

# Data Mining for Bee Micro-sensors

Laboratorio Nacional de Análisis y  
Síntesis Ecológica

Framework Developed by:

Ulises Olivares, Gloria Ruiz, María J. Aguilar, Mauricio  
Quesada

HIGH PERFORMANCE COMPUTING APPLIED TO BIOLOGICAL SCIENCES, UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO - ESCUELA NACIONAL DE ESTUDIOS SUPERIORES UNIDAD MORELIA - LABORATORIO NACIONAL DE ANÁLISIS Y SÍNTESIS ECOLÓGICA

This work was supported by grants from Consejo Nacional de Ciencia y Tecnología (CONACyT: Laboratorio Nacional de Análisis y Síntesis Ecológica U-3-2015-2-250996, CONACYT and CONACyT: Propuesta para el desarrollo de una infraestructura tecnológica para la creación de repositorios masivos de datos biológicos con fines de conservación y análisis de información I0028-2015-02-271432, CONACYT).

*First release, April 2017*



## Contents

I	Morelia Hive 1 .....	5
1	Introduction .....	7
2	Analysis of Raw Data .....	9
3	Analysis of Clean Data .....	19
4	Analysis of Foraging Behavior .....	29
II	Morelia Hive 2 .....	31
5	Introduction .....	33
6	Analysis of Raw Data .....	35
7	Analysis of Clean Data .....	45
8	Analysis of Foraging Behavior .....	55



**Part I**

**Morelia Hive 1**





## 1. Introduction

### Introduction

The main propose of this document is to show a concise report about the activity of bees and behavior in a specific period of time. This report also shows a complete analysis of the most active hours.

This report corresponds to a period of time of 26 day(s). From 2016-07-02 to 2016-07-31. During this period of time, a total amount of 2822 lectures were registered from 51 different bees. There exist a total of 5 non-active days. We define an 'active day' if there is more than one observation. (see Figure 1.1).

Relation: Active VS Non-active Days

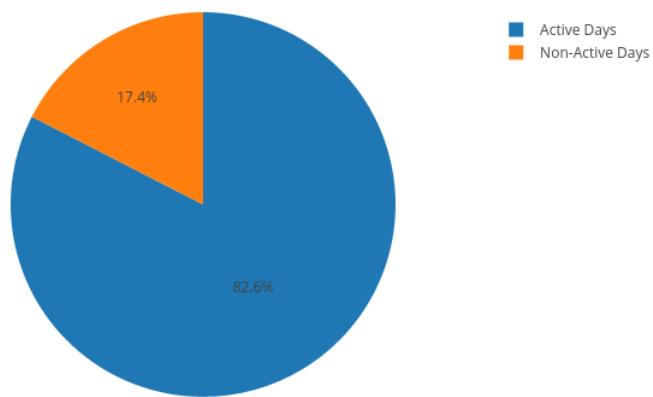


Figure 1.1: Days with and without Empty Reads



## 2. Analysis of Raw Data

### Activity Per Day of Raw Data

This section addresses the analysis of raw data. Which implies that this date is presented without filters or a data preprocessing step to clean the data. This section presents several graphs which reflects the behavior of a beehive during a specific period of time.

Day	Date	# Observations	# Bees per day
1	2016-07-02	1	1
2	2016-07-03	1	1
3	2016-07-08	50	8
4	2016-07-09	145	11
5	2016-07-10	115	10
6	2016-07-11	50	7
7	2016-07-12	21	5
8	2016-07-13	26	7
9	2016-07-14	65	4
10	2016-07-15	731	14
11	2016-07-16	510	11
12	2016-07-17	68	5
13	2016-07-18	43	3
14	2016-07-19	32	3
15	2016-07-20	33	3
16	2016-07-21	16	3
17	2016-07-22	6	2
18	2016-07-23	342	16
19	2016-07-24	256	12
20	2016-07-25	66	8
21	2016-07-26	105	7

22	2016-07-27	29	5
23	2016-07-28	21	5
24	2016-07-29	37	6
25	2016-07-30	27	4
26	2016-07-31	26	4
--	Average	108	6

**Bee Life Cycle**

In this section is analyzed the Life Cycle of each bee in the hive

Register	Bee ID	Life Cycle in Days
1	0004	1
2	0005	1
3	0023	1
4	0024	5
5	0029	8
6	0031	1
7	0053	5
8	0055	1
9	0056	1
10	0060	1
11	0061	1
12	0062	1
13	0063	6
14	0064	1
15	0068	16
16	0071	1
17	0075	5
18	0077	18
19	0079	2
20	0081	1
21	0082	1
22	0090	3
23	0093	1
24	0095	1
25	0108	9
26	0112	1
27	0130	9
28	0137	5
29	0145	3
30	0146	2
31	0153	3
32	0154	1
33	0155	1

---

34	0156	2
35	0157	2
36	0162	3
37	0165	2
38	0188	7
39	0189	2
40	0194	1
41	0203	1
42	0208	2
43	0212	9
44	0213	9
45	0215	1
46	0220	1
47	0223	2
48	0234	7
49	0235	2
50	0250	1
51	0137	1
--	Average	3

#### **Analysis of Activity per Hour**

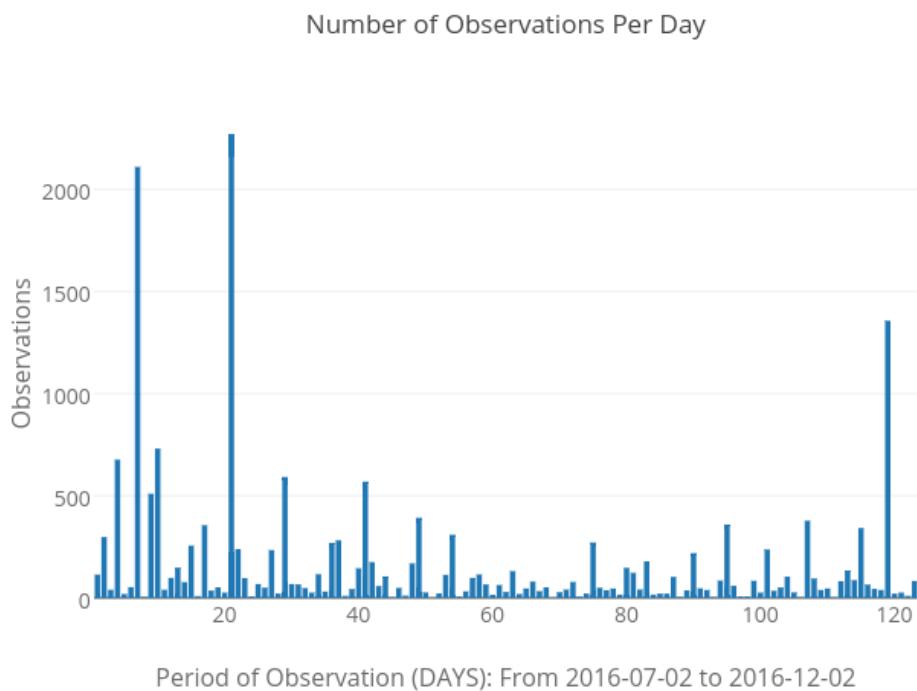


Figure 2.1: Number of Observations per Day

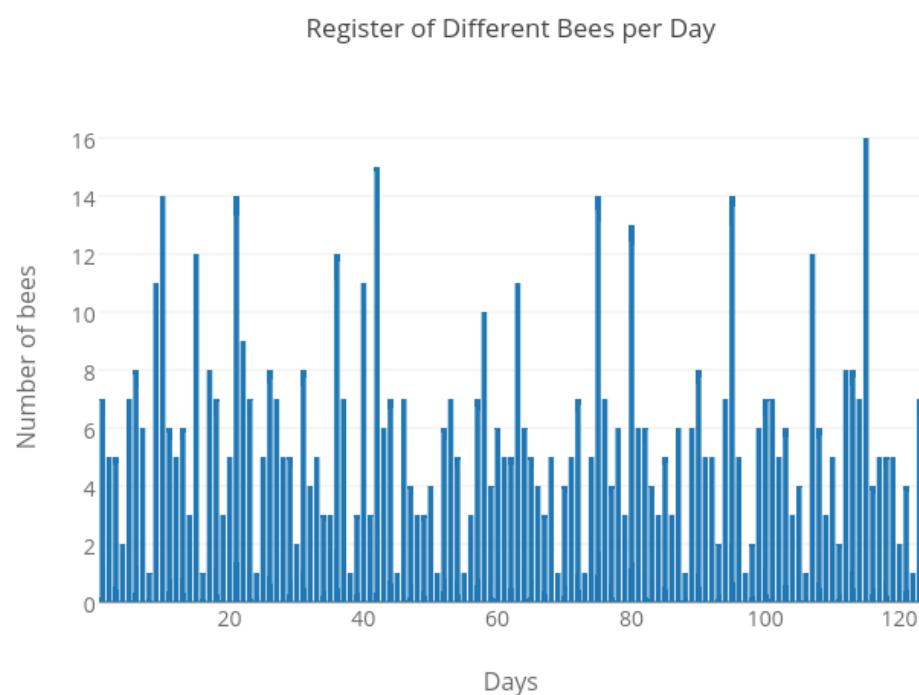


Figure 2.2: Different Bees Per Day

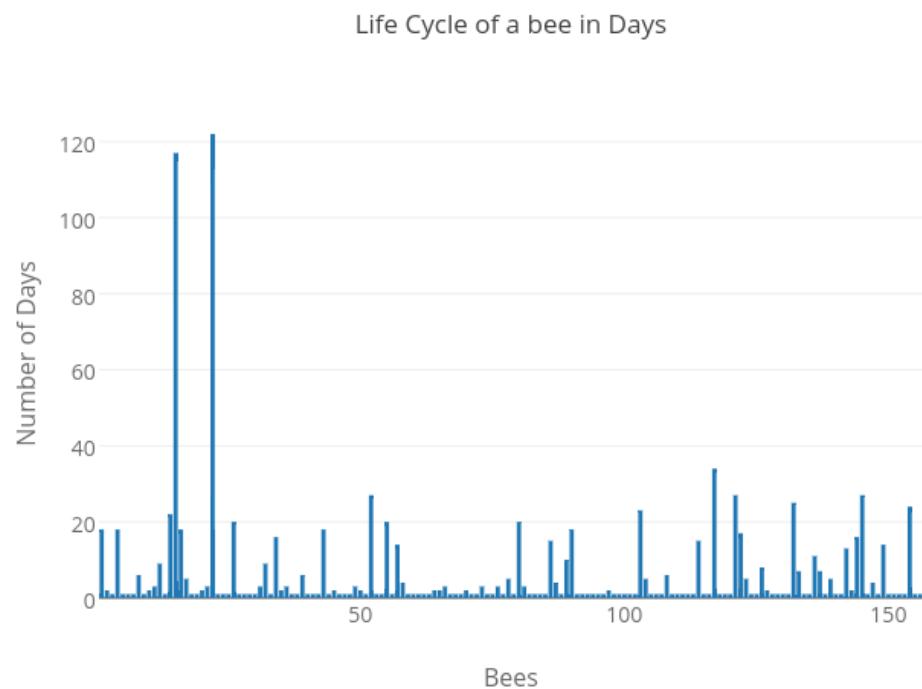


Figure 2.3: Bee Life cycle in days

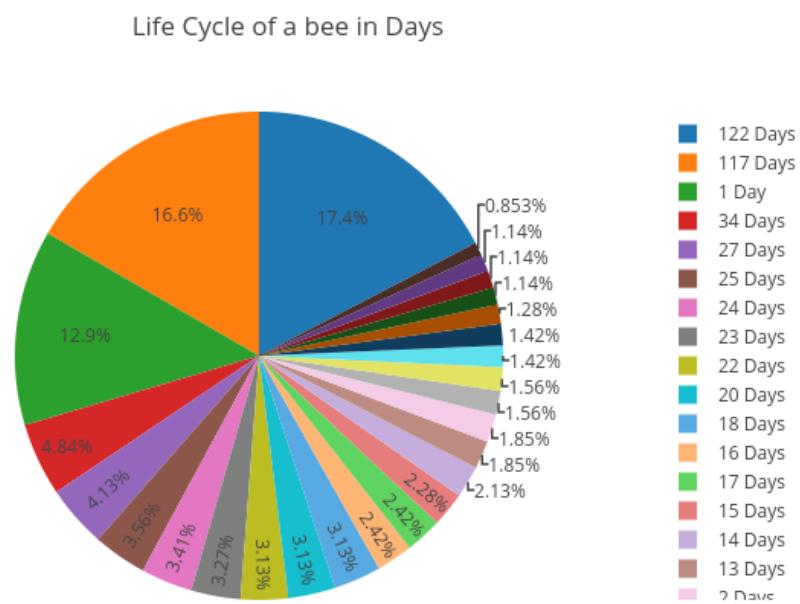


Figure 2.4: Bee Life cycle in days

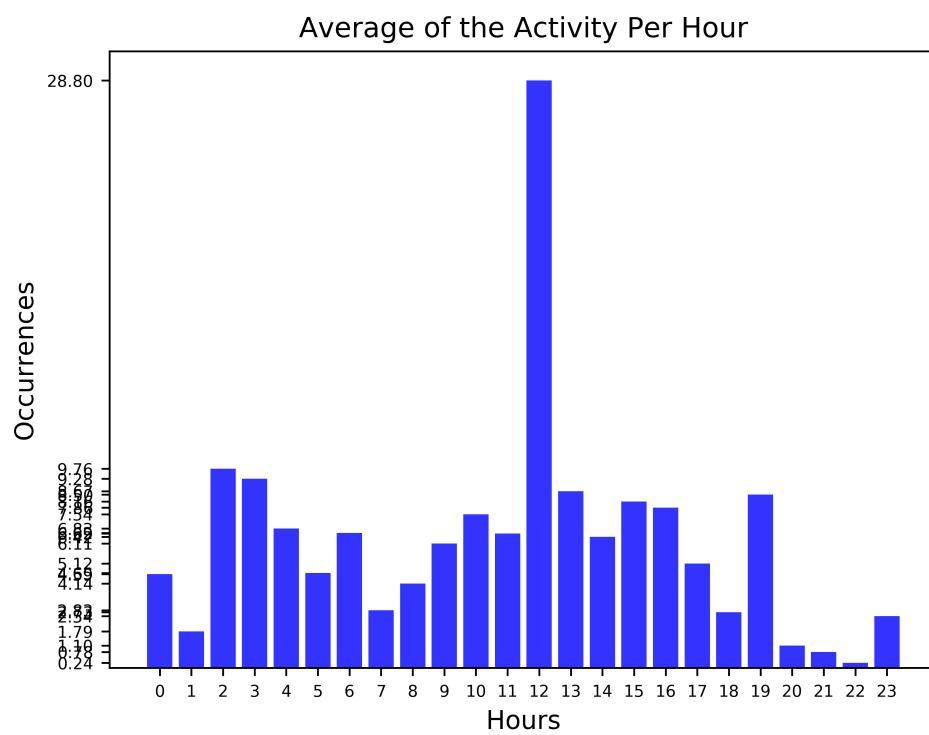


Figure 2.5: Histogram of frequencies per hour

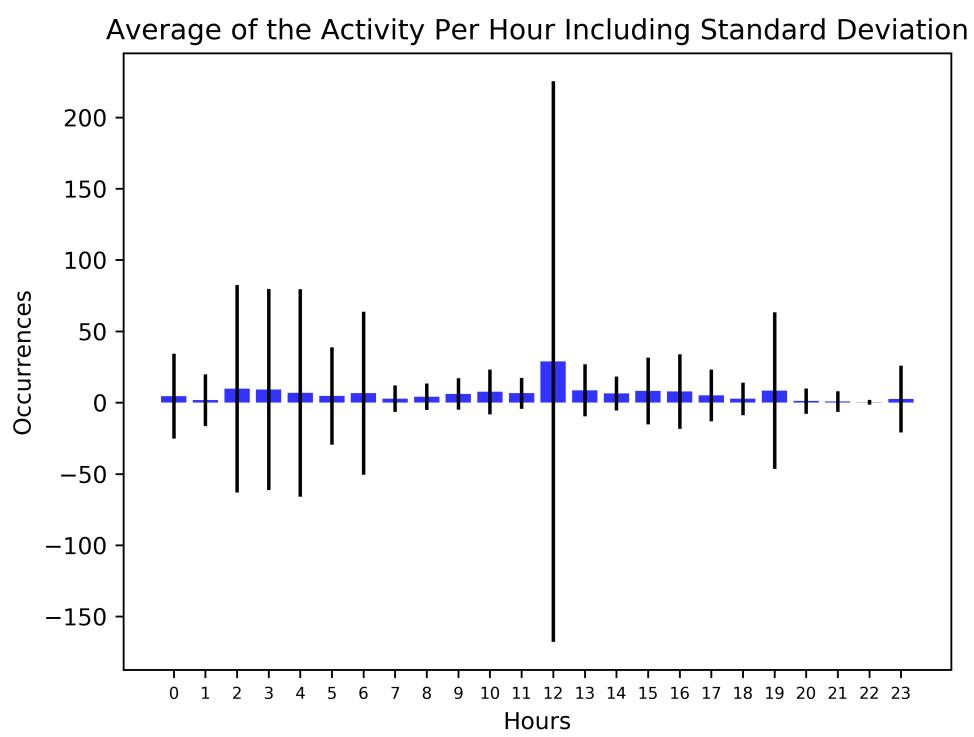


Figure 2.6: Histogram of frequencies per hour. It includes standard deviation





### 3. Analysis of Clean Data

#### Activity Per Day of Clean Data

In this section is presented an analysis of input data. During this analysis some filters were applied. One of these filters is the definition of a threshold which removes all the observations that fall in a period of time less than 60 seconds. This preprocessing step tends to remove all the lost chips which generated unnecessary and repeated registers

Day	Date	# Observations	# Bees per day
1	2016-07-08	9	3
2	2016-07-09	35	10
3	2016-07-10	42	8
4	2016-07-11	33	5
5	2016-07-12	12	4
6	2016-07-13	16	5
7	2016-07-14	16	3
8	2016-07-15	143	8
9	2016-07-16	69	7
10	2016-07-17	31	5
11	2016-07-18	20	3
12	2016-07-19	22	3
13	2016-07-20	26	3
14	2016-07-21	12	2
15	2016-07-22	4	2
16	2016-07-23	86	10
17	2016-07-24	60	11
18	2016-07-25	24	4
19	2016-07-26	36	7
20	2016-07-27	19	4

21	2016-07-28	13	3
22	2016-07-29	25	4
23	2016-07-30	19	4
24	2016-07-31	20	4
--	Average	33	5

**Bee Life Cycle**

Register	Bee ID	Life Cycle in Days
1	0024	4
2	0029	5
3	0053	3
4	0055	1
5	0062	1
6	0063	6
7	0068	16
8	0071	1
9	0075	5
10	0077	18
11	0079	2
12	0090	2
13	0095	1
14	0108	9
15	0112	1
16	0130	8
17	0137	4
18	0145	2
19	0146	1
20	0153	3
21	0155	1
22	0156	1
23	0157	2
24	0162	2
25	0165	2
26	0188	5
27	0189	2
28	0203	1
29	0208	2
30	0212	8
31	0213	6
32	0215	1
33	0223	1
34	0234	7
35	0235	2

--	Average	3
----	---------	---

**Analysis of Activity per Hour**

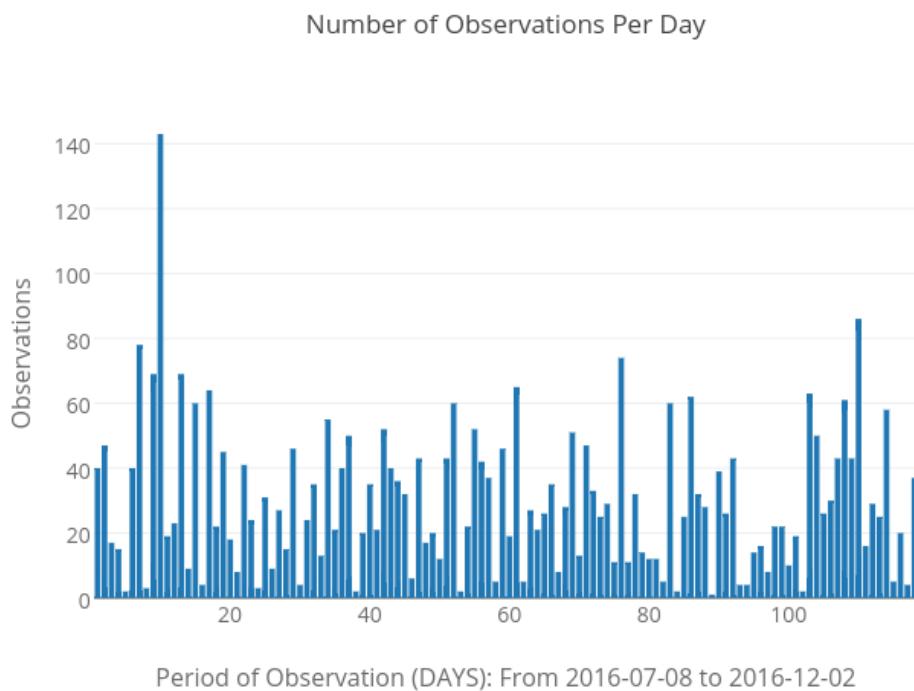


Figure 3.1: Number of Observations per Day

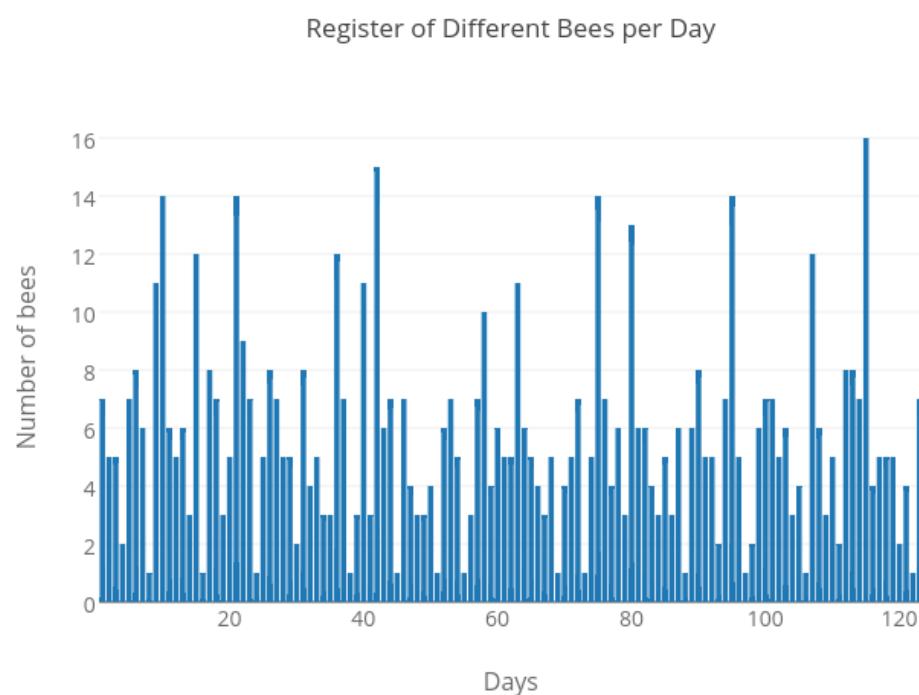


Figure 3.2: Different Bees Per Day

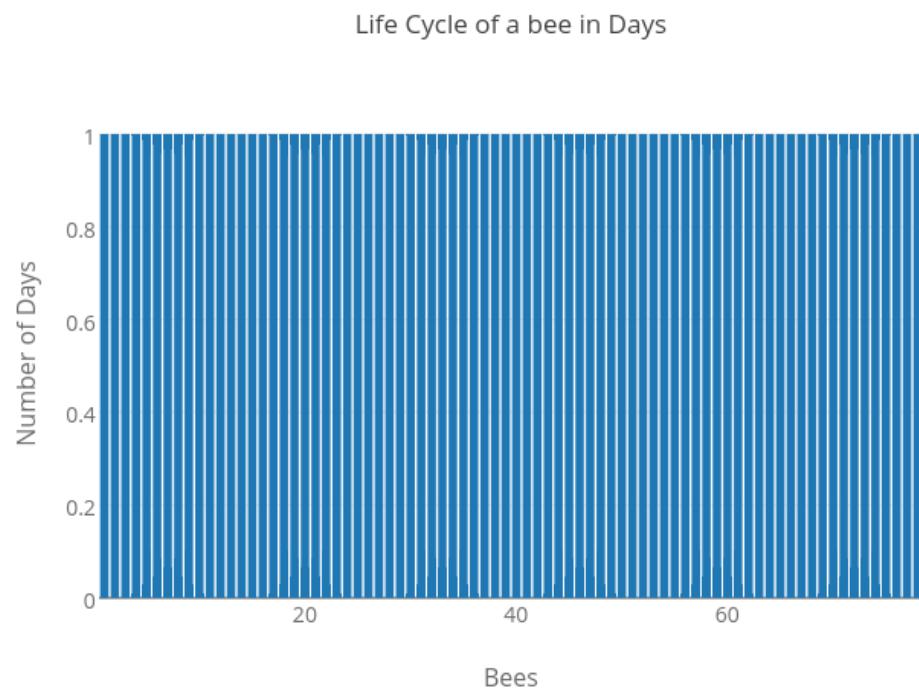


Figure 3.3: Bee Life cycle in days

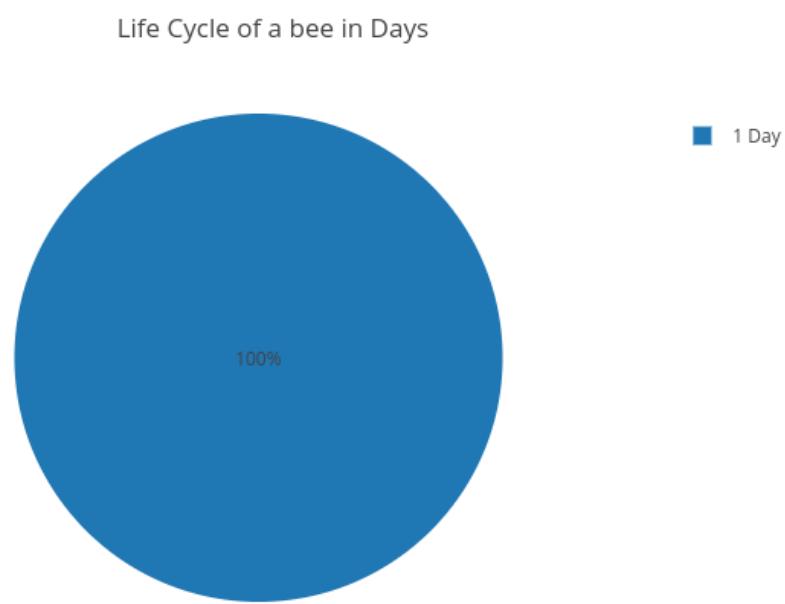


Figure 3.4: Bee Life cycle in days

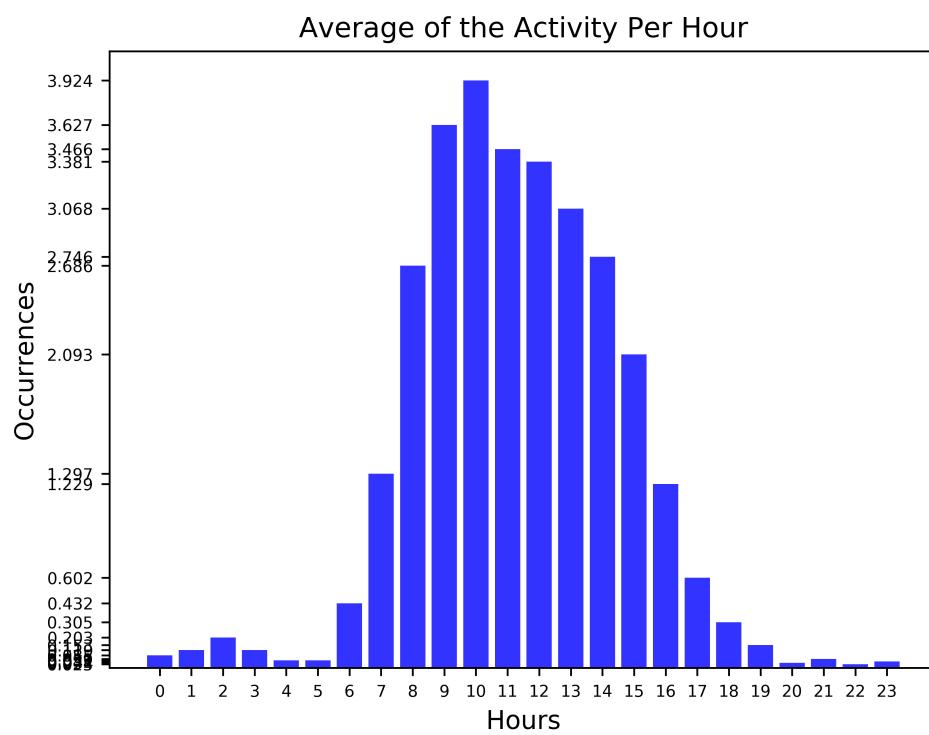


Figure 3.5: Histogram of frequencies per hour

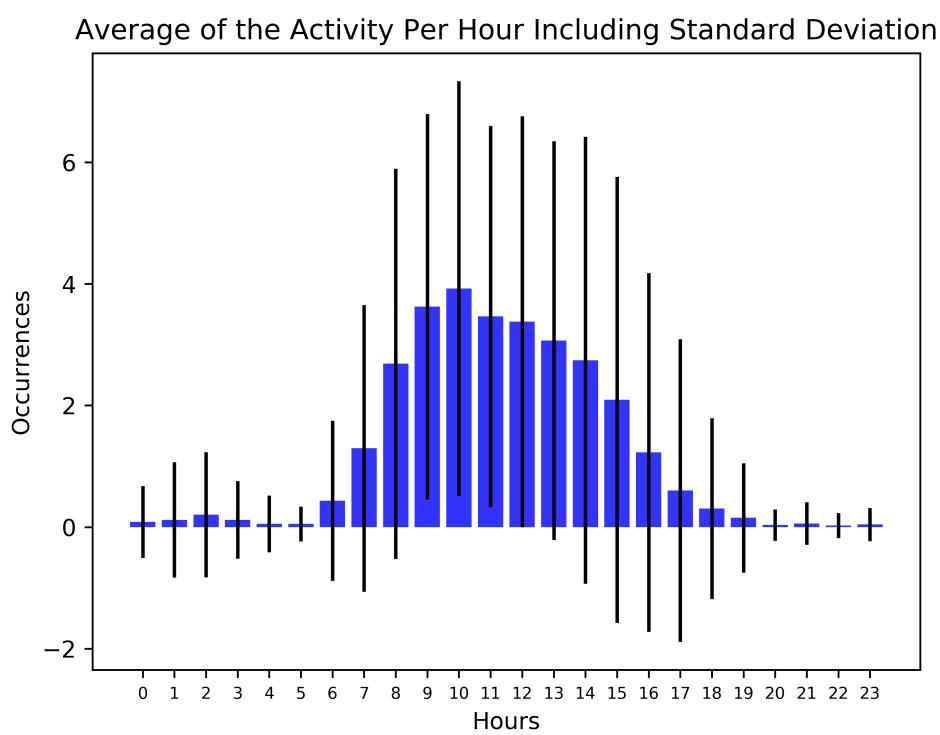


Figure 3.6: Histogram of frequencies per hour. It includes standard deviation





## 4. Analysis of Foraging Behavior



**Part II**

**Morelia Hive 2**





## 5. Introduction

### Introduction

The main propose of this document is to show a concise report about the activity of bees and behavior in a specific period of time. This report also shows a complete analysis of the most active hours.

This report corresponds to a period of time of 26 day(s). From 2016-07-01 to 2016-07-31. During this period of time, a total amount of 486970 lectures were registered from 58 different bees. There exist a total of 5 non-active days. We define an 'active day' if there is more than one observation. (see Figure 1.1).

Relation: Active VS Non-active Days

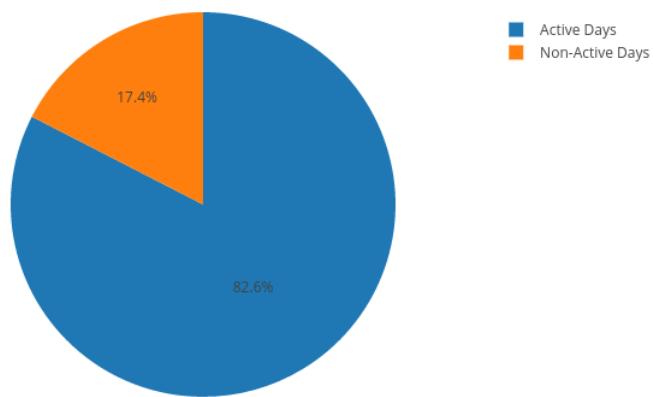


Figure 5.1: Days with and without Empty Reads



## 6. Analysis of Raw Data

### Activity Per Day of Raw Data

This section addresses the analysis of raw data. Which implies that this date is presented without filters or a data preprocessing step to clean the data. This section presents several graphs which reflects the behavior of a beehive during a specific period of time.

Day	Date	# Observations	# Bees per day
1	2016-07-01	5	2
2	2016-07-03	3	1
3	2016-07-04	5	1
4	2016-07-08	20	4
5	2016-07-09	91	5
6	2016-07-10	8	1
7	2016-07-11	11	2
8	2016-07-12	3	2
9	2016-07-13	1	1
10	2016-07-14	689	2
11	2016-07-15	377	4
12	2016-07-16	980	3
13	2016-07-17	135	3
14	2016-07-18	4	1
15	2016-07-19	6	1
16	2016-07-20	7	2
17	2016-07-22	1	1
18	2016-07-23	16023	27
19	2016-07-24	73807	28
20	2016-07-25	83741	12
21	2016-07-26	73707	13

22	2016-07-27	67496	7
23	2016-07-28	15132	3
24	2016-07-29	9108	1
25	2016-07-30	69867	2
26	2016-07-31	75743	4
--	Average	18729	5

### Bee Life Cycle

In this section is analyzed the Life Cycle of each bee in the hive

Register	Bee ID	Life Cycle in Days
1	61DC	1
2	0000	1
3	0087	1
4	0062	1
5	0071	1
6	0002	1
7	0010	1
8	0014	2
9	0031	2
10	0032	1
11	0036	2
12	0045	3
13	0053	1
14	0054	2
15	0065	4
16	0066	1
17	0067	1
18	0072	10
19	0074	1
20	0077	5
21	0080	4
22	0083	2
23	0111	7
24	0114	1
25	0116	4
26	0119	6
27	0125	2
28	0126	1
29	0128	1
30	0129	1
31	0136	4
32	0145	1
33	0151	8

34	0160	2
35	0167	2
36	0168	1
37	0170	2
38	0176	9
39	0177	1
40	0178	1
41	0187	2
42	0189	5
43	0192	1
44	0197	2
45	0201	2
46	0203	4
47	0204	5
48	0208	2
49	0213	4
50	0219	1
51	0222	1
52	0223	1
53	0228	3
54	0231	4
55	0234	2
56	0243	1
57	0244	1
58	0246	1
--	Average	2

### **Analysis of Activity per Hour**

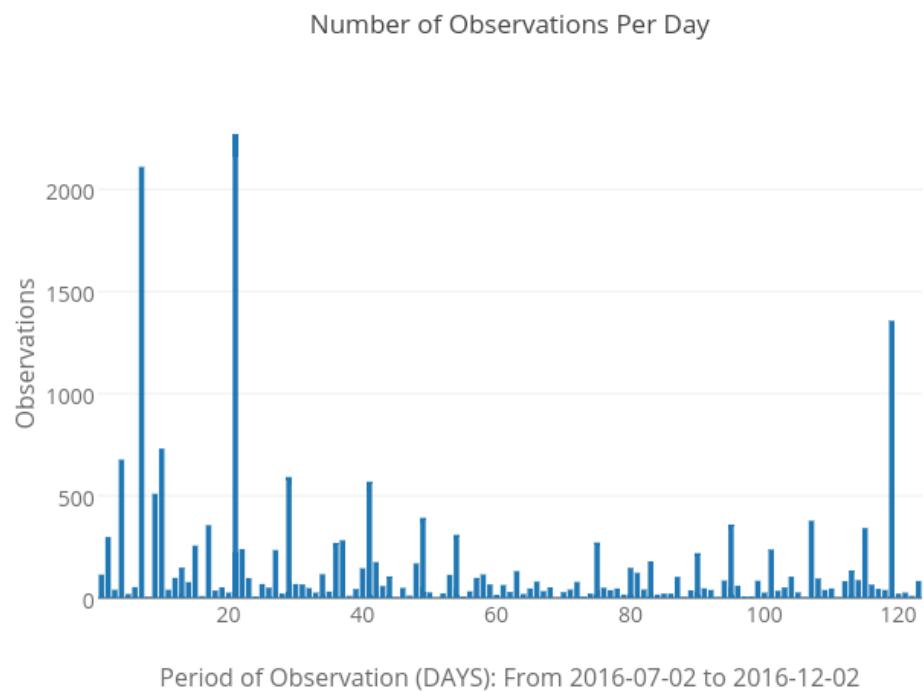


Figure 6.1: Number of Observations per Day

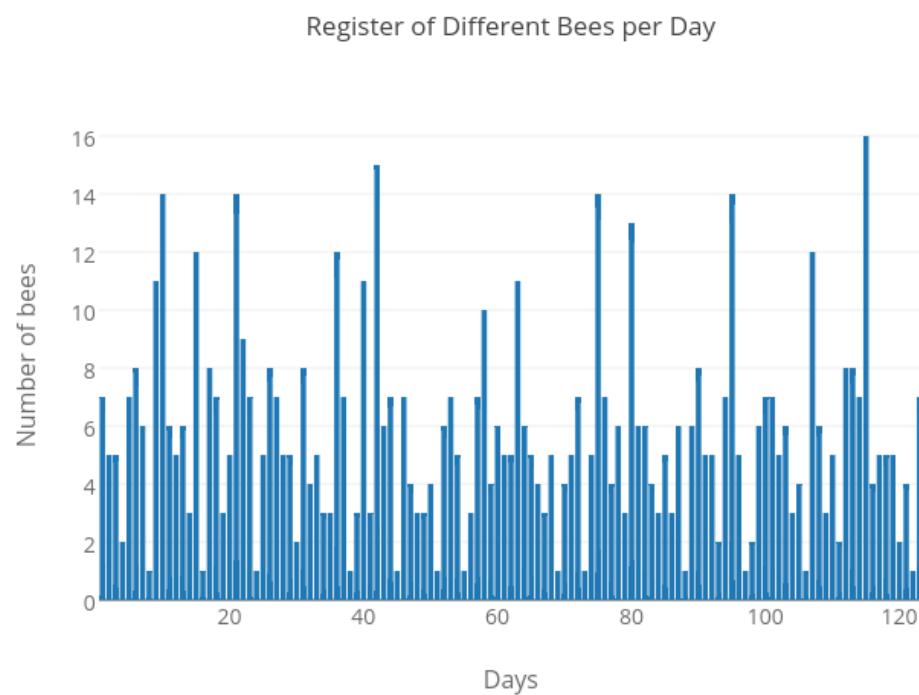


Figure 6.2: Different Bees Per Day

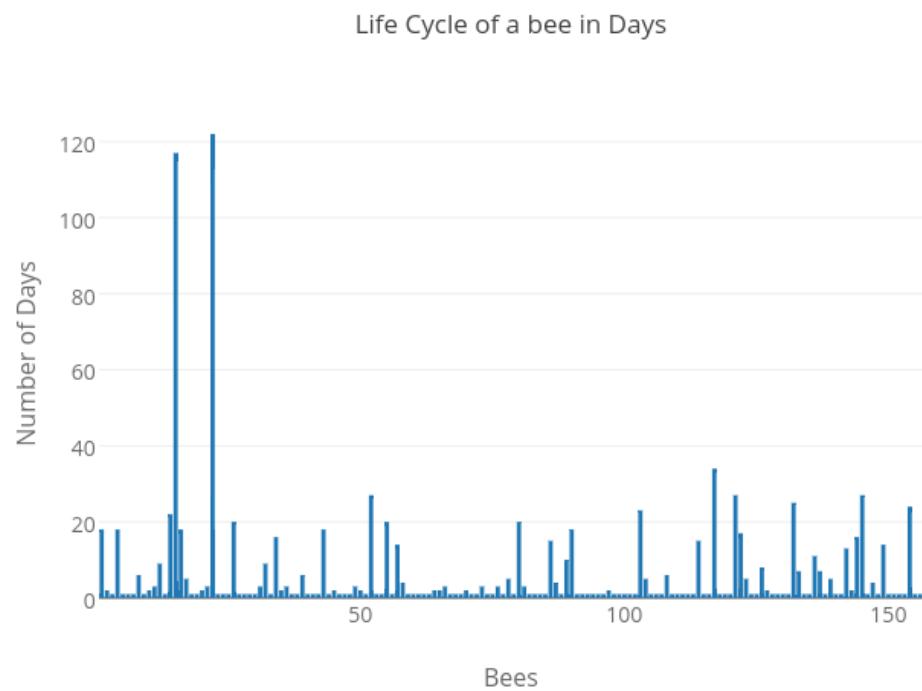


Figure 6.3: Bee Life cycle in days

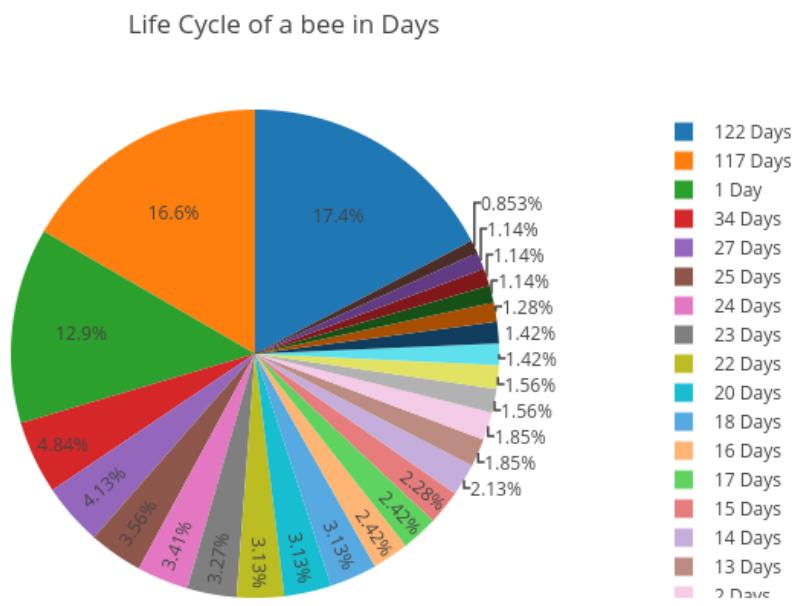


Figure 6.4: Bee Life cycle in days

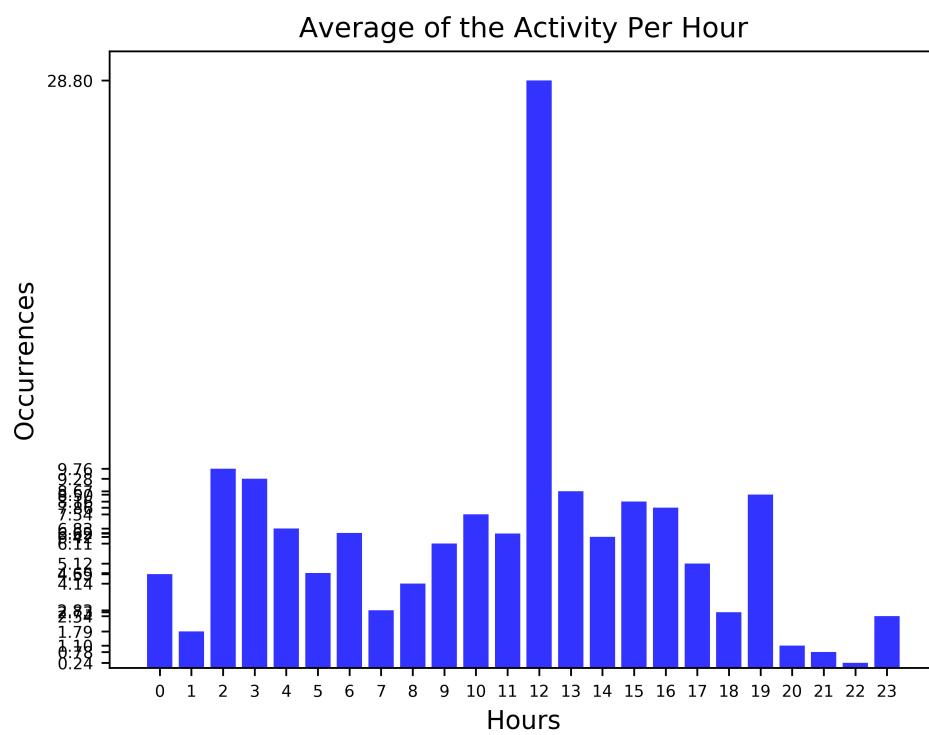


Figure 6.5: Histogram of frequencies per hour

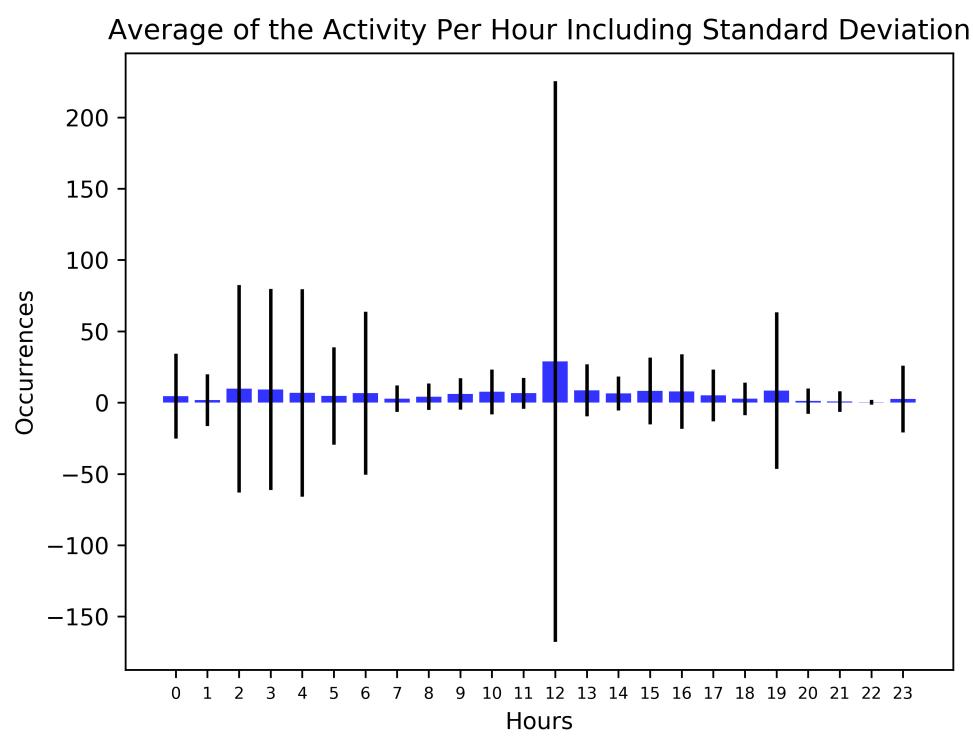


Figure 6.6: Histogram of frequencies per hour. It includes standard deviation





## 7. Analysis of Clean Data

### Activity Per Day of Clean Data

In this section is presented an analysis of input data. During this analysis some filters were applied. One of these filters is the definition of a threshold which removes all the observations that fall in a period of time less than 60 seconds. This preprocessing step tends to remove all the lost chips which generated unnecessary and repeated registers

Day	Date	# Observations	# Bees per day
1	2016-07-08	5	3
2	2016-07-09	15	3
3	2016-07-10	1	1
4	2016-07-11	7	2
5	2016-07-12	1	1
6	2016-07-14	38	2
7	2016-07-15	64	4
8	2016-07-16	97	2
9	2016-07-17	26	3
10	2016-07-18	3	1
11	2016-07-19	2	1
12	2016-07-20	2	2
13	2016-07-23	131	19
14	2016-07-24	311	19
15	2016-07-25	482	9
16	2016-07-26	414	7
17	2016-07-27	450	5
18	2016-07-28	19	2
19	2016-07-29	79	1
20	2016-07-30	80	2

21	2016-07-31	11	3
--	Average	106	4

**Bee Life Cycle**

Register	Bee ID	Life Cycle in Days
1	0062	1
2	0071	1
3	0014	1
4	0031	2
5	0045	2
6	0053	1
7	0054	2
8	0065	1
9	0066	1
10	0072	10
11	0077	4
12	0080	2
13	0111	1
14	0114	1
15	0116	3
16	0119	6
17	0125	2
18	0126	1
19	0128	1
20	0129	1
21	0136	4
22	0145	1
23	0151	8
24	0160	1
25	0167	1
26	0170	2
27	0176	9
28	0178	1
29	0187	1
30	0189	4
31	0201	2
32	0203	4
33	0204	5
34	0208	2
35	0213	4
36	0222	1
37	0223	1
38	0228	1

39	0231	3
40	0234	2
41	0243	1
42	0244	1
43	0246	1
--	Average	2

**Analysis of Activity per Hour**

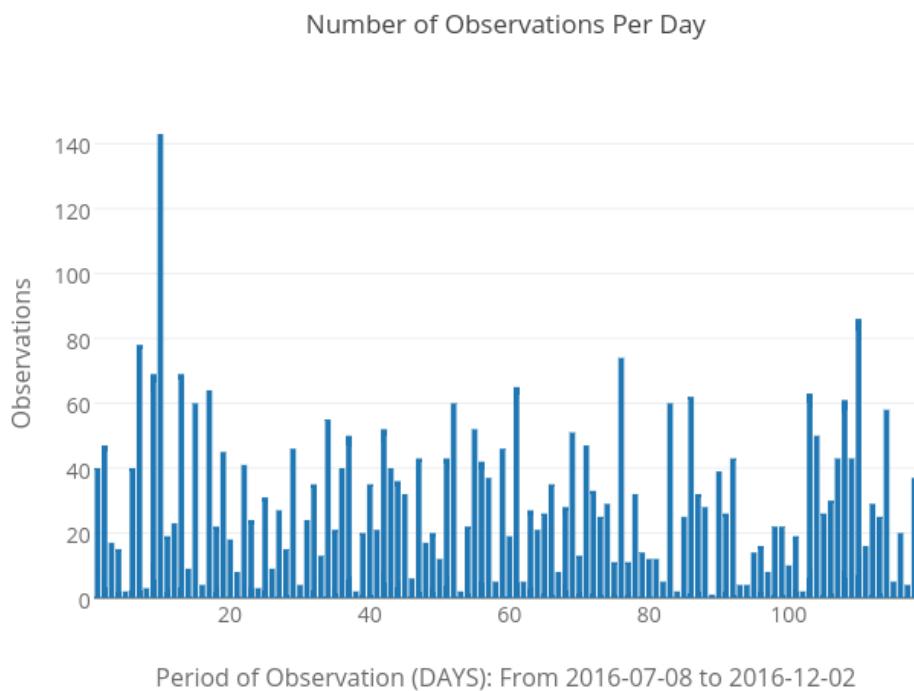


Figure 7.1: Number of Observations per Day

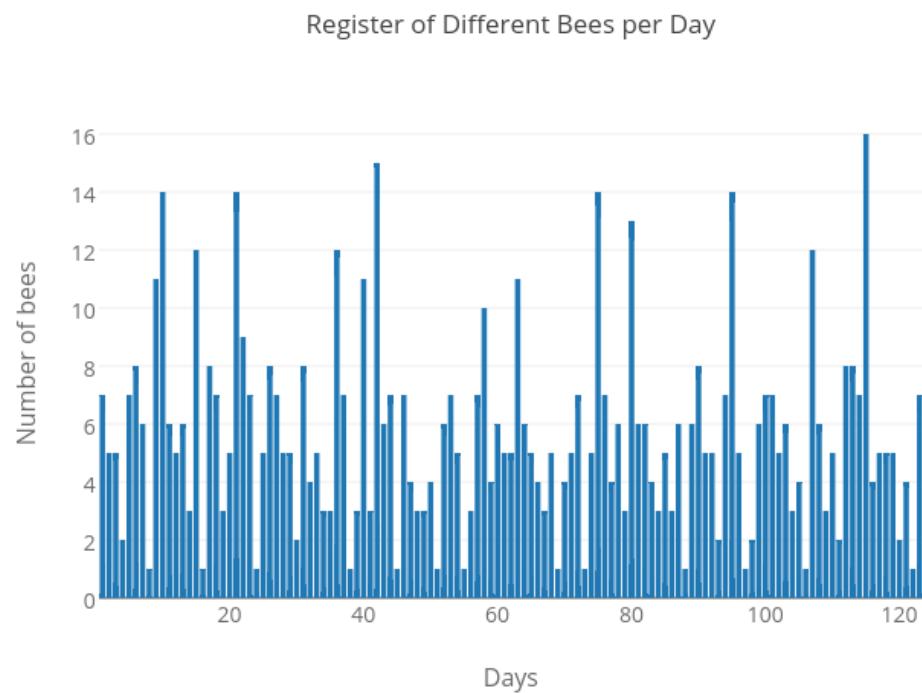


Figure 7.2: Different Bees Per Day

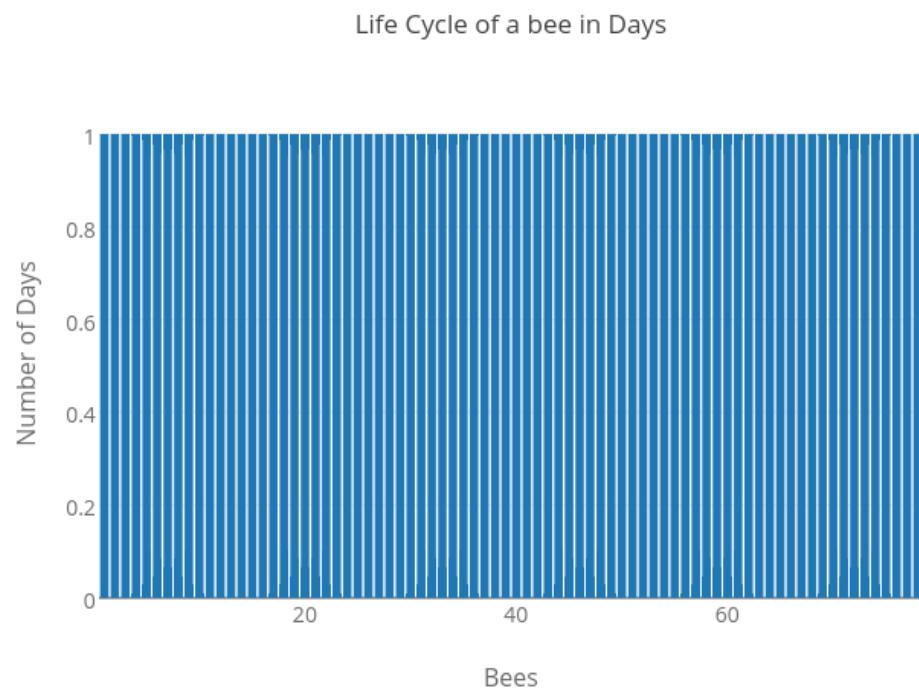


Figure 7.3: Bee Life cycle in days

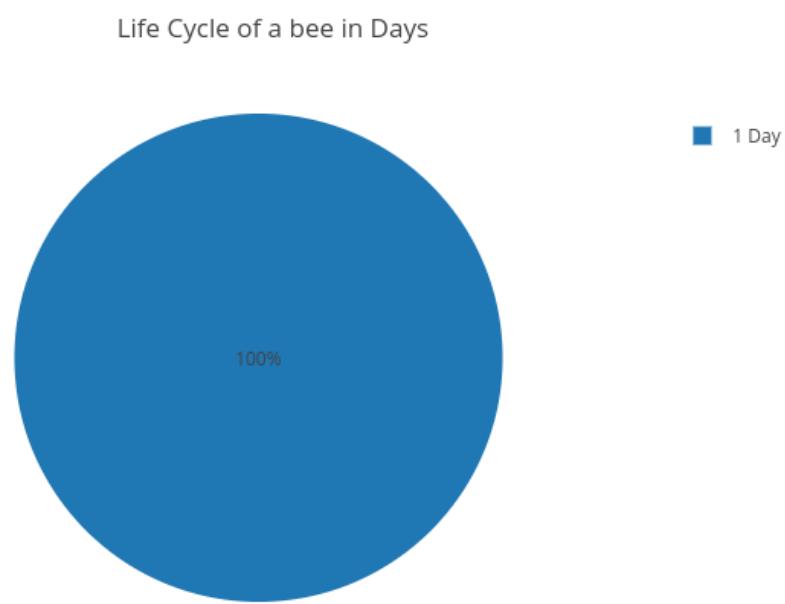


Figure 7.4: Bee Life cycle in days

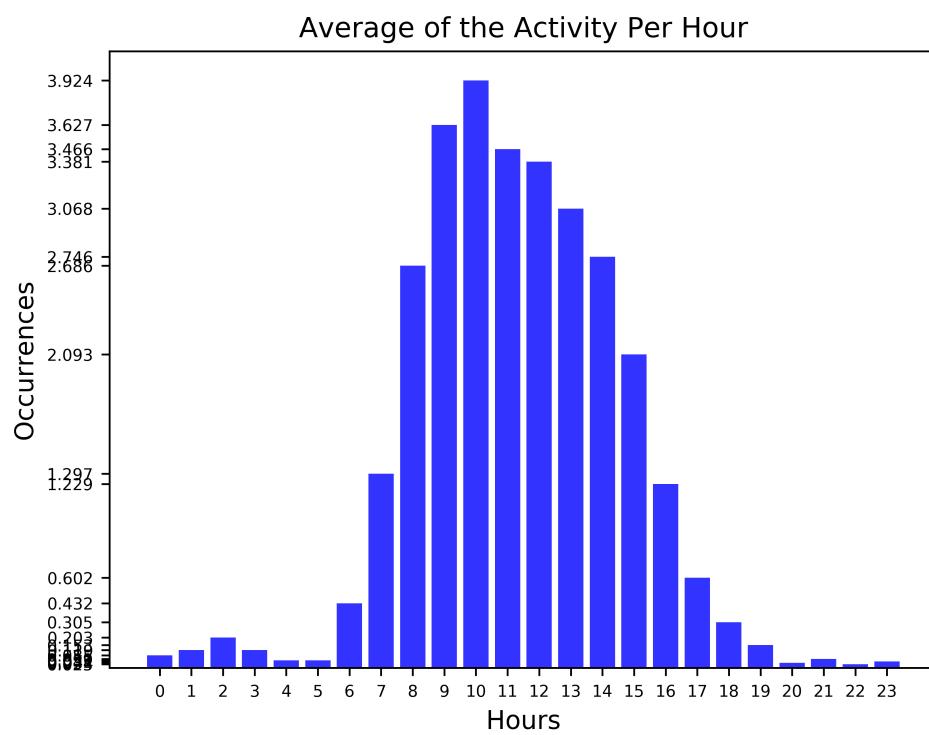


Figure 7.5: Histogram of frequencies per hour

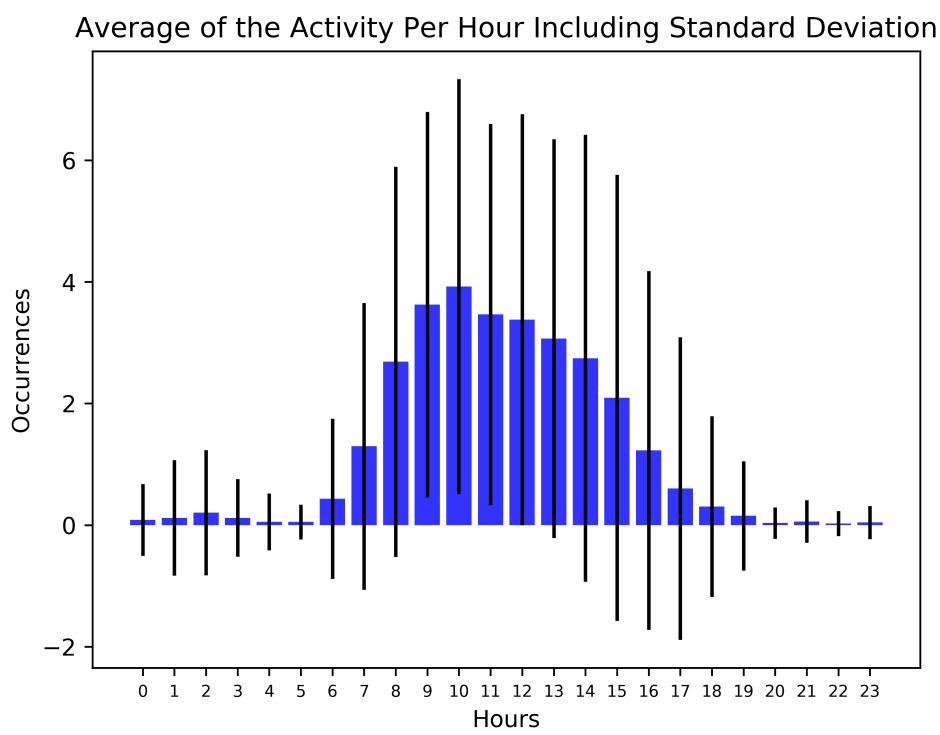


Figure 7.6: Histogram of frequencies per hour. It includes standard deviation





## 8. Analysis of Foraging Behavior