

eTourPlan: A Knowledge-Based Tourist Route and Activity Planner

Thesis Oral Defence for MCS Degree Program

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Acknowledgement

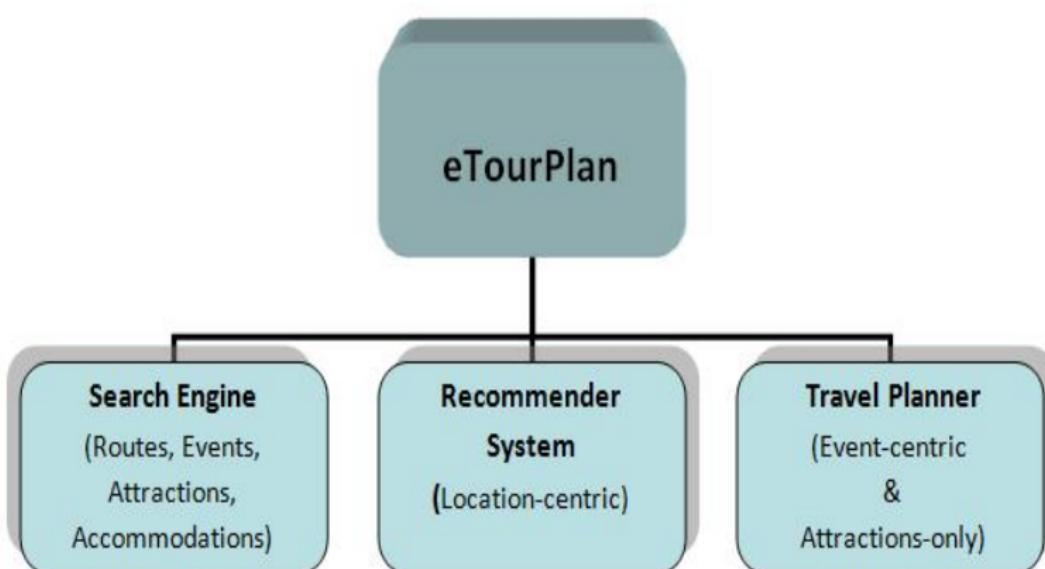
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 - University of New Brunswick (UNB)

Outline

- 1 Introduction
 - 2 Background
 - 3 Knowledge Base Design: Ontology and Facts
 - 4 Knowledge Base Design: Rules
 - 5 Evaluation of eTourPlan on the Bhutan KB
 - 6 Conclusion and Future Work

1.1 Introduction

A knowledge-based eTourism prototype



- Tourism is the world's largest and fastest growing industry
 - The World Tourism Organization predicts that one billion international tourists will travel by the year 2010
 - Most of the prevalent travel recommenders are location-centric
 - **Shortcoming:** Do not function as complete trip planners.
e.g., time (visit a number of places) > time (available to traveller)
 - Pre-customized travel packages in mass tourism
 - **Shortcoming:** limited flexibility to users' preference specification
 - Independent sources for various tourist facility information (activity and accommodation)
 - **Shortcoming:** Tourist consultants and travellers must visit multiple independent sources to plan a trip tailored to given preferences

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1.2.2 Motivation

- eTourism is an information-based heterogenous business (distributed nature of its high volume of information)
 - Information gathering, integration, distribution, and exchange are the backbones of the travel industry
 - The Semantic Web is a major endeavour to enhance the Web by enriching its content with semantic (meta)data that can be processed by inference-enabled Web applications
 - Modelling a well-structured and comprehensive Knowledge Base (KB) for consulting will help bolster the eTourism domain

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To design, implement, and evaluate a knowledge-based eTourism prototype for Bhutan

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- To design a light-weight ontology to capture all the tourism subdomains [aligned with the **Harmonise** eTourism ontology]
 - To build a Bhutan fact base consisting of **FOAF-like** profiles for tourist entities, structured by this ontology
 - To implement rule subsystems needed for generating **travel plans** containing **tour recommendations**:
 - Partonomy rules for the subdivision of regions
 - Derivation rules to deduce transitive closure facts about distances etc.
 - Inference rules for various planning and recommendation modes
 - Query rules to perform semantic searches
 - To evaluate the overall operation of the eTourPlan prototype as run in the **OO jDREW** reasoning engine prototype (giving feedback to the **OO jDREW** open source community)

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1.4 Travel Planner

eTourPlan

- A knowledge-based eTourism prototype using Semantic Web techniques:
 - A well-structured and comprehensive KB for tourism subdomains
 - Rule subsystems for search, recommendation and travel planning
 - Utilizing Bhutan tourist information as a use case
 - Results of running eTourPlan in the prototype RuleML engine OO jDREW are reported



2.1.1 Travel Planning Strategies

	Attraction-Only Planning	Event-Only Planning	Event-Centric Planning
Complete Planning	Planning attractions based on related locations	Planning events based on their dates and locations	Planning events with additional attraction recommendation
Sequence Planning	System orders the user-specified attractions	System orders the user-specified events	System orders both events and attractions
Partial Planning	System orders and adds to user-specified attractions	System orders and adds to user's specified events	System orders and adds to user's specified events and attractions



2.1.2 Recommender System

Knowledge-based Recommenders

- Use ontologies and rules for knowledge representation
 - Derive implicit facts from ontology-structured facts using rules
 - Provide recommendations as wide-ranging as its KB
 - Respond to user's stated requirements

A “NEED” for providing trip planning options

2.2 The Semantic Web

Concept

- Machine-understandable metadata
- Knowledge representation and automatic data integration
- Desirable for structuring vast information-based business (e.g. Tourism)

Semantic Web techniques

- Knowledge representation by using XML, RDF and ontologies
- To perform inferences and automated reasoning using Description-Logic and/or Rule Engines

2.3 FOAF: Friend Of A Friend

[Friend Of A Friend: Semantic Social Networking](#)

- Provides extended RDF Schema (RDFS) vocabulary
 - Person-centric RDF knowledge representation
 - Enables Semantic Web methods for formalised personal homepages

An approach similar to FOAF is transferred to semantically describe and link profiles for tourist entities

2.4 The Harmonise ontology

Ontology: Shared understanding of the relevant concepts and relationships of a domain

Harmonise ontology:

- eTourism ontology for information exchange in travel and tourism
 - Classifications of data items for events, attractions, accommodations, and restaurants
 - A market validation by 12 pilot organizations (based across Europe) through the Harmo-TEN project
 - Some key players in the Tourism Harmonization Network are:
 - the Open Travel Alliance (OTA)
 - the World Tourism Organization (WTO)
 - the Travel Technology Initiative (TTI)
 - the International Federation for IT, Travel and Tourism (IFITT)



2.5 Semantic eTourism Prototype

Machine-readable representation of information in the form of:

Ontologies:

- Good basis for reasoning and classification
 - Uniform definitions of tourism subdomains
 - Remove semantic ambiguity

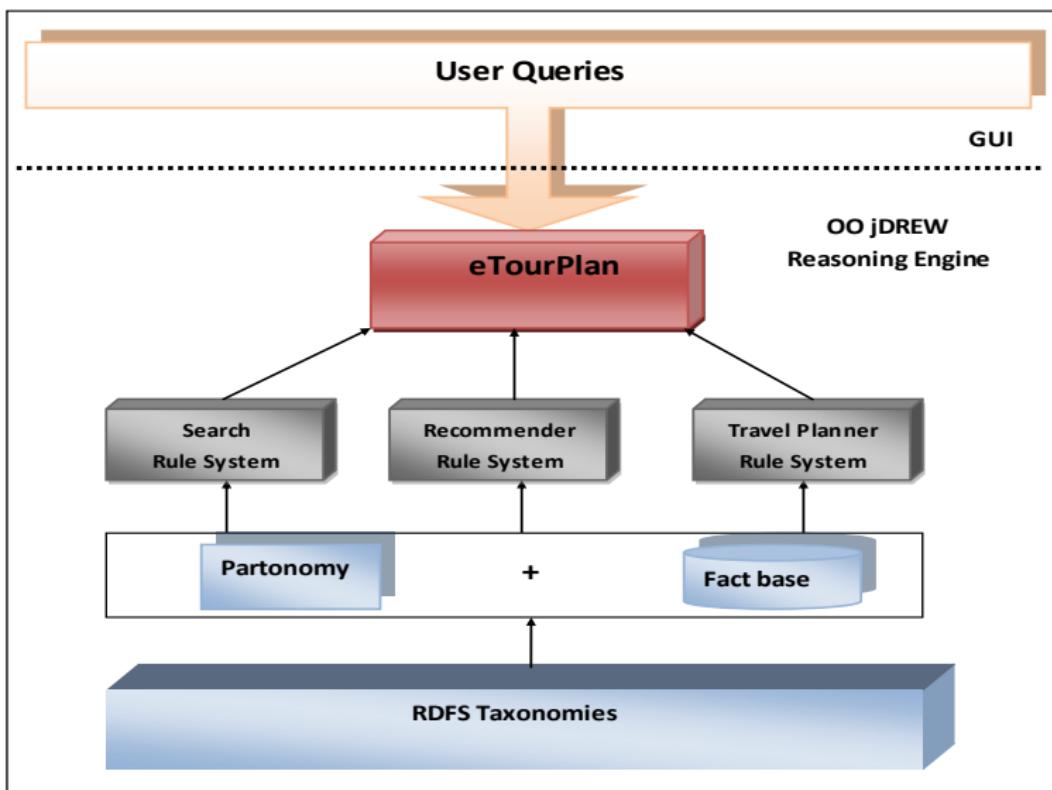
Facts:

- Object-centric descriptions of tourist entities

Rules:

- Semantic search against the above facts (formal knowledge) rather than keyword search against texts (natural language)
 - Higher services based on deduction (Travel planning and recommendation)

3.1 The eTourPlan Architecture



3.2 Ontology Design

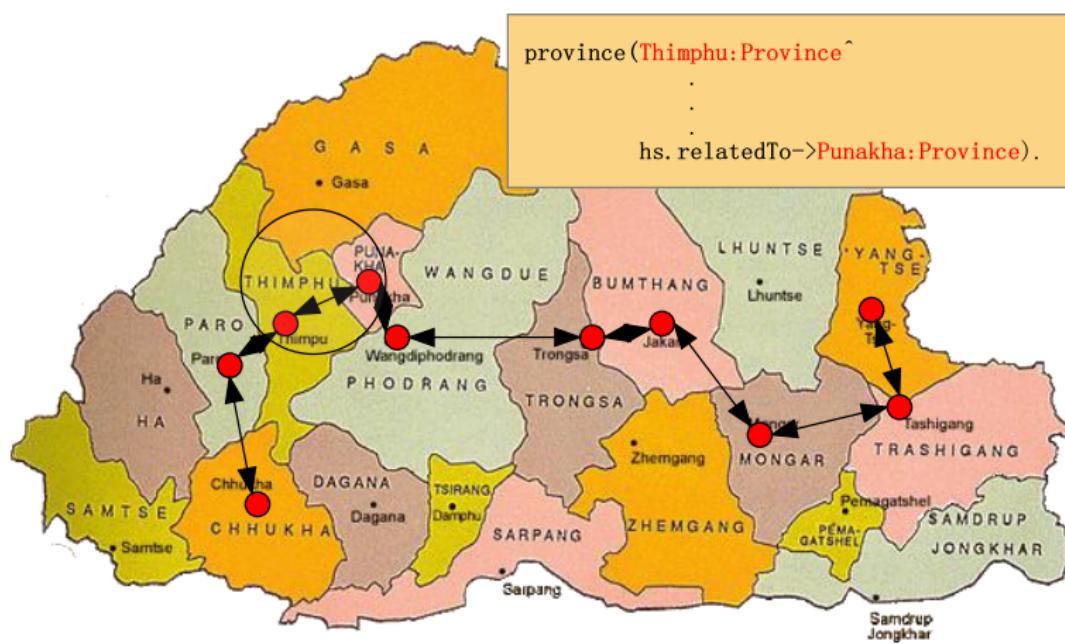
- ‘Reference model’ for a specific domain
- RDFS light-weight ontologies (adapted from the Harmonise eTourism ontology)
- To structure the FOAF-like profiles of tourist entities:
 - province
 - event
 - attraction
 - accommodation
- **Why Harmonise?**
 - Mature and standard ontology
 - Interoperability among many agents and applications
 - Expressed in RDFS (SubClassOf hierarchies are supported by OO jDREW)

3.3.1 FOAF-like Province Profile

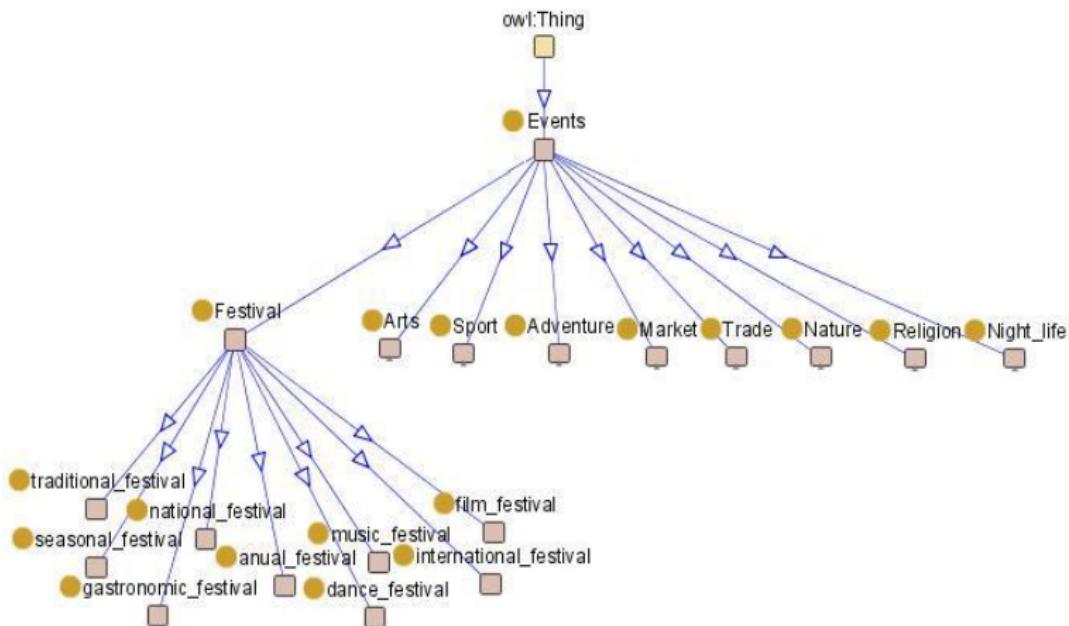
Profile of Thimphu Province

```
province(Thimphu:Province^
    hs.url->"http://www.thimphu.gov.bt";
    et.capital->Thimphu_City:City;
    et.area->"1,819 sq.km";
    et.elevation-> "1,300 to 7300 meters";
    et.numBlocks->10:Integer;
    et.numAttractions->3:Integer;
    et.numEvents->2:Integer;
    et.numAccommodations->0:Integer;
    hs.languagesSpoken->"Dzongkha";
    hs.description->"Thimphu is the capital of Bhutan";
    hs.relatedTo->Punakha:Province).
```

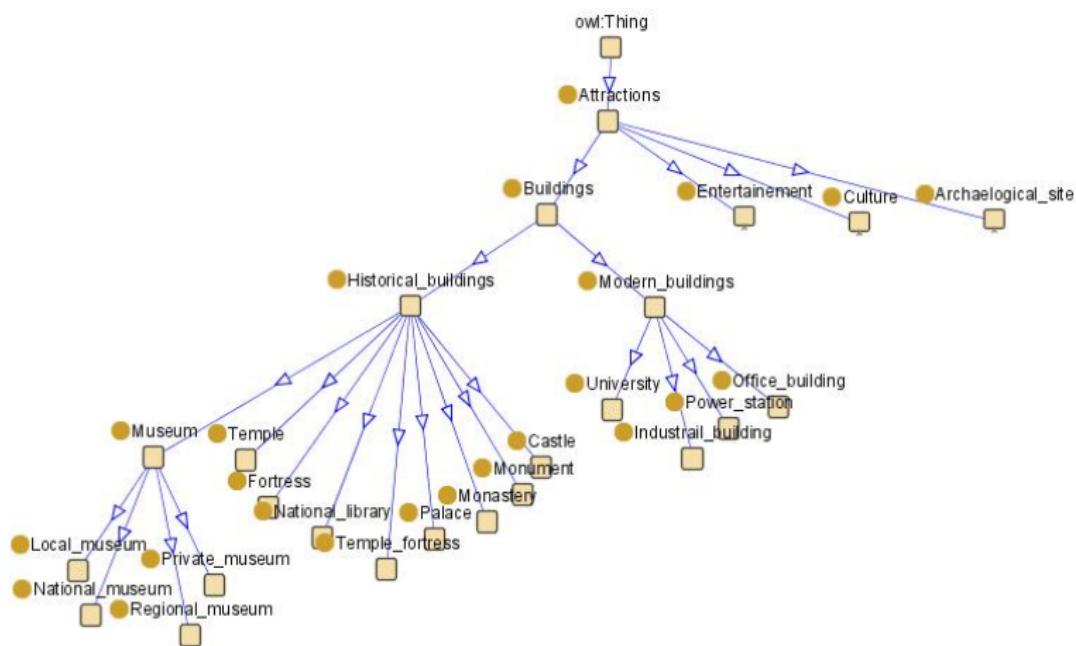
3.3.2 Harmonise's "relatedTo" relation between provinces in the KB



3.3.3 Events Class



3.3.4 Attractions Class



3.3.5 FOAF-like Profiles of an Event and an Attraction

Profile of Thimphu_Tshechu

```
event(Thimphu_Tshechu:Annual_festival^
    hs.url->“ ”;
    hs.startDate->date[2008:Real,10:Real,09:Real];
    hs.endDate->date[2008:Real,10:Real,11:Real];
    et.theme->Cultural_Religious_Heritage;
    hs.location->Tashichoe_Dzong:Fortress;
    et.province->Thimphu:Province;
    hs.description->“It is a popular festival in Thimphu”;
    hs.relatedTo->Thimphu_Drupchen:Annual_festival).
```

Profile of Ta_Dzong

```
attraction(Ta_Dzong:National_museum^
    hs.url->“www.nationalmuseum.gov.bt/”;
    et.subblock->Goepay:Village;
    et.province->Paro:Province;
    et.theme->Cultural_Religious_Heritage;
    et.open->Open[DaysOfWeek[Tue, Wed, Thu, Fri, Sat, Sun],
        Period[10:Real, 16:Real]];
    et.capitalDistance->0.5:Real;
    hs.description->“It is the biggest and the oldest museum
        in Bhutan”;
    hs.contact->“ ”;
    hs.schedule->“12 months”;
    hs.relatedTo->Tashichoe_Dzong:Fortress).
```

4.1 eTourPlan Rule Subsystems

① Partonomy Rules

- Administrative subdivision of a country

② Rule System for Route Planning

- Searching routes between Provinces
- System route planning based on Province profiles
- Route planning via user-preferred Provinces

③ Rule System for Parametric Search of Tourist Entities

- Provincial information
- Activity opportunities (Events and Attractions)
- Accommodation information

④ Rule System for Location-Centric Travel Recommender

- Tour through user-preferred Provinces
- Tour of system-recommended Provinces

⑤ Rule Systems for eTourPlan Travel Planner

- Attraction-only Planning
- Event-centric Planning

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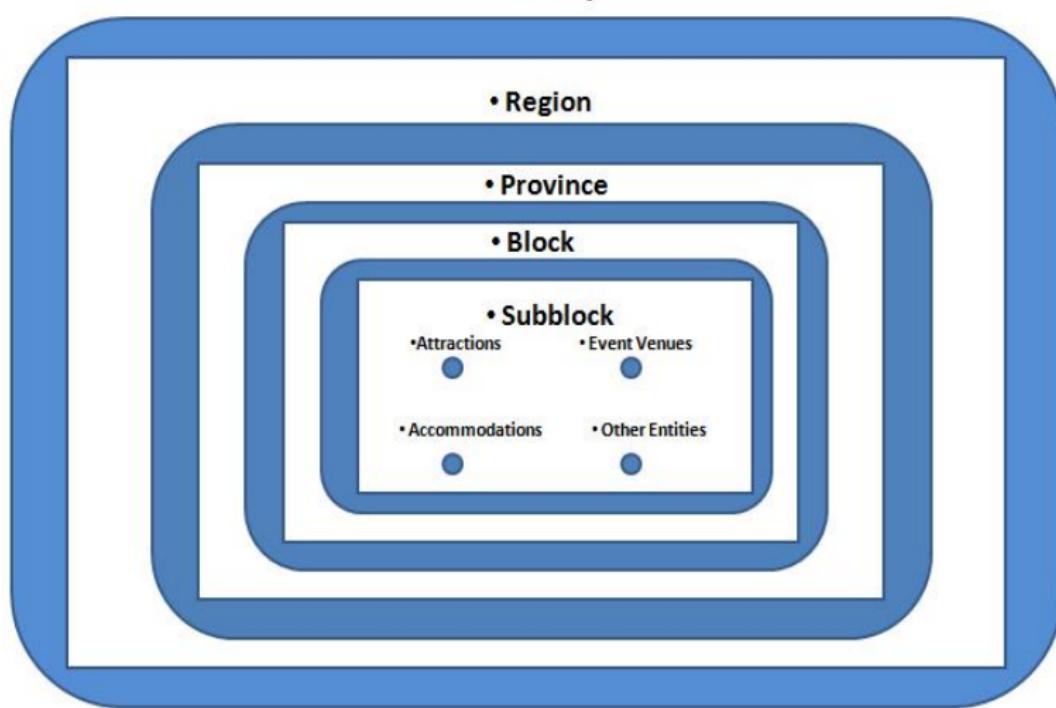
- Attraction-only Planning
- Event-centric Planning

4.2.1.1 Partonomy

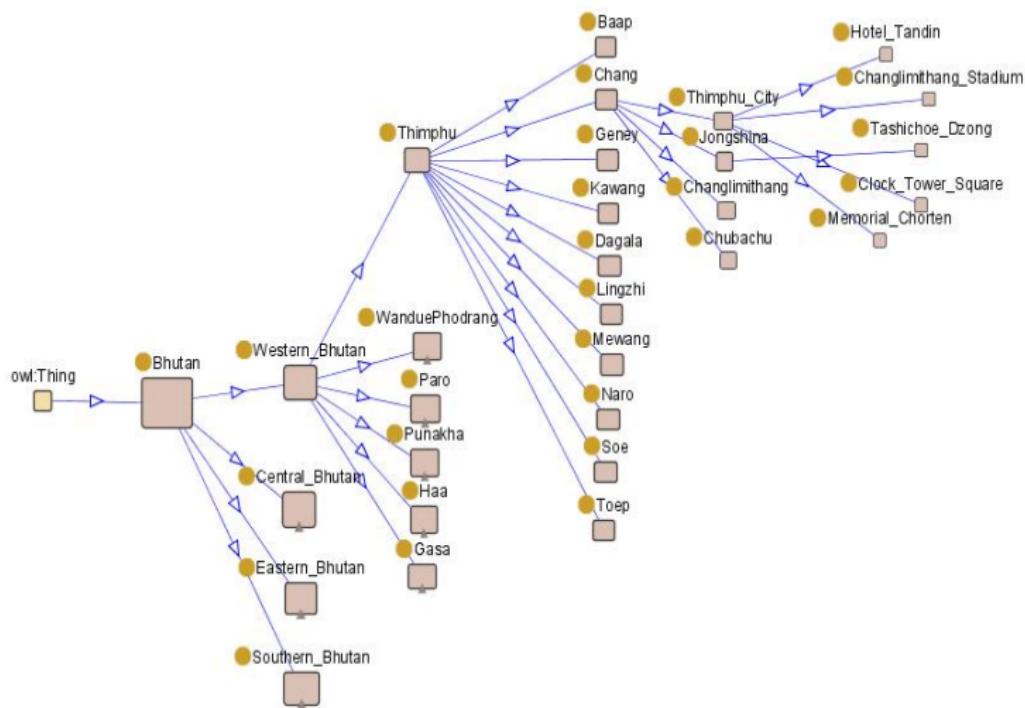
Classification of Regions subdomain

- Partonomy classifies subparts and superparts based on the “partOf” relation, allowing geographically focused search
 - Enriched domain-specific partonomy rule with taxonomic type definition
 - Clear interrelation between a taxonomy and a partonomy
 - Avoids information ambiguity
 - General partonomy rule
 - A generic definition of the binary “partOf” relation
 - Transitive closure of the “partOf” relation

4.2.1.2 Subparts of a Country (e.g. Bhutan)



4.2.1.3 Excerpt from the Partonomy of Bhutan



4.2.1.4 Partonomy KB (Ground Facts in RuleML/POSL)

```
%siteOf(?Attraction:Attractions, ?Subblock:Subblock).  
siteOf(Tashichoe_Dzong:Fortress, Jongshina:Town).  
siteOf(Memorial_Chorten:Temple, Thimphu_City:City).  
siteOf(Hotel_Tandin:Hotel, Thimphu_City:City).
```

```
%partOfBlock(?Subblock:Subblock, ?Block:Block).  
partOfBlock(Jongshina:Town, Chang:Block).  
partOfBlock(Thimphu_City:City, Chang:Block).  
partOfBlock(Chubachu:Town, Chang:Block).  
partOfBlock(Changlimithang:Town, Chang:Block).
```

```
%partOfProvince(?Block:Block, ?Province:Province).  
partOfProvince(Baap:Block, Thimphu:Province).  
partOfProvince(Chang:Block, Thimphu:Province).
```

```
partOfProvince(Dagala:Block, Thimphu:Province).  
partOfProvince(Geney:Block, Thimphu:Province).  
partOfProvince(Kawang:Block, Thimphu:Province).  
partOfProvince(Lingzhi:Block, Thimphu:Province).  
partOfProvince(Mewang:Block, Thimphu:Province).  
partOfProvince(Naro:Block, Thimphu:Province).  
partOfProvince(Soe:Block, Thimphu:Province).  
partOfProvince(Toep:Block, Thimphu:Province).
```

```
%partOfRegion(?Province:Province, ?Region:Region).  
partOfRegion(Thimphu:Province, Western:Region).
```

```
%partOfCountry(?Region:Region, ?Country:Country).  
partOfCountry(Western:Region, Bhutan:Country).
```

4.2.1.5 Partonomy KB (Rule with Query and Result)

KB (Rule):

```
getFullAddress(?Location, [?Subblock, ?Block, ?Province, ?Region, ?Country]):-
    siteOf(?Location, ?Subblock),
    partOfBlock(?Subblock, ?Block),
    partOfProvince(?Block, ?Province),
    partOfRegion(?Province, ?Region),
    partOfCountry(?Region, ?Country).
```

Sample Query:

```
getFullAddress(Ta_Dzong:National_museum, ?Address)
```

OO jDREW TD Result:

```
?Address= [Hungrel:Village, %Subblock of type "Village"
           Hungrel:Block,   %Block
           Paro:Province,
           Western:Region,
           Bhutan:Country]
```

4.2.1.6 Search Queries and Results

Sample Queries:

1. getAttraction(?Attraction, Bhutan:Country)
2. getAttraction(?Attraction, Western:Region)
3. getAttraction(?Attraction, Bumthang:Province)
4. getAttraction(?Attraction, Chhoekhor:Block)
5. getAttraction(?Attraction, Chamkhar:Town)

OO jDREW TD Results for Query 5:

?Attraction= Bumthang_Dzong:Fortress
?Attraction= Zugney:Textiles
?Attraction= Ugyen_Chholing_Museum:Local_museum
?Attraction= Petseling_Gompa:Temple

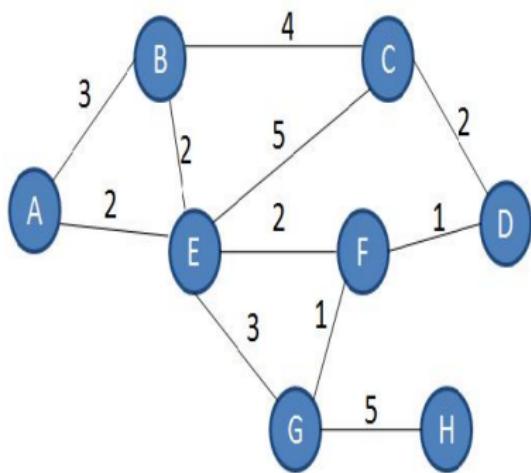


Figure: A connected sample graph

Table: POSL representation of the connected graph

```
distanceTime(startPoint->A; endPoint->B; bus->3:Real).
distanceTime(startPoint->A; endPoint->E; bus->2:Real).
distanceTime(startPoint->B; endPoint->C; bus->4:Real).
distanceTime(startPoint->B; endPoint->E; bus->2:Real).
distanceTime(startPoint->E; endPoint->F; bus->2:Real).
distanceTime(startPoint->C; endPoint->D; bus->2:Real).
distanceTime(startPoint->C; endPoint->E; bus->5:Real).
distanceTime(startPoint->D; endPoint->F; bus->1:Real).
distanceTime(startPoint->E; endPoint->G; bus->3:Real).
distanceTime(startPoint->F; endPoint->G; bus->1:Real).
distanceTime(startPoint->G; endPoint->I; bus->5:Real).
```

KB (Rule):

```

dTRShortest(startPoint->?Province1; endPoint->?Province2;
            route->?AllRoutes; shortestRoute->?ShortestRoute):-  

routeCount(startPoint->?Province1; endPoint->?Province2;
           count->?Count:Integer),  

dTRLList(startPoint->?Province1; endPoint->?Province2;
          visited->[]; currentMinRoute->[R,10000:Real];
          route->?Routes; min->?ShortestRoute;
          count->?Count:Integer).

```

4.2.2 Route and Distance-time Computation (Cont'd)

Sample Query:

```
dTRShortest(startPoint->A; endPoint->H;  
           route-> ?AllRoutes;  
           shortestRoute-> ?ShortestRoute)
```

OO jDREW TD Result:

```
?AllRoutes= [[[A, E, G, H], 10.0:Real],  
            [[A, B, E, G, H], 13.0:Real],  
            [[A, E, F, G, H], 10.0 : Real],  
            [[A, B, C, E, G, H], 20.0 : Real],  
            [[A, B, E, F, G, H], 13.0 : Real],  
            [[A, B, C, D, F, G, H], 16.0 : Real],  
            [[A, B, C, E, F, G, H], 20.0 : Real],  
            [[A, E, C, D, F, G, H], 16.0 : Real],  
            [[A, B, C, D, F, E, G, H], 20.0 : Real],  
            [[A, B, E, C, D, F, G, H], 19.0 : Real],  
            [[A, E, B, C, D, F, G, H], 17.0 : Real]]  
  
?ShortestRoute= [[A, E, G, H], 10.0 : Real]
```

4.3.1 Rule System for eTourPlan Attraction-only Planning

The planner performs the following steps:

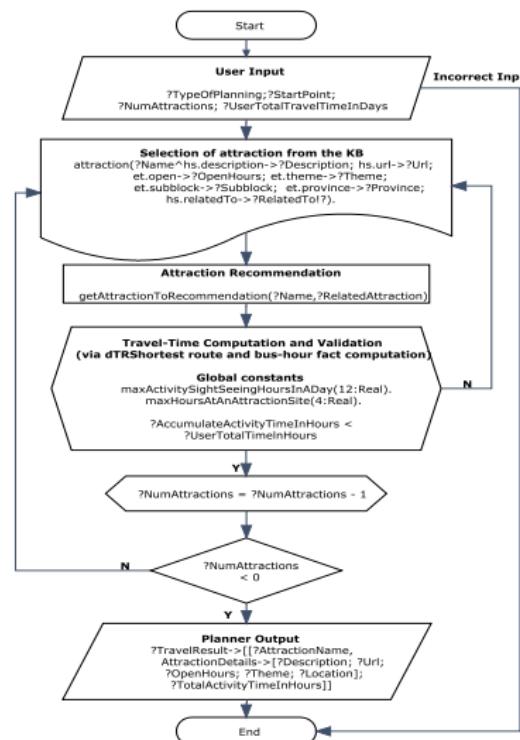
- From the user-specified starting point, an attraction is selected and chains to the next related attraction.

- Compute and validate route and travel-time constrained by global constants:

-maxActivitySightSeeingHoursInADay(12:Real)

-maxHoursAtAnAttractionSite(4:Real)

- On successful validation of distance and remaining time, add detailed information of the selected attraction to the travel plan.



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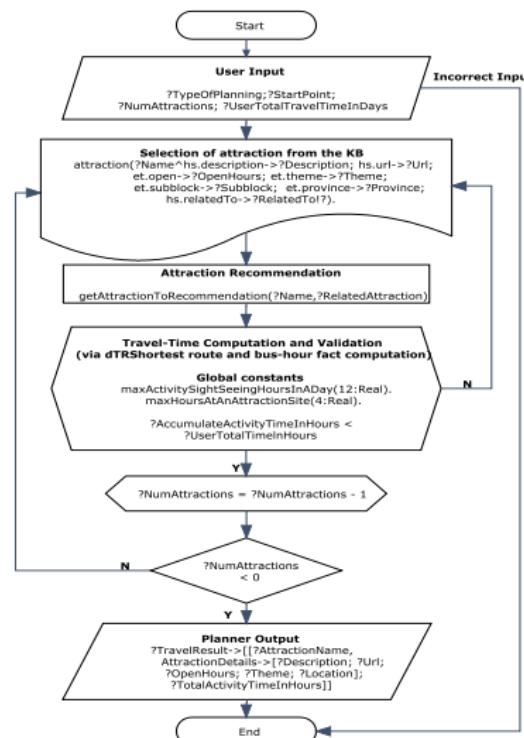
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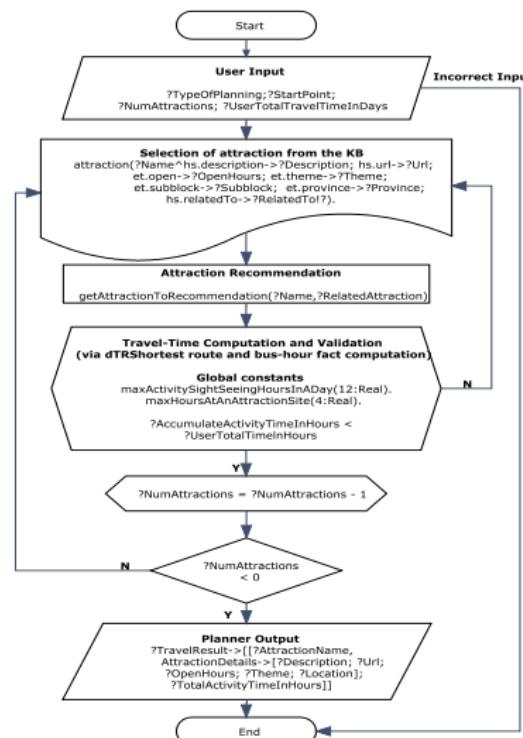
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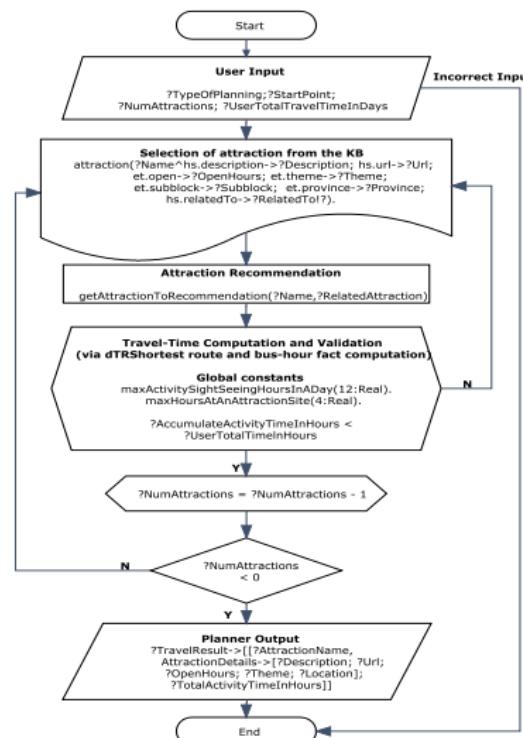
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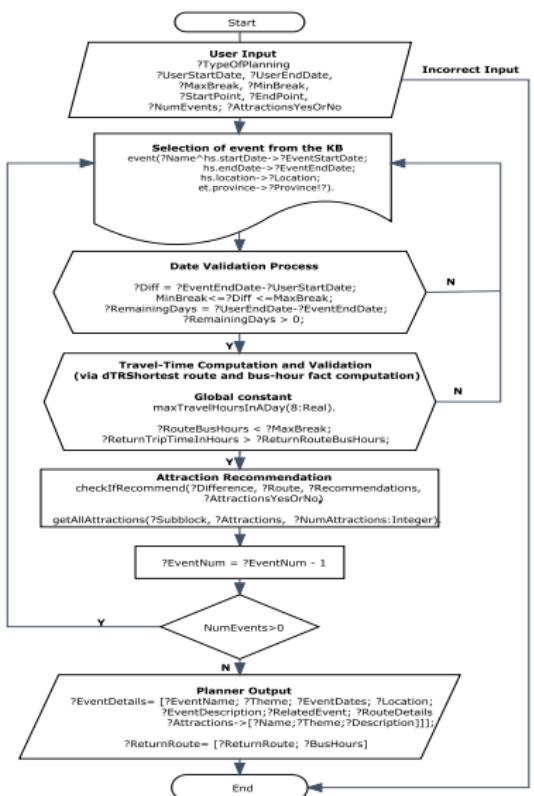
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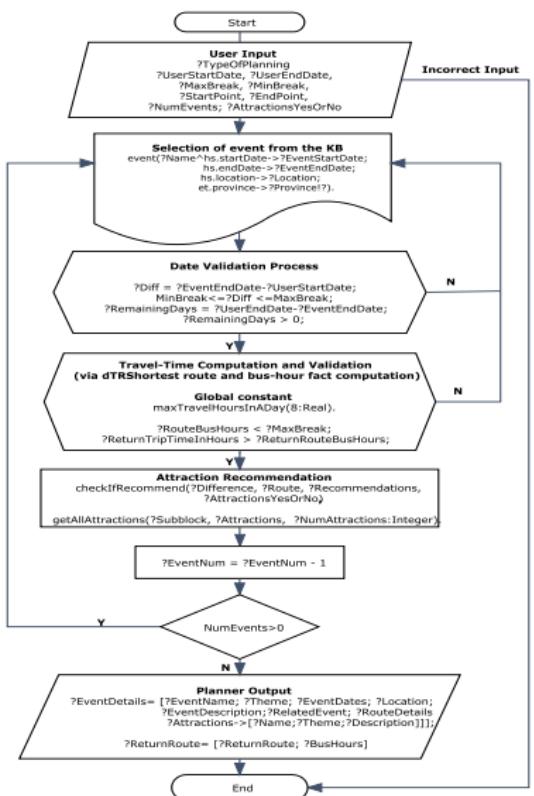
- 1 Events are selected by validating the event dates against the user's travel dates, minimum break, and maximum break.
- 2 Compute and validate route and bus hours constrained by maximum break.
- 3 On successful validation of distance and remaining time, add detailed information of the selected event to the travel plan.
- 4 Recommend attractions located in the subblock of the selected event.
- 5 Provide on-route attraction recommendation if the user selects the option (constrained by the global constant "maxTimeGapBetweenEvents").



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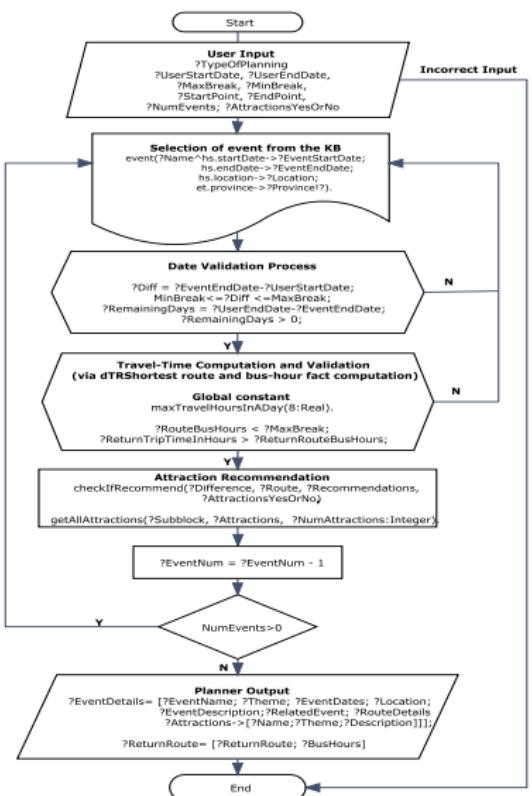
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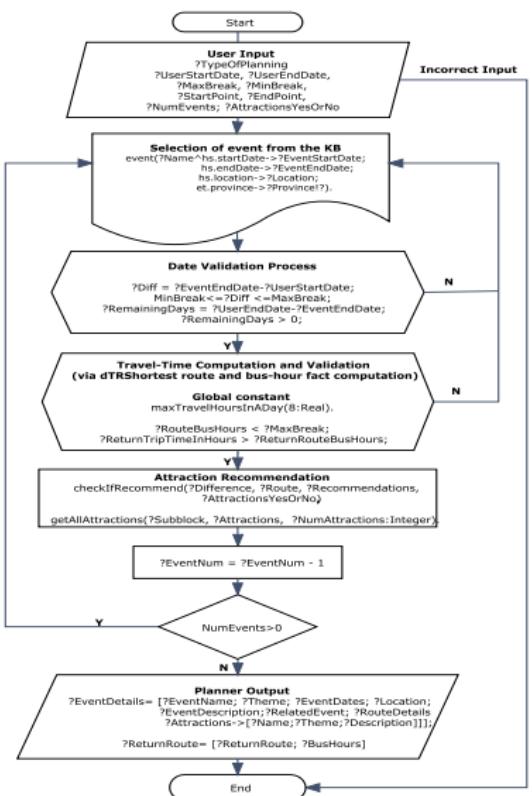
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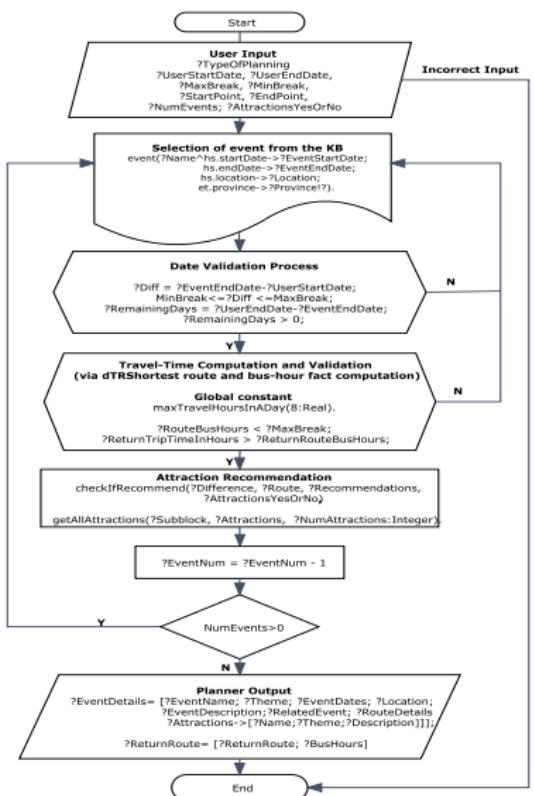
- 1 Events are selected by validating the event dates against the user's travel dates, minimum break, and maximum break.
- 2 Compute and validate route and bus hours constrained by maximum break.
- 3 On successful validation of distance and remaining time, add detailed information of the selected event to the travel plan.
- 4 Recommend attractions located in the subblock of the selected event.
- 5 Provide on-route attraction recommendation if the user selects the option (constrained by the global constant "maxTimeGapBetweenEvents").



4.3.2 Rule System for eTourPlan Event-centric Planning

The planner performs the following steps:

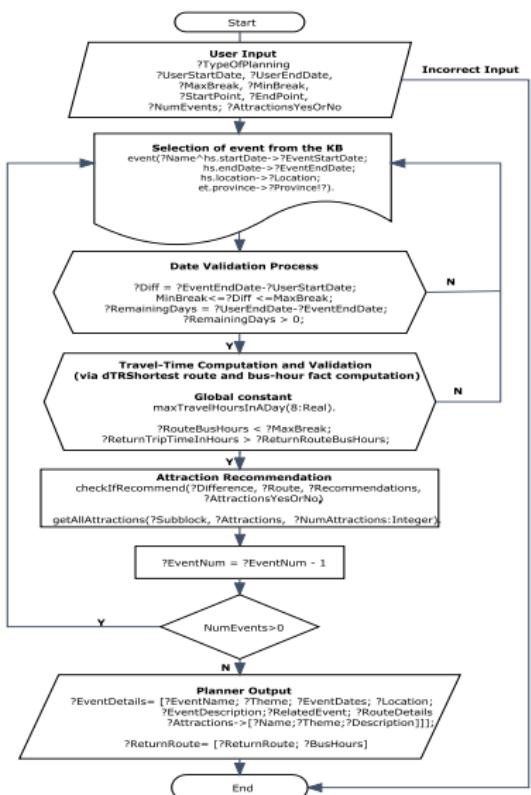
- 1 Events are selected by validating the event dates against the user's travel dates, minimum break, and maximum break.
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5.1.1 Parametric Search Operations

① Search for Provincial Information

- name
- region

② Search for Route Information

- startPoint, endPoint
- list of user-specified provinces

③ Search for Activities (Events and Attractions)

- name:type
- _:type (refers to the classification of activity)
- theme

at (Subblock, Block, Province, Region, Country) of Partonomy

④ Search for Accommodations

- name:type (refers to the type of accommodation)
- _:type
- price

at (Subblock, Block, Province, Region, Country) of Partonomy

5.1.1 Parametric Search Operations

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 - **_:type** (refers to the classification of activity)
 - **theme**

at (Subblock, Block, Province, Region, Country) of Partonomy

④ Search for Accommodations

- **name:type** (refers to the type of accommodation)
 - **_:type**
 - **price**

at (Subblock, Block, Province, Region, Country) of Partonomy

5.1.2 Sample Activity Search Query and Result

Query
<pre>getActivityDetails(actName->?Name:Events; theme->Recreation; address->[?Subblock, ?Block, ?Province, Southern:Region, ?Country]; ?ActivityDetails)</pre>

Output Variables	Variable Bindings
?ActivityDetails	[ActName->Yangphel_Archery_Tournament:Sport_archery; WebLink->" http://www.bhutanarchery.com/default.asp "; EventDates->[StartDate->date[2008:Real, 08:Real, 23:Real]; EndDate->date[2008:Real, 10:Real, 02:Real]]; Description->"11TH Yangphel open archery tournament"; Address->[Phuentsholing_Upper_Town:Town, Phuentsholing:Block, Chukha:Province, Southern:Region, Bhutan:Country]; Theme->Recreation; RelatedTo->"Thimphu_Drupchen:Annual_festival"]

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Query
<pre>getActivityDetails(actName->?Name:Events; theme->Recreation; address->[?Subblock, ?Block, ?Province, Southern:Region, ?Country]; ?ActivityDetails)</pre>

Output Variables	Variable Bindings
?ActivityDetails	[ActName->Yangphel_Archery_Tournament:Sport_archery; WebLink->" http://www.bhutanarchery.com/default.asp "; EventDates->[StartDate->date[2008:Real, 08:Real, 23:Real]; EndDate->date[2008:Real, 10:Real, 02:Real]]; Description->"11TH Yangphel open archery tournament"; Address->[Phuentsholing_Upper_Town:Town, Phuentsholing:Block, Chukha:Province, Southern:Region, Bhutan:Country]; Theme->Recreation; RelatedTo->"Thimphu_Drupchen:Annual_festival"]

5.2.1 Location-centric Recommender

- Provides route and tourism information for
 - ① **SystemRecommendation**: Number of 'N' "relatedTo" provinces
 - ② **UserPrefBased**: User-specified list of provinces

	User Input Values	Query Formats (Input values are blue bold-faced)
1	typeOfRecommend numProvinces	locCentricRecommend(typeOfRecommend-> SystemRecommendation ; userInputs->[startPoint-> Paro:Province ; numProvinces-> 3:Integer]; [?Routes, ?Recommendations, ?TotalBusHours])
2	typeOfRecommend startPoint userPrefList endPoint	locCentricRecommend(typeOfRecommend-> UserPrefBased ; userInputs->[startPoint-> Paro:Province ; userPrefList-> [Chukha:Province] ; endPoint-> Thimphu:Province]; [?Routes, ?Recommendations, ?TotalBusHours])

Table: Queries of different input/output modes for location-centric Recommendation

5.2.2 Recommendation Results for Query 2

Table: Location-centric recommendation for user-preferred Provinces

Output Variables	Variable Bindings (For Query 2)
?Routes	[[Paro, Chuzom, Chukha], 6.5 :Real, [Chukha, Chuzom, Thimphu], 7.0 :Real]
?Recommendations	<p>Chukha; EventList-></p> <p>[[EventName->Chukha_Tshechu:Annual_festival; Description->"One of the most amazing festivals in Chukha"; Address->[Chukha_Town:Town, Gelling:Block, Southern:Region, Bhutan:Country, EventDates->[StartDate->date[2008:Real, 03:Real, 19:Real]; EndDate->date[2008:Real, 03:Real, 21:Real]]], [EventName-> Yangphel_Archery_Tournament:Sport_archery; Description->"11TH Yangphel open archery tournament"; Address->[Phuentsholing_Upper_Town:Town, Phuentsholing:Block,, Southern:Region, Bhutan :Country, EventDates->[StartDate->date[2008:Real, 08:Real, 23:Real]; EndDate->date[2008:Real, 10:Real, 02 :Real]]]];</p>

5.2.2 Recommendation Results (Cont'd)

?Recommendations	<pre>AttractionList-> [[AttractionName->Chukha_Dzong:Fortress; WebLink->""; Description->"It is one of the most beautiful attractions."; AccommodationList-> [[Hotel_Druk_Phuentsholing:Hotel; WebLink->"www.drukhotels.com/"; MinPrice->"2700:Real"; Rating->4:Real], [Hotel_Namgay:Hotel; WebLink->"www.hotelNamgay.bt"; MinPrice->"1800:Real"; Rating->3:Real]]]</pre>
?TotalBusHours	13.5:Real

5.3.1 eTourPlan Travel Planner

- Two modes of Travel Planning:

- ① AttractionOnly: Based on "relatedTo" attractions
 - ② EventCentric: Based on temporal-geographic search criteria

	User Input Values	Query Formats (Input values are bold-faced)
1	typeOfPlanning startPoint endPoint numAttractions userTotalTravelTimeInDays	eTourPlan(typeOfPlanning-> AttractionOnly ; userInputs->[startPoint-> Paro:Province ; endPoint-> Thimphu:Province ; numAttractions-> 4:Integer ; userTotalTravelTimeInDays-> 4:Integer]; ?TravelResult)
2	typeOfPlanning startPoint endPoint userStartDate userEndDate maxBreak minBreak attractionRecommendation eventNum	eTourPlan(typeOfPlanning-> EventCentric ; userInputs->[startPoint-> Paro:Province ; endPoint-> Thimphu:Province ; userStartDate-> date[2008:Real,10:Real,01:Real] ; userEndDate-> date[2008:Real,11:Real,10:Real] ; maxBreak-> 10:Real ; minBreak-> 0:Real ; attractionRecommendation-> No ; eventNum-> 3:Integer]; ?TravelResult)

Table: Queries of different input/output modes for Travel Planning

5.3.2 Travel Planning Scenario

User queries for an event-centric plan of 3 events between the 1st of October and the 10th of November and specifies a "maxBreak" of 10 days and "minBreak" of 0 days between main events. User also specifies the starting province, "Paro:Province", and the final destination province, as "Thimphu:Province". User checks "No" for on-route attraction recommendation, knowing that the planner provides recommendation of attractions at the subblock of event location.

5.3.3 Event Schedules

Table: Evaluation of event-centric travel results

Event	Event Schedules	Event Sequences of length ?EventNum= 3
1	Tamshingphala_Choepa:Traditional_festival startDate->date[2008:Real,10:Real,08:Real] endDate->date[2008:Real,10:Real,10:Real] province->Bumthang	1,2,5
2	Tangbi_Mani:Traditional_festival startDate->date[2008:Real,10:Real,13:Real] endDate->date[2008:Real,10:Real,15:Real] province->Bumthang	
3	Thimphu_Drupchen:Annual_festival startDate->date[2008:Real,10:Real,04:Real] endDate->date[2008:Real,10:Real,08:Real] province->Thimphu	3,2,5 3,4,2 3,4,5
4	Thimphu_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,09:Real] endDate->date[2008:Real,10:Real,11:Real] province->Thimphu	4,2,5
5	Wangdue_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,20:Real] endDate->date[2008:Real, 10:Real, 29:Real] province->WangduePhodrang	

5.3.4 Multiple Travel Plans

Table: Options for event-centric travel plans

Option	Event Sequences of length "3"	Province
1	Tamshingphala_Choepa:Traditional_festival Tangbi_Mani:Traditional_festival Wangdue_Tshechu:Annual_festival	Bumthang Bumthang WangduePhodrang
2	Thimphu_Drupchen:Annual_festival Tangbi_Mani:Traditional_festival Wangdue_Tshechu:Annual_festival	Thimphu Bumthang WangduePhodrang
3	Thimphu_Drupchen:Annual_festival Thimphu_Tshechu:Annual_festival Tangbi_Mani:Traditional_festival	Thimphu Thimphu Bumthang
4	Thimphu_Drupchen:Annual_festival Thimphu_Tshechu:Annual_festival Wangdue_Tshechu:Annual_festival	Thimphu Thimphu WangduePhodrang
5	Thimphu_Tshechu:Annual_festival Tangbi_Mani:Traditional_festival Wangdue_Tshechu:Annual_festival	Thimphu Bumthang WangduePhodrang

5.3.5 Complete Result of the First Travel Plan Option (Events 1, 2 and 5)

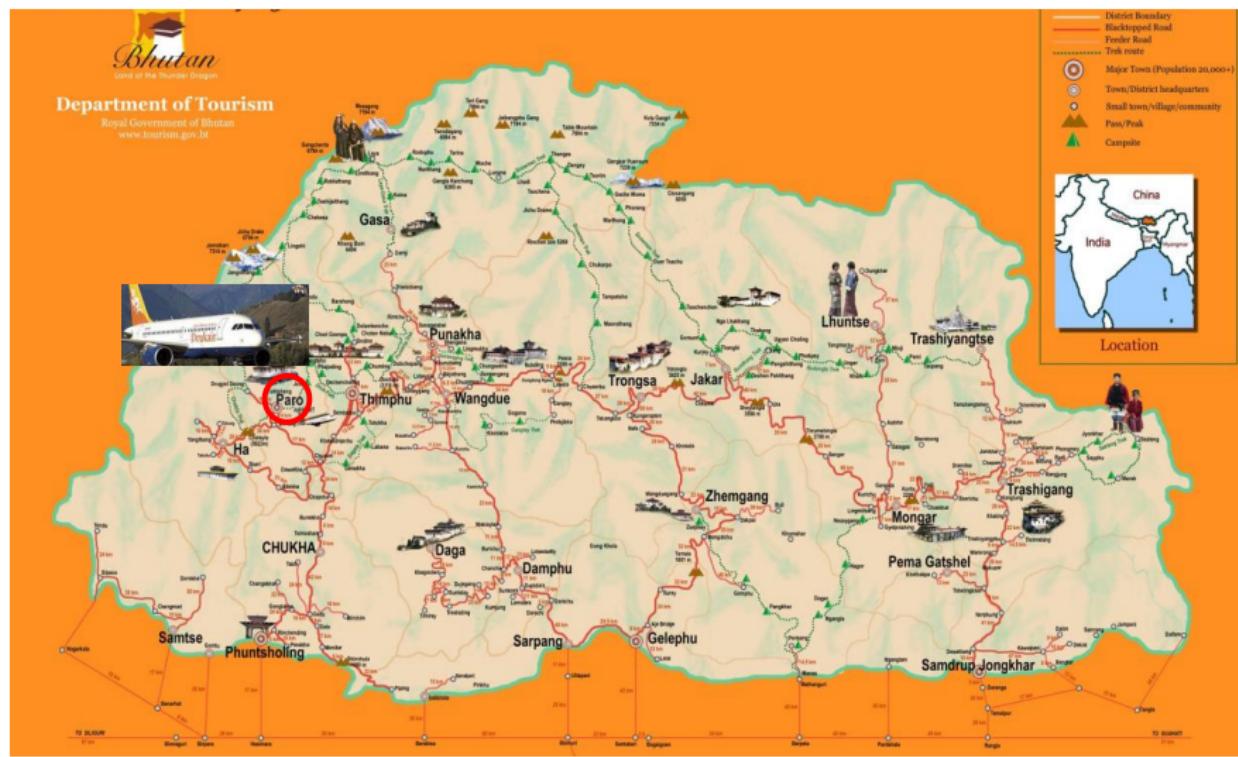
Table: Event-centric travel results

Output Variables	Variable Bindings
?TravelResult	<pre> [[[EventName->Tamshingphala_Choepa:Traditional_festival; EventDates->[Startdate->date[2008:Real, 10:Real, 08:Real]; Enddate->date[2008:Real, 10:Real, 10:Real]]; Theme->Cultural_Religious_Heritage; EventDescription->"One of the most amazing festivals in Bumthang" Location->[Tamshing_Lhakhang:Temple, Tamshing_Village:Village, Bumthang:Province]; RelatedEvent->Tangbi_Mani:Traditional_festival; RouteDetails->[[Paro:Province, Chuzom:Province, Thimphu:Province, Lobesa:Province, WangduePhodrang:Province, Trongsa:Province, Bumthang:Province], []]; RouteBusHours->16.7:Real]; RecommendedAttractions->[Tamshing_Lhakhang:Temple, "It was built by Pema Lingpa,the Treasure Revealer in 1505."]]; [EventName->Tangbi_Mani:Traditional_festival; EventDates->[Startdate->date[2008:Real, 10:Real, 13:Real]; Enddate->date[2008:Real, 10:Real, 15:Real]]; Theme->Cultural_Religious_Heritage; EventDescription->"A prestigious annual festival in Bumthang" Location->[Tangbi_Monastery:Monastery, Tangbi:Village, Bumthang:Province]; RelatedEvent->Wangdue_Tshechu:Annual_festival]; </pre>

5.3.5 Detailed Result of a Travel Plan (Cont'd)

?TravelResult	<pre> RouteDetails->[[Bumthang:Province], []; RouteBusHours->0:Real]]; RecommendedAttractions->[Tangbi_Monastery:Monastery "Located in upper Tang valley."], [EventName->Wangdue_Tshechu:Annual_festival; EventDates->[Startdate->date[2008:Real, 10:Real, 20:Real]; Enddate->date[2008:Real, 10:Real, 29:Real]]; Theme->Cultural_Religious_Heritage; EventDescription->"A very popular festival in western Bhutan" Location->[Wangdue_Dzong:Fortress, Wangdue_Town:Town, WangduePhodrang:Province]; RouteDetails->[[Bumthang:Province, Trongsa:Province, WangduePhodrang:Province], []; []; RouteBusHours->0:Real]; RecommendedAttractions->[Wangdue_Dzong:Fortress "It is one of the most beautiful attractions."], ReturnRoute->[[WangduePhodrang:Province, Lobesa:Province, Thimphu:Province]; Returntime->12.2:Real]] </pre>
---------------	--

5.3.6 Travel Plan (Option 4) -At the starting point



5.3.6 Travel Plan -Event 1 found

Bhutan
Land of the Thunder Dragon
Department of Tourism
Royal Government of Bhutan
www.tourism.gov.bt

Thimphu_Drubchen:Annual_Festival

start Date - 2008. 10. 04
end Date - 2008. 10. 08
route - [Paro, Chuzom, Thimphu], 4.5
location -
Tashichoe_Dzong:Fortress
Subblock - Jongshina:Town

Attractions:
Trashichoe_dzong:Fortress

5.3.6 Travel Plan -Event 2 found

Bhutan
Land of the Thunder Dragon

Department of Tourism
Royal Government of Bhutan
www.tourism.gov.bt

Thimphu_Tshechu:Annual_Festival

startDate - 2008.10.09
endDate - 2008.10.11
route - [Thimphu], 0.5]
location -
Tashichhoe_Dzong:Fortress
Subblock - Jongshina:Town

Attractions:
Trashichoe_dzong:Fortress

Tshering Dema

5.3.6 Travel Plan -Event 3 found



Tangbi_Mani:Traditional_festival

startDate - 2008.10.13

endDate - 2008.10.15

route - [Thimphu, Lobesa, Wangdue, Trongsa, Bumthang, 12.2]

location -

[Tangbi_Monastery:Monastery, Subblock- Tangbi:Village,

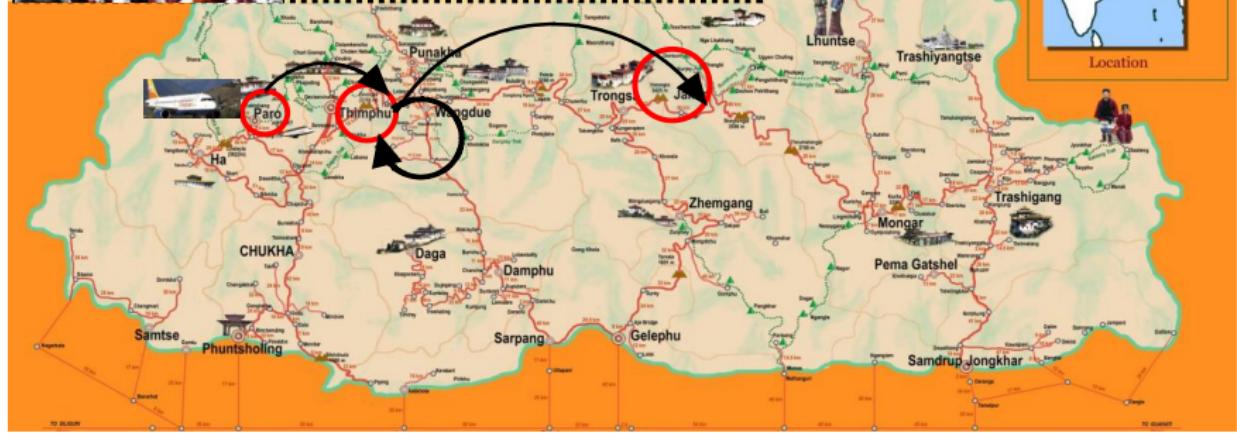
Attractions:

Tangbi_Monastery:Monastery,
"Located in upper Tang valley."

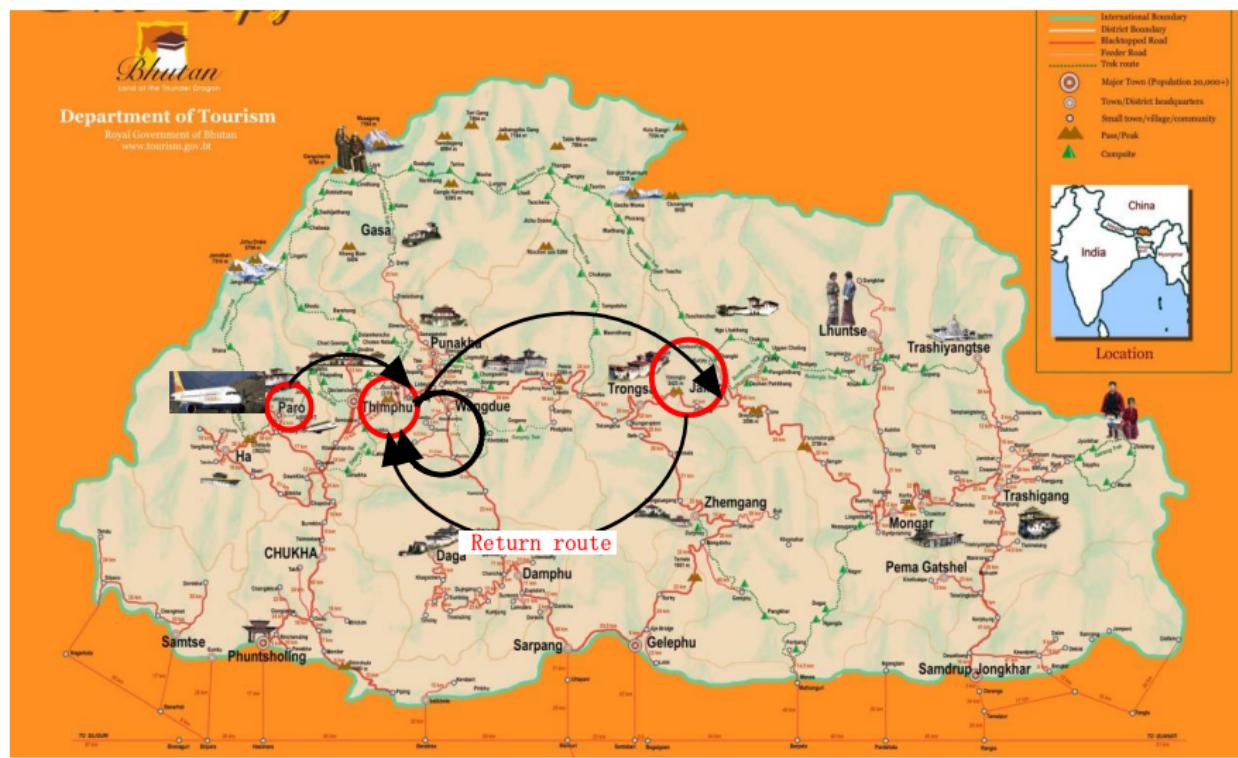
- International Boundary
- District Boundary
- Blackened Road
- Forest Reserve
- Trek route
- Major Town (Population 20,000+)
- Town/District headquarters
- Pass/Peak
- Compass



Location



5.3.6 Travel Plan -Return route to the end point



5.3.6 Travel Planning -On-route attraction recommendation (Optional)

Return route - [[Bumthang, Trongsa, Wangdue, Lobesa Thimphu], 12, 2]

On-route Attraction Recommendation

- Bumthang->
 - [[Bumthang_Dzong:Fortress, Chamkar:Town], [Ugyen_Chholing_Museum:Local_museum]]
- Trongsa->
 - [[Trongsa_Dzong:Fortress, Samcholing:Village], [Samcholing_Palace:Popular_architecture]]
- Wangdue->
 - [[Wangdue_Dzong:Fortress, Wangdue_Town:Town], [Trongsa_Dzong:Fortress, Samcholing:Village]]
- Lobesa->
 - [[Thimphu_Tashichhoe_Dzong:Fortress, Jongshina:Town], [Memorial_Chorten:Temple, Thimphu_City:City]]

Tshering Dema

eTourPlan: A Knowledge-Based Tourist Route and Activity Planner

5.4.1 Execution times

- Development & Test environment:
 - OO jDREW engine version 0.96
 - On Windows XP with Intel Core 2 Duo 2.66 GHz
- eTourPlan KB:
 - 115 classes, 73 facts, and 37 rules
- Low OO jDREW execution times for retrieving subdomain information:
 - Object-centric profile descriptions for each of the subdomains are well-structured with RDFS type definitions and partonomy rules
 - Search rules are object-centric; therefore search is localised to a specific domain

5.4.2 Execution times

- High OO jDREW execution times for recursive search predicates:
 - Incorporation of recursive predicates such as "getAllAttractions", "getAllEvents", and "getAllAccommodations"
 - The textual order between rules is not exploited by our pure logic programs (simulate exhaustive breadth-first parallel execution with iterative deepening)
 - For the recursive search predicates, execution times grow exponentially with the number of candidate activities

6.1 Contributions

eTourPlan: A knowledge-based tourist route and activity planner

- Designed and implemented a KB comprised of object-centric facts of Bhutan tourist information, structured by light weight ontologies
- Realized rule subsystems for various tourist services
 - Semantic searches
 - Tour recommendation
 - Travel planning
- Iterated through a step-wise "model and test" cycle to obtain the executable specification of the eTourPlan prototype
- Tested and evaluated the eTourPlan KB (115 classes, 73 facts, and 37 rules) in the OO jDREW reasoning engine:
 - Constitutes a real world use case (based on Bhutan tourism information)
 - Offers multiple options for a diversity of travel plans
 - Provides precise parametric search results for various queries on the tourism KB
- Demo can be given on demand

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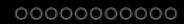
6.2 Future Work

- Other planning strategies such as partial planning and sequence planning
 - Cost estimation for the total travel
 - The current executable specification can be integrated with a database or could be translated to a self-contained database application
 - A user-friendly GUI would increase the utility of the key operations of the eTourPlan prototype
 - The semantic model and search of eTourPlan can be extended to a "Semantic Bhutan" portal (and transferred to other regions such as New Brunswick)

Thank You

THANK YOU!

QUESTIONS?



BACKUP SLIDES

4.3.1.9 Search Rules

KB (Rules):

%—at a subblock level—%
getAttraction(?Attraction:Attractions, ?Subblock:Subblock):-
siteOf(?Attraction:Attractions, ?Subblock:Subblock)

%—at a block level—%
getAttraction(?Attraction:Attractions, ?Block:Block):-
 partOfBlock(?Attraction:Attractions, ?Block:Block).

```
getAttraction(?Attraction:Attractions, ?Block:Block):-  
    partOfBlock(?Subblock:Subblock, ?Block:Block),  
    getAttraction(?Attraction:Attractions, ?Subblock:Subblock).
```

%—at a province level %
getAttraction(?Attraction:Attractions, ?Province:Province):-
partOfProvince(?Attraction:Attractions, ?Province:Province).

```
getAttraction(?Attraction:Attractions, ?Province:Province):-  
    partOfProvince(?Block:Block, ?Province:Province),  
    getAttraction(?Attraction:Attractions, ?Block:Block).
```

4.3.1.10 Search Rules

KB

```

%—at a region level——————%
getAttraction(?Attraction:Attractions, ?Region:Region):-
    partOfRegion(?Attraction:Attractions, ?Region:Region).

getAttraction(?Attraction:Attractions, ?Region:Region):-
    partOfRegion(?Province:Province, ?Region:Region),
    getAttraction(?Attraction:Attractions, ?Province:Province).

%—at a country level——————%
getAttraction(?Attraction:Attractions, ?Country:Country):-
    partOfCountry(?Attraction:Attractions, ?Country:Country).
getAttraction(?Attraction:Attractions, ?Country:Country):-
    partOfCountry(?Region:Region, ?Country:Country),
    getAttraction(?Attraction:Attractions, ?Region:Region).

```

Sample Queries:

```
getAttraction(?Attraction:Attractions, Bhutan:Country)
getAttraction(?Attraction:Attractions, Western:Region)
getAttraction(?Attraction:Attractions, Bumthang:Province)
getAttraction(?Attraction:Attractions, Chhoekhor:Block)
getAttraction(?Attraction:Attractions, Chamkhar:Town)
```

4.3.2.1 Route and Distance Time Computation

Facilitates the Transportation subdomain

- Two-level Computation
 - Precomputation of all routes (“dTR” predicate)
 - Optimal route (i.e. shortest distance by “dTRShortest” predicate)
 - Implemented in the OO jDREW Top-Down FindAll Solutions architecture
 - Stored as precomputed facts in the KB

4.3.3 Precomputation of Route and Distance-time Facts

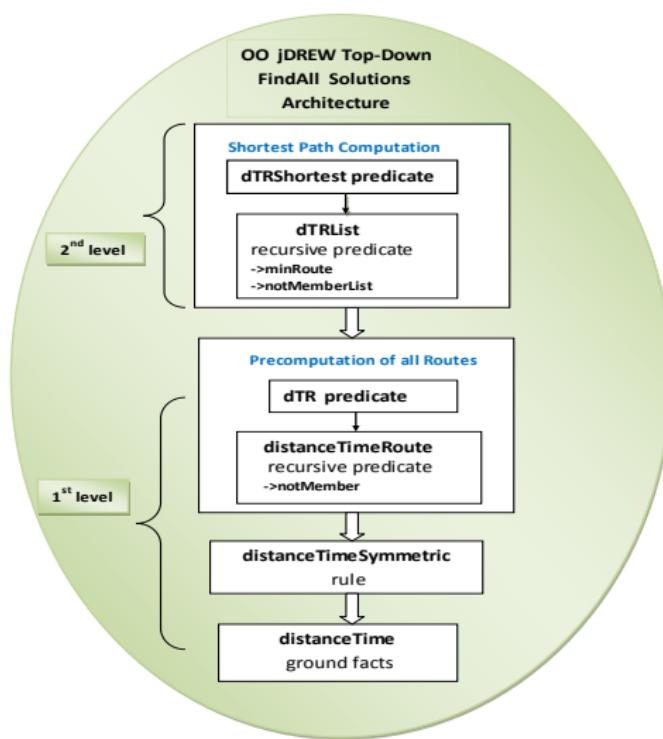


Figure: Two-level Computation

4.3.1.6 Partonomy Extensions (Sample KB)

- “**getFullAddress**” Rule extended

- Computes a location based on GPS coordinates
- Precise addressing scheme

Sample GPS Facts:

```
address(Bumthang_Dzong:Fortress,  
        Loc[latitude->Detail[degree->48:Real; minute->0:Real];  
              longitude->Detail[degree->66:Real; minute->40:Real]]).
```

Rule:

```
getFullAddress(?Location, [?Subblock, ?Block, ?Province, ?Region, ?Country,  
                      ?Latitude, ?Longitude]) :-  
    getLatitude(?Location, ?Latitude),  
    getLongitude(?Location, ?Longitude),  
    siteOf(?Location, ?Subblock),  
    partOfBlock(?Subblock, ?Block),  
    partOfProvince(?Block, ?Province),  
    partOfRegion(?Province, ?Region),  
    partOfCountry(?Region, ?Country).
```

4.3.1.7 Partonomy KB (Query and Result)

Sample Query:

```
getFullAddress(Bumthang_Dzong:Fortress, ?Address)
```

OO jDREW TD Result:

```
?Address= [4800.0:Real,  
6666.666666666667:Real,  
Chamkhar:Town,  
Chhoekhor:Block,  
Bumthang:Province,  
Central:Region,  
Bhutan:Country]
```

5.1.2 Sample Search Queries

Query	Entity	Search Query
1	Province	getProvinceDetails(region->?Region:Region; name-> Bumthang:Province ; ?ProvinceDetails)
2	Route	getRouteDetails(startPoint-> Chukha:Province ; endPoint-> Punakha:Province ; ?RouteDetails , ?ShortestRoute)
3	Activity	getActivityDetails(actName->?Name: Events ; theme-> Recreation ; address->[?Subblock, ?Block, ?Province, Southern:Region , ?Country]; ?ActivityDetails)
4	Accommodation	getAccommodationDetails(accName->?Name: Resort ; address->[Tsento_Shari:Village , ?Block, ?Province, ?Region, ?Country]; setMaxPrice->[Yes , 1500:Real]; ?AccommodationDetails)

5.1.1 Search for Provincial Information (Input Modes and Search Result for Query 1)

Query	User Input Values	Query Formats (Input values are bold-faced)
1	name	getProvinceDetails(region->?Region:Region; name-> Bumthang:Province ; ?ProvinceDetails)
2	region	getProvinceDetails(region-> Central:Region ; name->?Name:Province; ?ProvinceDetails)
3	None	getProvinceDetails(region->?Region:Region; name->?Name:Province; ?ProvinceDetails)

Output Variables	Variable Bindings (For Query 1)
?ProvinceDetails	[WebLink->"http://www.bumthang.gov.bt/"; Description->"Bumthang is one of the most attractive touristic province with several festivals throughout the year"; Capital->Chamkhar:Town; Geography->[Area->"1,819 sq.km"; Elevation->"1,300 to 7300 meters"]; TouristInfo->[NumAttractions->16:Integer; NumEvents->13:Integer; NumAccommodations->10 :Integer]; Contact->"admbumthang@druknet.bt"]
?Region:Region	Central:Region

5.1.1 Search for Provincial Information (Input Modes and Search Result for Query 1)

Query	User Input Values	Query Formats (Input values are bold-faced)
1	name	getProvinceDetails(region->?Region:Region; name-> Bumthang:Province ; ?ProvinceDetails)
2	region	getProvinceDetails(region-> Central:Region ; name->?Name:Province; ?ProvinceDetails)
3	None	getProvinceDetails(region->?Region:Region; name->?Name:Province; ?ProvinceDetails)

Output Variables	Variable Bindings (For Query 1)
?ProvinceDetails	[WebLink->"http://www.bumthang.gov.bt"; Description->"Bumthang is one of the most attractive touristic province with several festivals throughout the year"; Capital->Chamkhar:Town; Geography->[Area->"1,819 sq.km"; Elevation->"1,300 to 7300 meters"]; TouristInfo->[NumAttractions->16:Integer; NumEvents->13:Integer; NumAccommodations->10 :Integer]; Contact->"admbumthang@druknet.bt"]
?Region:Region	Central:Region

5.1.2 Search for Route Details (Input/Output Modes)

Query	User Input Values	Query Formats (Input values are bold-faced)
1	startPoint endPoint	getRouteDetails(startPoint-> Chukha:Province ; endPoint-> Punakha:Province ; ?RouteDetails , ?ShortestRoute)

Output Variables	Variable Bindings (For Query 1)
?RouteDetails	[[[[Chukha, Chuzom, Thimphu, Lobesa, Punakha], 11.2:Real], [[Chukha, Chuzom, Thimphu, Lobesa, WangduePhodrang, Punakha], 11.90:Real]]; numRoutes->2:Integer]
?ShortestRoute	[[[Chukha, Chuzom, Thimphu, Lobesa, Punakha], 11.2 : Real]

5.1.2 Search for Route Details (Input/Output Modes)

Query	User Input Values	Query Formats (Input values are bold-faced)
1	startPoint endPoint	getRouteDetails(startPoint-> Chukha:Province ; endPoint-> Punakha:Province ; ?RouteDetails , ?ShortestRoute)

Output Variables	Variable Bindings (For Query 1)
?RouteDetails	[[[[Chukha, Chuzom, Thimphu, Lobesa, Punakha], 11.2:Real], [[Chukha, Chuzom, Thimphu, Lobesa, WangduePhodrang, Punakha], 11.90:Real]]; numRoutes->2:Integer]
?ShortestRoute	[[[Chukha, Chuzom, Thimphu, Lobesa, Punakha], 11.2 : Real]

5.1.3 Search for Activity Opportunities (Input/Output Modes)

Query	User Input Values	Query Formats (Input values are bold-faced)
1	actName	getActivityDetails(actName-> Paro_Tshechu:Events ; theme-> ?Theme; address-> ?Address; ?ActivityDetails)
2	actName: type and/or address element	getActivityDetails(actName-> ?Name: Festivals ; theme-> ?Theme; address-> [?Subblock, Chhoekhor:Block , ?Province, ?Region, ?Country]; ?ActivityDetails)
3	theme and/or address element	getActivityDetails(actName-> ?Name; theme-> Cultural_Religious_Heritage ; address-> [?Subblock, ?Block, Paro:Province , ?Region, ?Country]; ?ActivityDetails)
4	theme actName: type address element	getActivityDetails(actName-> ?Name: Events ; theme-> Recreation ; address-> [?Subblock, ?Block, ?Province, Southern:Region , ?Country]; ?ActivityDetails)
5	None	getActivityDetails(actName-> ?Name; theme-> Theme; address-> ?Address; ?ActivityDetails)

5.1.4 Activity Search Result of Query 4

Output Variables	Variable Bindings (For Query 4)
?ActivityDetails	<pre>[ActName->Yangphel_Archery_Tournament:Sport_archery; WebLink->"http://www.bhutanarchery.com/default.asp"; EventDates->[StartDate->date[2008:Real, 08:Real, 23:Real]; EndDate->date[2008:Real, 10:Real, 02:Real]]; Description->"11TH Yangphel open archery tournament"; Address->[Phuentsholing_Upper_Town:Town, Phuentsholing:Block, Chukha:Province, Southern:Region, Bhutan:Country]; Theme->Recreation; RelatedTo->"Thimphu_Drupchen:Annual_festival"]</pre>

3.3.6 Accommodations Class

Profile of Wangdicholing_Lodge

```
accommodation(Wangdicholing_Lodge:Lodge^
    hs.url->"http://www.wangdicholing.bt";
    et.rating->3:Real;
    et.minPrice->800:Real;
    et.subblock->Chamkhar:Town;
    et.province->Bumthang:Province;
    hs.telecoms->Telecoms[
        et.landline->9753631452;
        et.cell->97517682948];
    hs.contact->"manager@wangdicholing.bt";
    hs.relatedTo->Yangphel_Guest_house:Guest_house).
```

5.1.5 Search for Accommodation Details

Query	User Input Values	Query Formats (Input values are bold-faced)
1	accName	getAccommodationDetails(accName-> Aman_Resort:Resort ; address-> ?Address; setMaxPrice-> ?SetMaxPrice; ?AccommodationDetails)
2	accName:type and/or address element	getAccommodationDetails(accName-> ?Name: Guest_house ; address-> [Chamkhar:Town , ?Block, ?Province, ?Region, ?Country]; setMaxPrice-> ?SetMaxPrice; ?AccommodationDetails)
3	setMaxPrice and/or address element	getAccommodationDetails(accName-> ?Name; address-> [Chamkhar:Town , ?Block, ?Province, ?Region, ?Country]; setMaxPrice-> [Yes , 2000:Real]; ?AccommodationDetails)
4	accName:type setMaxPrice address element	getAccommodationDetails(accName-> ?Name: Resort ; address-> [Tsento_Shari:Village , ?Block, ?Province, ?Region, ?Country]; setMaxPrice-> [Yes , 1500:Real]; ?AccommodationDetails)
5	None	getAccommodationDetails(accName-> ?Name; address-> ?Address; setMaxPrice-> ?SetMaxPrice; ?AccommodationDetails)



5.1.6 Accommodation Search Result of Query 4

Output Variables	Variable Bindings (For Query 4)
?AccommodationDetails	[AccName->Rangen:Resort; WebLink->"www.rangnen.bt "; Address->[Tsento_Shari:Village, Tsento:Block, Paro:Province, Western:Region, Bhutan:Country]; Standard->[StarRating->2:Real; MinPrice->1000:Real]; ContactDetails-> [Telecoms->[Landline->9758211452; Cell->97517682948]; Email->"manager@rangnen.bt"]; RelatedTo->"Holiday_Home:Hotel"]

Location-centric recommendation by the system

Output Variables	Variable Bindings
?Routes	[[[Paro, Chuzom, Thimphu], 6.5 :Real], [[Thimphu, Lobesa, Punakha], 4.2:Real]]
?Recommendations	[[Paro:Province; WebLink->"http://www.paro.gov.bt/"; TouristInfo-> NumAttractions->3:Integer; NumEvents->1:Integer; NumAccommodations->3:Integer]], [Thimphu:Province; WebLink->"http://www.thimphu.gov.bt/"; TouristInfo-> NumAttractions->3:Integer; NumEvents->1:Integer; NumAccommodations->3:Integer]], [Punakha:Province; WebLink->"http://www.punakha.gov.bt/"; TouristInfo-> NumAttractions->2:Integer; NumEvents->1:Integer; NumAccommodations->0:Integer]]
?TotalBusHours	8.7:Real

5.3.2 Resulting Multiple Travel Plans

Table: Evaluation of event-centric travel results

Event	Event Schedules	Event Sequences of length ?EventNum= 2
1	Tamshingphala_Choepa:Traditional_festival startDate->date[2008:Real,10:Real,08:Real] endDate->date[2008:Real,10:Real,10:Real] province->Bumthang	1,2 1,5
2	Tangbi_Mani:Traditional_festival startDate->date[2008:Real,10:Real,13:Real] endDate->date[2008:Real,10:Real,15:Real] province->Bumthang	
3	Thimphu_Drupchen:Annual_festival startDate->date[2008:Real,10:Real,04:Real] endDate->date[2008:Real,10:Real,08:Real] province->Thimphu	3,2 3,4
4	Thimphu_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,09:Real] endDate->date[2008:Real,10:Real,11:Real] province->Thimphu	4,2 4,5
5	Wangdue_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,20:Real] endDate->date[2008:Real, 10:Real, 29:Real] province->WangduePhodrang	

5.3.5 Travel Planning Results (Cont'd)

Table: Evaluation of event-centric travel results

Event	Event Schedules	Event Sequences of length ?EventNum= 4
1	Tamshingphala_Choepa:Traditional_festival startDate->date[2008:Real,10:Real,08:Real] endDate->date[2008:Real,10:Real,10:Real] province->Bumthang	
2	Tangbi_Mani:Traditional_festival startDate->date[2008:Real,10:Real,13:Real] endDate->date[2008:Real,10:Real,15:Real] province->Bumthang	
3	Thimphu_Drupchen:Annual_festival startDate->date[2008:Real,10:Real,04:Real] endDate->date[2008:Real,10:Real,08:Real] province->Thimphu	3,4,2,5
4	Thimphu_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,09:Real] endDate->date[2008:Real,10:Real,11:Real] province->Thimphu	
5	Wangdue_Tshechu:Annual_festival startDate->date[2008:Real,10:Real,20:Real] endDate->date[2008:Real, 10:Real, 29:Real] province->WangduePhodrang	

5.3.6 Illustration of a Travel Plan (Option 3)

