



RESEARCH ARTICLE

An inclusive survey on machine learning for CRM: a paradigm shift

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Abstract Customer relationship management (CRM) is the tool to enhance customer relationship in any business. Due to the exponential growth of data volume, in any field, it is significant to develop new techniques to discover the customer knowledge, automation of the system and moreover customer satisfaction to win customer lifetime value. CRM with machine learning could bring a catalytic change in business. Several supervised and unsupervised machine learning techniques are utilized to improve the customer experience and profitability of business. This paper reviews the available literature on the CRM with machine learning techniques for customer identification, customer attraction, and customer retention and customer development. This study reveals that supervised learning techniques are 48.48% utilized, unsupervised learning techniques are utilized 15.15%, and 9.09% utilized other techniques in CRM. Paradigm is also shifted toward the deep learning from machine learning as 28.28% text has been reported to

deep learning. Decision tree-based algorithm and support vector machine algorithms are most utilized algorithm of supervised learning. E-commerce and telecommunication sectors are the most important areas identified with the exponential growth of the users and hence need a suitable machine learning techniques for customer satisfaction and business profitability.

Keywords CRM · Machine learning · Churning · Decision tree · SVM · Deep learning

Introduction

In recent age of development, machine learning techniques prove like boon in each and every field. Machine learning techniques are utilized in research, academic, communication, and business. Machine learning has been useful to various complex problems like health care (Yinet al. 2019; Singh et al. 2020a), medical imaging (Fu et al. 2019), stock market (Lv et al. 2019), network operation and management (Boutaba et al. 2018), etc., and CRM is not also exception in this line. For any business, customer is on topmost priority. Customer satisfaction is a critical concept for the success of any businesses. A noble customer relationship management (CRM) program aids organization in satisfying the customer. Machine

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techniques are used to improve the customer relationship. The research in artificial intelligence (AI), machine learning (ML), deep learning, and data mining (DM) presented various excellent market algorithms and techniques to process the need of the customer and discover diverse approaches and techniques for creating an operative CRM to fulfill the customers need and requirement. Ngai et al. (2009) presented application of data mining techniques in customer relationship management for facilitating knowledge accumulation and base creation of CRM. Data are the main source of machine learning and data mining. Data mining discovers useful patterns and knowledge in the data, whereas machine learning comprises the algorithm that improves the automation without explicit program through experience based on data. Various businesses are struggling to actually know their customers, who make occasional buying and combine their own CRM data with Facebook consumer data to build look-alike models (Analytics 2018). AI, machine learning, deep learning and data mining have amazing power to transform CRM. Salesforce Einstein is the first inclusive AI for CRM, intended to aid all business to be smarter, projecting, assisting and retaining to customers (Laaksonen 2020). AI is used to evaluate the relationship of CRM, and machine learning is the core of AI (Jasek et al. 2018). The basic goal of CRM is to help companies to connect with customer, streamline the processes and improve the profitability. A well-defined CRM system can be based on customer segmentation strategy. Recency, frequency, and monetary (RFM) are important attributes of a customer's behavior that rely on customer segmentation. RFM model is useful in predicting churn rate, finding the best customer, retention rate, etc. Hence, RFM model is important in managing the relationship with the customer (Christy et al. 2018).

A high-level satisfied customer is one whose expectations have met. Meeting of customer expectations is the outcome of customer relationship management applications and services. Customer relationship management helps to get a 360⁰ view of the customer relationship management. The aim of CRM is to provide better services to customers, customization of market offerings, lessening in the customer defection rate, enhance long-term relationships, and sustaining corporate image and higher return on investment. Data mining and statistics are

conventional techniques of building the CRM and according to the present scenario where there is fierce competition to acquire and hold of customer; machine learning technique provides the best solution. Chagaset al. (2018) presented an application of machine learning techniques in CRM to expand analytical and mechanized services and features. By predicting the customer behavior companies can take personalized action to avoid the float of invasive advertisement. A customer is an essential part to start and sustain of your business. The life cycle of customer is the base to maintain the business. The life cycle of customer relationship consists four main steps, i.e., customer identification, customer attraction, retention and development (Sabbeh 2018), and is shown in Fig. 1.

Customer identification This is the first step of CRM framework. The objective of this step is to identify your target or prospect, customer that is associated with classification or segmentation.

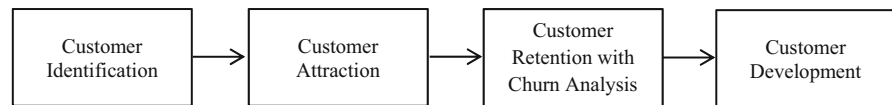
Customer Attraction In this step identified target customer is prioritized by providing them resource in order to attract the customer.

Customer retention Customer retention focus of the activities and actions realizes to fulfill the customer expectations and satisfaction for maintaining the customer. Various loyalty programs, promotional scheme and complaints management are key elements to retain customers.

Customer development Customer development step is related to enhance transaction amount, business value, and specific customer effectiveness. The foremost features of customer development are customer lifetime, value analysis, and up/cross-selling.

Customer churning analysis is also an important aspect in customer retention (Adebisi et al. 2016). The customer churn is closely related to the loyalty and customer retention rate. An adequate study of the churn analysis and customer retention creates a lifetime customer value. This paper aims to conduct the literature survey on the following:

- a. What are the machine learning techniques applied to CRM life cycle?
- b. How do machine learning techniques utilize customer churning prediction for better customer retention?

Fig. 1 Steps of CRM

To fulfill stated objective authors investigated the literature analytically to extract existing techniques and applications in CRM life cycle along with churning management. This study has focused on machine learning technique in CRM, and mostly, papers are surveyed from 2016 to 2020. The paper was extracted based on keyword search of 'ML' and 'CRM.' The paper is systematized as follows: After the introduction, 'Types of machine learning techniques' section relates the different types of machine learning techniques. 'Machine learning algorithm in CRM life cycle' section investigates the comparative analysis of machine learning techniques in CRM life cycle. 'Result and Discussion' section discusses the major result of reviewed papers. 'Conclusion' section concludes the paper.

Types of machine learning techniques

Machine learning is about predicting the future based on the past. Machine learning is a remarkable technique to get better with time as it learns and automates new paradigm of customer identification, attraction, retention and establishing the customer lifetime value. The role of machine learning techniques is significant in CRM due to its predictive analytics capabilities. The conventional CRMs only offer perceptions about customer data pattern based on past or present data. Machine learning is one of the game changing tools in business that are mostly customer centric. There are the following machine learning techniques (Ayodele 2010) that can enhance the capability of CRM life cycle:

- *Supervised learning* In a training dataset where target class label is known for given set of input features called supervised learning. In supervised learning data is already labeled with the correct output. Classification and regression are the best known supervised learning techniques. SVM, DT, KNN, neural network, Naïve Bayes, etc., are some well-known algorithm of supervised learning.
- *Unsupervised learning* In a training dataset where target class label is not known for the set of input label, called as unsupervised learning. Unsupervised learning relies on experience and observation. Clustering, association, and pattern mining are the best known unsupervised learning techniques. K-Mean, SOM, EM, etc., are some well-known algorithm of unsupervised learning.
- *Semi-supervised learning* This type of learning associates both labeled and unlabeled data to create a suitable model or classifier. Self-training, generative models (GMM and HMM), S3VM, and graph-based algorithms are some popular algorithm of semi-supervised learning (Zhu 2007).
- *Reinforcement learning* Reinforcement learning relies on reward and punishment for the automation of any system. An agent learns by cooperating with its surroundings. The agent takes incentive in case of correct result and penalties for incorrect result. PU and Q-learning is the well-known reinforcement learning algorithm.

Machine learning algorithm in CRM life cycle

This paper aims to survey various machine learning technique that is associated with CRM. In this section authors discuss various machine learning techniques that involve in customer identification, attraction, retention, churning and lifetime relationship management. The outcome of the reviewed paper is shown in tabular form. The table consists author of the paper, techniques applied, the best techniques identified (if any), year of publication and relevant area or sector as a main attribute of reviewed papers.

Machine learning in customer identification

The key concept to sustain in profitable business is to identify needs and requirement of your customer. Each organization has to pay attention on their buying behavior of customer (Yadav et al. 2018; Singh et al 2018). Leveraging the machine learning with CRM

could help to understand basic traits and need of customer. It is crucial to analyze the buying behavior and then identify customers requirement based on demographics factor such as gender, age, and income that divides the target customers into segments based on these factors to enhance profitability of any business. Wassouf et al. (2020) segmented customers of telecommunication based on the TFM, i.e., time–frequency–monetary, using random forest classifier of machine learning.

Customer segmentation has a significant impact on CRM. Dividing customers into various groups that could share analogous desires, and company can market to each group differently and emphasis on the needs of each kind of customer. K-Means algorithm is used to group the customers (Sandy 2019) and define business strategy based on their demographics and clusters. Mostly, unsupervised learning is used to identify customer segmentation in all types of business data. This data can offer perceptions for planning outage, creating network investment choices, forecasting future progress and predictive maintenance. ML techniques assist to analyze large chunks of data in an automated process. Singh et al (2020b) segmented customer into a number of classes, i.e., 'gold,' 'silver,' 'elite,' and 'occasional' using weka tool. Multilayer perceptron (MLP) is found as the best classification algorithm with an accuracy of 98.33% compared to others.

Due to this huge extent of data, organizations need to make use of effective clustering methods for customer segmentation. Decision process is based on many dimensions or features where some dimension may be irrelevant. Principal Component Analysis (PCA) is a technique to reduce the dimensionality. Due to voluminous dataset and multiple attributes for analysis, it is really very important to reduce the dimension before actual analysis and implementation. PCA followed by k-mode clustering algorithm has been used for segmentation (Kamthania et al. 2018). Toit et al. (2016) suggested that non-uniform binary split (NUBS) algorithm and PCA to increase convergence of K-Means with no expense and increase accuracy of power sector. Machine learning-based techniques assist in customer profiling in fast retail to maximize the sales (Fare et al. 2018).

Amnur (2017) suggested support vector machine (SVM) algorithm for classification because of its capability to model nonlinearities CRM solutions. By

using machine learning and CRM, Bank X optimized their profit by adding new customer and provided more advantages to the customer. Norlin and Paulsrud (2017) presented ML as a tool for predicting new customers in a B2B sales perspective. They used K-Mean and PU learning algorithm to fulfill his objective. PU learning was enhancing the sales process that was 4.8 times better than a random baseline classifier. Glas (2015) suggested customer prediction concept based on supervised machine learning techniques for recommendation engines. Authors applied C4.5, K-NN and FSC algorithm for the evaluation of model and found that C4.5 was performing well.

Nowadays social media also provide a great source of data that may be used to manage the relationship with customer. Generally, people discuss or shared their view about the product on social platform. By taking this concept, Korpusik et al. (2016) collected tweet data with labeled corpus of buy or not buy the product like mobile device and cameras. Authors proposed deep learning techniques for forecasting customer purchase behavior from twitter data. A feedforward neural network accomplished best at forecasting that tweet was significant to purchase behavior, with an accuracy of 81.2% on mobiles devices and 80.4% on cameras. Customer identification is significant in order to maintain relationship with them. The above reviewed papers are shown in Table 1.

From Table 1, this has been noted that for the customer identification and segmentation variation of K-Mean algorithm is widely applied. The well-known Principal Component Analysis (PCA) provides features of dimensional reduction of the original dataset. Then, K-Means clustering is applied on both original and reduced dataset for analytic purpose (Alkhayrat et al. 2020).

Machine learning in customer attraction

A state of the art based on ML technique like gradient tree boosting is applied for purchase prediction (Martínez et al. 2020). To attract the customer numerous promotional schemes and service is employing to attract and retain the customer. In case of limited resource and services one has to classify their prospect customer. Singh and Agrawal (2018) suggested the customer classification techniques based

Table 1 Customer identification and segmentation

S. No.	Reference	Techniques applied	Best	Year	Area
1	Glas	C 4.5, KNN, FSC	C 4.5	2015	Recommendation engine
2	Toit et al	NUBS, PCA and K-Means	Improved K-Means	2016	Power sector
3	Korpusik et al	LSTM, RNN	LSTM	2016	Recommender system
4	Amnur et al	SVM	SVM	2017	Bank
5	Norlin and Paulsruud	PU learning semi-supervised and K-Mean unsupervised	PU learning	2017	B2B sales in IT sector
6	Kamthania et al	PCA with K-modes	PCA with K-modes	2018	E-commerce business
7	Christy et al	K-Means, fuzzy C-Means	K-Means	2018	Online retail store
8	Sandy	K-Means	K-Means	2019	Starbucks
9	Singh et al	Naïve Bayes, regression J48, and MLP	MLP	2020	Shopping mall
10	Alkhayrat et al	PCA, K-Mean	PCA and K-Mean	2020	Telecommunication
11	Wassouf et al	Random forest, DT, gradient-boosted tree, and MLP	Random forest classifier	2020	Telecommunication

on machine learning algorithm to maximize the revenue by providing QoS to their loyal user in case of limited resource in telecommunication in order to attract new customer and retain their older customer.

Nguyen et al. (2020) indicated that predicting remanufactured product demand was a complex, nonlinear problem; however, machine learning techniques can predict the product demand with high accuracy.

Machine learning in customer retention

Customer retention is the base of any businesses. Customer retention strategies can be targeted on high risk customer that is most likely to be discontinued. This is also known as churn prediction. The efficient and early detection of this type of customer is necessary to maintain the overall company cost. Emtiyaz and Keyvanpour (2012) explored the possibility of analytical CRM by using semi-supervised Learning. Authors used both labeled and unlabeled data in order to retain their valuable customer. The multilayer perceptron neural network (MLPNN) found better than Neural Net, SVM, KNN and Naïve Bayes. The objective of customer churning analysis is important to identify precise lucrative customers who might be leave, therefore growing profitability and reducing marketing campaign costs. Authors

compared the concept of ML algorithms with data mining techniques. Authors applied the techniques on supermarkets and the results attained from the model were realistic and attaining 94% with random forest and 76% when logistic regression was implemented. Various literatures have been reported in retention of customer through machine learning (Ascarza et al. 2018). Singh and Agrawal (2019) proposed collaborative models that maximize the experience of their loyal customers by offering better quality of service (QoS) experiences to keep them in a system, thus affecting the total payoffs of the e-business. The retention of loyal customers costs lesser than acquiring the new customers. Their model utilized KNN classifier and accuracy result was compared with CART and SVM for different random state. Sabbeh in 2018 opted discriminant analysis, CART, KNN, SVM, LR, MLP, random forest and AdaBoost learning algorithm for the comparative study of telecom user to retain them. Both random forest and AdaBoost provided the best accuracy for customer retention.

The retention is twofold if business can understand why the customers show a downward trend in the industry. It assists the business to realize the pain points that customers suffer and hence take initial action to avoid them from churning. Hu (2018) suggested a downward prediction method and creating the policy to recognize the reasons by using semi-

supervised machine learning. The potential reasons are later called as 'levers' of the downward trend and found silent sufferers. Retention-related reviewed papers are summarized in Table 2. From Table 2, this has been observed that decision tree-based algorithm like CART, random forest and SVM is equally applied for the customer retention.

Machine learning in churning

A hierarchical multiple kernel support vector machine for customer churn prediction using longitudinal behavioral data was presented by Chen et al. (2012). The cost of acquiring new customers costs almost five to six times more than retaining current customers (Tong et al. 2017). Therefore, it is significant to identify the strategy for churning rate. Dullaghan and Rozaki (2017) presented a comprehensive study of the C.5 algorithm, within naïve Bayesian modeling for the task of segmenting telecommunication customers. The basic objective was to understand about the importance of churn prediction. The model is compared by each machine learning technique and the maximum accuracy that was achieved by the decision tree model in all the deals. Ahmad et al. (2019) established a churn prediction model for telecommunication operators. Authors applied four tree-based algorithms like DT, random forest, GBM tree algorithm and XGBOOST for model evaluation. XGBOOST tree model attained the best results in all the perspective. Churn prediction is definitely an important concept to sustain in market. Wen et al. (2018) analyze the payment behavior, business behavior along with some basic parameters for customer churn warning (CCW).

CCW algorithm was built on logistic regression algorithm. If the predicted loss probability exceeds the set threshold, the early warning system can sent a warning message so that enterprise can focus their customer. Asthana (2018) compared machine learning algorithm to predict customer churning rate in telecommunication industry. Dingli et al. (2017) proposed two-phase experiment in customer churning prediction. In the first phase, all models were applied and estimated using cross-validation on dataset, while in the second phase, the performance enhancement was suggested by boosting algorithm. The best classifier was the SVM-POLY using AdaBoost with accuracy of almost 97% and F-measure around 84%. Vafeiadis et al. (2015) compared BPN, SVM, Naïve Bayes, regression, and DT classifiers with and without boosting and reveal that BPN with 15 hidden nodes and DT classifiers achieved maximum accuracy 94% and F-measure 77% approximately in telecom industry.

Khodabandehlou et al. (2017) were presented systematic approach of six stages of predictive framework for customer churning by using supervised machine learning. They used five variables including RFM attributes. The suggested model had accuracy of 97.92% which was greater than RFM to predict churn prediction. The supervised machine learning approaches like artificial neural network (ANN) had the highest accuracy, and DT had minimum accuracy. Farquad et al. (2014) anticipated a hybrid method for extracting rules from SVM in order to churn prediction in Bank credit card customer. Concept of deep learning is to improve churn prediction in better way. Castanedo et al. (2016) suggested a feedforward

Table 2 Customer retention

S. No.	Reference	Techniques applied	Best	Year	Area
1	Emtiyaz and Keyvanpour	Neural Net, SVM, KNN and Naïve Bayes	MLP	2012	Not mentioned
2	Dingli et al	Random forest, logistic regression	Random forest	2017	Supermarket
3	Singh and Agrawal	KNN	KNN	2018	Telecommunication
4	Ascarza et al			2018	Review paper
5	Sabbeh	DT, SVM, MLP,...,random forest and AdaBoost	Random forest, AdaBoost	2018	Telecommunication
6	Singh and Agrawal	KNN, CART, SVM	KNN	2019	Market

neural network (deep learning algorithm) to predict customer churning rate in a prepaid mobile telecommunication network. The billions of call records from an enterprise business intelligence system were taken for churn prediction. The result was compared with random forest and found that neural network approach was significantly better than random forest Caigny et al (2018) presented a hybrid approach based on logistic regression and decision tree for churn prediction Spanoudes and Nguyen (2017) discussed that SVM and decision tree-based algorithm could not be able to modeled churn prediction and proposed deep neural network (DNN), deep learning concept for better result. Mishra and Reddy (2017) implemented deep learning approach called as convolutional neural network (CNN) for churn prediction with 86.85% accuracy in telecommunication industries. According to Table 3, decision tree-based algorithm is topmost applied algorithm for churn prediction after that SVM is working well.

Machine learning in customer development

Customer lifetime value (CLV) is an important aspect in customer development as 80% of business comes from 20% customers and called as 80/20 rule or Pareto principle (Koch 2011). Companies are seeking to learn

the approaches that can create value and optimize their resources and maximize their profits. Jangidet al. (2014) reviewed the current research in calculating CLV with RFM model, Econometric Model, persistence model, diffusion model and probability model. Authors proposed a model to implement an algorithm to predict CLV using multitask learning. Multitask learning is a division of machine learning containing numerous algorithms for sharing knowledge between different tasks. Vanderveld et al. (2016) utilized scores for email and mobile app as features, and provide the capability to identify changes in customer values by using random forest at Groupon. Due to advancement in online shopping, E or M transaction, as well as computing systems offered a great prospect to model and predict customer shopping behavior. Salehinejad and Rahnamayan (2016) proposed a customer shopping behavior prediction model based on recurrent neural networks (RNNs) with various parameter like client loyalty number (CLN), recency, frequency, and monetary (RFM).

Chen (2018) presented airline customer lifetime value can support airlines to classify the high-value, medium-value and low-value travelers. Authors utilized machine learning technique XGBoost to establish lifetime value with airline customer and airline company could make resource sharing with more

Table 3 Customer churning

S. No.	Reference	Techniques applied	Best	Year	Area
1	Farquad et al	SVM	SVM	2014 ^a	Bank: credit card of customer
2	Vafeiadis et al	BPN, Naïve Bayes, SVM, DT, regression	SVM-POLY with AdaBoost	2015	Telecommunication
3	Castanedo et al	Random forest, feedforward neural network (FFNN)	FFNN	2016	Telecommunication
4	Dullaghan and Rozaki	DT and Naïve Bayes	DT	2017	Telecommunication
5	Khodabandehlou et al	ANN, DT	ANN	2017	Customer behavior
6	Wen et al	CCW	CCW	2018	Bank of China
7	Spanoudes and Nguyen	Machine learning (SVM, DT), deep learning	DNN	2018	Any company
8	Asthana	BPN, SVM-RBF, SVM-POLY, DT-C5.0	SVM-POLY	2018	Telecommunication
9	Caigny et al	Logistic regression and decision trees	Hybrid approach	2018	Any company
10	Ahmad et al. [29]	DT, random forest, GBM, XGBOOST	XGBOOST	2019	Telecommunication

coherent way in less resource investment and more revenue gain. Bernat et al. (2018) suggested various different classes of prediction models to predict CLV. Authors used a machine learning technique—gradient tree boosting. The gradient tree boosting is used for both classification and regression problems that practices an ensemble of ‘weak’ DT to attain a ‘strong’ predictor. Ali and Lee (2018) discussed the merits of new machine learning approach for sales prediction that is salesperson centered as opposed to customer or product centered with the challenges and opportunities of time-evolving attributes in pattern discovery.

The main aim of CRM is customer satisfaction that also classified the dissatisfied customers. Meinzer et al. (2017) indicated the customer dissatisfaction classification for automotive industry. A machine learning problem was used to compare five classifiers and examined data from 19,008 real service visits in an automotive company. The 105 features were identified, and the most substantial available sources were related to warranty, diagnostic, dealer system and general vehicle data. The best outcome for customer dissatisfaction classification was 88.8% attained with the SVM classifier by using RBF kernel. The Pareto/NBD model outperforms the managerial heuristic in predicting customer lifetime value. With the Pareto/NBD CLV, it was possible to track behavioral changes for segments of the customer base over time that indicates how strong or weak the relationship is between customer segments (Ruibin and Borglöv 2018). Chamberlain et al. (2017) offered a novel method to create embedding of customers, which addresses problem of the ever changing product catalogue in online shopping. A significant improvement was achieved by applying random forest tree and neural network-based classification techniques.

Deep learning is an extension of machine learning also finding significant in terms of establishing customer lifetime value in various fields. A deep learning method CNN and DNN was compared with Pareto/NBD model in an online video game (Chen et al. 2018). CNN and DNN methods not only indicate greater accuracy, but more importantly such enhanced performance stems from significantly better predictions for top spenders, whose purchasing behavior was poorly taken by BTYD models. A summary of machine learning techniques in customer development is shown in Table 4.

According to Table 4, no single algorithm is dominating. However, SVM, decision-based algorithm and neural network-based algorithm are equally used. From Table 4, it has been observed that SVM-based algorithm is performing better in comparison with others. It has been also observed that neural network-based algorithm is also used extensively. Deep learning is a dominant set of techniques for learning in neural networks. Hence, it is very clear indication that trends are shifting toward deep learning from machine learning.

Result and discussion

The recent time focus on intelligent CRM is to maintain and enhance customer relationship life cycle. From small companies to worldwide firms, sales and marketing teams are implementing CRM to deliver better customer experiences, attain and retain customers that are shifting their businesses for the better experience. The relationship with the customer is really very important to increase profitability and productivity of business and organization. The main advantage of implementing the machine learning techniques is to form an accurate predictive model for identification of loyal and prospective customers and offer them better relationship service. The machine learning techniques provide organizations’ capability to recognize potential customers in its standard practices and therefore convey specifications that might satisfy customer to make transactions and decisions. Overall 35 papers are viewed related to CRM and ML techniques.

It has been observed that supervised learning is extensively used to analyze customer behavior and relationship management. Decision tree (DT)-based, support vector machine (SVM) and KNN-based algorithms are highly utilized supervised learning techniques in CRM. For the customer identification and segmentation, variation of K-Mean algorithm has been widely applied as unsupervised learning. Further, this is observed in Tables 1, 2, 3, 4 that at early time periods from 2012 to 2018, decision tree-based and SVM- or KNN-based algorithms were gaining popularity and from late 2018 to 2020, era is shifting toward deep learning which includes ANN-, CNN-, RNN- and DNN-related techniques. Figure 2 represents that 48.48% paper is related to supervised learning

Table 4 Customer lifetime development

S. No.	Reference	Techniques applied	Best	Year	Area
1	Jangid et al	Multitask learning		2014	Transaction
2	Salehinejad and Rahnamayan	RNN	RNN	2016	E-commerce
3	Meinzer et al	AdaBoost, kNN, SVM (linear), SVM (RBF) and random forest	SVM (RBF)	2017	Automotive industry
4	Chamberlain et al	Random forest, neural network	Neural network	2017	E-commerce
5	Jasek et al	EP/NBD, decision tree	EP/NBD	2018	Online retail
6	Jangid et al	XGBoost	XGBoost	2018	Airline company
7	Bernat et al	Gradient tree boosting	Gradient tree boosting	2018	Online retail
8	Chen et al	Pareto/NBD, CNN and DNN	CNN	2018	Online game

techniques, 27.27% papers are available of deep learning and 15.15% papers are related to unsupervised learning to manage customer relationship aspect with machine learning.

CRM is an important business tool which has been applied in various areas like B2B, airline, supermarket, bank, telecommunication, etc. Among these areas, telecommunication and e-commerce areas are most important identified for customer retention and churning prediction. Hence, the future trends are shifting from machine learning to deep learning where deep learning is realized as artificial intelligence in order to

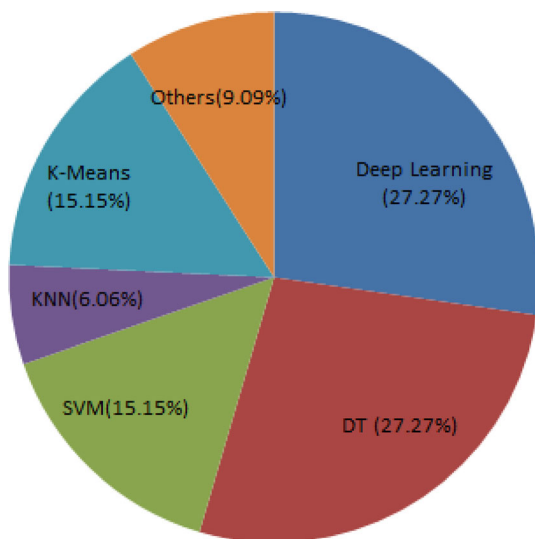
identify the customer needs and requirement in a better way. Deep learning provides greater precision and predictive analytics that focus on CRM life cycle and customer needs and behavior.

Future research direction

The future research direction in CRM is being defined by novel, agile application interfaces that can be customized for each type of customer needs and marketing team member's needs. Cloud platforms offer common user interfaces and usability criteria in CRM apps, making it possible to add or change fields within minutes.

Conclusion

Recently, machine learning has been effectively useful in businesses to maintain relationship with the customer. This study offers an inclusive knowledge on the applicability of ML practices in support of CRM life cycle elements such as customer identification, customer attraction, customer retention, customer churning prediction and customer lifetime value. Machine learning in CRM works remarkably to those areas which have a huge number of customers such as telecommunication, online or offline sale of daily product. Supervised learning such as decision tree and support vector machine (SVM) algorithm has most applied ML technique in CRM. This concludes

**Fig. 2** Paper distribution

that 48.48% techniques of supervised learning, 15.15% techniques of unsupervised and 9.09% other techniques have been applied in CRM. It has also been observed that 27.27% papers are related to deep learning which indicates that future trends are shifting to deep learning due to its ability to learn to improve on their own.

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