NLP Coverage

- Using the utterances in the pilot database and additional utterances collected throughout the WOZ - last summer, the dialog system grammar is tested and modified along with the necessary changes. The below table quantitatively summarizes the test results and the percent enhancements in the grammar achieved throughout the grammar changes. The modified grammar includes those features of the previous grammar as well as additions to accommodate the line of new grammar brought out by the WOZ utterances.

- The percent enhancement is calculated as follows.

  100 * (modified grammar - previous grammar) / modified grammar

- The percent enhancements do not include those enhancements such as elimination of duplicate or varying keywords (e.g. query_where, query_list) and adding the missing keyword or [Arrive_Loc]. These cases are not considered as errors because there are mechanisms in the dialog manager to handle them.

Table 1: Enhancements in the dialog system grammar

Queries	Number of utterances	Number of utterances added	Total utterances	Correct parsing (previous grammar)	Correct parsing (modified grammar)	% enhancement
Address	71	30	101	65/101	101/101	35
Direction	179	40	219	170/219	202/219	16
Distance	12	11	23	7/23	13/23	38
List of places	10	26	36	10/36	36/36	72
Building	2	8	10	2/10	10/10	80
Turn	5	0	5	0/5	5/5	100
Bus	1	6	7	0/7	7/7	100
Intersection	2	0	2	0/2	2/2	100
Which way	2	0	2	0/2	2/2	100
Special	1	0	1	0/1	0/1	0

- The below examples show how the grammar changes/additions are implemented.

----ADDRESS----

User: WHERE IS A GOOD PLACE TO EAT THAT IS CLOSE TO GIGGLESWICK

```
Parser:
    Query_Address:[Query_Address].query_where
    Query_Address:[Arrive_Loc].[Place_Spec].good [Place_Type].RESTAURANT
    Query_Address:[Arrive_Near].[Place_Name].[Business_Misc_Name].
    GIGGLESWICK
```

--The previous grammar did not resolve the [Arrive_Near] because of the segment "that is close to" which is equivalent to saying "near" some place. The non-terminal slot [vicinity] is defined so that it handles "that is close to" as well as other similar segments.

```
[vicinity]
          (*be *located VICINITY) ([which] [is] VICINITY)
VICINITY
          (nearby) (around *here)
          (within walking distance *[of] *here)
          (in the neighborhood *[of])
          (close *to) (close from) (*located near *to) (adjacent *to)
          (adjacency [of]) (in *[the] vicinity [of]) (outside) (off)
          ([on] *[the] local [an_address]) (in) (on) (at)
;
[an_address]
          (address) (location) (locations) (place) (places) (region) (regions)
          (area) (areas)
;
[which]
          (that) (which)
;
[on]
          (in) (on) (at) (around) (within) (with) ([of]) (from) (to) (onto)
;
[of]
      (of) (for) (about) (to) (on)
;
[the]
          (the) ([that]) (a) (an) ([any]) (one) (ones)
;
[that]
          (that) (this) (these) (those) (it)
;
[any]
          (any) (anything) (some) (something)
;
```

The corresponding grammar rule was implemented as follows.

```
[_query_where]
        ([whats] FAR)
FAR
        ([Arrive_Loc] *[Arrive_Near])
;
[whats]
              (what's) (what *[is]) (which *[is]) (where is) (where's)
              (where *are) (where're)
;
[is]
              (am) (is) (are) (were) (was) (do) (does) (did) (have) (has)
;
```

Another example for address query may be given as follows.

```
    User: WHERE ON MY WAY FROM THE HUNTER HENRY CENTER TO THE
HAMPTON
    HOTEL CAN I GET GASOLINE FOR MY CAR

    Parser:
          Query_Address:[Query_Address].query_isonway
          [Depart_Loc].[Building_Name].HUNTER HENRY ALUMNI CENTER
          [Arrive_Loc]. [Place_Name].[Hotel_Name].HAMPTON [Place_Type].HOTEL
          [Arrive_Loc].[Place_Type].CONVENIENT STORE
```

--This kind of utterance is new to the previous grammar and is handled using a new slot named [_query_isonway] as follows.

```
[_query_isonway]
              (*WHERE_ON [depart_arrive] *WHERE CAN_I)
CAN_I
              (CAN [i] [get] *[the] FAR)
WHERE
              ([how]) ([whats])
WHERE_ON
              (*[i] *[want] *[the] *FAR where [on] [its] [direction])
              (if [i] [go]) ([i] CAN [go])
CAN
              ([is]) ([can])
FAR
              ([Arrive_Loc] *[Arrive_Near])
;
[i]
              (i) (we) (you) (he) (she) (they)
```

```
;
[get]
          (get) (give) (list) (find) (help) (have) (locate)
;
[how]
          (how) (what)
;
[want]
          (want) (need) (would like) (like) (wish) (desire) (hope) (seek)
          (request) (prefer) (expect)
;
[its]
          (its) (our) (their) (your) (my)
;
[go]
          (go) (drive) (walk) (reach) (visit) (arrive) (drop by)
;
[can]
          (can) (could) (may) (might) (will) (would) (should) (ought to)
          (must) (shall)
;
```

----DIRECTION----

User: I'M AT THE INTERSECTION OF SOUTH JACKSON AND GILLESPIE, AND I NEED GET SOME CASH FROM THE BANK, WHERE IS THE BANK LOCATED

```
Parser:
    Query_General:[Depart_Loc].[Address].[Street_Name].SOUTH JACKSON
    [Street_Name].GILLESPIE
    Query_Direction:[Query_Direction].query_map
    [Arrive_Loc].[Place_Type].BANK
```

--This kind of utterance is new to the previous grammar and is handled using the following grammar rule. The bank is stated twice and is handled by the use of non-terminal slot [some_place] which includes a copy of all places and items in the grammar.

```
[_query_map]
          (*I WANTING PREFER FAR *located)
          (*[on] [some_place] PREFER FAR *located)
WANTING
```

```
          (WANTS *to *GET_GO *[on] *[the] [some_place])
          (WANTS [doing_things])
          (WANTS *to DO *[on] *[the] [some_place])
          (CAN GET_GO *[on] *[the] [some_place])
          (WANTS [get] *[the] [some_place] [on] *[the] [some_place])
WANTS
          ([want]) ([wants])
DO
          (buy) ([get]) (talk to ONE) (see ONE) (do [any])
ONE
          (somebody) (someone) (*MY friend) ([the])
MY
          ([its]) ([my])
PREFER
          ([i] [want]) (for example) (for instance) ([how] about) ([whats])
GET_GO
          ([get] *back) ([go] *back) (make *it *back) (*drive *to get)
          (arrive) ([know])
I
          ([i]) ([i_m])
CAN
          ([can]) ([is])
FAR
          ([Arrive_Loc] *[Arrive_Near])
;
[wants]
          (wants)  (needs) (likes) (wishes) (desires) (hopes) (seeks)
          (requests) (prefers) (expects)
;
[my]
          (my) (our) (his) (her) (their)
;
[know]
          (know) (be aware of) (acknowledge)
;
[i_m]
          (i'm) (i'll) (i'd) (we're) (you're) (he's) (she's)
;
[any]
          (any) (anything) (some) (something)
;
[doing_things]
          (going) (doing) (getting) (taking) (making) (driving) (eating)
          (finding) (*sight seeing) (looking) (swimming) (shopping) (walking)
          (jogging) (having fun) (dining) (talking *with *people)
      (chatting *with *people) (fooling around) (DRINKING) (WRITING)
```

```
        (READING) (TOURING) (mentoring) (tutoring) (teaching)(including)
        (*seminar presentation)
TOURING
        (*bicycle touring) (motorcycle touring) (sport touring)
DRINKING
        (drinking *beer) (drinking champagne) (drinking wine)
READING
        (reading *comic *book) (reading *comic books)
        (reading *[the] novel) (reading *[the] novels)
WRITING
        (*book writing) (paper writing) (tutorial writing)
;
#A copy of all places and items
[some_place]
        ([bank_item]) (highway patrol *[building_type]) ([street_name])
        ([high_way]) ([hunter_henry_alumni_center] *[building_type])
        ([simrall_electrical_and_computer_engineering] *[building_type])
        ([engineering_research_center] *[building_type])
        ([campus_service_name]) ([building_name]) ([business_misc_name])
        ([courthouse_grill_and_bar]) ([mississippi_state_university])
        ([merchants_and_farmers_bank]) ([kroger] *[building_type])
        ([college_of_business] *[building_type])
        ([college_of_agriculture_and_life_sciences] *[building_type])
        ([college_of_arts_and_sciences] *[building_type])
        ([information_technology_systems] *[building_type])
        ([geographic_information_systems] *[building_type])
        ([university_bookstore] *[building_type])
        ([computer_science] *[building_type])
        ([electrical_and_computer_engineering] *[building_type])
        ([electrical_engineering] *[building_type])
        ([industrial_engineering] *[building_type])
        ([center_for_advanced_vehicular_systems] *[building_type])
        ([institute_for_signal_and_information_processing] *[building_type])
        ([english_as_a_second_language_center] *[building_type])
        ([callejas_international_services_office] *[building_type])
        ([mathematics_and_statistics] *[building_type])
        ([diagnostic_instrumentation_and_analysis_laboratory] *[building_type])
        ([dean_of_engineering] *[building_type]) ([place_type_name])
        ([tva]) ([supermarket_name] *[building_type])
        ([walmart_name] *[building_type]) ([special_item_name])
        ([gtrairport_item] *[building_type]) ([hospital_item] *[building_type])
        ([cabletv_item] *[building_type]) ([yogurt_item])
        ([postoffice_item] *[building_type]) ([court_item] *[building_type])
        ([police_item] *[building_type]) ([restaurant_type]) ([flower_shop])
          ([barber_shop]) ([souvenir_type]) ([car_repair_shop])
          ([convenient_store]) ([convenient_item]) ([daycare_type])
```

```
            ([grocery_store]) ([grocery_item]) ([electronics_store])
            ([electronics_item]) ([bakery_type]) ([fruit_type]) ([vegetable_type])
            ([drink_items]) ([shoe_store]) ([shoe_type]) ([entertainment_type])
            ([sports_type]) ([game_type]) ([supermarket] *[building_type])
            ([supermarket_item]) ([cooking_items]) ([cleaning_items])
              ([personal_items]) ([cheese_type]) ([meat_type]) ([bar_item])
            ([movie_theater]) ([apparel_item]) ([appliance_item])
              ([furniture_item]) ([liquor_store_type]) ([liquor_store])
            ([whisky_type]) ([beer_type]) ([wine_type])
;
```

--DISTANCE--

```
    User:ONCE YOU TURN ONTO UNIVERSITY DRIVE FROM BARR AVENUE, HOW
FAR
        DOWN UNIVERSITY DRIVE IS THE HUNTER HENRY CENTER

    Parser:
        Query_Distance:[Query_Distance].query_distance
        [Depart_Loc].[Address].[Street_Name].UNIVERSITY DRIVE
        [Arrive_Loc].[Building_Name].HUNTER HENRY ALUMNI CENTER
```

--This kind of utterance is new to the previous grammar. The following rule handles it.

```
[_query_distance]
            (*AN_ITEM HOW_FAR *CAN *[that] *take)
AN_ITEM
            (*[once] *[i] *MOVE *[on] [some_place] [on] [some_place])
MOVE
            (move) (turn) (take) ([go]) ([get])
CAN
            ([is]) ([can])
HOW_FAR
            ([how] [far] *down) ([how] many miles)
;
[once]
            (once) (when)
;
[far]
            (far) (close) (long)
;
```

--LIST OF PLACES--

User: WHICH WALMART IS CLOSE TO KROGER

Parser:

Query_List:[Query_List].query_list [Arrive_Loc].[Place_Name].[Supermarket_Name].WALMART [Arrive_Near].[Place_Name].[Supermarket_Name].KROGER

--The previous grammar did not resolve [query_list] and [Arrive_Near]. The modified grammar handles the deficiency as follows.

```
[_query_list]
          ([whats] [Arrive_Loc] [is] [Arrive_Near])
;
```

- Utterances using "here" and "there".

  User:
  HOW CAN I GO FROM HERE TO WALMART?
  Parser:
  Query_Direction:[Query_Direction].query_map
  [Depart_Loc].HERE
  [Arrive_Loc].[Place_Name].[Supermarket_Name].WALMART

  User:
  HOW CAN I GO FROM THERE TO WALMART?
  Parser:
  Query_Direction:[Query_Direction].query_map
  [Depart_Loc].THERE
  [Arrive_Loc].[Place_Name].[Supermarket_Name].WALMART

  User:
  HOW CAN I GO FROM HERE TO THERE?
  Parser:
  Query_Direction:[Query_Direction].query_map
  [Depart_Loc].HERE
  [Arrive_Loc].THERE

  No new slots are needed, the dialog manager will keep track of arrival and departure locations that will correspond to HERE and THERE.

- The user may visit multiple places in sequence, e.g.

  User:
  FIRST I WILL GO TO WALMART FROM HERE AND THEN TO KROGER, DIRECTION PLEASE
  Parser:
  Query_Direction:[Query_Direction].query_map
  [Arrive_First].[Place_Name].[Supermarket_Name].WALMART
  [Depart_Loc].HERE

[Arrive_Loc].[Place_Name].[Supermarket_Name].KROGER

This utterance has the form of a regular "direction" query between arrival and departure locations, but involves a third place to visit in between. So the in-between place is put in the slot [Arrive_First]. The user specifies that he/she will depart from the current location, which was quantified in the slot [Depart_Loc].HERE.

User:
STARTING FROM WALMART, I WILL GO TO KROGER AND THEN TO WENDY'S, CAN YOU ESTIMATE THE DISTANCE FOR THAT ROUTE?
Parser:
Query_Distance:[Query_Distance].query_distance
[Depart_Loc].[Place_Name].[Supermarket_Name].WALMART
[Arrive_First].[Place_Name].[Supermarket_Name].KROGER
[Arrive_Loc].[Place_Name].[Restaurant_Name].WENDY'S

This utterance has the form of a regular "distance" query between arrival and departure locations, but involves a third place to visit in between. So the in-between place is put in the slot [Arrive_First].

User:
I WANT GAS FOR MY CAR, WHERE CAN I GET IT ON THE WAY FROM ERC TO WALMART?
Parser:
Query_Address:[Query_Address].query_isonway
[Arrive_First].[Place_Type].CONVENIENT STORE
[Depart_Loc].[Campus_Service_Name].ENGINEERING RESEARCH CENTER
[Arrive_Loc].[Place_Name].[Supermarket_Name].WALMART

In this case, [query_isonway] and [Arrive_First] are needed. The user wishes to travel from one place to another, but on the way, he/she wants to visit another place passing by or stopping at. Here, [Arrive_First] refers to the place visited in between.

- Another utterance pattern may be given as follows.

User:
IS ARBY'S LOCATED ON HWY 12 OR HWY 82 OR HWY 25?
Parser:
Query_Address:[Query_Address].query_isitat
[Arrive_Loc].[Place_Name].[Restaurant_Name].ARBY'S
[Arrive_First].[Address].[Street_Name].HWY 12
[Arrive_Second].[Address].[Street_Name].HWY 82
[Arrive_Third].[Address].[Street_Name].HWY 25

This utterance requires modeling of four arrival locations and so [Arrive_Third]. The user wants to visit one specific location, but he/she wants to know beforehand if it is located on some certain street by indicating those street names one after another, which was quantified by the keyword [query_isitat]. Here, [Arrive_First], [Arrive_Second] and [Arrive_Third] may refer to user specified street names, areas or locations.

- Utterances asking for geographical directions.

User:
IS DR. JOSEY'S OFFICE NORTH OR SOUTH OF WALMART
Parser:
Query_Direction:[Query_Direction].which_way

[Arrive_Loc].[Person_Title].DR. [Person_Name].JOSEY'S [Place_Type].OFFICE
[Arrive_First].[Place_Name].[Supermarket_Name].WALMART

In this utterance, three locations are involved, i.e. the user's current location which is stored in DM context, Dr. Josey's office - [Arrive_Loc] and Walmart which is used for direction determination implemented as [Arrive_First]. The new keyword - "which_way" is necessary to capture what the utterance refers to.

User:
IS KROGER EAST OR WEST FROM HERE
Parser:
Query_Direction:[Query_Direction].which_way
[Arrive_Loc].[Place_Name].[Supermarket_Name].KROGER
Query_Direction:[Depart_Loc].HERE

Only two locations are involved in the utterance above. Departure location is explicitly stated and captured by the slot [Depart_Loc]. Arrival location is captured by the slot [Arrive_Loc]. The keyword "which_way" quantifies the actual purpose of the utterance.

User:
SHOULD I GO EAST OR WEST IF I WANT TO GET TO THE ACADEMY
Parser:
Query_Direction:[Query_Direction].which_way
Query_Direction:[Arrive_Loc].[Address].[Street_Name].ACADEMY

Again, the keyword "which_way" quantifies the actual purpose of the utterance.

- Utterances related to streets intersecting at some point.

User:
DOES LYNN LANE INTERSECT ACADEMY ROAD
Parser:
Query_Intersect:[Query_Intersect].query_intersect
[Arrive_First].[Address].[Street_Name].LYNN LANE
[Arrive_Second].[Address].[Street_Name].ACADEMY ROAD

No actual arrival or departure locations are involved in the utterance, but info. about two streets intersecting, which are captured by the slots [Arrive_First] and [Arrive_Second]. The keyword "query_intersect" has the role to determine what to do with the captured slots.

- Utterances asking for the next turn that takes to certain arrival location.

User:
I'M ON NASH STREET WHAT'S MY NEXT TURN
Parser:
Query_Direction:[Query_Direction].query_turn
[Depart_Loc].[Address].[Street_Name].NASH STREET
[Arrive_Loc].NEXT_TURN

The departure location is explicitly given, i.e. one of the streets on which the user navigates. The arrival location is the next left or right turn that the navigator may take, depending on where he/she is headed. The keyword "query_turn" help determine the purpose of the utterance.

User:
IF I GO TO HOLIDAY INN SHOULD I TURN RIGHT AT THE SECOND INTERSECTION

Parser:
Query_Direction:[Query_Direction].query_turn
[Arrive_First].[Place_Name].[Hotel_Name].HOLIDAY INN
[Arrive_Loc].NEXT_TURN

The current location of the user is kept in the DM context. The arrival location is the next turn that the user will take to get his/her final arrival location, which is captured in the slot [Arrive_First].

User:
SHOULD I TURN RIGHT OR LEFT AT LOGAN STREET
Parser:
Query_Direction:[Query_Direction].query_turn
[Arrive_Loc].NEXT_TURN
[Arrive_First].[Address].[Street_Name].LOGAN STREET

Here, the structure is same as in the utterance above. The user takes a right or left turn depending on his/her final arrival location.

- Utterances seeking the faster route.

User:
TO DRIVE FROM MSU CAMPUS TO WALMART IS IT FASTER TO TAKE HIGHWAY 12 OR HIGHWAY 82
Parser:
Query_Distance:[Query_Distance].query_distance
[Depart_Loc].[Place_Name].[Business_Misc_Name].MISSISSIPPI STATE UNIVERSITY
[Arrive_Loc].[Place_Name].[Supermarket_Name].WALMART
[Arrive_First].[Address].[Street_Name].HIGHWAY 12
[Arrive_Second].[Address].[Street_Name].HIGHWAY 82

Regular departure and arrival locations are captured by the corresponding slots, but the user enters two more location names, which are captured by the slots [Arrive_First] and [Arrive_Second] and are used for determining the faster route between departure and arrival locations.

- Options with parser appear to be broad, however, need to be implementable in the dialog manager and database server.

- This report will be continuously updated once new material is covered.