MULTI-AGENT SYSTEMS

Fall 17 - Project 1

M. Alp Şarkışla – Burak Suyunu

2017717018 - 2017700117

BDI Agent: Gotta Decide 'em All!

1. Introduction

In this Project we implemented a BDI agent that will attend a conference in Amsterdam between July 15-21. Besides attending the conference, she will do many other activities like visiting museums, going to funfairs, riding bicycle and catching Pokémon. Since she is a BDI agent, she has Beliefs, Desires and Intentions. Beliefs consist of her future plans and can be influenced by unknown events. Desires consist of her daily plans and can be influenced by beliefs and needs. In any given time (each hour to make things simpler) agent chooses a suitable intention from her desire pool. She also needs to eat and rest to gain energy and reduce hunger. Intentions needs energy to be accomplished. Each intention (activity) affects hunger and energy differently. Naturally, she can't to activities if she doesn't have enough time or energy.

- Note: Numbers in bracelets refers to corresponding table numbers that you can find in the appendix. IDs refers to the event, desire or randomDesire ids in mentioned tables.

2. Design and Implementation

We have planned and unknown events that creates a scenario. Planned events are agents' plans for future, things that she must do, and unknown events are events that happen without prior knowledge. Unknown events can be either a surprise event or can be triggered by another event. They result in cancelation or creation of future events. Beliefs only consist of planned events since we don't know when an unknown event will happen. Belief updates itself when an unknown event cancels or postpones a planned event. Then like a chain reaction, when events updates beliefs, beliefs updates desires.

In her free, unplanned, time, she eats and rest when needed. If she has no such needs, or a planned desire then she decides to do a random event from random desire pool. Each random event has different (energy, hunger, time) value that represents how much they cost. She chooses an activity that she can afford [1].

Desires consists of daily plans and free time events [2]. In each hour one event from the desire will be chosen as intention. If today's plan is changed due to unknown event, planned desire is updated as well. If unknown event changes future event, when the day comes the new plan will be added to daily plans. Free time events chosen randomly by looking at the current time, energy and hunger values. She can't do 2-hour event if she has a plan in two hours. To make things more interesting, we added bad outcomes to random events that result in cancellation of her current intention.

To implement this, we designed three tables in form of txt: Event, Desire and randomDesires. In the event table each event has a date and time (when it happens) and some events changes beliefs and/or desires. Events are sum of three different tables [5]:

- **Unknown events**; Events that happen without prior knowledge. Agent reacts these by updating its desire and/or belief. For example; As you can observe in Table 4, when her flight is delayed (**Flight Delay**(ID:1) event happens) in 15 July 10.00 she makes a new plan (adds new belief (ID:3) and deletes her old one (ID:2)) to eat while waiting (add **lunch** (ID:1) desire). So, in previous plan she would flight in 11.00, now she will eat in 11.00 and fly in 12.00) [4].
- **Planned events**; Events that agent has planned. These create beliefs. These can only be changed by unknown events. By changing we mean deleting old belief and/or desire and adding new belief and/or desire.
- **Triggered events**; New beliefs are stored in this table. They act like planned events when they are triggered by unknown events. Unknown events may replace old beliefs(plans) with these (**Postponement of Presentation**(ID:5) changes **THE BIG MOMENT** date and time (ID:6 deleted and replaced with ID:7)) or they might add another new plan for the future (**Meeting with friends**(ID:14) adds **Visit Van Gogh Museum**(ID:15) [11])

Desire table [3] shows desires created by beliefs (Planned Desires). They all have information of their time, energy cost and activation time and date. For example; **Rest** (ID:4) is added to desire list after **Landing to Amsterdam** (ID:4) unknown event happens. **Rest** (ID:4) takes one hour and refills +5 energy [9]. In each morning, agent looks today's beliefs and adds its corresponding desire to list [7]. These desires will turn to intentions when the time comes. If that belief is later changes by an unknown event, desire is changed as well (Also pulled from the table) [4,9].

RandomDesires table [6] shows extra desires that agent wants to do in her free time. The main difference of **random desires** from planned desires are random desires are independent of time and date. They are not planned beforehand. In each hour, if she doesn't have anything planned, she will do a random desire. She chooses what to do by looking at her plans (She won't do 2-hour activity if she has a plan for the next hour) and checking her energy and hunger values [1]. Hunger increases automatically in each hour and energy decreases depending of the event. If she has low energy or high hunger, she prone to rest and eat, or if she has a lot of energy she prone to do an activity. An example of how to code works shown below:

In July 15, she knows times of her flight to Amsterdam, return flight to home, her speech, conference dinner, hotel check out and Pokémon Sculpture Exhibition she has ticket for [2]. Also, she plans to study the first night since she has presentation tomorrow (the second day) [2]. All this knowledge creates beliefs and beliefs that affect today (flight and study) create initial desires [2]. In 1 hour before the flight, flight is delayed (**Flight Delay**(ID:1) unknown event happens) and this results in shift in her Flight time. This interpreted as updating belief and desire (**Flight** belief (ID:2 to 3) and desire (ID:12 to 2) to get on plane time changes) [4,8]. After the plane lands (**Landing the Amsterdam**(ID:4) unknown event happens), she plans the rest of the day (**Checking to Hotel**(ID:3), **Rest**(ID:4) and **Dinner**(ID:5) desires added to desire pool) [9]. After one hour of study, she got a call that tells her presentation in tomorrow is postponed to July 19 (**Postponement of Presentation**(ID:5) unknown event happens). Then she updates her beliefs (**The BIG MOMENT** belief date changes (ID:6 to 7)) and her plans of going to exhibition on July 18 night must be cancelled since now she must study in night of July 18 (**Study to speech**(ID:10) belief replaces her **Pokémon Sculpture Exhibition**(ID:8)) [10].

Another example is in sometime in July 16, when she hangs out with friends (**Meeting with friends**(ID:14) unknown event happens), she will hear Van Gogh Museum is a must go place and will make plans to go there tomorrow (**Go to Van Gogh Museum**(ID:15) **belief** is added) [11].

3. GUI

We created dynamically updating tables using matlplotlib library in python. This GUI makes following everything much better. We added random events, hunger and energy to make agent more realistic. As you can observe, different simulations are all result in similar lunch times [12,13]. We used very basic table structure to create scenarios that enabled us to add new events or desires with ease.

4. Conclusion

We have implemented all the functionalities that we want. We used very basic data representation which helps changing scenario with ease. We also implemented a simple GUI that shows every step of our agent. To sum up the process, beliefs are planned events and can only be changed by unknown events. Desires are consisting of daily plans and random free time actions and intention is the current desire.
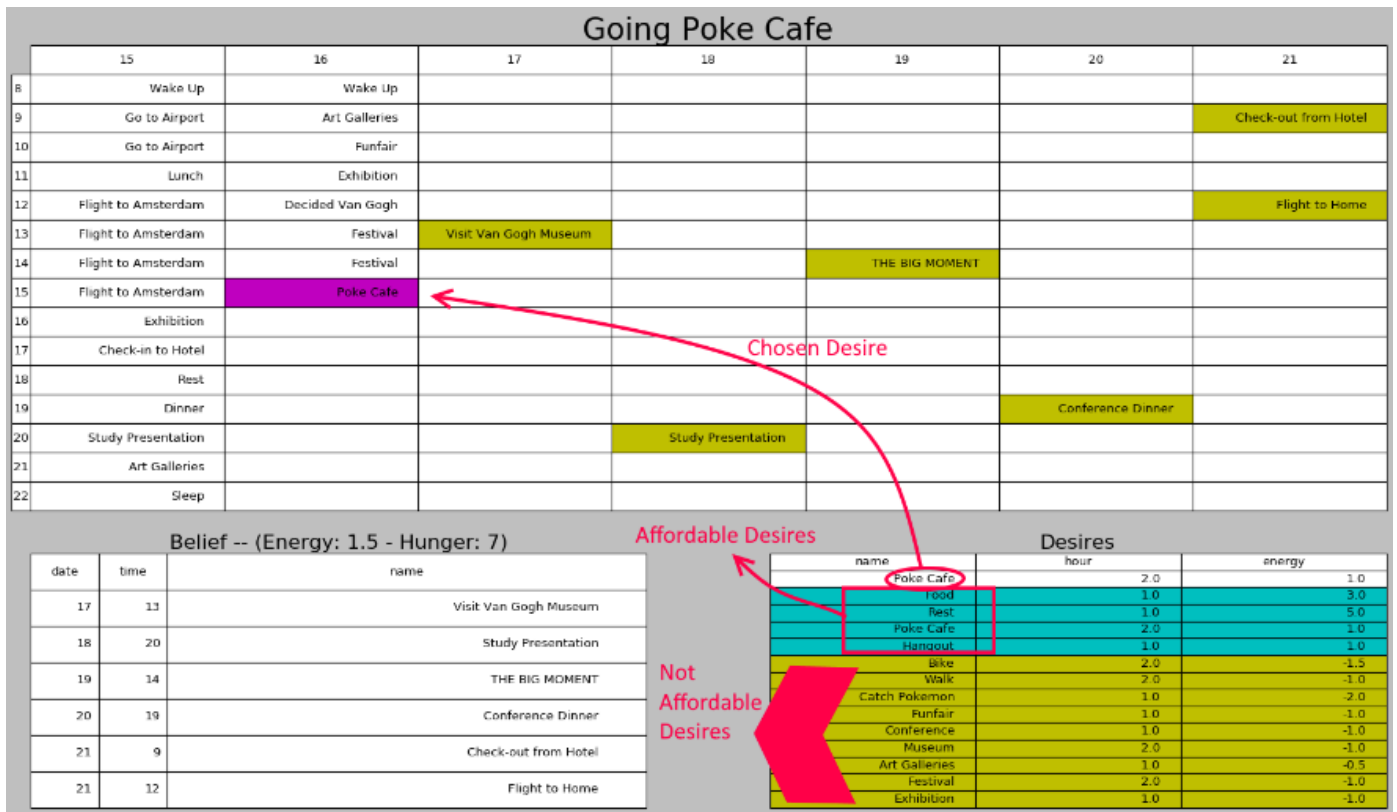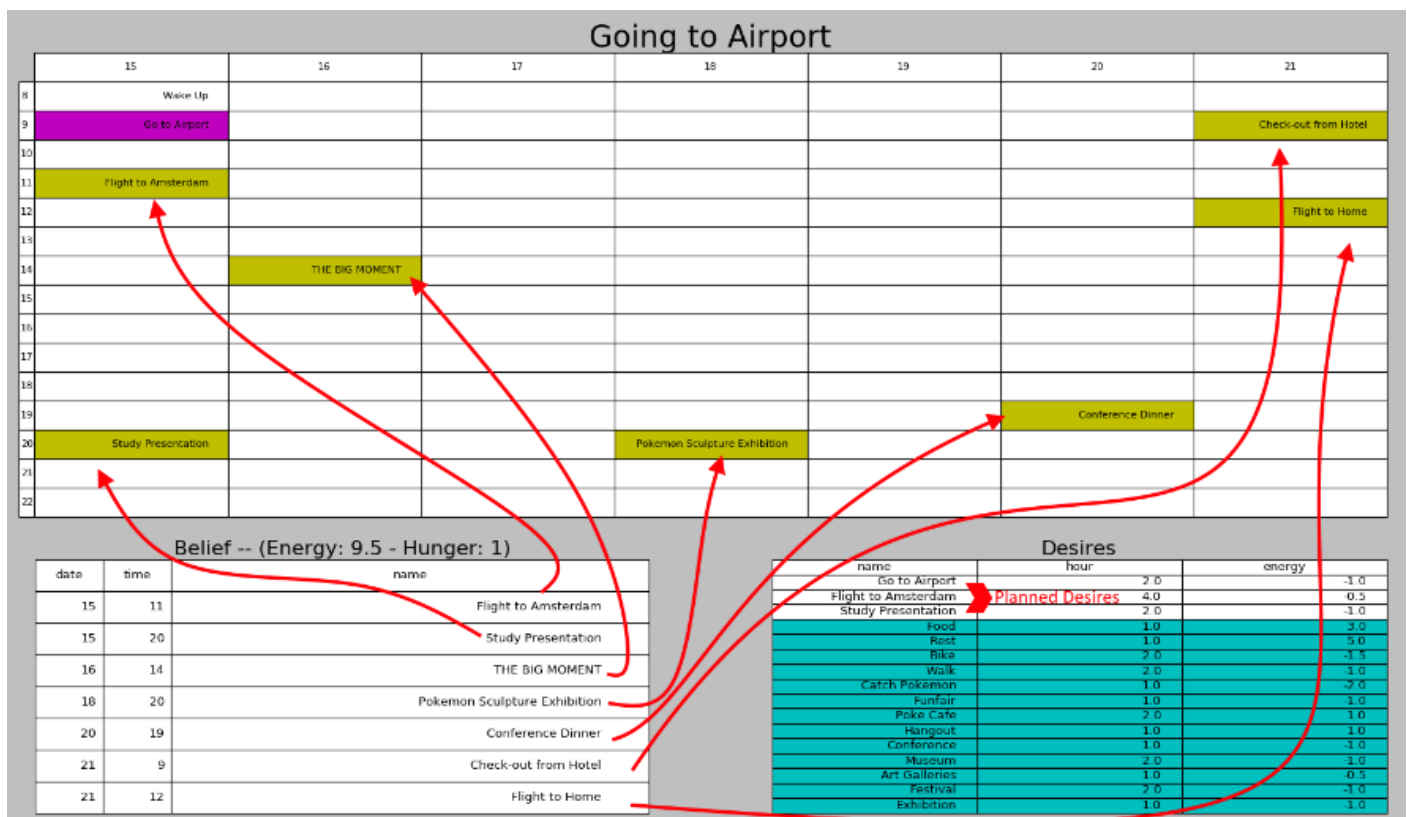
Going Poke Cafe

	15	16	17	18	19	20	21
8	Wake Up	Wake Up					
9	Go to Airport	Art Galleries					Check-out from Hotel
10	Go to Airport	Funfair					
11	Lunch	Exhibition					
12	Flight to Amsterdam	Decided Van Gogh					Flight to Home
13	Flight to Amsterdam	Festival	Visit Van Gogh Museum				
14	Flight to Amsterdam	Festival			THE BIG MOMENT		
15	Flight to Amsterdam	Poke Cafe					
16	Exhibition						
17	Check-in to Hotel			Chosen Desire			
18	Rest						
19	Dinner					Conference Dinner	
20	Study Presentation			Study Presentation			
21	Art Galleries						
22	Sleep						

Belief -- (Energy: 1.5 - Hunger: 7)

date	time	name
17	11	Visit Van Gogh Museum
18	20	Study Presentation
19	14	THE BIG MOMENT
20	19	Conference Dinner
21	9	Check-out from Hotel
21	12	Flight to Home

Affordable Desires

Not Affordable Desires

Desires

name	hour	energy
Poke Cafe	2.0	1.0
Food	1.0	3.0
Rest	1.0	5.0
Poke Cafe	2.0	1.0
Hangout	1.0	1.0
Bike	2.0	-1.5
Walk	2.0	-1.0
Catch Pokemon	1.0	-2.0
Funfair	1.0	-1.0
Conference	1.0	-1.0
Museum	2.0	-1.0
Art Galleries	1.0	-0.5
Festival	2.0	-1.0
Exhibition	1.0	-1.0

TABLE 1: DESIRES AND INTENTIONS

Going to Airport

	15	16	17	18	19	20	21
8	Wake Up						
9	Go to Airport						Check-out from Hotel
10							
11	Flight to Amsterdam						
12							Flight to Home
13							
14		THE BIG MOMENT					
15							
16							
17							
18							
19					Conference Dinner		
20	Study Presentation			Pokemon Sculpture Exhibition			
21							
22							

Belief -- (Energy: 9.5 - Hunger: 1)

date	time	name
15	11	Flight to Amsterdam
15	20	Study Presentation
16	14	THE BIG MOMENT
18	20	Pokemon Sculpture Exhibition
20	19	Conference Dinner
21	9	Check-out from Hotel
21	12	Flight to Home

Desires

name	hour	energy
Go to Airport	2.0	-1.0
Flight to Amsterdam	4.0	0.5
Study Presentation	2.0	-1.0
Food	1.0	3.0
Rest	1.0	5.0
Bike	2.0	-1.5
Walk	2.0	-1.0
Catch Pokemon	1.0	-2.0
Funfair	1.0	-1.0
Poke Cafe	2.0	1.0
Hangout	1.0	1.0
Conference	1.0	-1.0
Museum	2.0	-1.0
Art Galleries	1.0	-0.5
Festival	2.0	-1.0
Exhibition	1.0	1.0

Planned Desires

TABLE 2: INITIAL ACTIVITIES

id	name	date	time	intentionName	hour	energy
17	Go to Airport	15	9	Going to Airport	2	-1
1	Lunch	15	11	Eating Lunch	1	3
12	Flight to Amsterdam	15	11	Flying to Amsterdam	4	-0.5
2	Flight to Amsterdam	15	12	Flying to Amsterdam	4	-0.5
16	Go to Hotel	15	16	Going to Hotel	1	-1
3	Check-in to Hotel	15	17	Checking-in to Hotel	1	-1
4	Rest	15	18	Resting	1	5
5	Dinner	15	19	Eating Dinner	1	3
6	Study Presentation	15	20	Studying Presentation	2	-1
18	Meeting Friends	16	12	Hanging Out With New Friends	1	-0.5
13	THE BIG MOMENT	16	14	TA DAAAAAAA	1	-2
19	Van Gogh Museum	17	13	Visiting Van Gogh Museum	2	-1
7	Study Presentation	18	20	Studying Presentation	2	-1
15	Pokemon Sculpture Exhibition	18	20	Going to PSE	2	-1
14	THE BIG MOMENT	19	14	TA DAAAAAAA	1	-2
8	Conference Dinner	20	19	Enjoying After Party	3	-0.5
9	Check-out from Hotel	21	9	Checking-out from Hotel	1	-1
10	Go to Airport	21	10	Going to Airport	2	-1
11	Flight to Home	21	12	Coming Home	4	0

TABLE 3: DESIRE TABLE
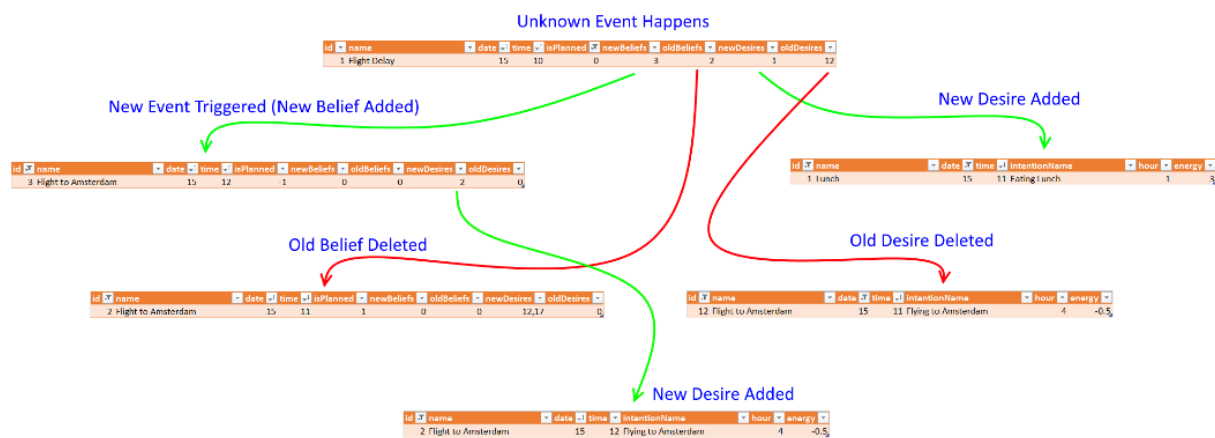
TABLE 4: UNKNOWN EVENT HAPPENS

id	name	date	time	isPlanned	newBeliefs	oldBeliefs	newDesires	oldDesires
1	Flight Delay	15	10	0	3	2	1	12
2	Flight to Amsterdam	15	11	1	0	0	12,17	0
3	Flight to Amsterdam	15	12	-1	0	0	2	0
4	Landing to Amsterdam	15	16	0	0	0	3,4,5	0
9	Study Presentation	15	20	1	0	0	6	0
5	Postponement of Presentation	15	21	0	7,10	6,8	0	6,13,15
14	Meet With Friends	16	12	0	15	0	18	0
6	THE BIG MOMENT	16	14	1	0	0	13	0
15	Visit Van Gogh Museum	17	13	-1	0	0	19	0
8	Pokemon Sculpture Exhibition	18	20	1	0	0	15	0
10	Study Presentation	18	20	-1	0	0	7	0
7	THE BIG MOMENT	19	14	-1	0	0	14	0
11	Conference Dinner	20	19	1	0	0	8	0
12	Check-out from Hotel	21	9	1	0	0	9,10	0
13	Flight to Home	21	12	1	0	0	11	0

Unknown Events
Triggered Events
Planned Events

TABLE 5: EVENT TABLE

id	name	date	time	intentionName	hour	energy
20	Food	0	0	Eating Food	1	3
21	Rest	0	0	Resting	1	5
22	Bike	0	0	Riding Bike	2	-1.5
23	Walk	0	0	Walking In VondelPark	2	-1
24	Catch Pokemon	0	0	Catching Pokemon	1	-2
25	Funfair	0	0	Going Funfair	1	-1
26	Poke Cafe	0	0	Going Poke Cafe	2	1
27	Hangout	0	0	Hanging Out With Friends	1	1
28	Conference	0	0	Going Conference	1	-1
29	Museum	0	0	Going to a Museum	2	-1
30	Art Galleries	0	0	Visiting an Art Gallery	1	-0.5
31	Festival	0	0	Going to a Festival	2	-1
32	Exhibition	0	0	Visiting an Exhibition	1	-1

TABLE 6: RANDOM DESIRES

Planned Events (Belief)

id	name	date	time	isPlanned	newBeliefs	oldBeliefs	newDesires	oldDesires
2	Flight to Amsterdam	15	11	1	0	0	12,17	0
9	Study Presentation	15	20	1	0	0	6	0
6	THE BIG MOMENT	16	14	1	0	0	13	0
8	Pokemon Sculpture Exhibition	18	20	1	0	0	15	0
11	Conference Dinner	20	19	1	0	0	8	0
12	Check-out from Hotel	21	9	1	0	0	9,1	0
13	Flight to Home	21	12	1	0	0	11	0

Planned Desires

id	name	date	time	intentionName	hour	energy
17	Go to Airport	15	9	Going to Airport	2	-1
12	Flight to Amsterdam	15	11	Flying to Amsterdam	4	-0.5
6	Study Presentation	15	20	Studying Presentation	2	-1

Desire list is created every morning according to planned events

TABLE 7: BELIEFS TO DESIRES

TABLE 8: FLIGHT DELAY

TABLE 9: LANDING TO AMSTERDAM

Visiting an Exhibition

	15	16	17	18	19	20	21
8	Wake Up						
9	Go to Airport						Check-out from Hotel
10	Go to Airport						
11	Lunch						
12	Flight to Amsterdam						Flight to Home
13	Flight to Amsterdam						
14	Flight to Amsterdam				THE BIG MOMENT		
15	Flight to Amsterdam						
16	Hangout						
17	Check-in to Hotel						
18	Rest						
19	Dinner					Conference Dinner	
20	Study Presentation		Study Presentation				
21	Exhibition						
22							

Belief -- (Energy: 7.0 - Hunger: 2)

date	time	name
18	20	Study Presentation
19	14	THE BIG MOMENT
20	19	Conference Dinner
21	9	Check-out from Hotel
21	12	Flight to Home

Desires

name	hour	energy
Food	1.0	3.0
Rest	1.0	5.0
Catch Pokemon	1.0	-2.0
Funfair	1.0	-1.0
Hangout	1.0	1.0
Conference	1.0	-1.0
Art Galleries	1.0	-0.5
Exhibition	1.0	-1.0
Bike	2.0	-1.5
Walk	2.0	-1.0
Poke Cafe	2.0	1.0
Museum	2.0	-1.0
Festival	2.0	-1.0

TABLE 10: POSTPONMENT OF PRESENTATION

Decided to Go Van Gogh Museum While Friend Meeting

	15	16	17	18	19	20	21
8	Wake Up	Wake Up					
9	Go to Airport	Catch Pokemon					Check-out from Hotel
10	Go to Airport	Catch Pokemon					
11	Lunch	Catch Pokemon					
12	Flight to Amsterdam	Decided Van Gogh					Flight to Home
13	Flight to Amsterdam		Visit Van Gogh Museum				
14	Flight to Amsterdam				THE BIG MOMENT		
15	Flight to Amsterdam						
16	Exhibition						
17	Check-in to Hotel						
18	Rest						
19	Dinner					Conference Dinner	
20	Study Presentation			Study Presentation			
21	Art Galleries						
22	Sleep						

Belief -- (Energy: 2.0 - Hunger: 4)

date	time	name
17	13	Visit Van Gogh Museum
18	20	Study Presentation
19	14	THE BIG MOMENT
20	19	Conference Dinner
21	9	Check-out from Hotel
21	12	Flight to Home

Desires

name	hour	energy
Meeting Friends	1.0	-0.5
Food	1.0	3.0
Rest	1.0	5.0
Poke Cafe	2.0	1.0
Hangout	1.0	1.0
Bike	2.0	-1.5
Walk	2.0	-1.0
Catch Pokemon	1.0	-2.0
Funfair	1.0	-1.0
Conference	1.0	-1.0
Museum	2.0	-1.0
Art Galleries	1.0	-0.5
Festival	2.0	-1.0
Exhibition	1.0	-1.0

TABLE 11: VISIT VAN GOGH

At Home - The End

	15	16	17	18	19	20	21
8	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up
9	Go to Airport	Catch Pokemon	Funfair	Bike	Hangout	Conference	Check-out from Hotel
10	Go to Airport	Conference	Festival	Bike	Rest	Museum Cancelled	Go to Airport
11	Lunch	Conference	Festival	Rest	Exhibition Cancelled	Walk	Go to Airport
12	Flight to Amsterdam	Decided Van Gogh	Catch Pokemon	Bike	Museum Cancelled	Walk	Flight to Home
13	Flight to Amsterdam	Rest	Van Gogh Museum	Bike	Art Galleries	Funfair	Flight to Home
14	Flight to Amsterdam	Food	Van Gogh Museum	Food	THE BIG MOMENT	Food	Flight to Home
15	Flight to Amsterdam	Poke Cafe	Food	Bike	Rest	Art Galleries	Flight to Home
16	Art Galleries	Poke Cafe	Poke Cafe	Bike	Food	Exhibition Cancelled	The End
17	Check-in to Hotel	Museum Cancelled	Poke Cafe	Rest	Catch Pokemon	Rest	
18	Rest	Hangout	Poke Cafe	Museum Cancelled	Art Galleries	Exhibition	
19	Dinner	Catch Pokemon	Poke Cafe	Hangout	Hangout	Conference Dinner	
20	Study Presentation	Festival	Art Galleries	Study Presentation	Exhibition Cancelled	Conference Dinner	
21	Art Galleries	Festival	Hangout	Study Presentation	Friends Forgot Meeting	Conference Dinner	
22	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	

Belief -- (Energy: 3.5 - Hunger: 7)

Date	Time	Name

Desires

name	hour	energy
Food	1.0	3.0
Rest	1.0	5.0
Walk	2.0	-1.0
Funfair	1.0	-1.0
Poke Cafe	2.0	1.0
Hangout	1.0	1.0
Conference	1.0	-1.0
Museum	2.0	-1.0
Art Galleries	1.0	-0.5
Festival	2.0	-1.0
Exhibition	1.0	-1.0
Bike	2.0	-1.5
Catch Pokemon	1.0	-2.0

TABLE 12: POSSIBLE ENDING 1

At Home - The End

	15	16	17	18	19	20	21
8	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up	Wake Up
9	Go to Airport	Rest	Rest	Exhibition Cancelled	Art Galleries	Poke Cafe	Check-out from Hotel
10	Go to Airport	Exhibition	Bike	Walk	Bike	Poke Cafe	Go to Airport
11	Lunch	Friends Forgot Meeting	Bike	Walk	Bike	Art Galleries	Go to Airport
12	Flight to Amsterdam	Decided Van Gogh	Art Galleries	Exhibition	Festival	Festival	Flight to Home
13	Flight to Amsterdam	Art Galleries	Van Gogh Museum	Walk	Festival	Festival	Flight to Home
14	Flight to Amsterdam	Rest	Van Gogh Museum	Walk	THE BIG MOMENT	Food	Flight to Home
15	Flight to Amsterdam	Food	Food	Food	Food	Funfair	Flight to Home
16	Art Galleries	Funfair	Exhibition	Art Galleries	Hangout	Poke Cafe	The End
17	Check-in to Hotel	Exhibition	Poke Cafe	Rest	Poke Cafe	Poke Cafe	
18	Rest	Walk	Poke Cafe	Bike	Poke Cafe	Exhibition Cancelled	
19	Dinner	Walk	Conference	Bike	Poke Cafe	Conference Dinner	
20	Study Presentation	Museum Cancelled	Rest	Study Presentation	Poke Cafe	Conference Dinner	
21	Rest	Hangout	Food	Study Presentation	Hangout	Conference Dinner	
22	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	

Belief -- (Energy: 3.5 - Hunger: 7)

Date	Time	Name

Desires

name	hour	energy
Food	1.0	3.0
Rest	1.0	5.0
Walk	2.0	-1.0
Funfair	1.0	-1.0
Poke Cafe	2.0	1.0
Hangout	1.0	1.0
Conference	1.0	-1.0
Museum	2.0	-1.0
Art Galleries	1.0	-0.5
Festival	2.0	-1.0
Exhibition	1.0	-1.0
Bike	2.0	-1.5
Catch Pokemon	1.0	-2.0

TABLE 13: POSSIBLE ENDING 2