

# Help Yourself : A Virtual Self-Assist Agent

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## ABSTRACT

In this work, we describe an unsupervised framework for creating self-assist systems which can serve as virtual call center agents to guide the customer in performing different domain-dependent tasks (like *troubleshooting a problem, changing settings etc.*). We describe a framework for creating an intent graph from a corpus of knowledge articles from a given domain which is used in creating the dialogue system. To the best of our knowledge, this is the first work in creating virtual self-assist agents.

## Categories and Subject Descriptors

I.2.7 [Natural Language Processing]: Dialogue

## General Terms

Algorithms and Experimentation

## Keywords

Virtual Agent; Dialogue; Intent Extraction; Intent Graph

## 1. INTRODUCTION

Contact center business represents a significant business opportunity estimated at \$600B business worldwide. This includes all contact centers with external sales/support, internal corporate call centers, marketing, polling and fundraising, excluding emergency services. This is a highly labor intensive industry with an estimated \$300B to be spent in labor in 2013.

Self-Assist systems are virtual agents that can solve customer problems in an automated manner. Existing systems are simple transactional systems and syntactically rigid. For example, *What is my bill amount ?* (using SMS), *Book tickets from London to New York on 22nd April* (using Online booking) *etc.* Several knowledge management systems are in use in contact centers to enable creation, search and retrieval of knowledge articles. These are used by the call center agents to answer customer queries, help them in performing certain domain-dependent tasks (like *Change the ringtone of iPhone 4S, Setup Wi-Fi, Transfer contacts from blackberry to iPhone etc.*) or troubleshooting problems (like

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WWW'14 Companion, April 7–11, 2014, Seoul, Korea.  
ACM 978-1-4503-2745-9/14/04.  
<http://dx.doi.org/10.1145/2567948.2577021>.

Learn how to transfer contacts from a BlackBerry device to an iPhone

Last Updated: Nov 16, 2013

### Back Up Contacts

If the contacts on the BlackBerry device are already synchronized to Google or to a Microsoft Exchange account they can be synchronized directly to the iPhone. You do not need to worry about exporting them from the BlackBerry device, ...

### Export the On-device Contacts

1. Ensure you have installed BlackBerry Desktop software on the PC. The latest version can be found on BlackBerry ...
2. On the PC, open the BlackBerry Desktop Software application.
3. Connect the BlackBerry device to the PC via USB cable.
4. In BlackBerry Desktop Software, click Organizer from the menu on the left.
5. If a warning is displayed to Turn off wireless sync, follow these steps to turn it off on the device:
6. On the BlackBerry, in the Contacts application press the Menu key, then select Options.
7. If necessary, click the contact list.
8. Change the Wireless Synchronization field to No or clear Wireless Synchronization check box.
9. Press the Menu key, then select Save.
10. In BlackBerry Desktop Software, click Device, then Sync by Type, and Organizer.
11. Check the box to sync Address Book, and then click Microsoft Outlook Express.
- ...
18. Your contacts are now backed up to the Gmail or Exchange account.

### Import Contacts

In the above steps you have backed up the BlackBerry device contacts to a Google or Exchange account. The following instructions guide you through the process of importing the contacts from these accounts to the iPhone.

### Synchronize Contacts with Google or Exchange Account

1. On the iPhone tap Settings.
2. Tap Mail, Contacts, Calendars.
3. Tap Add Account ...

## Figure 1: Article on Transferring Contacts from Blackberry to iPhone

*Troubleshoot connectivity issue in Samsung Galaxy S-III, Unable to connect to internet, Phone auto re-booting etc.*

We use these knowledge articles from a given domain to automatically construct an *intent graph* consisting of *basic intents, methods* to satisfy intents and *steps* to perform the method. This graph is used to create a dialogue system that guides the user interactively in attaining his objective, keeping track of the user progress (success or failure) at each step, and help in resolving issues, if any, in the process.

## 2. INTENT GRAPH EXTRACTION

### 2.1 Basic Intent Extraction

A document may have several topics or objectives of user interest. Each such topic is defined as a basic intent. For example, a document titled 'Learn to transfer user contacts from Blackberry to iPhone' (Fig. 1) may have the following basic intents: "import contacts, export contacts, back up and synchronize contacts".

Although it is easy to identify the basic intents from the document stylistic markers in the above article, it may be quite difficult in some cases where there is no explicit basic

This article helps you troubleshoot data connectivity issues on your Sprint Force 4G LTE.

You may have data connectivity issues if you're unable to:

- Connect to the Internet
- Browse websites
- Send or receive multimedia messages
- Load Internet content within applications
- Send or receive email

These steps help identify and resolve the underlying cause. After completing each step, test to see if the issue is fixed. If not, continue to the next step.

Verify your Sprint Force™ 4G LTE is connected to the Sprint network using Sprint Zone.

Be sure mobile data is enabled. Some features require a data connection to work properly.

1. Access Sprint Zone.
2. Scroll to and tap My Device.
3. Tap Dashboard.
4. Scroll to and tap Data Network.
5. Your data connection status displays.
6. Tap Update Profile.
7. After the profile update is complete, tap OK.
8. Test your device to see if the issue is resolved.
9. Perform a soft reset.

A soft reset reconnects your Sprint Force 4G LTE to the Sprint network.

1. Press and hold the Power key, tap Power off, and then tap OK to turn your Sprint Force 4G LTE off.
2. Remove the battery. After 30 seconds, reinsert the battery.
3. Press and hold the Power key to turn your Sprint Force 4G LTE back on.
4. Test your device to see if the issue is resolved.

Do you know if other Sprint customers are experiencing the same problem in the same location?

## Figure 2: Article on Troubleshooting Connectivity Issues in Sprint

intent; this requires the system to assign a basic intent to a section of the article from the context, or abstract a basic intent from document sub-sections. For example in Fig. 2, the basic intents extracted are “Data Connectivity Issues, Troubleshoot Connectivity Issues, Temporary Solution using Wi-Fi and Customer Care help”. In Fig. 3 the extracted basic intents are “Removable UICC Cards, A UICC card, An ICC ID, Swapping UICC, Sharing UICCs between two phones, iPhone 5 devices come with a UICC, Remove UICC Card etc.”. The following features are used for identifying basic intent sections in a knowledge article:

1. *Discourse Coherence* - A coherently structured discourse is a collection of sentences having some relation with each other. During intent extraction, sentences having some discourse relation with each other, connected by co-ordinating conjunctions like *as, follows etc.* (Example: *as follows, so proceed etc.*), sub-ordinating conjunctions like *above, before etc.* (Example: *above steps, before proceeding etc.*), adjectives like *next, previous etc.* (Example: *next and previous steps*) and adverbs like *following, furthermore etc.* are considered to be a part of the same intent section.

2. *Paragraph and Section Break* - Paragraph and section breaks indicate discontinuity in the current intent section. However, discourse particles may still connect the segments as coherent.

3. *Document Stylistic Markers* - Font and header sizes, bold and strong font patterns *etc.* are used to identify the basic intent of an extracted intent section.

4. *Context Change* - Context change or change of intent is detected by the number of domain keywords overlap, being less than some threshold, between consecutive segments.

5. *Lexical Chain* - A lexical chain [3] is a sequence of related words in the text, spanning short (adjacent words or sentences) or long distances (entire text). It is independent of the grammatical structure and captures the cohesive structure of the text. A basic intent segment contains domain keywords that are part of the same lexical chain. WordNet [2] is used in the identification of lexical chains.

All LTE phones require a Universal Integrated Circuit Card (UICC), but the iPhone 5 is one of the first devices to have a removable Universal Integrated Circuit Card(UICC).

A UICC card is the physical smart card that allows for LTE network authentication and access. It's a new generation SIM (Subscriber Identification Module) card. No customer-specific information—like contacts, address book, or account information, photos, or personal data—is stored on this card.

The ICC ID (Integrated Circuit Card ID) is a unique 20-character ID serial number assigned to the card. The UICC is a term to describe the card itself, the ICCID is the serial number assigned to the UICC card.

A removable UICC can be moved to a different device, but this is discouraged. You have to have to confirm (perform a swap) of the both ICCIDs in the activation (or billing) system.

UICCs may not be shared between two devices. Each UICC is assigned to a transceiver and paired together. Users may not simply pop a UICC out of one device and use it immediately in another device. This is known as 'pop and swap'. Sprint specifically activates and checks for the paired equipment when connecting to the Sprint network.

Each iPhone 5 has a removable UICC that has a unique ICC ID: this is the ICC ID that auto-populates in the activation/billing system. When a device has a removable UICC, you must confirm that the ICC ID matches the ICC ID displayed in the system. The need to replace a UICC, or swap it to a different device, should be a very rare occurrence.

All iPhone 5 devices come with a UICC inserted into the device.

If you remove your UICC card, LTE service will stop working until you reinsert the UICC card.

Sprint Retail stores will stock replacement UICC cards.

No. The SIM is not to be used for storing any personal or application data when using your phone. Attempting to tamper with the SIM itself may cause the UICC to become unusable.

## Figure 3: Knowledge Article on UICC Cards

### 2.2 Methods, Steps and Operators

A basic intent may have multiple *methods* to satisfy the intent. For example, the intent ‘software upgradation’ can have two possible methods corresponding to ‘automatic upgradation’ and ‘manual upgradation’. In Fig. 2 and 3, there is only one method for each basic intent. In Fig. 3, one can ‘troubleshoot connectivity issues’ by three methods: (a) Check if device is connected to Sprint Zone (b) Perform a soft reset (c) Temporary Solution using Wi-Fi.

The methods are extracted from the basic intent section identified during intent extraction. In case of multiple methods, relations are established between successive discourse segments using domain keyword overlap, linguistic markers (like *follow, above, steps below, these etc.*) and syntactic continuity using lexical chain.

A method consists of a sequence of *steps*. For example, the method to satisfy the basic intent ‘export on-device contacts’ has a sequence of eighteen ordered steps (Fig. 1). Each logical unit (sentences in case of a paragraph, items in case of a list) in any method is considered as a step. Steps are connected by *operators* suggesting the sequence to perform the steps. The steps for a method or the methods for an intent may have the following operators connecting them:

- All : This represents an unordered sequence of steps
- Or: This denotes that either of the steps (or methods) may be performed on the method (or intent)
- Next: This represents an ordered sequence of steps

Discourse markers (like *follow, in order, next etc.*) and document stylistic markers (like *unordered and ordered lists etc.*) are used to identify the operator type. In Fig. 1, the steps for ‘export on-device contacts’ are connected by a *next* operator. In Fig. 2, the different types of ‘data connectivity issues’ are connected by *or* operator. In Fig. 2, the methods for ‘troubleshooting data connectivity issues’ are connected by an *all* operator.

### 2.3 Concept and Discourse Linkages

Concept Linkages are created between related intents or methods across multiple documents. The basic intent ‘Troubleshooting network connectivity issue’ in an article may

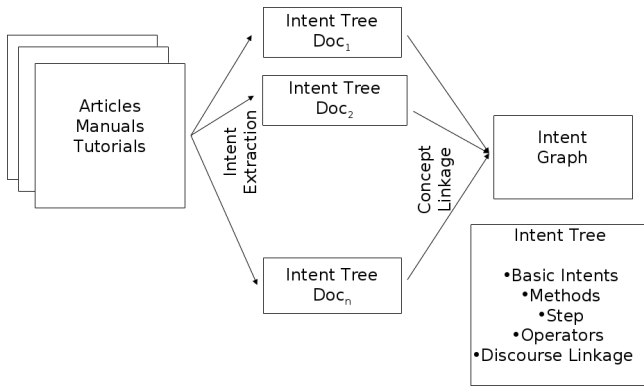


Figure 4: Intent Graph Creation from Knowledge Articles

```

<TitleIntent>
Learn to Transfer Contact from BlackBerry to iPhone
<Intent: Operator <All>> Back Up Contacts
  <Method>If the contacts on the BlackBerry device are already synchronized to Google
  or to ..... import them to a Google or Exchange account that will be set up to synchron ...
  </Method>
</Intent>
<Intent: Operator <All>> Export the On-device Contacts
<Method>
  *<Step: Operator <Next>> Ensure you have installed BlackBerry Desktop software on
  the PC. The latest version can be found on the BlackBerry website.</Step>
  *<Step: Operator <Next>> On the PC, open BlackBerry Desktop application. </Step>
  *<Step: Operator <Next>> Connect the BlackBerry to the PC via USB cable. </Step>
  .....
  *<Step: <Operator <Next>> Now you can Import this .CSV file to Gmail / Outlook acc.
  </Step>
  *<Step: <Operator <Or>> For Gmail - click Settings > Import.</Step>
  *<Step: <Operator <Or>> For Outlook - click File > Import and Export.</Step>
  </Method>
</Intent>
<Intent: Operator <All>> Import Contact
<Method> In the above steps you have backed up the device contacts to a Google or
Exchange account.The following instructions guide you through...</Method>
</Intent>
</TitleIntent>

```

Figure 5: Intent Graph of Knowledge Article in Fig. 1 (XML format)

have a method to ‘Perform a soft reset’ whose steps may appear in some other document.

Discourse linkages are created within the same article based on the discourse markers (like *previous*, *before*, *following etc.*). These allow preserving the sequence of information within the article. For example, in Fig. 1, the steps to ‘import contacts’ refer to the ‘above steps’ in the article to ‘export on-device contacts’.

A basic intent tree for an article consists of the basic intents in the knowledge article, the methods and the steps. There may be logical *intra-tree linkages* corresponding to the *discourse linkage*. Multiple basic intent trees across different knowledge articles form an *intent graph*, where the basic intents (or methods) may be connected by *concept linkages*. Fig. 4 shows the intent graph extraction from knowledge articles. Fig. 5 shows the XML format of the extracted intent tree corresponding to Fig. 1. It also shows the intra-tree discourse linkage corresponding to the element ‘above’. Fig. 6 shows the visual abstraction of intent tree creation from Fig. 1.

### 3. SELF-ASSIST DIALOGUE SYSTEM

The previous section discusses the construction of intent graph from an unlabeled corpus. The dialogue system uses the graph as its knowledge base in conducting a dialogue with a user. The dialogue system has the following modules:

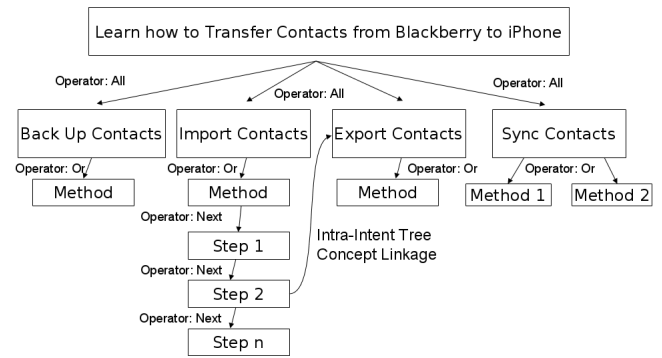


Figure 6: Intent Graph of Article in Fig. 1 (Graphical format)

### 3.1 User Intent Classification

This module matches the user query to one of the basic intents in the intent graph. The keywords in the user query are extracted using *tf-idf*, followed by *lemmatization*, which are then matched with the states in the intent graph using *cosine-similarity* and *dependency relations* of the keywords with the neighboring words. The top K intents having a similarity score greater than a threshold are retained, and passed on to the next module for analysis.

### 3.2 Question Generation

In case there are multiple matched basic intents with a similar score, this module frames a question to know from the user which of the extracted basic intents from the graph is most similar to his query. This module uses the *Part-of-Speech tag pattern* of the first few words in the intent to frame a question using simple rules like: (a) Any basic intent starting with a *verb* is prefix-ed with ‘Do you want to’ (For example, the intent ‘Learn to transfer ...’ is framed into ‘Do you want to learn to transfer ...’) (b) Any basic intent starting with *To* is prefix-ed with ‘Do you want’ (c) Any basic intent starting with a *conjunction* is prefix-ed with ‘Do you want to know’ (d) Any basic intent starting with *WP* (*what, who, whom etc.*) or *WRB* (*how, where, why etc.*) POS tags are displayed as it is, and so on.

### 3.3 User Response Classification

The system monitors the user response to find out if the user is following the instructions as provided by the agent, or is stuck at some point. The user response is classified as: (a) *Continue* - This indicates that the user is following the query and the system moves on to the next state (b) *Issue* - The system detects that the user is facing some difficulty with an instruction and extracts the cause. It then frames a question to validate the issue and searches the intent graph for a probable resolution. The system stores the *user-state* and the *intent-graph state* in a stack before recursing into the intent graph for solving the problem. It returns a failure if it cannot find a resolution in a limited number of attempts. (c) *Switch* - This indicates a context switch whereby the user has jumped to some other query in the midst of the previous transaction. This is detected by the number of keywords overlap between system response to the previous user query and current user response, the response type from the user (*affirmative, negative etc.*) and the distance between the intent-graph states of the previous

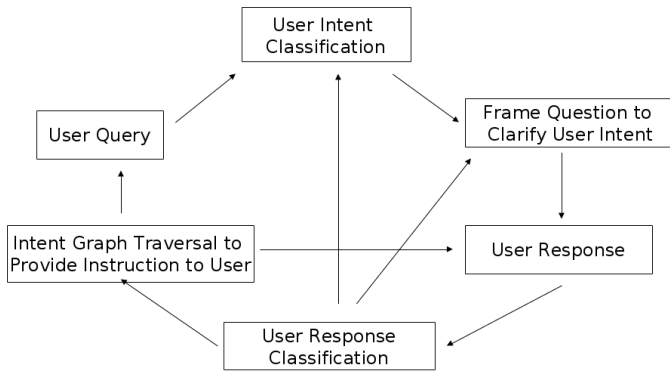


Figure 7: Self-Assist Dialogue Generation

and current user query/response. (d) *Abort* - The system detects if the user is angry or frustrated (probably due to punts from the system) and quits from the current conversation with an apology. A dependency-parsing based feature-specific sentiment analysis [4] algorithm is used to find the polarity (positive or negative) of the user response about each of the keywords present in the sentence. If the polarity is positive, with respect to all the keywords in the sentence, the system continues to the next state, or else tries to resolve the issue in case of a negative sentiment about any keyword.

### 3.4 Intent Graph Traversal

The system maintains the *intent graph* in memory and stores the graph states and user response states in a stack. The system matches the *user query* to a *basic intent* in the graph and extracts *methods* for the intent from the graph. In case of multiple methods, the system *frames a question* to know which method to display. It then displays *steps* for the method according to the *operator* connecting the steps. After each instruction, the system waits for user response to monitor the user progress. The system follows the *intra-tree discourse linkages* to show methods or steps logically preceding or succeeding that of the current basic intent. It follows the inter-tree concept linkages to display methods for concepts present in some other intent tree, than the one it is currently traversing.

## 4. EXPERIMENTATION

3048 knowledge articles are collected from the Sprint website [5]. The articles are cleaned using JTidy and the extracted intent graph is indexed for use by the dialogue system. Stanford dependency parser [1] is used during intent classification and user response classification. Stanford POS-Tagger is used in the question generation module to use the part-of-speech tag pattern of the start words in framing a question. Only a qualitative evaluation of the self-assist agent is done where it is found to respond accurately to most of the user queries.

## 5. CONCLUSIONS

In this work, we present the framework and implementation of a virtual self-assist agent to guide a person in performing various domain-dependent tasks. The system automatically constructs an intent graph from a corpus of knowledge articles, which allows it to inter-actively guide

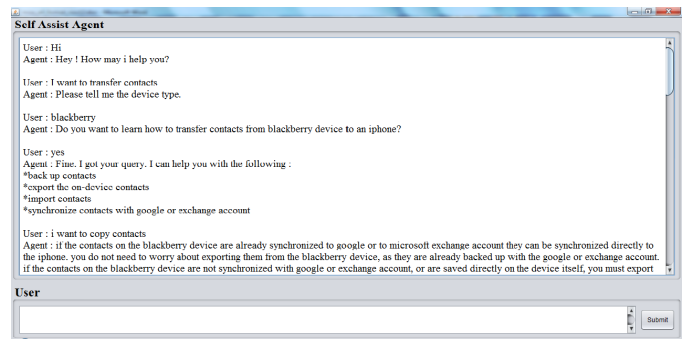


Figure 8: Self-Assist Interface

```

User : Hi
Agent : Hey ! How may i help you?
User : I want to transfer contacts
Agent : Please tell me the device type.
User : blackberry
Agent : Do you want to learn how to transfer contacts from blackberry device to an iphone?
User : yes
Agent : Fine. I got your query. I can help you with the following :
*back up contacts
*export the on-device contacts
*import contacts
*synchronize contacts with google or exchange account
User : i want to copy contacts
Agent : if the contacts on the blackberry device are already synchronized to google or to microsoft exchange account they can be synchronized directly to the iphone. you do not need to worry about exporting them from the blackberry device, as they are already backed up with the google or exchange account. if the contacts on the blackberry device are not synchronized with google or exchange account, or are saved directly on the device itself, you must export them from the device and then import them to google or exchange account that will be set upto synchronize with the iphone.
User : ok
Agent : Do you want to have more information ?
User : no
Agent : Tell me how else can I help you.
User : i want to synchronize contacts with google
Agent : Do you want to synchronize contacts with google or exchange account?
User : yes
Agent : on the iphone tap settings.
User : ok
Agent : tap mail, contacts, calendars.
User : done
Agent : tap add account.
User : next
Agent : tap microsoft exchange. (do not tap gmail for gmail accounts).
User : but i cannot find microsoft exchange
Agent : Do you want some other information ?
User : yes
Agent : Do you want to know which email providers are supported by blackberry enterprise server?
Do you want to troubleshoot issues related to email on your blackberry bold 9930?
Do you want to troubleshoot issues related to email on your blackberry curve 3q?
Do you want to troubleshoot issues related to email on your blackberry style 9670?
integrate your blackberry with corporate email account if you do not have access to blackberry enterprise server
User : i want to know about blackberry enterprise server
Agent : blackberry enterprise server is designed specifically to work with microsoft exchange, IBM lotus domino and novell groupwise email programs.
User : ok.. cool
Agent : Returning to your previous query.
User : fine
Agent : enter the email address, domain (exchange accounts, for gmail leave blank), username, and password.
User : done
Agent : tap next.
User : cool
Agent : tap server and enter the exchange server address (m.google.com for gmail accounts).
User : ok
Agent : tap next.
User : done
Agent : tap to ensure that contacts is set to on.
User : checked
Agent : tap save.
User : saved
Agent : the google or exchange account contacts are now synchronized to the iphone.
User : ok.. thanks
Agent : Tell me how else can I help you.
  
```

Figure 9: Self-Assist Dialogue Snapshot

the user. The system monitors the user progress at each step and attempts to resolve issues, if any.

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