	39.7	23.0	192.6	158.9	0.24	0.11
23141	0.0643	39.0	29.7	0.0601	33.8	31.5	0.0598	36.7	31.6	0.0499	43.8	38.5	0.0557	308.1	26.1	461.5	157.3	0.24	0.11
23142	0.0643	39.0	29.7	0.0601	33.8	31.5	0.0598	36.7	31.6	0.0499	38.5	38.5	0.0557	308.1	26.1	456.1	157.3	0.24	0.11
23211	0.0639	39.2	29.8	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0503	43.7	38.3	0.0526	30.3	27.4	186.5	157.1	0.24	0.11
23212	0.0639	39.2	29.8	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0503	38.3	38.3	0.0526	30.3	27.4	181.1	157.1	0.24	0.11
23221	0.0639	39.2	29.8	0.0598	34.0	31.7	0.0639	39.2	29.8	0.0502	43.7	38.3	0.0524	27.5	27.5	183.6	157.1	0.24	0.11
23222	0.0639	39.2	29.8	0.0598	34.0	31.7	0.0639	39.2	29.8	0.0502	38.3	38.3	0.0524	27.5	27.5	178.2	157.1	0.24	0.11
23231	0.0594	41.7	31.9	0.0558	36.2	33.9	0.0594	41.7	31.9	0.0542	43.2	37.3	0.0654	40.4	23.3	203.2	158.2	0.24	0.11
23232	0.0594	41.7	31.9	0.0558	36.2	33.9	0.0594	41.7	31.9	0.0542	37.3	37.3	0.0654	40.4	23.3	197.3	158.2	0.24	0.11
23241	0.0631	39.6	30.1	0.0591	34.3	32.0	0.0631	39.6	30.1	0.0509	43.6	38.1	0.0546	308.6	26.5	465.7	156.9	0.24	0.11
23242	0.0631	39.6	30.1	0.0591	34.3	32.0	0.0631	39.6	30.1	0.0509	38.1	38.1	0.0546	308.6	26.5	460.2	156.9	0.24	0.11
23311	0.0650	38.6	29.4	0.0607	33.5	31.2	0.0607	33.5	31.2	0.0493	43.9	38.7	0.0535	29.9	27.0	179.5	157.4	0.24	0.11
23312	0.0650	38.6	29.4	0.0607	33.5	31.2	0.0607	33.5	31.2	0.0493	38.7	38.7	0.0535	29.9	27.0	174.3	157.4	0.24	0.11
23321	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0608	33.5	31.2	0.0492	43.9	38.7	0.0533	27.1	27.1	176.6	157.5	0.24	0.11
23322	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0608	33.5	31.2	0.0492	38.7	38.7	0.0533	27.1	27.1	171.4	157.5	0.24	0.11
23331	0.0603	41.1	31.4	0.0566	35.7	33.4	0.0566	35.7	33.4	0.0534	43.3	37.5	0.0666	39.8	23.0	195.6	158.8	0.24	0.11
23332	0.0603	41.1	31.4	0.0566	35.7	33.4	0.0566	35.7	33.4	0.0534	37.5	37.5	0.0666	39.8	23.0	189.8	158.8	0.24	0.11
23341	0.0643	39.0	29.7	0.0601	33.9	31.5	0.0601	33.9	31.5	0.0499	43.8	38.4	0.0556	308.1	26.1	458.6	157.3	0.24	0.11
23342	0.0643	39.0	29.7	0.0601	33.9	31.5	0.0601	33.9	31.5	0.0499	38.4	38.4	0.0556	308.1	26.1	453.3	157.3	0.24	0.11
23411	0.0649	38.7	29.5	0.0606	33.6	31.3	0.0611	31.0	31.0	0.0494	43.9	38.6	0.0534	29.9	27.0	177.2	157.4	0.24	0.11
23412	0.0649	38.7	29.5	0.0606	33.6	31.3	0.0611	31.0	31.0	0.0494	38.6	38.6	0.0534	29.9	27.0	171.9	157.4	0.24	0.11
23421	0.0650	38.7	29.4	0.0607	33.6	31.2	0.0611	31.0	31.0	0.0493	43.9	38.6	0.0532	27.1	27.1	174.3	157.4	0.24	0.11

23422	0.0650	38.7	29.4	0.0607	33.6	31.2	0.0611	31.0	31.0	0.0493	38.6	38.6	0.0532	27.1	27.1	169.0	157.4	0.24	0.11
23431	0.0602	41.2	31.5	0.0565	35.8	33.5	0.0568	33.3	33.3	0.0535	43.3	37.5	0.0665	39.8	23.1	193.3	158.7	0.24	0.11
23432	0.0602	41.2	31.5	0.0565	35.8	33.5	0.0568	33.3	33.3	0.0535	37.5	37.5	0.0665	39.8	23.1	187.5	158.7	0.24	0.11
23441	0.0641	39.1	29.7	0.0599	33.9	31.6	0.0604	31.4	31.4	0.0501	43.8	38.4	0.0555	308.2	26.1	456.3	157.2	0.24	0.11
23442	0.0641	39.1	29.7	0.0599	33.9	31.6	0.0604	31.4	31.4	0.0501	38.4	38.4	0.0555	308.2	26.1	450.9	157.2	0.24	0.11
24111	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0604	36.5	31.3	0.0489	44.0	38.8	0.0535	29.9	27.0	180.0	157.6	0.24	0.11
24112	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0604	36.5	31.3	0.0489	38.8	38.8	0.0535	29.9	27.0	174.9	157.6	0.24	0.11
24121	0.0650	38.6	29.4	0.0612	31.0	31.0	0.0605	36.4	31.3	0.0488	44.0	38.8	0.0533	27.1	27.1	177.2	157.6	0.24	0.11
24122	0.0650	38.6	29.4	0.0612	31.0	31.0	0.0605	36.4	31.3	0.0488	38.8	38.8	0.0533	27.1	27.1	172.0	157.6	0.24	0.11
24131	0.0603	41.1	31.4	0.0569	33.2	33.2	0.0561	38.7	33.7	0.0531	43.3	37.6	0.0666	39.7	23.0	196.1	158.9	0.24	0.11
24132	0.0603	41.1	31.4	0.0569	33.2	33.2	0.0561	38.7	33.7	0.0531	37.6	37.6	0.0666	39.7	23.0	190.3	158.9	0.24	0.11
24141	0.0642	39.0	29.7	0.0605	31.3	31.3	0.0597	36.8	31.7	0.0495	43.9	38.6	0.0556	308.2	26.1	459.2	157.4	0.24	0.11
24142	0.0642	39.0	29.7	0.0605	31.3	31.3	0.0597	36.8	31.7	0.0495	38.6	38.6	0.0556	308.2	26.1	453.9	157.4	0.24	0.11
24211	0.0637	39.3	29.9	0.0600	31.5	31.5	0.0637	39.3	29.9	0.0500	43.8	38.4	0.0525	30.4	27.5	184.2	157.2	0.24	0.11
24212	0.0637	39.3	29.9	0.0600	31.5	31.5	0.0637	39.3	29.9	0.0500	38.4	38.4	0.0525	30.4	27.5	178.8	157.2	0.24	0.11
24221	0.0638	39.2	29.9	0.0601	31.5	31.5	0.0638	39.2	29.9	0.0499	43.8	38.5	0.0523	27.5	27.5	181.3	157.2	0.24	0.11
24222	0.0638	39.2	29.9	0.0601	31.5	31.5	0.0638	39.2	29.9	0.0499	38.5	38.5	0.0523	27.5	27.5	175.9	157.2	0.24	0.11
24231	0.0593	41.7	31.9	0.0560	33.7	33.7	0.0593	41.7	31.9	0.0540	43.2	37.4	0.0653	40.5	23.3	200.9	158.2	0.24	0.11
24232	0.0593	41.7	31.9	0.0560	33.7	33.7	0.0593	41.7	31.9	0.0540	37.4	37.4	0.0653	40.5	23.3	195.0	158.2	0.24	0.11
24241	0.0630	39.6	30.2	0.0594	31.9	31.9	0.0630	39.6	30.2	0.0506	43.7	38.2	0.0545	308.7	26.5	463.4	157.0	0.24	0.11
24242	0.0630	39.6	30.2	0.0594	31.9	31.9	0.0630	39.6	30.2	0.0506	38.2	38.2	0.0545	308.7	26.5	458.0	157.0	0.24	0.11
24311	0.0649	38.7	29.5	0.0611	31.0	31.0	0.0606	33.6	31.3	0.0489	44.0	38.8	0.0534	29.9	27.0	177.2	157.5	0.24	0.11
24312	0.0649	38.7	29.5	0.0611	31.0	31.0	0.0606	33.6	31.3	0.0489	38.8	38.8	0.0534	29.9	27.0	172.0	157.5	0.24	0.11
24321	0.0650	38.7	29.4	0.0611	31.0	31.0	0.0607	33.6	31.2	0.0489	44.0	38.8	0.0532	27.1	27.1	174.4	157.6	0.24	0.11
24322	0.0650	38.7	29.4	0.0611	31.0	31.0	0.0607	33.6	31.2	0.0489	38.8	38.8	0.0532	27.1	27.1	169.2	157.6	0.24	0.11
24331	0.0602	41.2	31.5	0.0568	33.3	33.3	0.0565	35.8	33.5	0.0532	43.3	37.5	0.0665	39.8	23.1	193.3	158.8	0.24	0.11
24332	0.0602	41.2	31.5	0.0568	33.3	33.3	0.0565	35.8	33.5	0.0532	37.5	37.5	0.0665	39.8	23.1	187.6	158.8	0.24	0.11
24341	0.0641	39.1	29.7	0.0604	31.4	31.4	0.0599	33.9	31.6	0.0496	43.9	38.6	0.0555	308.2	26.1	456.4	157.3	0.24	0.11
24342	0.0641	39.1	29.7	0.0604	31.4	31.4	0.0599	33.9	31.6	0.0496	38.6	38.6	0.0555	308.2	26.1	451.1	157.3	0.24	0.11
24411	0.0648	38.8	29.5	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0490	44.0	38.7	0.0533	30.0	27.1	174.9	157.5	0.24	0.11
24412	0.0648	38.8	29.5	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0490	38.7	38.7	0.0533	30.0	27.1	169.6	157.5	0.24	0.11
24421	0.0648	38.7	29.5	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0490	44.0	38.8	0.0531	27.2	27.2	172.0	157.5	0.24	0.11
24422	0.0648	38.7	29.5	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0490	38.8	38.8	0.0531	27.2	27.2	166.8	157.5	0.24	0.11
24431	0.0601	41.2	31.5	0.0568	33.3	33.3	0.0568	33.3	33.3	0.0532	43.3	37.5	0.0664	39.9	23.1	191.0	158.7	0.24	0.11
24432	0.0601	41.2	31.5	0.0568	33.3	33.3	0.0568	33.3	33.3	0.0532	37.5	37.5	0.0664	39.9	23.1	185.2	158.7	0.24	0.11
24441	0.0640	39.1	29.8	0.0603	31.4	31.4	0.0603	31.4	31.4	0.0497	43.8	38.5	0.0554	308.2	26.2	454.0	157.3	0.24	0.11
24442	0.0640	39.1	29.8	0.0603	31.4	31.4	0.0603	31.4	31.4	0.0497	38.5	38.5	0.0554	308.2	26.2	448.7	157.3	0.24	0.11
31111	0.0619	33.0	30.7	0.0617	35.9	30.7	0.0617	35.9	30.7	0.0483	44.1	39.0	0.0546	29.4	26.5	178.3	157.6	0.24	0.11
31112	0.0619	33.0	30.7	0.0617	35.9	30.7	0.0617	35.9	30.7	0.0483	39.0	39.0	0.0546	29.4	26.5	173.2	157.6	0.24	0.11
31121	0.0620	33.0	30.6	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0482	44.1	39.1	0.0544	26.6	26.6	175.4	157.7	0.24	0.11
31122	0.0620	33.0	30.6	0.0618	35.9	30.7	0.0618	35.9	30.7	0.0482	39.1	39.1	0.0544	26.6	26.6	170.4	157.7	0.24	0.11
31131	0.0576	35.1	32.8	0.0572	38.1	33.1	0.0572	38.1	33.1	0.0528	43.4	37.6	0.0681	38.9	22.8	193.7	159.4	0.24	0.11
31132	0.0576	35.1	32.8	0.0572	38.1	33.1	0.0572	38.1	33.1	0.0528	37.6	37.6	0.0681	38.9	22.8	187.9	159.4	0.24	0.11
31141	0.0612	33.3	31.0	0.0610	36.2	31.1	0.0610	36.2	31.1	0.0490	44.0	38.8	0.0568	307.6	25.7	457.3	157.5	0.24	0.11
31142	0.0612	33.3	31.0	0.0610	36.2	31.1	0.0610	36.2	31.1	0.0490	38.8	38.8	0.0568	307.6	25.7	452.1	157.5	0.24	0.11
31211	0.0608	33.5	31.2	0.0605	36.4	31.3	0.0651	38.6	29.4	0.0495	43.9	38.6	0.0536	29.8	27.0	182.3	157.4	0.24	0.11
31212	0.0608	33.5	31.2	0.0605	36.4	31.3	0.0651	38.6	29.4	0.0495	38.6	38.6	0.0536	29.8	27.0	177.0	157.4	0.24	0.11
31221	0.0608	33.5	31.2	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0494	43.9	38.6	0.0533	27.1	27.1	179.4	157.4	0.24	0.11
31222	0.0608	33.5	31.2	0.0606	36.4	31.3	0.0651	38.6	29.4	0.0494	38.6	38.6	0.0533	27.1	27.1	174.1	157.4	0.24	0.11
31231	0.0567	35.7	33.4	0.0562	38.7	33.7	0.0604	41.1	31.4	0.0538	43.3	37.4	0.0667	39.7	23.0	198.3	158.8	0.24	0.11
31232	0.0567	35.7	33.4	0.0562	38.7	33.7	0.0604	41.1	31.4	0.0538	37.4	37.4	0.0667	39.7	23.0	192.5	158.8	0.24	0.11
31241	0.0601	33.8	31.5	0.0598	36.7	31.6	0.0643	39.0	29.7	0.0502	43.8	38.4	0.0557	308.1	26.1	461.4	157.2	0.24	0.11
31242	0.0601	33.8	31.5	0.0598	36.7	31.6	0.0643	39.0	29.7	0.0502	38.4	38.4	0.0557	308.1	26.1	456.0	157.2	0.24	0.11
31311	0.0618	33.0	30.7	0.0617	35.9	30.7	0.0618	33.0	30.7	0.0483	44.1	39.0	0.0546	29.4	26.5	175.5	157.6	0.24	0.11
31312	0.0618	33.0	30.7	0.0617	35.9	30.7	0.0618	33.0	30.7	0.0483	39.0	39.0	0.0546	29.4	26.5	170.4	157.6	0.24	0.11
31321	0.0619	33.0	30.7	0.0618	35.9	30.7	0.0619	33.0	30.7	0.0482	44.1	39.0	0.0543	26.6	26.6	172.6	157.7	0.24	0.11
31322	0.0619	33.0	30.7	0.0618	35.9	30.7	0.0619	33.0	30.7	0.0482	39.0	39.0	0.0543	26.6	26.6	167.5	157.7	0.24	0.11
31331	0.0575	35.2	32.9	0.0570	38.2	33.1	0.0575	35.2	32.9	0.0530	43.4	37.6	0.0679	39.0	22.8	190.9	159.3	0.24	0.11
31332	0.0575	35.2	32.9	0.0570	38.2	33.1	0.0575	35.2	32.9	0.0530	37.6	37.6	0.0679	39.0	22.8	185.1	159.3	0.24	0.11
31341	0.0611	33.4	31.0	0.0610	36.2	31.1	0.0611	33.4	31.0	0.0490	44.0	38.7	0.0567	307.6	25.7	454.5	157.5	0.24	0.11
31342	0.0611	33.4	31.0	0.0610	36.2	31.1	0.0611	33.4	31.0	0.0490	38.7	38.7	0.0567	307.6	25.7	449.3	157.5	0.24	0.11
31411	0.0617	33.1	30.7	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0485	44.1	38.9	0.0545	29.4	26.6	173.1	157.6	0.24	0.11
31412	0.0617	33.1	30.7	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0485	38.9	38.9	0.0545	29.4	26.6	168.0	157.6	0.24	0.11
31421	0.0618	33.1	30.7	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0483	44.1	39.0	0.0542	26.7	26.7	170.2	157.6	0.24	0.11
31422	0.0618	33.1	30.7	0.0617	35.9	30.8	0.0623	30.5	30.5	0.0483	39.0	39.0	0.0542	26.7	26.7	165.1	157.6	0.24	0.11
31431	0.0574	35.2	32.9	0.0570	38.2	33.2	0.0578	32.7	32.7	0.0530	43.4	37.6	0.0678	39.0	22.8	188.6	159.2	0.24	0.11
31432	0.0574	35.2	32.9	0.0570	38.2	33.2	0.0578	32.7	32.7	0.0530	37.6	37.6	0.0678	39.0	22.8	182.8	159.2	0.24	0.11
31441	0.0610	33.4	31.1	0.0608	36.3	31.2	0.0615	30.8	30.8	0.0492	43.9	38.7	0.0566	307.7	25.7	452.1	157.5	0.24	0.11
31442	0.0610	33.4	31.1	0.0608	36.3	31.2	0.0615	30.8	30.8	0.0492	38.7	38.7	0.0566	307.7	25.7	446.9	157.5	0.24	0.11
32111	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0605	36.4	31.3	0.0449	44.9	40.5	0.0536	29.8	27.0	183.3	159.3	0.24	0.11
32112	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0605	36.4	31.3	0.0449	40.5	40.5	0.0536	29.8	27.0	178.9	159.3	0.24	0.11
32121	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0449	44.9	40.5	0.0533	27.1	27.1	180.5	159.3	0.24	0.11
32122	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0606	36.4	31.3	0.0449	40.5	40.5	0.0533	27.1	27.1	176.0	159.3	0.24	0.11
32131	0.0567	35.7	33.4	0.0604	41.1	31.4	0.0562	38.7	33.7	0.0496	43.9	38.5	0.0667	39.7	23.0	198.9	159.9	0.24	0.11

32132	0.0567	35.7	33.4	0.0604	41.1	31.4	0.0562	38.7	33.7	0.0496	38.5	38.5	0.0667	39.7	23.0	193.6	159.9	0.24	0.11
32141	0.0601	33.8	31.5	0.0643	39.0	29.7	0.0598	36.7	31.6	0.0457	44.7	40.1	0.0557	308.1	26.1	462.4	159.0	0.24	0.11
32142	0.0601	33.8	31.5	0.0643	39.0	29.7	0.0598	36.7	31.6	0.0457	40.1	40.1	0.0557	308.1	26.1	457.8	159.0	0.24	0.11
32211	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	44.6	39.9	0.0526	30.3	27.4	187.3	158.7	0.24	0.11
32212	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	39.9	39.9	0.0526	30.3	27.4	182.6	158.7	0.24	0.11
32221	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	44.6	39.9	0.0524	27.5	27.5	184.5	158.7	0.24	0.11
32222	0.0597	34.0	31.7	0.0639	39.2	29.8	0.0639	39.2	29.8	0.0461	39.9	39.9	0.0524	27.5	27.5	179.8	158.7	0.24	0.11
32231	0.0558	36.2	33.9	0.0594	41.7	31.9	0.0594	41.7	31.9	0.0506	43.7	38.2	0.0654	40.4	23.3	203.6	159.1	0.24	0.11
32232	0.0558	36.2	33.9	0.0594	41.7	31.9	0.0594	41.7	31.9	0.0506	38.2	38.2	0.0654	40.4	23.3	198.2	159.1	0.24	0.11
32241	0.0591	34.3	32.0	0.0631	39.6	30.1	0.0631	39.6	30.1	0.0469	44.4	39.6	0.0546	308.6	26.5	466.5	158.4	0.24	0.11
32242	0.0591	34.3	32.0	0.0631	39.6	30.1	0.0631	39.6	30.1	0.0469	39.6	39.6	0.0546	308.6	26.5	461.7	158.4	0.24	0.11
32311	0.0607	33.5	31.2	0.0650	38.6	29.4	0.0607	33.5	31.2	0.0450	44.9	40.5	0.0535	29.9	27.0	180.5	159.2	0.24	0.11
32312	0.0607	33.5	31.2	0.0650	38.6	29.4	0.0607	33.5	31.2	0.0450	40.5	40.5	0.0535	29.9	27.0	176.0	159.2	0.24	0.11
32321	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0449	44.9	40.5	0.0533	27.1	27.1	177.6	159.3	0.24	0.11
32322	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0608	33.5	31.2	0.0449	40.5	40.5	0.0533	27.1	27.1	173.2	159.3	0.24	0.11
32331	0.0566	35.7	33.4	0.0603	41.1	31.4	0.0566	35.7	33.4	0.0497	43.8	38.5	0.0666	39.8	23.0	196.1	159.8	0.24	0.11
32332	0.0566	35.7	33.4	0.0603	41.1	31.4	0.0566	35.7	33.4	0.0497	38.5	38.5	0.0666	39.8	23.0	190.8	159.8	0.24	0.11
32341	0.0600	33.9	31.5	0.0643	39.0	29.7	0.0600	33.9	31.5	0.0458	44.7	40.1	0.0556	308.1	26.1	459.6	158.9	0.24	0.11
32342	0.0600	33.9	31.5	0.0643	39.0	29.7	0.0600	33.9	31.5	0.0458	40.1	40.1	0.0556	308.1	26.1	454.9	158.9	0.24	0.11
32411	0.0606	33.6	31.3	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0451	44.9	40.4	0.0534	29.9	27.0	178.1	159.1	0.24	0.11
32412	0.0606	33.6	31.3	0.0649	38.7	29.4	0.0611	31.0	31.0	0.0451	40.4	40.4	0.0534	29.9	27.0	173.6	159.1	0.24	0.11
32421	0.0607	33.6	31.2	0.0650	38.7	29.4	0.0611	31.0	31.0	0.0450	44.9	40.4	0.0532	27.1	27.1	175.2	159.2	0.24	0.11
32422	0.0607	33.6	31.2	0.0650	38.7	29.4	0.0611	31.0	31.0	0.0450	40.4	40.4	0.0532	27.1	27.1	170.8	159.2	0.24	0.11
32431	0.0565	35.8	33.5	0.0602	41.2	31.5	0.0568	33.3	33.3	0.0498	43.8	38.5	0.0664	39.8	23.1	193.8	159.7	0.24	0.11
32432	0.0565	35.8	33.5	0.0602	41.2	31.5	0.0568	33.3	33.3	0.0498	38.5	38.5	0.0664	39.8	23.1	188.5	159.7	0.24	0.11
32441	0.0599	33.9	31.6	0.0641	39.1	29.7	0.0604	31.4	31.4	0.0459	44.7	40.0	0.0555	308.2	26.1	457.2	158.8	0.24	0.11
32442	0.0599	33.9	31.6	0.0641	39.1	29.7	0.0604	31.4	31.4	0.0459	40.0	40.0	0.0555	308.2	26.1	452.5	158.8	0.24	0.11
33111	0.0618	33.0	30.7	0.0618	33.0	30.7	0.0617	35.9	30.7	0.0482	44.1	39.1	0.0546	29.4	26.5	175.5	157.7	0.24	0.11
33112	0.0618	33.0	30.7	0.0618	33.0	30.7	0.0617	35.9	30.7	0.0482	39.1	39.1	0.0546	29.4	26.5	170.4	157.7	0.24	0.11
33121	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0618	35.9	30.7	0.0481	44.1	39.1	0.0543	26.6	26.6	172.7	157.7	0.24	0.11
33122	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0618	35.9	30.7	0.0481	39.1	39.1	0.0543	26.6	26.6	167.6	157.7	0.24	0.11
33131	0.0575	35.2	32.9	0.0575	35.2	32.9	0.0570	38.2	33.1	0.0525	43.4	37.7	0.0679	39.0	22.8	190.9	159.4	0.24	0.11
33132	0.0575	35.2	32.9	0.0575	35.2	32.9	0.0570	38.2	33.1	0.0525	37.7	37.7	0.0679	39.0	22.8	185.2	159.4	0.24	0.11
33141	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0610	36.2	31.1	0.0489	44.0	38.8	0.0567	307.6	25.7	454.6	157.6	0.24	0.11
33142	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0610	36.2	31.1	0.0489	38.8	38.8	0.0567	307.6	25.7	449.4	157.6	0.24	0.11
33211	0.0607	33.5	31.2	0.0607	33.5	31.2	0.0650	38.6	29.4	0.0493	43.9	38.7	0.0535	29.9	27.0	179.5	157.4	0.24	0.11
33212	0.0607	33.5	31.2	0.0607	33.5	31.2	0.0650	38.6	29.4	0.0493	38.7	38.7	0.0535	29.9	27.0	174.2	157.4	0.24	0.11
33221	0.0608	33.5	31.2	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0492	43.9	38.7	0.0533	27.1	27.1	176.6	157.5	0.24	0.11
33222	0.0608	33.5	31.2	0.0608	33.5	31.2	0.0651	38.6	29.4	0.0492	38.7	38.7	0.0533	27.1	27.1	171.4	157.5	0.24	0.11
33231	0.0566	35.7	33.4	0.0566	35.7	33.4	0.0603	41.1	31.4	0.0534	43.3	37.5	0.0666	39.8	23.0	195.6	158.8	0.24	0.11
33232	0.0566	35.7	33.4	0.0566	35.7	33.4	0.0603	41.1	31.4	0.0534	37.5	37.5	0.0666	39.8	23.0	189.8	158.8	0.24	0.11
33241	0.0600	33.9	31.5	0.0600	33.9	31.5	0.0643	39.0	29.7	0.0500	43.8	38.4	0.0556	308.1	26.1	458.7	157.3	0.24	0.11
33242	0.0600	33.9	31.5	0.0600	33.9	31.5	0.0643	39.0	29.7	0.0500	38.4	38.4	0.0556	308.1	26.1	453.3	157.3	0.24	0.11
33311	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0482	44.1	39.0	0.0546	29.4	26.5	172.7	157.7	0.24	0.11
33312	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0482	39.0	39.0	0.0546	29.4	26.5	167.6	157.7	0.24	0.11
33321	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0481	44.1	39.1	0.0543	26.6	26.6	169.9	157.7	0.24	0.11
33322	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0619	33.0	30.7	0.0481	39.1	39.1	0.0543	26.6	26.6	164.8	157.7	0.24	0.11
33331	0.0574	35.2	32.9	0.0574	35.2	32.9	0.0574	35.2	32.9	0.0526	43.4	37.7	0.0678	39.1	22.8	188.2	159.3	0.24	0.11
33332	0.0574	35.2	32.9	0.0574	35.2	32.9	0.0574	35.2	32.9	0.0526	37.7	37.7	0.0678	39.1	22.8	182.5	159.3	0.24	0.11
33341	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0489	44.0	38.8	0.0567	307.6	25.7	451.7	157.5	0.24	0.11
33342	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0611	33.4	31.0	0.0489	38.8	38.8	0.0567	307.6	25.7	446.5	157.5	0.24	0.11
33411	0.0617	33.1	30.8	0.0617	33.1	30.8	0.0622	30.5	30.5	0.0483	44.1	39.0	0.0544	29.5	26.6	170.3	157.6	0.24	0.11
33412	0.0617	33.1	30.8	0.0617	33.1	30.8	0.0622	30.5	30.5	0.0483	39.0	39.0	0.0544	29.5	26.6	165.2	157.6	0.24	0.11
33421	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0482	44.1	39.0	0.0542	26.7	26.7	167.5	157.6	0.24	0.11
33422	0.0618	33.1	30.7	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0482	39.0	39.0	0.0542	26.7	26.7	162.4	157.6	0.24	0.11
33431	0.0573	35.3	33.0	0.0573	35.3	33.0	0.0577	32.8	32.8	0.0527	43.4	37.7	0.0677	39.1	22.8	185.9	159.2	0.24	0.11
33432	0.0573	35.3	33.0	0.0573	35.3	33.0	0.0577	32.8	32.8	0.0527	37.7	37.7	0.0677	39.1	22.8	180.1	159.2	0.24	0.11
33441	0.0610	33.4	31.1	0.0610	33.4	31.1	0.0615	30.9	30.9	0.0490	44.0	38.7	0.0565	307.7	25.7	449.4	157.5	0.24	0.11
33442	0.0610	33.4	31.1	0.0610	33.4	31.1	0.0615	30.9	30.9	0.0490	38.7	38.7	0.0565	307.7	25.7	444.1	157.5	0.24	0.11
34111	0.0617	33.1	30.7	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0478	44.2	39.2	0.0545	29.4	26.6	173.3	157.8	0.24	0.11
34112	0.0617	33.1	30.7	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0478	39.2	39.2	0.0545	29.4	26.6	168.2	157.8	0.24	0.11
34121	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0477	44.2	39.2	0.0542	26.7	26.7	170.4	157.9	0.24	0.11
34122	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0477	39.2	39.2	0.0542	26.7	26.7	165.4	157.9	0.24	0.11
34131	0.0574	35.2	32.9	0.0578	32.7	32.7	0.0570	38.2	33.2	0.0522	43.5	37.8	0.0678	39.0	22.8	188.7	159.4	0.24	0.11
34132	0.0574	35.2	32.9	0.0578	32.7	32.7	0.0570	38.2	33.2	0.0522	37.8	37.8	0.0678	39.0	22.8	183.0	159.4	0.24	0.11
34141	0.0610	33.4	31.1	0.0615	30.8	30.8	0.0608	36.3	31.2	0.0485	44.1	38.9	0.0566	307.7	25.7	452.3	157.7	0.24	0.11
34142	0.0610	33.4	31.1	0.0615	30.8	30.8	0.0608	36.3	31.2	0.0485	38.9	38.9	0.0566	307.7	25.7	447.1	157.7	0.24	0.11
34211	0.0606	33.6	31.3	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0489	44.0	38.8	0.0534	29.9	27.0	177.2	157.5	0.24	0.11
34212	0.0606	33.6	31.3	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0489	38.8	38.8	0.0534	29.9	27.0	172.0	157.5	0.24	0.11
34221	0.0607	33.6	31.2	0.0611	31.0	31.0	0.0650	38.7	29.4	0.0489	44.0	38.8	0.0532	27.1	27.1	174.4	157.6	0.24	0.11
34222	0.0607	33.6	31.2	0.0611	31.0	31.0	0.0650	38.7	29.4	0.0489	38.8	38.8	0.0532	27.1	27.1	169.2	157.6	0.24	0.11
34231	0.0565	35.8	33.5	0.0568	33.3	33.3	0.0602	41.2	31.5	0.0532	43.3	37.5	0.0664	39.8	23.1	193.4	158.8	0.24	0.11
34232	0.0565	35.8	33.5	0.0568	33.3	33.3	0.0602	41.2	31.5	0.0532	37.5	37.5	0.0664	39.8	23.1	187.6	158.8	0.24	0.11
34241	0.0599	33.9	31.6	0.0604	31.4	31.4	0.0641	39.1	29.7	0.0496	43.9	38.5	0.0555	308.2	26.1	456.4	157.3	0.24	0.11

34242	0.0599	33.9	31.6	0.0604	31.4	31.4	0.0641	39.1	29.7	0.0496	38.5	38.5	0.0555	308.2	26.1	451.1	157.3	0.24	0.11
34311	0.0617	33.1	30.8	0.0622	30.5	30.5	0.0617	33.1	30.8	0.0478	44.2	39.2	0.0544	29.5	26.6	170.4	157.8	0.24	0.11
34312	0.0617	33.1	30.8	0.0622	30.5	30.5	0.0617	33.1	30.8	0.0478	39.2	39.2	0.0544	29.5	26.6	165.4	157.8	0.24	0.11
34321	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0477	44.2	39.2	0.0542	26.7	26.7	167.6	157.8	0.24	0.11
34322	0.0618	33.1	30.7	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0477	39.2	39.2	0.0542	26.7	26.7	162.6	157.8	0.24	0.11
34331	0.0573	35.3	33.0	0.0577	32.8	32.8	0.0573	35.3	33.0	0.0523	43.4	37.8	0.0677	39.1	22.8	185.9	159.3	0.24	0.11
34332	0.0573	35.3	33.0	0.0577	32.8	32.8	0.0573	35.3	33.0	0.0523	37.8	37.8	0.0677	39.1	22.8	180.2	159.3	0.24	0.11
34341	0.0610	33.4	31.1	0.0615	30.9	30.9	0.0610	33.4	31.1	0.0485	44.1	38.9	0.0565	307.7	25.7	449.5	157.7	0.24	0.11
34342	0.0610	33.4	31.1	0.0615	30.9	30.9	0.0610	33.4	31.1	0.0485	38.9	38.9	0.0565	307.7	25.7	444.3	157.7	0.24	0.11
34411	0.0615	33.2	30.8	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0480	44.2	39.1	0.0543	29.5	26.6	168.0	157.8	0.24	0.11
34412	0.0615	33.2	30.8	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0480	39.1	39.1	0.0543	29.5	26.6	163.0	157.8	0.24	0.11
34421	0.0616	33.1	30.8	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0479	44.2	39.2	0.0541	26.7	26.7	165.2	157.8	0.24	0.11
34422	0.0616	33.1	30.8	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0479	39.2	39.2	0.0541	26.7	26.7	160.2	157.8	0.24	0.11
34431	0.0572	35.3	33.0	0.0576	32.8	32.8	0.0576	32.8	32.8	0.0524	43.4	37.7	0.0675	39.2	22.9	183.6	159.3	0.24	0.11
34432	0.0572	35.3	33.0	0.0576	32.8	32.8	0.0576	32.8	32.8	0.0524	37.7	37.7	0.0675	39.2	22.9	177.9	159.3	0.24	0.11
34441	0.0609	33.5	31.1	0.0613	30.9	30.9	0.0613	30.9	30.9	0.0487	44.0	38.9	0.0564	307.7	25.8	447.1	157.6	0.24	0.11
34442	0.0609	33.5	31.1	0.0613	30.9	30.9	0.0613	30.9	30.9	0.0487	38.9	38.9	0.0564	307.7	25.8	441.9	157.6	0.24	0.11
41111	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0616	35.9	30.8	0.0484	44.1	39.0	0.0545	29.4	26.5	175.9	157.6	0.24	0.11
41112	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0616	35.9	30.8	0.0484	39.0	39.0	0.0545	29.4	26.5	170.8	157.6	0.24	0.11
41121	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0617	35.9	30.8	0.0483	44.1	39.0	0.0542	26.7	26.7	173.0	157.6	0.24	0.11
41122	0.0623	30.5	30.5	0.0617	35.9	30.8	0.0617	35.9	30.8	0.0483	39.0	39.0	0.0542	26.7	26.7	167.9	157.6	0.24	0.11
41131	0.0579	32.7	32.7	0.0571	38.2	33.1	0.0571	38.2	33.1	0.0529	43.4	37.6	0.0680	38.9	22.8	191.3	159.3	0.24	0.11
41132	0.0579	32.7	32.7	0.0571	38.2	33.1	0.0571	38.2	33.1	0.0529	37.6	37.6	0.0680	38.9	22.8	185.6	159.3	0.24	0.11
41141	0.0616	30.8	30.8	0.0609	36.3	31.1	0.0609	36.3	31.1	0.0491	43.9	38.7	0.0566	307.7	25.7	454.9	157.5	0.24	0.11
41142	0.0616	30.8	30.8	0.0609	36.3	31.1	0.0609	36.3	31.1	0.0491	38.7	38.7	0.0566	307.7	25.7	449.7	157.5	0.24	0.11
41211	0.0611	31.0	31.0	0.0604	36.5	31.3	0.0649	38.7	29.4	0.0496	43.9	38.6	0.0535	29.9	27.0	179.9	157.3	0.24	0.11
41212	0.0611	31.0	31.0	0.0604	36.5	31.3	0.0649	38.7	29.4	0.0496	38.6	38.6	0.0535	29.9	27.0	174.6	157.3	0.24	0.11
41221	0.0612	31.0	31.0	0.0605	36.4	31.3	0.0650	38.6	29.4	0.0495	43.9	38.6	0.0533	27.1	27.1	177.0	157.4	0.24	0.11
41222	0.0612	31.0	31.0	0.0605	36.4	31.3	0.0650	38.6	29.4	0.0495	38.6	38.6	0.0533	27.1	27.1	171.7	157.4	0.24	0.11
41231	0.0569	33.2	33.2	0.0561	38.7	33.7	0.0603	41.1	31.4	0.0539	43.3	37.4	0.0666	39.7	23.0	196.0	158.7	0.24	0.11
41232	0.0569	33.2	33.2	0.0561	38.7	33.7	0.0603	41.1	31.4	0.0539	37.4	37.4	0.0666	39.7	23.0	190.1	158.7	0.24	0.11
41241	0.0605	31.3	31.3	0.0597	36.8	31.7	0.0642	39.0	29.7	0.0503	43.7	38.3	0.0556	308.2	26.1	459.0	157.2	0.24	0.11
41242	0.0605	31.3	31.3	0.0597	36.8	31.7	0.0642	39.0	29.7	0.0503	38.3	38.3	0.0556	308.2	26.1	453.6	157.2	0.24	0.11
41311	0.0622	30.5	30.5	0.0616	36.0	30.8	0.0617	33.1	30.7	0.0484	44.1	39.0	0.0545	29.4	26.6	173.1	157.6	0.24	0.11
41312	0.0622	30.5	30.5	0.0616	36.0	30.8	0.0617	33.1	30.7	0.0484	39.0	39.0	0.0545	29.4	26.6	168.0	157.6	0.24	0.11
41321	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0618	33.1	30.7	0.0484	44.1	39.0	0.0542	26.7	26.7	170.2	157.6	0.24	0.11
41322	0.0623	30.5	30.5	0.0616	35.9	30.8	0.0618	33.1	30.7	0.0484	39.0	39.0	0.0542	26.7	26.7	165.1	157.6	0.24	0.11
41331	0.0578	32.7	32.7	0.0570	38.2	33.2	0.0574	35.2	32.9	0.0530	43.4	37.6	0.0678	39.0	22.8	188.6	159.2	0.24	0.11
41332	0.0578	32.7	32.7	0.0570	38.2	33.2	0.0574	35.2	32.9	0.0530	37.6	37.6	0.0678	39.0	22.8	182.8	159.2	0.24	0.11
41341	0.0615	30.8	30.8	0.0608	36.3	31.1	0.0610	33.4	31.1	0.0492	43.9	38.7	0.0566	307.7	25.7	452.1	157.4	0.24	0.11
41342	0.0615	30.8	30.8	0.0608	36.3	31.1	0.0610	33.4	31.1	0.0492	38.7	38.7	0.0566	307.7	25.7	446.9	157.4	0.24	0.11
41411	0.0621	30.6	30.6	0.0614	36.0	30.9	0.0621	30.6	30.6	0.0486	44.0	38.9	0.0544	29.5	26.6	170.7	157.5	0.24	0.11
41412	0.0621	30.6	30.6	0.0614	36.0	30.9	0.0621	30.6	30.6	0.0486	38.9	38.9	0.0544	29.5	26.6	165.6	157.5	0.24	0.11
41421	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0485	44.1	38.9	0.0541	26.7	26.7	167.8	157.6	0.24	0.11
41422	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0622	30.5	30.5	0.0485	38.9	38.9	0.0541	26.7	26.7	162.7	157.6	0.24	0.11
41431	0.0577	32.8	32.8	0.0569	38.3	33.2	0.0577	32.8	32.8	0.0531	43.3	37.6	0.0677	39.1	22.8	186.2	159.1	0.24	0.11
41432	0.0577	32.8	32.8	0.0569	38.3	33.2	0.0577	32.8	32.8	0.0531	37.6	37.6	0.0677	39.1	22.8	180.5	159.1	0.24	0.11
41441	0.0614	30.9	30.9	0.0607	36.3	31.2	0.0614	30.9	30.9	0.0493	43.9	38.7	0.0565	307.7	25.8	449.7	157.4	0.24	0.11
41442	0.0614	30.9	30.9	0.0607	36.3	31.2	0.0614	30.9	30.9	0.0493	38.7	38.7	0.0565	307.7	25.8	444.5	157.4	0.24	0.11
42111	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0604	36.5	31.3	0.0451	44.9	40.4	0.0535	29.9	27.0	180.9	159.2	0.24	0.11
42112	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0604	36.5	31.3	0.0451	40.4	40.4	0.0535	29.9	27.0	176.5	159.2	0.24	0.11
42121	0.0612	31.0	31.0	0.0650	38.6	29.4	0.0605	36.4	31.3	0.0450	44.9	40.5	0.0533	27.1	27.1	178.0	159.2	0.24	0.11
42122	0.0612	31.0	31.0	0.0650	38.6	29.4	0.0605	36.4	31.3	0.0450	40.5	40.5	0.0533	27.1	27.1	173.6	159.2	0.24	0.11
42131	0.0569	33.2	33.2	0.0603	41.1	31.4	0.0561	38.7	33.7	0.0497	43.8	38.5	0.0666	39.7	23.0	196.6	159.8	0.24	0.11
42132	0.0569	33.2	33.2	0.0603	41.1	31.4	0.0561	38.7	33.7	0.0497	38.5	38.5	0.0666	39.7	23.0	191.3	159.8	0.24	0.11
42141	0.0605	31.3	31.3	0.0642	39.0	29.7	0.0597	36.8	31.7	0.0458	44.7	40.1	0.0556	308.2	26.1	460.0	158.9	0.24	0.11
42142	0.0605	31.3	31.3	0.0642	39.0	29.7	0.0597	36.8	31.7	0.0458	40.1	40.1	0.0556	308.2	26.1	455.4	158.9	0.24	0.11
42211	0.0600	31.5	31.5	0.0637	39.3	29.9	0.0637	39.3	29.9	0.0463	44.6	39.8	0.0525	30.4	27.5	185.0	158.6	0.24	0.11
42212	0.0600	31.5	31.5	0.0637	39.3	29.9	0.0637	39.3	29.9	0.0463	39.8	39.8	0.0525	30.4	27.5	180.2	158.6	0.24	0.11
42221	0.0601	31.5	31.5	0.0638	39.2	29.9	0.0638	39.2	29.9	0.0462	44.6	39.9	0.0523	27.6	27.6	182.1	158.7	0.24	0.11
42222	0.0601	31.5	31.5	0.0638	39.2	29.9	0.0638	39.2	29.9	0.0462	39.9	39.9	0.0523	27.6	27.6	177.4	158.7	0.24	0.11
42231	0.0560	33.7	33.7	0.0593	41.7	31.9	0.0593	41.7	31.9	0.0507	43.7	38.2	0.0653	40.5	23.3	201.3	159.0	0.24	0.11
42232	0.0560	33.7	33.7	0.0593	41.7	31.9	0.0593	41.7	31.9	0.0507	38.2	38.2	0.0653	40.5	23.3	195.9	159.0	0.24	0.11
42241	0.0594	31.8	31.8	0.0630	39.6	30.2	0.0630	39.6	30.2	0.0470	44.4	39.5	0.0545	308.7	26.5	464.1	158.3	0.24	0.11
42242	0.0594	31.8	31.8	0.0630	39.6	30.2	0.0630	39.6	30.2	0.0470	39.5	39.5	0.0545	308.7	26.5	459.3	158.3	0.24	0.11
42311	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0606	33.6	31.3	0.0451	44.9	40.4	0.0534	29.9	27.0	178.1	159.1	0.24	0.11
42312	0.0611	31.0	31.0	0.0649	38.7	29.4	0.0606	33.6	31.3	0.0451	40.4	40.4	0.0534	29.9	27.0	173.6	159.1	0.24	0.11
42321	0.0611	31.0	31.0	0.0650	38.7	29.4	0.0607	33.6	31.2	0.0450	44.9	40.4	0.0532	27.1	27.1	175.2	159.2	0.24	0.11
42322	0.0611	31.0	31.0	0.0650	38.7	29.4	0.0607	33.6	31.2	0.0450	40.4	40.4	0.0532	27.1	27.1	170.8	159.2	0.24	0.11
42331	0.0568	33.3	33.3	0.0602	41.2	31.5	0.0565	35.8	33.5	0.0498	43.8	38.5	0.0665	39.8	23.1	193.8	159.7	0.24	0.11
42332	0.0568	33.3	33.3	0.0602	41.2	31.5	0.0565	35.8	33.5	0.0498	38.5	38.5	0.0665	39.8	23.1	188.5	159.7	0.24	0.11
42341	0.0604	31.4	31.4	0.0641	39.1	29.7	0.0599	33.9	31.6	0.0459	44.7	40.0	0.0555	308.2	26.1	457.2	158.8	0.24	0.11
42342	0.0604	31.4	31.4	0.0641	39.1	29.7	0.0599	33.9	31.6	0.0459	40.0	40.0	0.0555	308.2	26.1	452.5	158.8	0.24	0.11
42411	0.0610	31.1	31.1	0.0648	38.8	29.5	0.0610	31.1	31.1	0.0452	44.8	40.3	0.0533	30.0	27.1	175.7	159.1	0.24	0.11

42412	0.0610	31.1	31.1	0.0648	38.8	29.5	0.0610	31.1	31.1	0.0452	40.3	40.3	0.0533	30.0	27.1	171.2	159.1	0.24	0.11
42421	0.0610	31.1	31.1	0.0648	38.7	29.5	0.0610	31.1	31.1	0.0452	44.8	40.4	0.0531	27.2	27.2	172.9	159.1	0.24	0.11
42422	0.0610	31.1	31.1	0.0648	38.7	29.5	0.0610	31.1	31.1	0.0452	40.4	40.4	0.0531	27.2	27.2	168.4	159.1	0.24	0.11
42431	0.0568	33.3	33.3	0.0601	41.2	31.5	0.0568	33.3	33.3	0.0499	43.8	38.5	0.0664	39.9	23.1	191.5	159.6	0.24	0.11
42432	0.0568	33.3	33.3	0.0601	41.2	31.5	0.0568	33.3	33.3	0.0499	38.5	38.5	0.0664	39.9	23.1	186.2	159.6	0.24	0.11
42441	0.0603	31.4	31.4	0.0640	39.1	29.8	0.0603	31.4	31.4	0.0460	44.6	40.0	0.0554	308.2	26.2	454.8	158.7	0.24	0.11
42442	0.0603	31.4	31.4	0.0640	39.1	29.8	0.0603	31.4	31.4	0.0460	40.0	40.0	0.0554	308.2	26.2	450.1	158.7	0.24	0.11
43111	0.0622	30.5	30.5	0.0617	33.1	30.7	0.0616	36.0	30.8	0.0483	44.1	39.0	0.0545	29.4	26.6	173.1	157.6	0.24	0.11
43112	0.0622	30.5	30.5	0.0617	33.1	30.7	0.0616	36.0	30.8	0.0483	39.0	39.0	0.0545	29.4	26.6	168.0	157.6	0.24	0.11
43121	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0616	35.9	30.8	0.0482	44.1	39.0	0.0542	26.7	26.7	170.3	157.7	0.24	0.11
43122	0.0623	30.5	30.5	0.0618	33.1	30.7	0.0616	35.9	30.8	0.0482	39.0	39.0	0.0542	26.7	26.7	165.2	157.7	0.24	0.11
43131	0.0578	32.7	32.7	0.0574	35.2	32.9	0.0570	38.2	33.2	0.0526	43.4	37.7	0.0678	39.0	22.8	188.6	159.3	0.24	0.11
43132	0.0578	32.7	32.7	0.0574	35.2	32.9	0.0570	38.2	33.2	0.0526	37.7	37.7	0.0678	39.0	22.8	182.9	159.3	0.24	0.11
43141	0.0615	30.8	30.8	0.0610	33.4	31.1	0.0608	36.3	31.1	0.0490	44.0	38.8	0.0566	307.7	25.7	452.2	157.5	0.24	0.11
43142	0.0615	30.8	30.8	0.0610	33.4	31.1	0.0608	36.3	31.1	0.0490	38.8	38.8	0.0566	307.7	25.7	447.0	157.5	0.24	0.11
43211	0.0611	31.0	31.0	0.0606	33.6	31.3	0.0649	38.7	29.4	0.0494	43.9	38.6	0.0534	29.9	27.0	177.1	157.4	0.24	0.11
43212	0.0611	31.0	31.0	0.0606	33.6	31.3	0.0649	38.7	29.4	0.0494	38.6	38.6	0.0534	29.9	27.0	171.9	157.4	0.24	0.11
43221	0.0611	31.0	31.0	0.0607	33.6	31.2	0.0650	38.7	29.4	0.0493	43.9	38.6	0.0532	27.1	27.1	174.3	157.4	0.24	0.11
43222	0.0611	31.0	31.0	0.0607	33.6	31.2	0.0650	38.7	29.4	0.0493	38.6	38.6	0.0532	27.1	27.1	169.0	157.4	0.24	0.11
43231	0.0568	33.3	33.3	0.0565	35.8	33.5	0.0602	41.2	31.5	0.0535	43.3	37.5	0.0665	39.8	23.1	193.3	158.7	0.24	0.11
43232	0.0568	33.3	33.3	0.0565	35.8	33.5	0.0602	41.2	31.5	0.0535	37.5	37.5	0.0665	39.8	23.1	187.5	158.7	0.24	0.11
43241	0.0604	31.4	31.4	0.0599	33.9	31.6	0.0641	39.1	29.7	0.0501	43.8	38.4	0.0555	308.2	26.1	456.3	157.2	0.24	0.11
43242	0.0604	31.4	31.4	0.0599	33.9	31.6	0.0641	39.1	29.7	0.0501	38.4	38.4	0.0555	308.2	26.1	450.9	157.2	0.24	0.11
43311	0.0622	30.5	30.5	0.0617	33.1	30.8	0.0617	33.1	30.8	0.0483	44.1	39.0	0.0544	29.5	26.6	170.3	157.6	0.24	0.11
43312	0.0622	30.5	30.5	0.0617	33.1	30.8	0.0617	33.1	30.8	0.0483	39.0	39.0	0.0544	29.5	26.6	165.2	157.6	0.24	0.11
43321	0.0623	30.5	30.5	0.0617	33.1	30.7	0.0617	33.1	30.7	0.0483	44.1	39.0	0.0542	26.7	26.7	167.5	157.7	0.24	0.11
43322	0.0623	30.5	30.5	0.0617	33.1	30.7	0.0617	33.1	30.7	0.0483	39.0	39.0	0.0542	26.7	26.7	162.4	157.7	0.24	0.11
43331	0.0577	32.8	32.8	0.0573	35.3	33.0	0.0573	35.3	33.0	0.0527	43.4	37.7	0.0677	39.1	22.8	185.8	159.2	0.24	0.11
43332	0.0577	32.8	32.8	0.0573	35.3	33.0	0.0573	35.3	33.0	0.0527	37.7	37.7	0.0677	39.1	22.8	180.1	159.2	0.24	0.11
43341	0.0615	30.9	30.9	0.0610	33.4	31.1	0.0610	33.4	31.1	0.0490	44.0	38.7	0.0565	307.7	25.7	449.4	157.5	0.24	0.11
43342	0.0615	30.9	30.9	0.0610	33.4	31.1	0.0610	33.4	31.1	0.0490	38.7	38.7	0.0565	307.7	25.7	444.2	157.5	0.24	0.11
43411	0.0621	30.6	30.6	0.0616	33.2	30.8	0.0621	30.6	30.6	0.0484	44.1	39.0	0.0543	29.5	26.6	167.9	157.6	0.24	0.11
43412	0.0621	30.6	30.6	0.0616	33.2	30.8	0.0621	30.6	30.6	0.0484	39.0	39.0	0.0543	29.5	26.6	162.8	157.6	0.24	0.11
43421	0.0621	30.6	30.6	0.0616	33.1	30.8	0.0621	30.6	30.6	0.0484	44.1	39.0	0.0541	26.7	26.7	165.1	157.6	0.24	0.11
43422	0.0621	30.6	30.6	0.0616	33.1	30.8	0.0621	30.6	30.6	0.0484	39.0	39.0	0.0541	26.7	26.7	160.0	157.6	0.24	0.11
43431	0.0576	32.8	32.8	0.0572	35.3	33.0	0.0576	32.8	32.8	0.0528	43.4	37.6	0.0676	39.2	22.9	183.5	159.2	0.24	0.11
43432	0.0576	32.8	32.8	0.0572	35.3	33.0	0.0576	32.8	32.8	0.0528	37.6	37.6	0.0676	39.2	22.9	177.8	159.2	0.24	0.11
43441	0.0613	30.9	30.9	0.0609	33.5	31.1	0.0613	30.9	30.9	0.0491	43.9	38.7	0.0564	307.8	25.8	447.0	157.4	0.24	0.11
43442	0.0613	30.9	30.9	0.0609	33.5	31.1	0.0613	30.9	30.9	0.0491	38.7	38.7	0.0564	307.8	25.8	441.8	157.4	0.24	0.11
44111	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0614	36.0	30.9	0.0479	44.2	39.2	0.0544	29.5	26.6	170.8	157.8	0.24	0.11
44112	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0614	36.0	30.9	0.0479	39.2	39.2	0.0544	29.5	26.6	165.8	157.8	0.24	0.11
44121	0.0622	30.5	30.5	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0478	44.2	39.2	0.0541	26.7	26.7	168.0	157.8	0.24	0.11
44122	0.0622	30.5	30.5	0.0622	30.5	30.5	0.0615	36.0	30.8	0.0478	39.2	39.2	0.0541	26.7	26.7	163.0	157.8	0.24	0.11
44131	0.0577	32.8	32.8	0.0577	32.8	32.8	0.0569	38.3	33.2	0.0523	43.4	37.8	0.0677	39.1	22.8	186.3	159.3	0.24	0.11
44132	0.0577	32.8	32.8	0.0577	32.8	32.8	0.0569	38.3	33.2	0.0523	37.8	37.8	0.0677	39.1	22.8	180.7	159.3	0.24	0.11
44141	0.0614	30.9	30.9	0.0614	30.9	30.9	0.0607	36.3	31.2	0.0486	44.0	38.9	0.0565	307.7	25.8	449.9	157.6	0.24	0.11
44142	0.0614	30.9	30.9	0.0614	30.9	30.9	0.0607	36.3	31.2	0.0486	38.9	38.9	0.0565	307.7	25.8	444.7	157.6	0.24	0.11
44211	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0648	38.8	29.5	0.0490	44.0	38.7	0.0533	30.0	27.1	174.9	157.5	0.24	0.11
44212	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0648	38.8	29.5	0.0490	38.7	38.7	0.0533	30.0	27.1	169.6	157.5	0.24	0.11
44221	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0648	38.7	29.5	0.0490	44.0	38.8	0.0531	27.2	27.2	172.0	157.5	0.24	0.11
44222	0.0610	31.1	31.1	0.0610	31.1	31.1	0.0648	38.7	29.5	0.0490	38.8	38.8	0.0531	27.2	27.2	166.8	157.5	0.24	0.11
44231	0.0568	33.3	33.3	0.0568	33.3	33.3	0.0601	41.2	31.5	0.0532	43.3	37.5	0.0664	39.9	23.1	191.0	158.7	0.24	0.11
44232	0.0568	33.3	33.3	0.0568	33.3	33.3	0.0601	41.2	31.5	0.0532	37.5	37.5	0.0664	39.9	23.1	185.2	158.7	0.24	0.11
44241	0.0603	31.4	31.4	0.0603	31.4	31.4	0.0640	39.1	29.8	0.0497	43.8	38.5	0.0554	308.2	26.2	454.0	157.3	0.24	0.11
44242	0.0603	31.4	31.4	0.0603	31.4	31.4	0.0640	39.1	29.8	0.0497	38.5	38.5	0.0554	308.2	26.2	448.7	157.3	0.24	0.11
44311	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0616	33.2	30.8	0.0479	44.2	39.1	0.0543	29.5	26.6	168.0	157.8	0.24	0.11
44312	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0616	33.2	30.8	0.0479	39.1	39.1	0.0543	29.5	26.6	163.0	157.8	0.24	0.11
44321	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0616	33.1	30.8	0.0479	44.2	39.2	0.0541	26.7	26.7	165.2	157.8	0.24	0.11
44322	0.0621	30.6	30.6	0.0621	30.6	30.6	0.0616	33.1	30.8	0.0479	39.2	39.2	0.0541	26.7	26.7	160.1	157.8	0.24	0.11
44331	0.0576	32.8	32.8	0.0576	32.8	32.8	0.0572	35.3	33.0	0.0524	43.4	37.7	0.0676	39.2	22.9	183.6	159.2	0.24	0.11
44332	0.0576	32.8	32.8	0.0576	32.8	32.8	0.0572	35.3	33.0	0.0524	37.7	37.7	0.0676	39.2	22.9	177.9	159.2	0.24	0.11
44341	0.0613	30.9	30.9	0.0613	30.9	30.9	0.0609	33.5	31.1	0.0487	44.0	38.9	0.0564	307.8	25.8	447.1	157.6	0.24	0.11
44342	0.0613	30.9	30.9	0.0613	30.9	30.9	0.0609	33.5	31.1	0.0487	38.9	38.9	0.0564	307.8	25.8	441.9	157.6	0.24	0.11
44411	0.0619	30.7	30.7	0.0619	30.7	30.7	0.0619	30.7	30.7	0.0481	44.1	39.1	0.0542	29.6	26.7	165.7	157.7	0.24	0.11
44412	0.0619	30.7	30.7	0.0619	30.7	30.7	0.0619	30.7	30.7	0.0481	39.1	39.1	0.0542	29.6	26.7	160.6	157.7	0.24	0.11
44421	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0480	44.2	39.1	0.0539	26.8	26.8	162.8	157.7	0.24	0.11
44422	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0620	30.6	30.6	0.0480	39.1	39.1	0.0539	26.8	26.8	157.7	157.7	0.24	0.11
44431	0.0575	32.9	32.9	0.0575	32.9	32.9	0.0575	32.9	32.9	0.0525	43.4	37.7	0.0674	39.3	22.9	181.3	159.2	0.24	0.11
44432	0.0575	32.9	32.9	0.0575	32.9	32.9	0.0575	32.9	32.9	0.0525	37.7	37.7	0.0674	39.3	22.9	175.6	159.2	0.24	0.11
44441	0.0612	31.0	31.0	0.0612	31.0	31.0	0.0612	31.0	31.0	0.0488	44.0	38.8	0.0563	307.8	25.8	444.7	157.6	0.24	0.11
44442	0.0612	31.0	31.0	0.0612	31.0	31.0	0.0612	31.0	31.0	0.0488	38.8	38.8	0.0563	307.8	25.8	439.5	157.6	0.24	0.11

Table B.1: Exhaustive search and bottom curve follower approach results

1-Process combinations;2-Alocated tolerance of X1 in LM;3-Toelrance cost of X1 in LM;4-Tolerance cost of X1 in BCF; 5-Alocated tolerance of X2 in LM;6-Toelrance cost of X2 in LM;7-Tolerance cost of X2 in BCF; 8-Alocated tolerance of X3 in LM;9-Toelrance cost of X3 in LM;10-Tolerance cost of X3 in BCF; 11-Alocated tolerance of X4 in LM;12-Toelrance cost of X4 in LM;13-Tolerance cost of X4 in BCF;14-Alocated tolerance of X5 in LM;15-Toelrance cost of X5 in LM;16-Tolerance cost of X5 in BCF;17-Total tolerance cost in LM;18-Total tolerance cost in BCF;19-t_{asm1};20-t_{asm2};

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LIST OF FIGURES AND TABLES

Tensile properties characterization of okra woven fiber reinforced polyester composites

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ABSTRACT

The present research exploits a new natural fiber namely okra for the preparation of okra fiber reinforced polyester composites. Chemically treated (chemical treatment-2) okra woven FRP composites showed the highest tensile strength and modulus of 64.41 MPa and 946.44 MPa respectively than all other composites investigated in the present research. Specific tensile strength and modulus of untreated and treated okra FRP composites is 34.31% and 39.84% higher than pure polyester specimen respectively.

Key words: Okra woven fiber, Density, Tensile strength, Tensile modulus, Specific tensile strength, Specific tensile modulus.

1. INTRODUCTION

Chemically treated and untreated henequen natural fibers were used as reinforcement for the preparation of composites and they were micromechanically characterized using pull out and single fiber fragmentation test [1]. A film stacking method was used for processing sisal, kenaf, hemp, jute and coir by compression molding. Tensile, flexural and impact properties were determined and compared [2]. Natural rubber is reinforced with untreated sisal and oil palm fibers chopped to different fiber lengths. The effects of concentration and modification of fiber surface in sisal/oil palm hybrid fiber reinforced rubber composites have been studied. Increasing the concentration of fibers resulted in reduction of tensile strength and tear strength, but increased modulus of the composites [3]. Composites of cellulose acetate butyrate reinforced with cellulose sheets synthesized by Gluconacetobacter xylinus were produced by solvent evaporation casting. The composites contained 10% and 32% volume cellulose, and showed a Young's modulus of 3.2 and 5.8 GPa, and a strength of 52.6 and 128.9 MPa, respectively, in tensile tests [4]. Coconut fiber has been used as reinforcement in low-density polyethylene. The effect of natural waxy surface layer of the fiber on fiber/matrix interfacial bonding and composite properties has been studied by single fiber pullout test and evaluating the tensile properties of oriented discontinuous fiber composites [5]. Tensile and flexural behaviors of pineapple leaf fiber–polypropylene composites as a function of volume fraction were investigated. The tensile modulus and tensile strength of the composites were found to be increasing with fiber content in accordance with the rule of mixtures [6]. Investigations of the effect of maleic anhydride grafted polypropylene (MAHgPP) coupling agents on the properties of jute fiber/polypropylene (PP) composites have been considered with two kinds of matrices (PP1 and PP2). Both mechanical behavior of random short fiber composites and micro-mechanical properties of single fiber model composites were examined [7]. The composites were formulated with arecanut fiber with a maximum volume fraction of 0.39, resulting in mean tensile strength and modulus of 24 and 40% [8]. The used reinforcement was made of long Alfa fibers, extracted from the stem of the Alfa plant by the soda process. The used matrix is based on unsaturated polyester resin. Experiments show that the specific tensile properties of these fibers are very interesting and are close to those obtained on some man-made fibers. Composite plates were prepared using unidirectional Alfa cloths, from which specimens are cut for mechanical experiments. The influence of fibers orientation and fibers fraction on the mechanical properties of the Alfa/Polyester composites have been evaluated [9]. Hemp, hard wood A. hard wood B, rice hulls, silane treated e-glass fibers were used as reinforcement for the thermoplastic HDPE (Formolene HB5502B) for fabricating composites and the tensile properties were tested [10]. The composites were formulated up to a maximum of 31% volume of fiber resulting in a tensile strength of 80.55 MPa and tensile modulus of 1.52 GPa for elephant grass fibers extracted by retting. The tensile strength and modulus of chemically treated elephant grass fiber composites have increased by approximately 1.45 times to those of elephant grass fiber composite extracted by retting [11]. Rice straw polyester composites having volume fraction of 40% resulted in mean tensile strength 1045 MPa [12]. PLA (polylactic acid) was reinforced with Cordenka rayon fibres and flax fibres, respectively. The mechanical properties of these composites which are examples for completely biodegradable composites were tested and compared. The samples were produced using injection moulding. The highest impact strength (72 kJ/m^2) and tensile strength (58 MPa) were found for Cordenka reinforced PLA at a fibre-mass proportion of 30%. The highest Young's modulus (6.31 GPa) was found for the composite made of PLA and flax. A poor adhesion between the matrix and the fibers was shown for both composites using SEM [13]. All-cellulose composites were successfully prepared by a surface selective dissolution method of aligned ligno-cellulosic fibers using lithium chloride/N, N-dimethylacetamide as a solvent. The effect of the immersion time of the aligned fibers in the solvent during preparation was investigated. The structure and mechanical properties of the composites were characterized by X-ray diffraction, scanning electron microscopy, and tensile testing [14]. The monotonic tensile behavior of a high performance sisal natural fiber was studied. Tensile tests were performed on a microforce testing system using four different gage lengths. The cross-sectional area of the fiber was measured using scanning electron microscope (SEM) micrographs and image analysis. The measured Young's modulus was also corrected for machine compliance. Weibull statistics were used to quantify the degree of variability in fiber strength, at the different gage lengths. The Weibull modulus decreased from 4.6 to 3.0 as the gage length increased from 10 mm to 40 mm, respectively. SEM was used to investigate the failure mode of the fibers [15]. Effect of stacking sequence on tensile, flexural and interlaminar shear properties of untreated woven jute and glass fabric reinforced polyester hybrid composites has been investigated experimentally [16]. A study on the effect of alkaline treatment on tensile properties of sugar palm fiber reinforced epoxy composites was presented in the paper [17]. The unidirectional biodegradable composite materials were made from kenaf fibers and an emulsion-type PLA resin. Thermal analysis of kenaf fibers revealed that tensile strength of kenaf fibers decreased when kept at 180^0 C for 60 min. The unidirectional fiber-reinforced composites showed tensile and flexural strengths of 223 MPa and 254 MPa, respectively. Moreover, tensile and flexural strength and elastic moduli of the kenaf fiber-reinforced composites increased linearly up to a fiber content of 50% [18]. This paper presents extensive experiments and micromechanics-based modeling to evaluate systematically the tensile properties of kenaf bast fibers bundle (KBFB) and kenaf bast fiber-reinforced epoxy strands. Uniaxial tension behaviors of KBFBs and KBFB-reinforced epoxy strands were evaluated statistically using large sample sets. The elastic modulus, tensile strength, as well as failure strains of KBFBs, displayed large scatter statistically ranging from 10% to 30%. The loading rate-dependency was evaluated at three strain rates ranging from approximately 10^{-4} ~ 10^{-2}/s. The tensile strength increases gradually as the loading rate increases, while the tensile modulus almost remains the same as the loading rate increases until the loading rate reaches 10^{-2}/s, at which a much higher modulus was presented [19]. Natural fibers used in this study were both pre-treated and modified residues from sugarcane bagasse. Polymer of high density polyethylene (HDPE) was employed as matrix in to composites, which were produced by mixing high density polyethylene with cellulose (10%) and Cell/ZrO2_nH2O (10%), using an extruder and hydraulic press. Tensile tests showed that the Cell/ZrO2_nH2O (10%)/HDPE composites present better tensile strength than cellulose (10%)/HDPE composites [20].

In the present research hybrid okra (botanically called as “Abelmoschus esculentus”) fiber was taken for the preparation of composites. It is referred by a synonym “Hibiscus esculentus L”. Hybrid okra variety 2405133 seeds were supplied by Syngenta India Linited, Shivaji Nagar, and Pune, India. The characteristics of seed are given in **Table 1**.

Table 1: Seed characteristics

Germination (Min.)	65%
Physical purity (Min.)	99%
Inert matter (Max.)	1%
Moisture (Max.)	8%
Genetic purity (Min.)	95%

The chemical used for seed treatment is THIRAM.

2. MATERIALS

2.1. Hybrid okra variety 2405133 fiber extraction

The removed okra stems were placed in a pit containing stagnant mud water for 6 days (i.e. 30th August, 2008 to 4th September, 2008) at ambient conditions. On 7th day i.e. 5th September, 2008 the stems were washed out with sufficient quantity of water till the complete pulp detached from the fiber. Then the fiber was dried for 7 days at ambient conditions. The fiber obtained is 5 ft. to 7 ft. long. Up to 2 ft. fiber length okra fiber was in woven form. Now onwards this is called as Okra woven (OW) fiber. Extracted okra woven fiber was shown in **Figure 1**.

FIGURE 1: Extracted okra woven fiber

2.2 Matrix

Ecmalon 4413 general purpose unsaturated polyester resin of medium reactivity was used in the present investigation. The properties of the liquid resin were tested in accordance with IS 6746-1994 and the values can vary within tolerances mentioned therein **Table 2**.

Table 2: Matrix characteristics

Appearance	Clear
Viscosity @ 25^0C	500 (Brookfield viscometer)
Specific gravity (25/25^0C)	1.13
Acid value (mgKOH/g)	25
Volatiles @ 150^0C (%)	35
Gel time @ 25^0C (minutes)	20

The resin contains a volatile monomer with a flash point at 32^0C and is of moderate fire hazard.

3. CHEMICAL TREATMENT (CT)

Extracted hybrid okra fiber was treated with different chemicals to investigate the variation in the properties after treatment.

3.1. Chemical treatment-1 (CT-1): Okra woven fiber was treated with 0.125 M NaOH solution for 6 hours. Pre treated okra fiber with sodium hydroxide was treated with 0.03163 M $KMnO_4$ solution in presence of 0.01876 M H_2SO_4 for a period of 14 hours. Now onwards it is okra woven chemical treatment-1 (OW CT-1).

3.2. Chemical treatment-2 (CT-2): Okra woven fiber was treated with 0.125 M NaOH solution for 45 minutes. Pre treated okra fiber with sodium hydroxide was treated with 0.006327 M $KMnO_4$ solution in presence of 0.00375 M H_2SO_4 for a period of 5 minutes. Now onwards it is okra woven chemical treatment-2 (OW CT-2).

4. METHODS

4.1. Fiber volume fraction: The volume fraction of fiber was calculated by a method which enables the rule of mixtures and analysis of measured composite properties. The method involves measuring the density of the composite (ρ_C) of mass M_C at a given mass fraction of the resin M_R. Volume fraction of resin (V_R) was calculated using the formula

$$V_R = \frac{M_R \times \rho_C}{M_C \times \rho_R}$$

Where ρ_R = density of resin in kg/m^3

Then the fiber volume fraction is determined by the relation

$$V_F = 1 - V_R$$

4.2. Moisture removal: The fiber was placed in a NSW-143 Oven Universal (Super deluxe model), supplied by Narang Scientific Works Private Limited, New Delhi, India, at a temperature of 70^0 C for 1 hour. Then fiber was allowed to cool to room temperature. The fiber was then taken out for the preparation of composite specimen.

4.3. Physical dimensions: The prepared specimens were measured according to ASTM D 5947-06. Mitutoyo Micrometer, model 293-230 having L.C. 0.001 mm, range 0-25 mm, supplied by Haresh Machine Tools Company, Mumbai, India was used for the measurement of dimensions.

4.4. Samples weighing: Fiber and prepared composite specimens were weighed using Shimadzu, Electronic Balance, Type BL-220H, Readability 0.001 g, and Supplied by Vinay Scientific Company, Vijayawada, India.

4.5. Tensile properties characterization: The specimens were prepared according to ASTM D 5083-02 using hand-lay up technique and were tested using Electronic Tensometer, supplied by Kudale Instruments Private Limited, Pune, India.

5. RESULTS AND DISCUSSION

Variation of density with increase in percentage volume fraction of untreated and chemically treated okra woven fiber reinforced polyester composites is shown in **Figure 2, 3 and 4**. The density of all the composites decreased with increase in volume fraction of fiber. This is due to the low density of the fiber than that of the matrix and thereby resulting composite density obviously decreased.

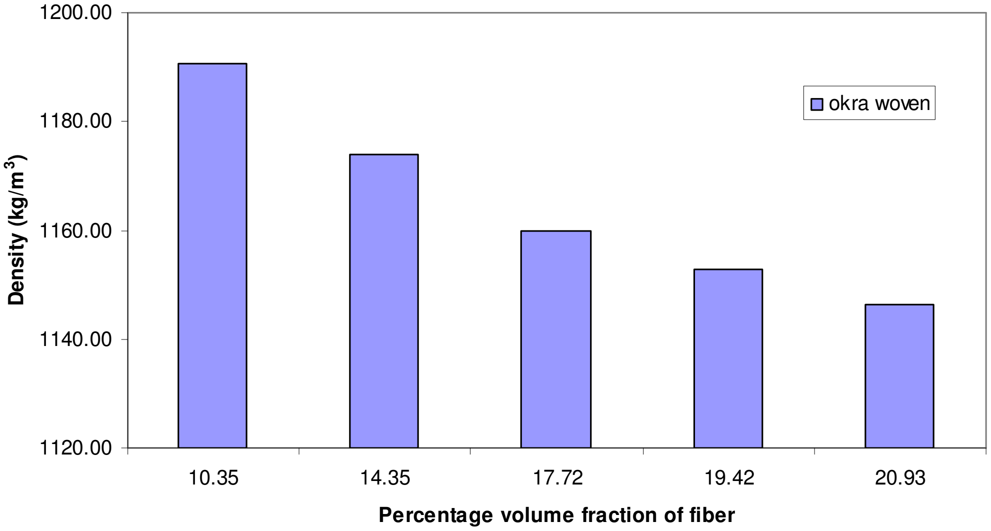

FIGURE 2: Density of okra woven fiber reinforced polyester composites with varying percentage volume fraction of okra fiber

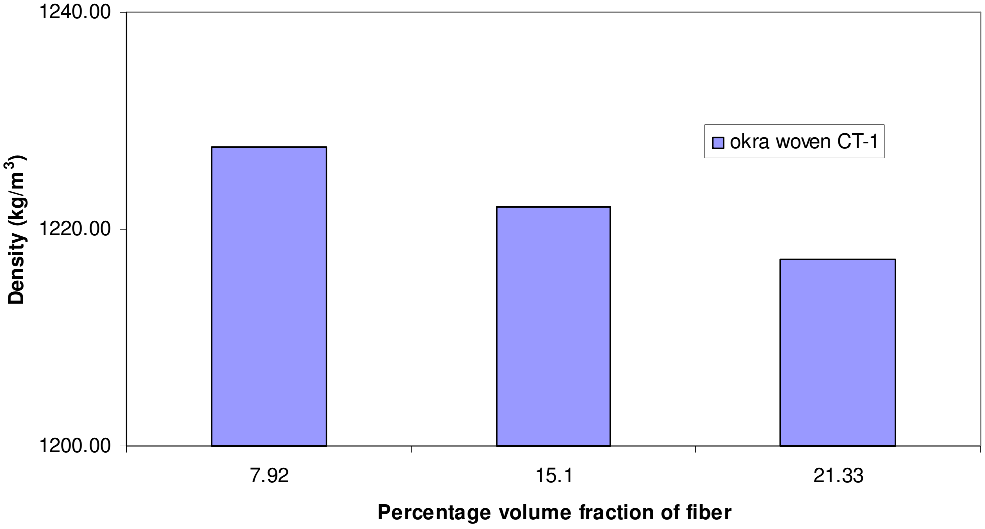

FIGURE 3: Density of okra woven chemical treatment-1 fiber reinforced polyester composites with varying percentage volume fraction of okra fiber

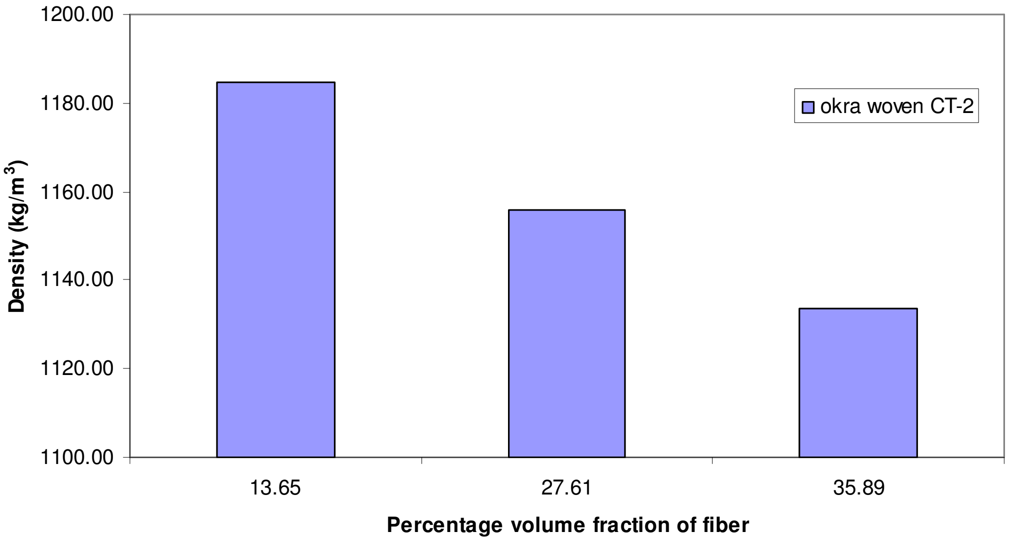

FIGURE 4: Density of okra woven chemical treatment-2 fiber reinforced polyester composites with varying percentage volume fraction of okra fiber

Okra woven fiber chemical treatment-2 reinforced polyester composites showed linear increase in their tensile strength up to the volume fraction of 27.61% **Figure 5**. There is a clear increase in the tensile strength and its value was 76.9%, 79.82%, 134.47% higher than okra woven CT-1, okra woven untreated FRP composites and plain polyester specimens respectively.

Figure 6 shows variation of specific tensile strength with percentage volume fraction of untreated and chemically treated okra woven fiber reinforced polyester composites. From the volume fraction of 14.35% to 19.42% specific tensile strength is almost same for okra woven FRP composites before and after chemical treatment of okra woven fiber. At highest volume fraction, untreated okra woven FRP composites have shown specific tensile strength 4.48% higher than okra woven CT-1 FRP composites. Increase in treatment time under H_2SO_4 caused ingestion of lingo cellulose content in the fiber and also weaken the knot portions in the okra woven fiber.

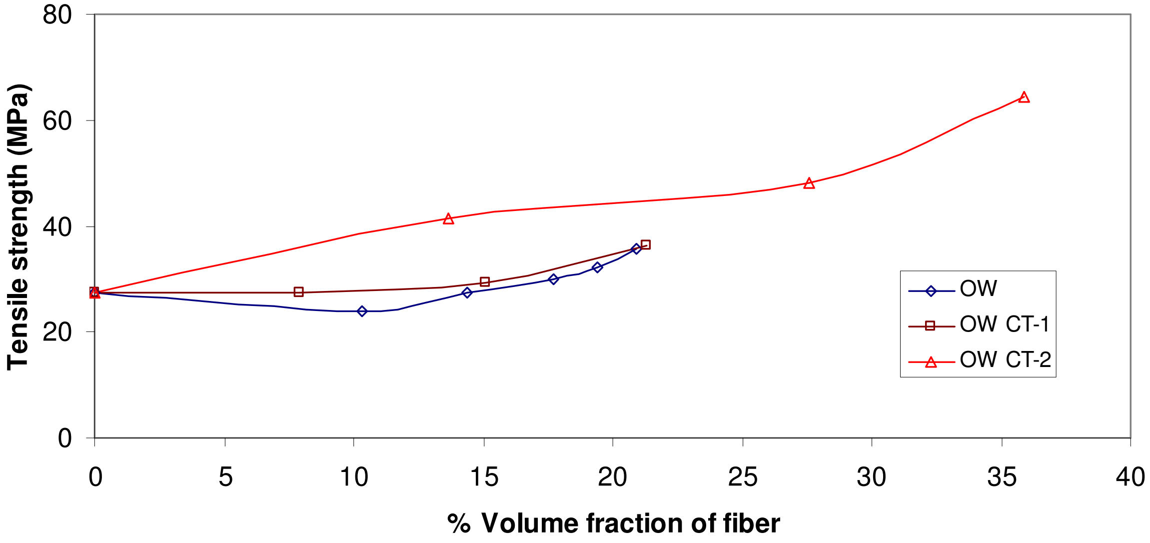

FIGURE 5: Effect of percentage volume fraction of fiber on tensile strength of untreated and treated okra woven fiber reinforced polyester composites

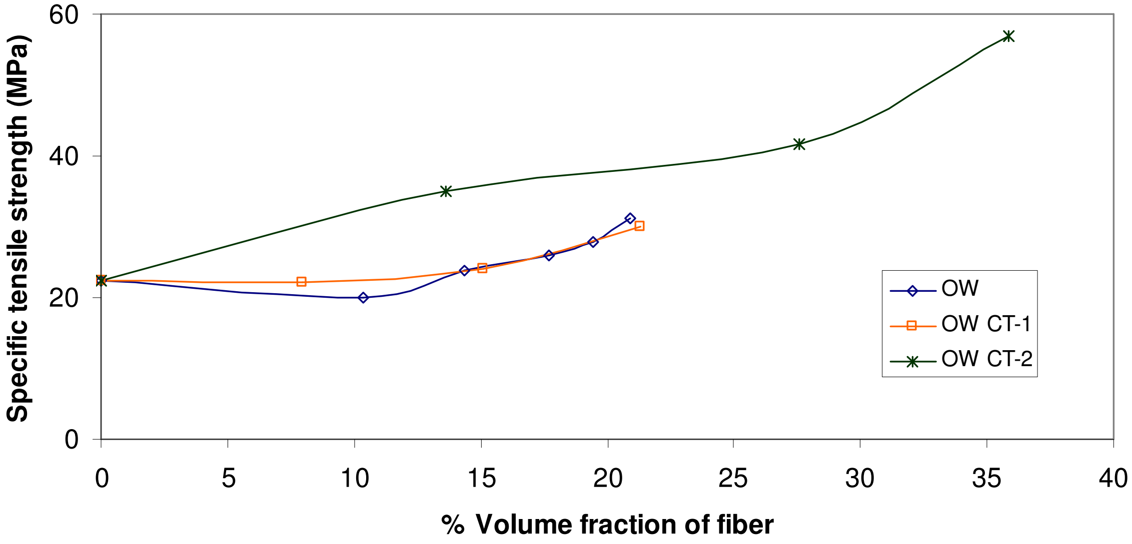

FIGURE 6: Effect of percentage volume fraction of fiber on specific tensile strength of untreated and treated okra woven fiber reinforced polyester composites

Tensile modulus of okra woven chemical treatment-2 fiber reinforced polyester composites shown linear increase in its value with increase in percentage volume fraction of fiber and is higher than all other composites considered in the present research **Figure 7.** Composites fabricated using okra woven CT-2 fiber showed tensile modulus of 30.58%, 18.03% than okra woven CT-1 and untreated okra woven FRP composites respectively.

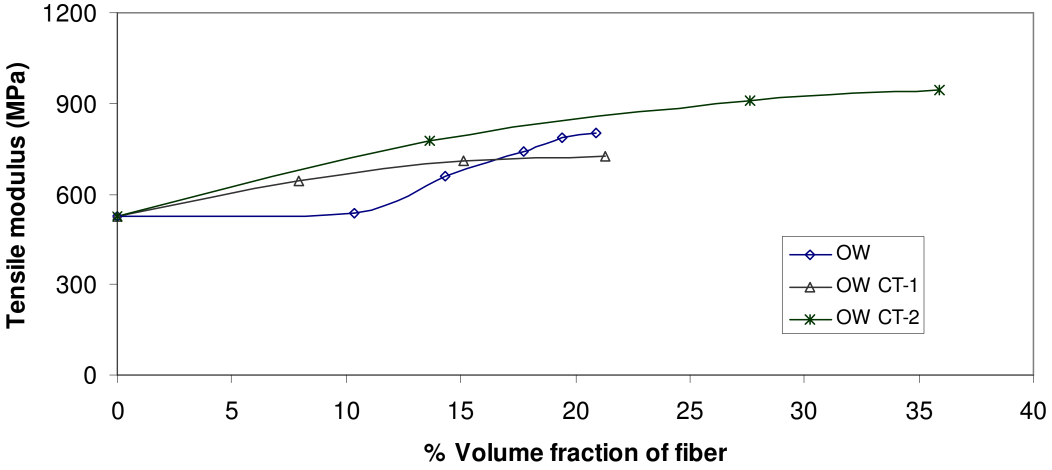

FIGURE 7: Effect of percentage volume fraction of fiber on tensile modulus of untreated and treated okra woven fiber reinforced polyester composites

Figure 8 shows specific tensile strength variation with increase in percentage volume fraction of untreated and chemically treated okra woven fiber reinforced polyester composites. Specific tensile modulus of okra woven FRP composites increased linearly from 14.35% to 20.93% volume fraction and chemical treatment-1 of okra woven fiber caused uniform and linear increase in its value with increase in volume fraction.

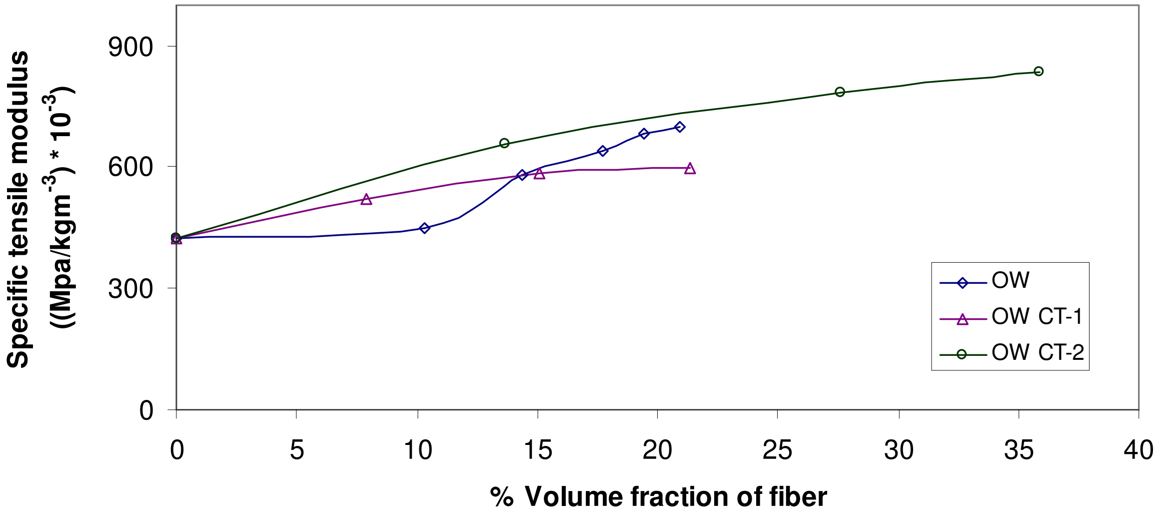

FIGURE 8: Effect of percentage volume fraction of fiber on specific tensile modulus of untreated and treated okra woven fiber reinforced polyester composites

6. CONCLUSIONS AND FUTURE WORK

1. Okra woven natural fiber extracted manually and optimum period of placing stems in mud water is 6 days. Changes in the time period on either side caused the pulp adhere to fiber in the former case and putrid of fiber in the later case.
2. Special care must be taken starting from seed selection, growth of plant till the extraction of fiber. If it is not happened resulted in fiber breakage.
3. Knot portions of the fiber must be properly impregnated with resin.
4. Okra FRP composites is useful for the preparation of doors for house hold purposes with light weight.
5. Practical suitability of okra natural fiber in domestic and industries is to be tested.

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