



Data Mining for Bee Micro-sensors

Laboratorio Nacional de Análisis y
Síntesis Ecológica

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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 123 day(s). From 2016-07-02 to 2016-12-02. During this period of time, a total amount of 18653 lectures were registered from 156 different bees. There exist a total of 26 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

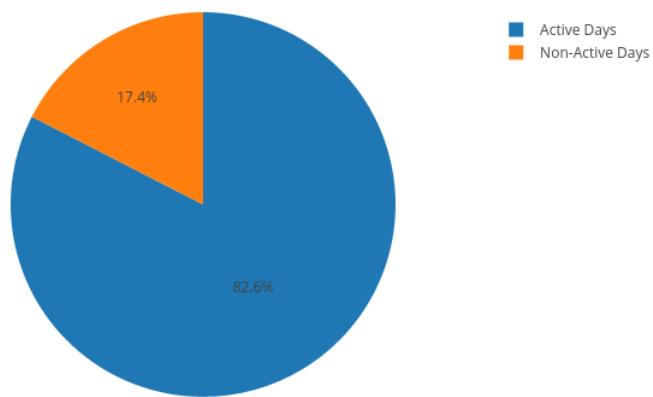


Figure 1.1: Days with and without Empty Reads



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
27	2016-08-01	41	5
28	2016-08-02	39	5
29	2016-08-03	35	5
30	2016-08-04	21	5
31	2016-08-05	98	5
32	2016-08-06	15	6
33	2016-08-07	175	15
34	2016-08-08	147	13
35	2016-08-09	131	11
36	2016-08-10	82	8
37	2016-08-11	85	7
38	2016-08-12	239	9
39	2016-08-13	53	8
40	2016-08-14	113	7
41	2016-08-15	269	12
42	2016-08-16	271	14
43	2016-08-17	98	7
44	2016-08-18	378	12
45	2016-08-19	219	8
46	2016-08-20	356	8
47	2016-08-21	83	7
48	2016-08-22	49	7
49	2016-08-23	48	4
50	2016-08-24	52	5
51	2016-08-25	27	4
52	2016-08-26	84	6
53	2016-09-20	77	3
54	2016-09-21	68	2
55	2016-09-22	104	3
56	2016-09-23	21	2
57	2016-09-24	5	1
58	2016-09-25	4	1
59	2016-09-26	10	1
60	2016-09-27	6	1
61	2016-09-28	4	1
62	2016-09-29	7	1
63	2016-09-30	7	1
64	2016-10-01	9	1

65	2016-10-02	10	1
66	2016-10-03	3	1
67	2016-10-04	3	2
68	2016-10-07	3	1
69	2016-10-09	2271	14
70	2016-10-10	19	7
71	2016-10-11	2	2
72	2016-10-12	237	7
73	2016-10-13	21	3
74	2016-10-14	28	4
75	2016-10-15	22	6
76	2016-10-16	569	3
77	2016-10-17	234	7
78	2016-10-18	40	6
79	2016-10-19	44	5
80	2016-10-20	39	3
81	2016-10-21	47	5
82	2016-10-22	38	4
83	2016-10-23	66	4
84	2016-10-24	169	3
85	2016-10-25	116	3
86	2016-10-26	52	3
87	2016-10-27	298	5
88	2016-10-28	87	7
89	2016-10-29	59	5
90	2016-10-30	41	6
91	2016-10-31	46	5
92	2016-11-01	95	6
93	2016-11-02	114	7
94	2016-11-03	36	7
95	2016-11-04	26	5
96	2016-11-05	11	4
97	2016-11-06	19	6
98	2016-11-07	123	6
99	2016-11-08	359	14
100	2016-11-09	134	8
101	2016-11-10	2110	6
102	2016-11-11	97	7
103	2016-11-12	282	7
104	2016-11-13	309	5
105	2016-11-14	78	7
106	2016-11-15	103	6
107	2016-11-16	51	6

108	2016-11-17	1357	5
109	2016-11-18	148	6
110	2016-11-19	592	5
111	2016-11-20	58	6
112	2016-11-21	63	5
113	2016-11-22	46	6
114	2016-11-23	39	5
115	2016-11-24	46	5
116	2016-11-25	40	5
117	2016-11-26	26	5
118	2016-11-27	31	3
119	2016-11-28	392	3
120	2016-11-29	80	4
121	2016-11-30	179	4
122	2016-12-01	16	3
123	2016-12-02	677	2
--	Average	151	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	0004	1
2	0005	1
3	0006	1
4	0016	1
5	0023	1
6	0024	5
7	0027	1
8	0029	8
9	0031	1
10	0053	5
11	0055	1
12	0056	1
13	0060	1
14	0061	1
15	0062	1
16	0063	6
17	0064	1
18	0068	16
19	0071	1
20	0075	5
21	0077	18
22	0079	122

23	0081	1
24	0082	1
25	0083	1
26	0087	2
27	0090	3
28	0093	1
29	0094	1
30	0095	1
31	0096	1
32	0103	1
33	0108	17
34	0112	1
35	0118	1
36	0130	23
37	0137	5
38	0145	3
39	0146	2
40	0153	3
41	0154	1
42	0155	1
43	0156	2
44	0157	2
45	0158	1
46	0162	3
47	0165	2
48	0174	1
49	0188	7
50	0189	2
51	0194	1
52	0203	1
53	0207	1
54	0208	2
55	0212	16
56	0213	27
57	0215	1
58	0218	1
59	0220	1
60	0223	117
61	0234	18
62	0235	2
63	0237	1
64	0250	1
65	0256	20

66	0257	3
67	0258	1
68	0261	1
69	0264	14
70	0266	20
71	0267	20
72	0270	1
73	0273	3
74	0276	9
75	0278	1
76	0282	1
77	0283	6
78	0286	1
79	0287	1
80	0290	14
81	0292	4
82	0295	1
83	0296	1
84	0304	1
85	0307	3
86	0309	1
87	0311	5
88	0312	1
89	0314	1
90	0315	1
91	0316	3
92	0318	1
93	0319	1
94	0321	1
95	0324	1
96	0327	1
97	0330	6
98	0331	1
99	0332	1
100	0333	1
101	0336	1
102	0340	1
103	0341	11
104	0342	7
105	0354	1
106	0383	1
107	0391	1
108	0431	1

109	0483	1
110	0484	4
111	0488	1
112	0498	1
113	0528	1
114	0544	15
115	0546	1
116	0551	1
117	0553	27
118	0568	1
119	0569	1
120	0595	1
121	0598	1
122	0604	1
123	0605	1
124	0608	4
125	0610	27
126	0612	2
127	0616	9
128	0626	1
129	0627	1
130	0634	1
131	0636	22
132	0642	2
133	0643	13
134	0652	34
135	0668	1
136	0672	1
137	0674	1
138	0675	10
139	0676	18
140	0678	15
141	0683	2
142	0694	1
143	0697	1
144	0701	1
145	0711	1
146	0717	25
147	0724	24
148	0735	18
149	0738	18
150	0744	1
151	0746	2

152	0747	3
153	0754	1
154	0777	1
155	0795	1
156	0137	1
--	Average	6

Analysis of Activity per Hour

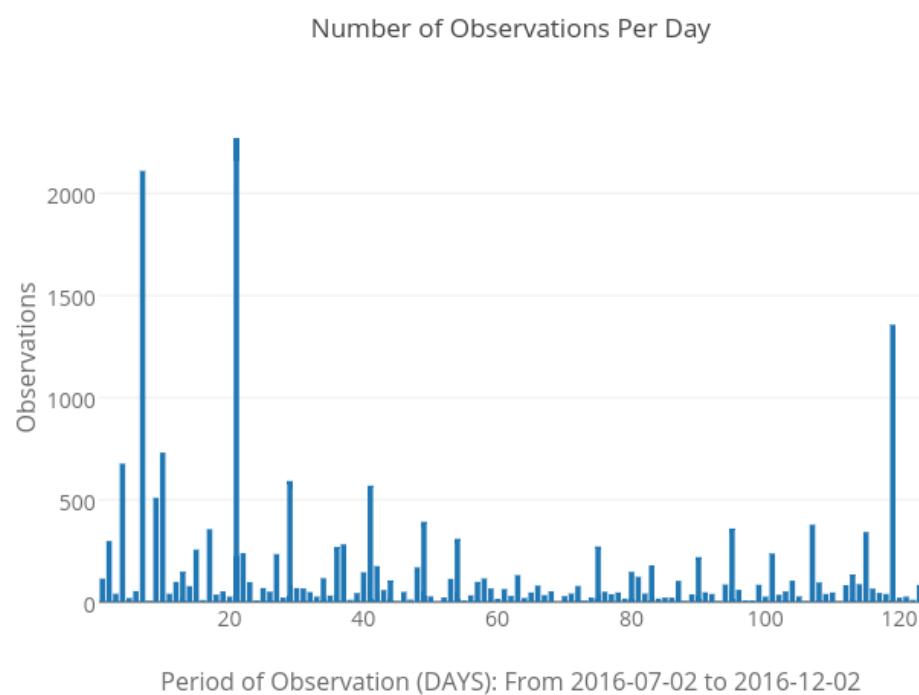


Figure 2.1: Number of Observations per Day

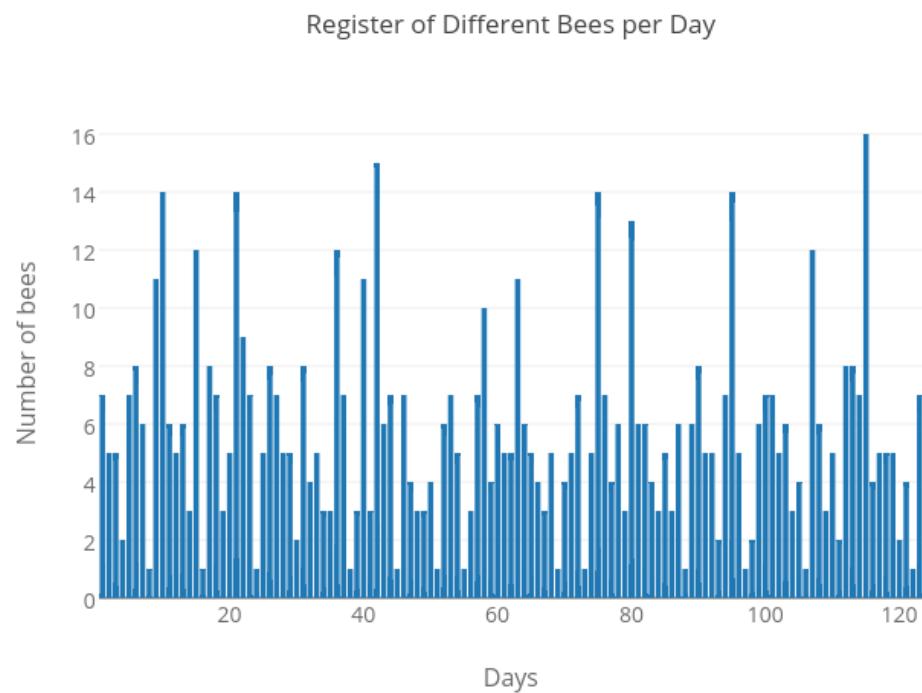


Figure 2.2: Different Bees Per Day

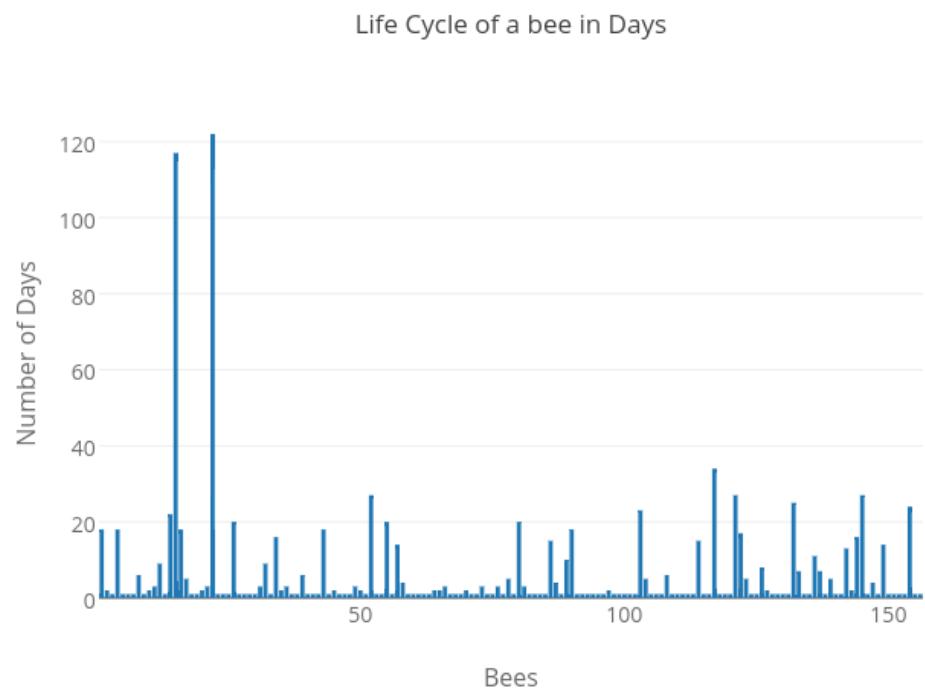


Figure 2.3: Bee Life cycle in days

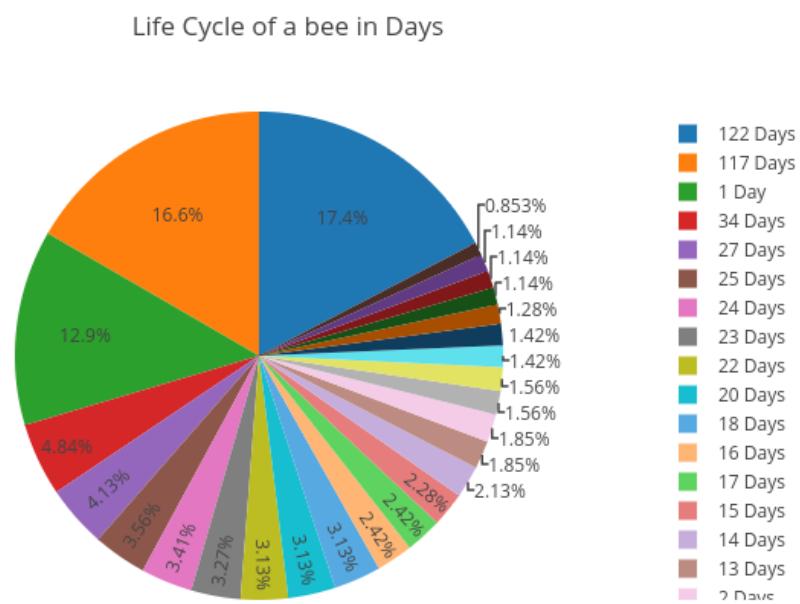


Figure 2.4: Bee Life cycle in days

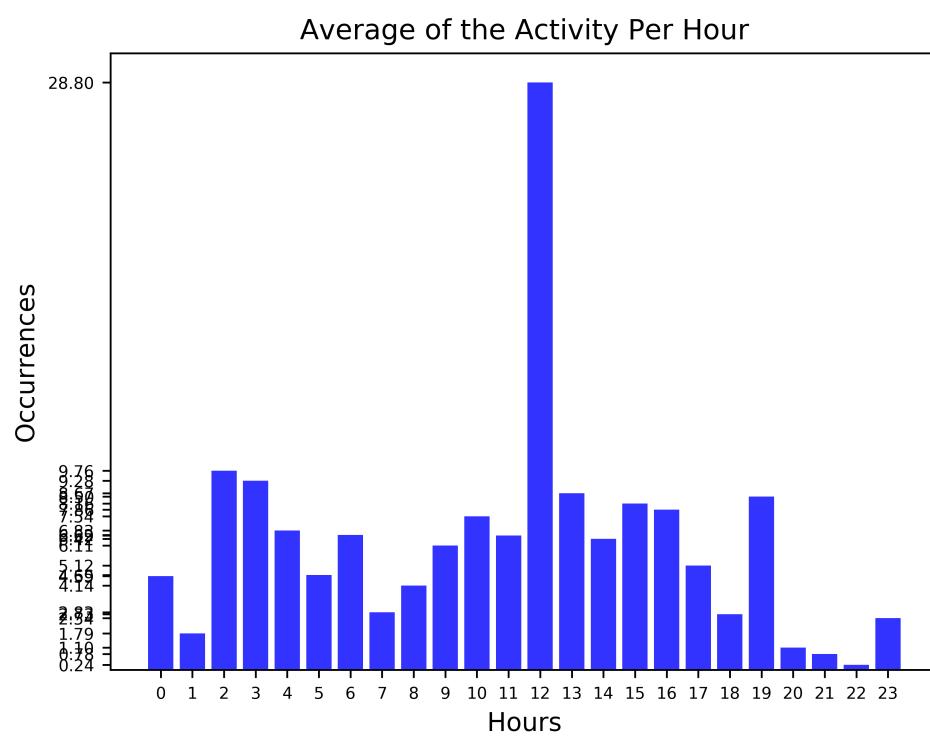


Figure 2.5: Histogram of frequencies per hour

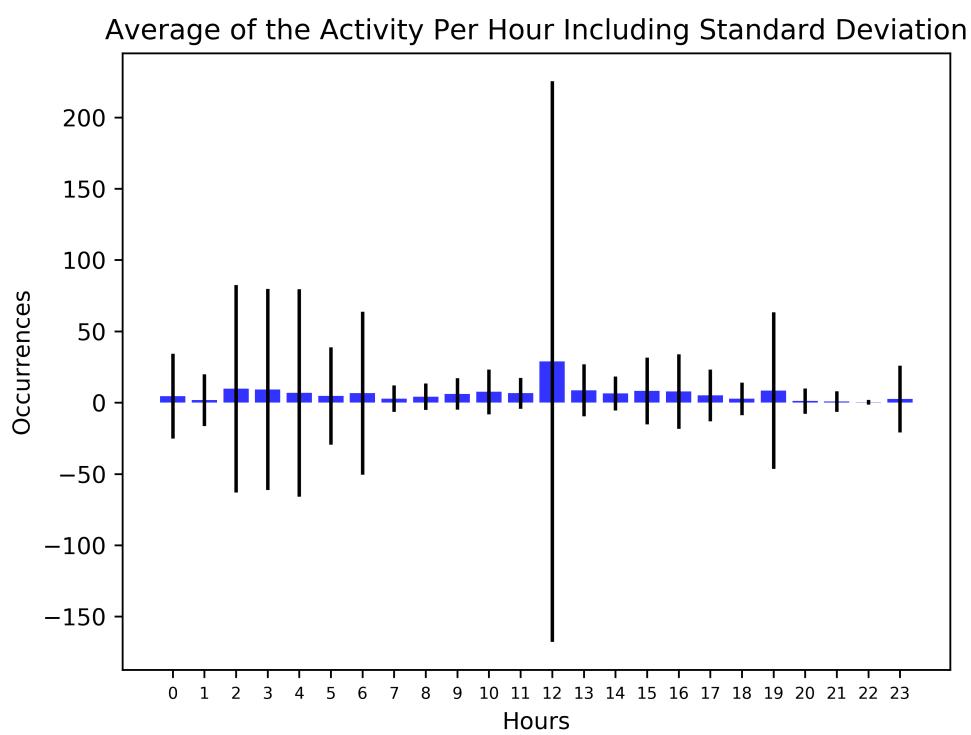


Figure 2.6: Histogram of frequencies per hour. It includes standard deviation



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
25	2016-08-01	28	5
26	2016-08-02	25	5
27	2016-08-03	22	5
28	2016-08-04	15	4
29	2016-08-05	23	5
30	2016-08-06	5	1
31	2016-08-07	52	10
32	2016-08-08	74	8
33	2016-08-09	65	11
34	2016-08-10	43	8
35	2016-08-11	39	7
36	2016-08-12	41	8
37	2016-08-13	40	7
38	2016-08-14	43	6
39	2016-08-15	40	5
40	2016-08-16	47	9
41	2016-08-17	52	7
42	2016-08-18	63	8
43	2016-08-19	62	7
44	2016-08-20	64	7
45	2016-08-21	37	6
46	2016-08-22	32	5
47	2016-08-23	35	4
48	2016-08-24	35	4
49	2016-08-25	20	4
50	2016-08-26	14	4
51	2016-09-20	9	1
52	2016-09-21	4	1
53	2016-09-22	10	2
54	2016-09-23	5	2
55	2016-09-25	2	1
56	2016-09-26	2	1
57	2016-09-27	2	1
58	2016-09-28	3	1
59	2016-09-29	3	1
60	2016-09-30	4	1
61	2016-10-01	4	1
62	2016-10-02	4	1
63	2016-10-03	2	1

64	2016-10-04	1	1
65	2016-10-09	8	3
66	2016-10-10	2	2
67	2016-10-12	8	5
68	2016-10-13	5	2
69	2016-10-14	8	3
70	2016-10-15	12	4
71	2016-10-16	21	3
72	2016-10-17	27	4
73	2016-10-18	19	3
74	2016-10-19	29	3
75	2016-10-20	26	3
76	2016-10-21	32	4
77	2016-10-22	25	3
78	2016-10-23	37	3
79	2016-10-24	43	3
80	2016-10-25	55	3
81	2016-10-26	45	3
82	2016-10-27	47	3
83	2016-10-28	43	4
84	2016-10-29	43	4
85	2016-10-30	32	3
86	2016-10-31	27	3
87	2016-11-01	50	4
88	2016-11-02	40	5
89	2016-11-03	22	3
90	2016-11-04	13	3
91	2016-11-05	6	3
92	2016-11-06	5	4
93	2016-11-07	11	4
94	2016-11-08	26	11
95	2016-11-09	61	6
96	2016-11-10	78	4
97	2016-11-11	24	5
98	2016-11-12	50	6
99	2016-11-13	60	5
100	2016-11-14	51	6
101	2016-11-15	60	5
102	2016-11-16	22	4
103	2016-11-17	58	5
104	2016-11-18	69	5
105	2016-11-19	46	5
106	2016-11-20	40	5

107	2016-11-21	46	5
108	2016-11-22	29	5
109	2016-11-23	28	5
110	2016-11-24	30	5
111	2016-11-25	17	4
112	2016-11-26	18	4
113	2016-11-27	21	3
114	2016-11-28	17	3
115	2016-11-29	21	3
116	2016-11-30	14	4
117	2016-12-01	11	2
118	2016-12-02	15	2
--	Average	29	4

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	0087	1
13	0090	2
14	0095	1
15	0108	14
16	0112	1
17	0130	22
18	0137	4
19	0145	2
20	0146	1
21	0153	3
22	0155	1
23	0156	1
24	0157	2
25	0162	2
26	0165	2
27	0188	5

28	0189	2
29	0203	1
30	0208	2
31	0212	15
32	0213	24
33	0215	1
34	0223	1
35	0234	18
36	0235	2
37	0256	17
38	0257	3
39	0264	3
40	0266	17
41	0267	20
42	0273	3
43	0276	8
44	0283	6
45	0290	14
46	0292	4
47	0307	2
48	0311	5
49	0312	1
50	0316	3
51	0330	1
52	0341	11
53	0342	3
54	0484	4
55	0544	13
56	0553	24
57	0605	1
58	0608	4
59	0610	26
60	0616	9
61	0636	17
62	0642	1
63	0643	13
64	0652	34
65	0675	10
66	0676	18
67	0678	14
68	0683	1
69	0701	1
70	0711	1

71	0717	25
72	0724	22
73	0735	16
74	0738	18
75	0744	1
76	0746	1
77	0747	3
78	0777	1
--	Average	7

Analysis of Activity per Hour

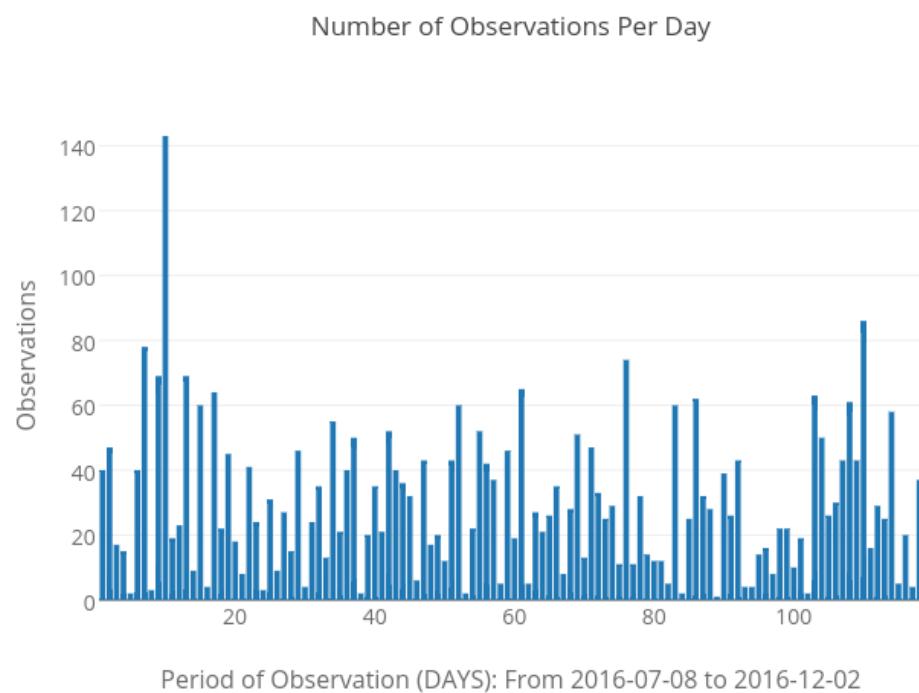


Figure 3.1: Number of Observations per Day

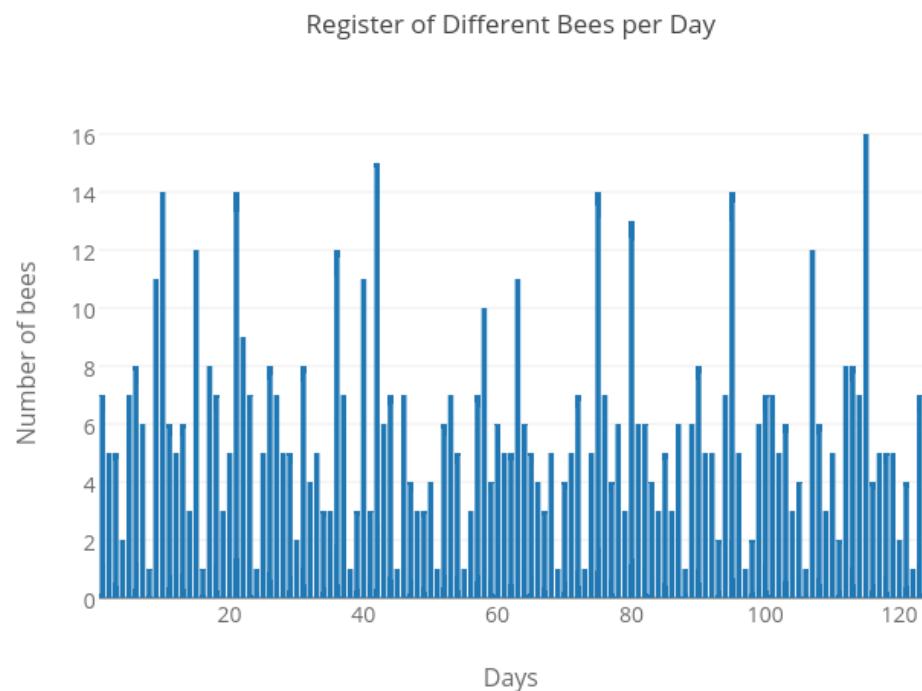


Figure 3.2: Different Bees Per Day

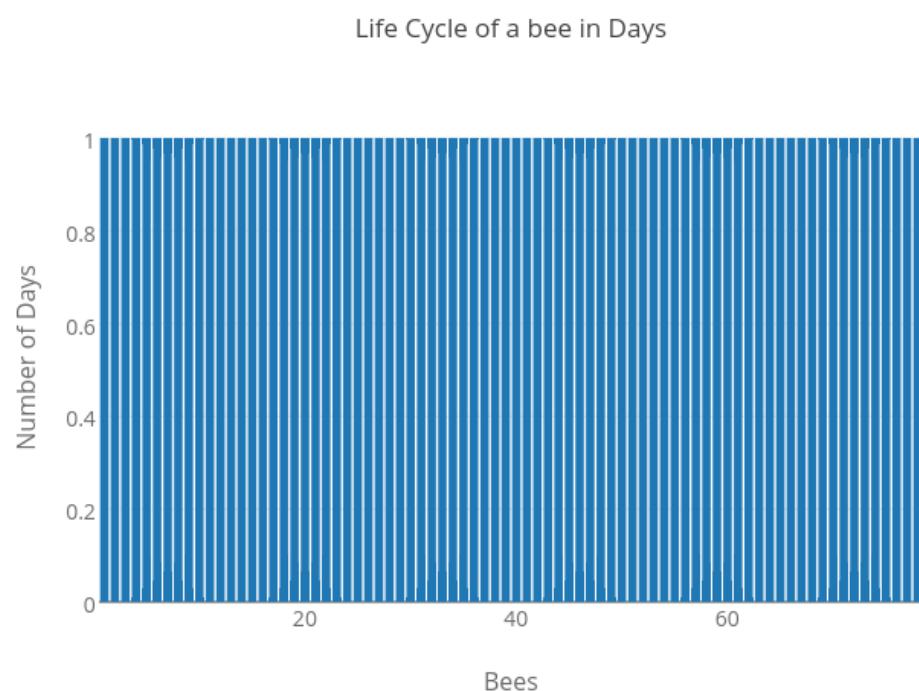


Figure 3.3: Bee Life cycle in days

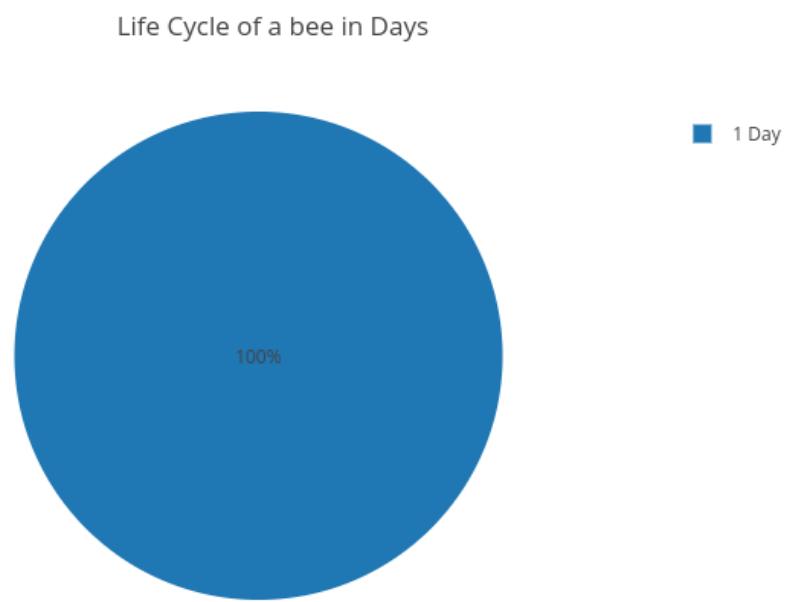


Figure 3.4: Bee Life cycle in days

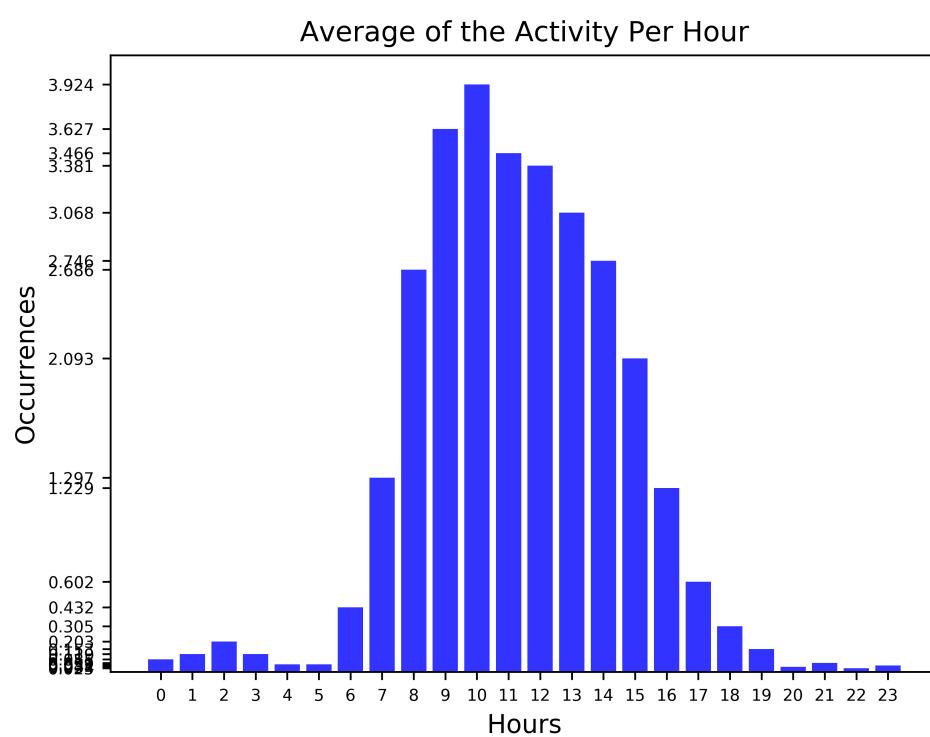


Figure 3.5: Histogram of frequencies per hour

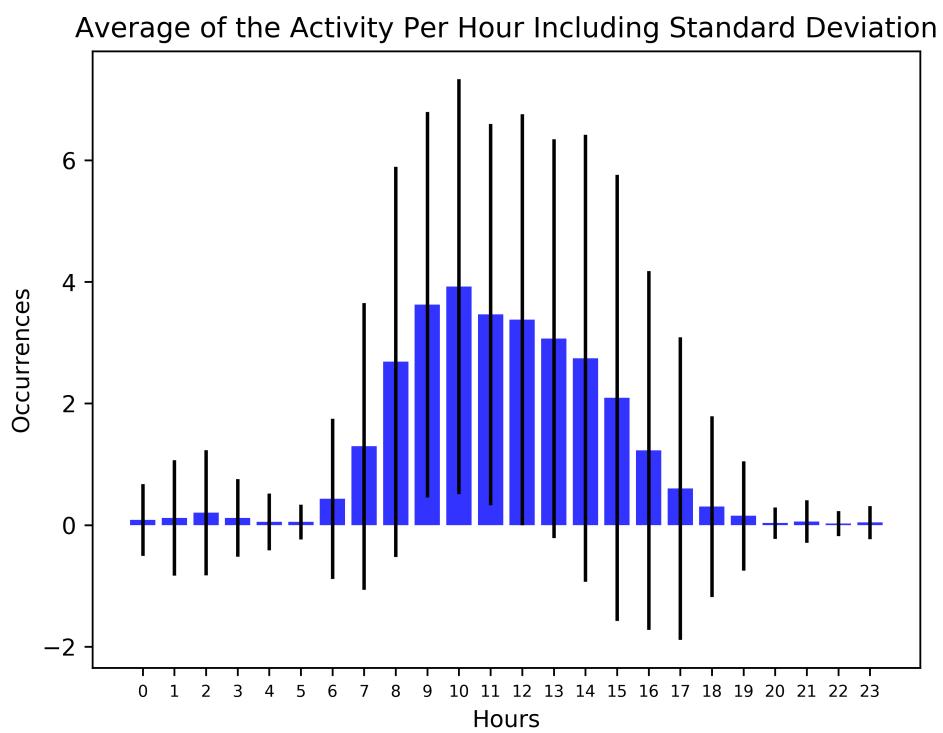


Figure 3.6: Histogram of frequencies per hour. It includes standard deviation



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 70 day(s). From 2016-07-01 to 2016-11-19. During this period of time, a total amount of 1113295 lectures were registered from 72 different bees. There exist a total of 20 non-active days. We define an 'active day' if there is more than one observation. (see Figure1.1).

Relation: Active VS Non-active Days

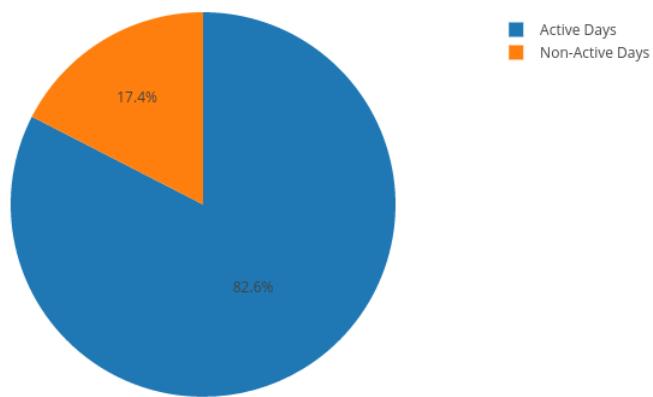


Figure 5.1: Days with and without Empty Reads



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
27	2016-08-01	125216	4
28	2016-08-02	152995	6
29	2016-08-03	54565	6
30	2016-08-04	65197	4
31	2016-08-05	66056	3
32	2016-10-10	7	4
33	2016-10-11	7	5
34	2016-10-12	7	4
35	2016-10-13	5	2
36	2016-10-14	3	3
37	2016-10-15	1	1
38	2016-10-16	15	2
39	2016-10-17	7	1
40	2016-10-18	18	2
41	2016-10-19	3	2
42	2016-10-20	14	2
43	2016-10-21	5	1
44	2016-10-22	2	1
45	2016-10-23	8	1
46	2016-10-24	4	3
47	2016-10-25	17	2
48	2016-10-26	3	1
49	2016-10-27	8	2
50	2016-10-28	4	1
51	2016-10-29	310	2
52	2016-10-30	1	1
53	2016-10-31	27	2
54	2016-11-01	9	2
55	2016-11-02	1	1
56	2016-11-03	5	2
57	2016-11-04	8	2
58	2016-11-05	3	1
59	2016-11-06	1	1
60	2016-11-07	1	1
61	2016-11-08	23	1
62	2016-11-09	10	1
63	2016-11-10	8	1
64	2016-11-11	1	1

65	2016-11-13	1	1
66	2016-11-15	1	1
67	2016-11-16	15804	1
68	2016-11-17	59508	1
69	2016-11-18	54868	1
70	2016-11-19	31568	1
--	Average	15904	3

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	14DC	1
4	0087	1
5	0062	1
6	0071	1
7	0002	1
8	0010	1
9	0014	2
10	0031	2
11	0032	1
12	0036	2
13	0045	3
14	0046	2
15	0053	1
16	0054	2
17	0065	4
18	0066	1
19	0067	1
20	0072	10
21	0074	1
22	0077	5
23	0080	4
24	0083	2
25	0111	7
26	0114	1
27	0116	4
28	0119	6
29	0125	2
30	0126	1
31	0128	1
32	0129	1

33	0136	4
34	0145	1
35	0151	12
36	0160	7
37	0167	2
38	0168	1
39	0170	2
40	0176	14
41	0177	1
42	0178	1
43	0187	2
44	0189	13
45	0192	1
46	0197	2
47	0201	2
48	0203	4
49	0204	5
50	0208	2
51	0213	4
52	0217	3
53	0219	1
54	0222	1
55	0223	1
56	0228	3
57	0231	4
58	0234	2
59	0243	4
60	0244	1
61	0246	1
62	0453	5
63	0482	2
64	0493	1
65	0526	1
66	0530	1
67	0533	5
68	0537	16
69	0541	26
70	0570	1
71	0571	1
72	0581	14
--	Average	3

Analysis of Activity per Hour

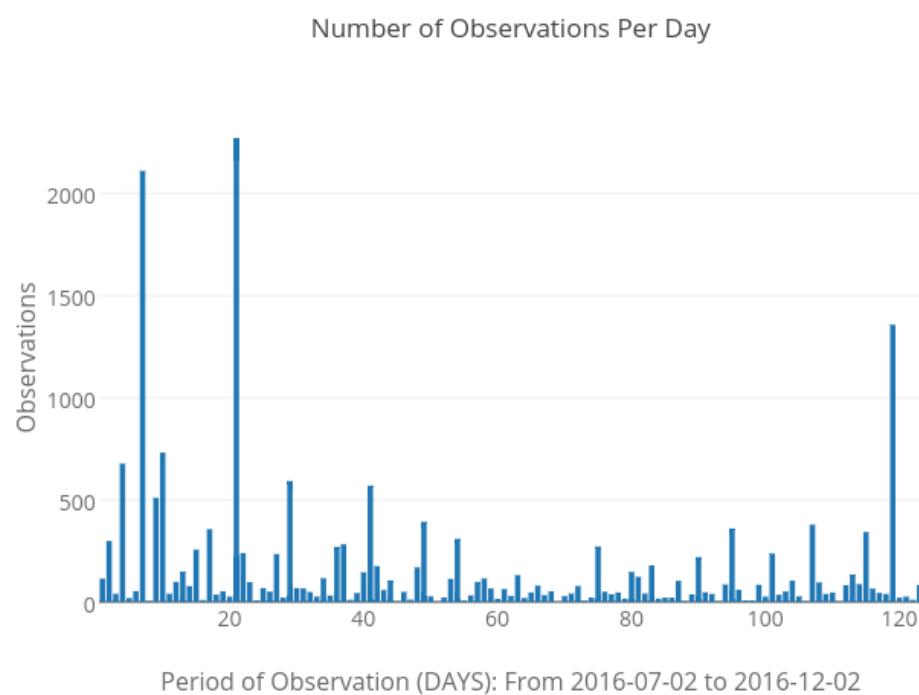


Figure 6.1: Number of Observations per Day

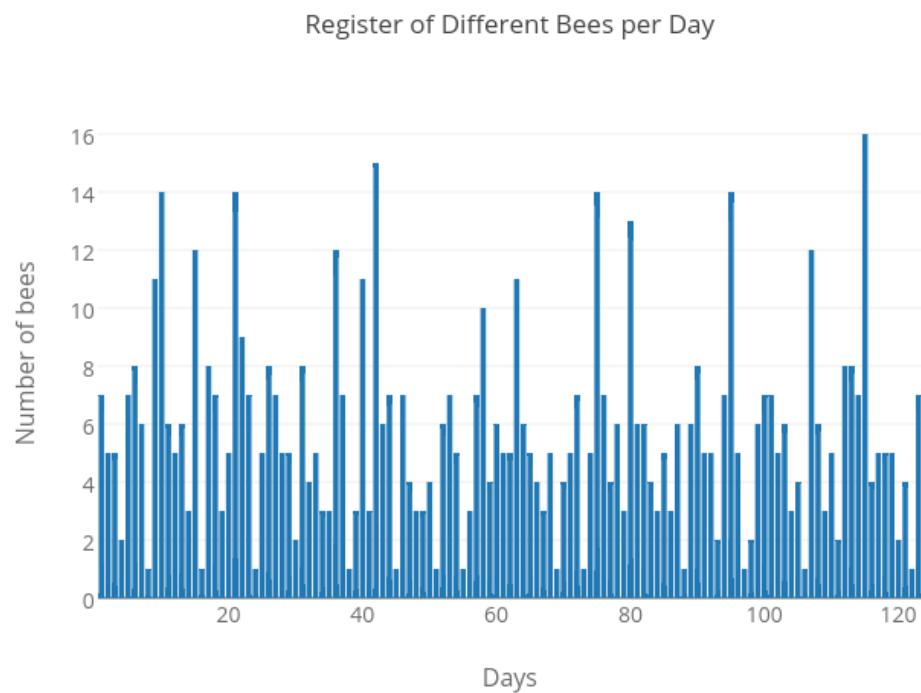


Figure 6.2: Different Bees Per Day

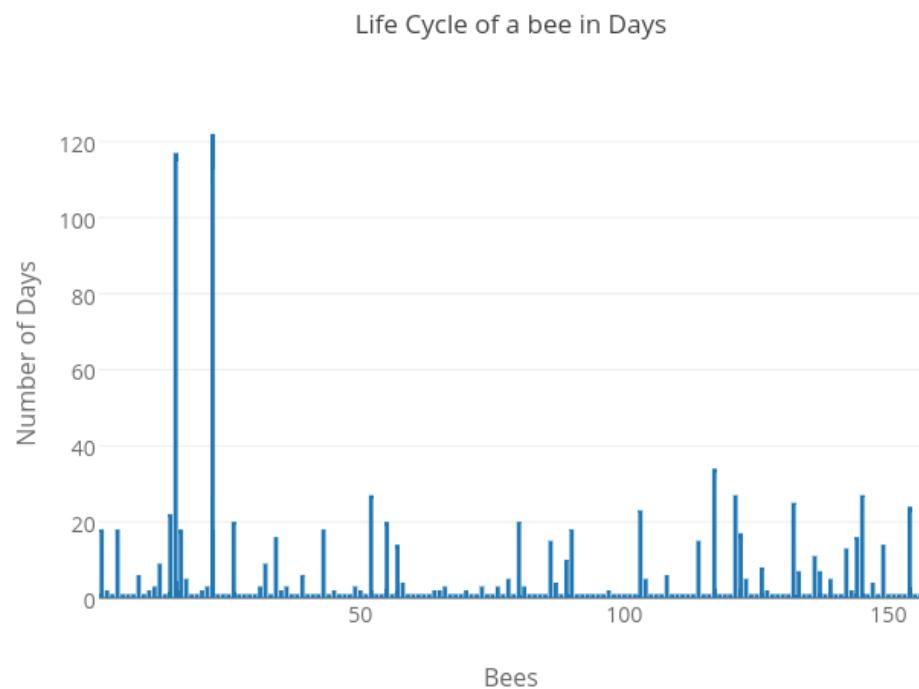


Figure 6.3: Bee Life cycle in days

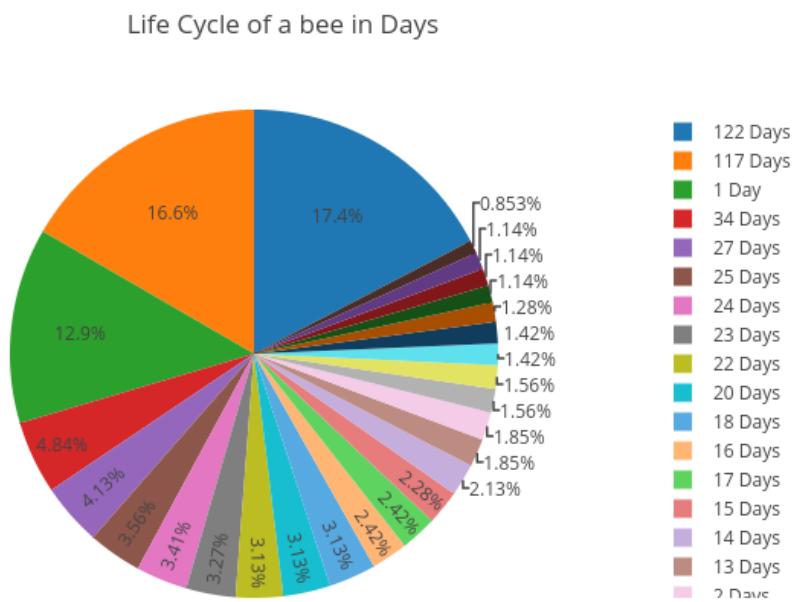


Figure 6.4: Bee Life cycle in days

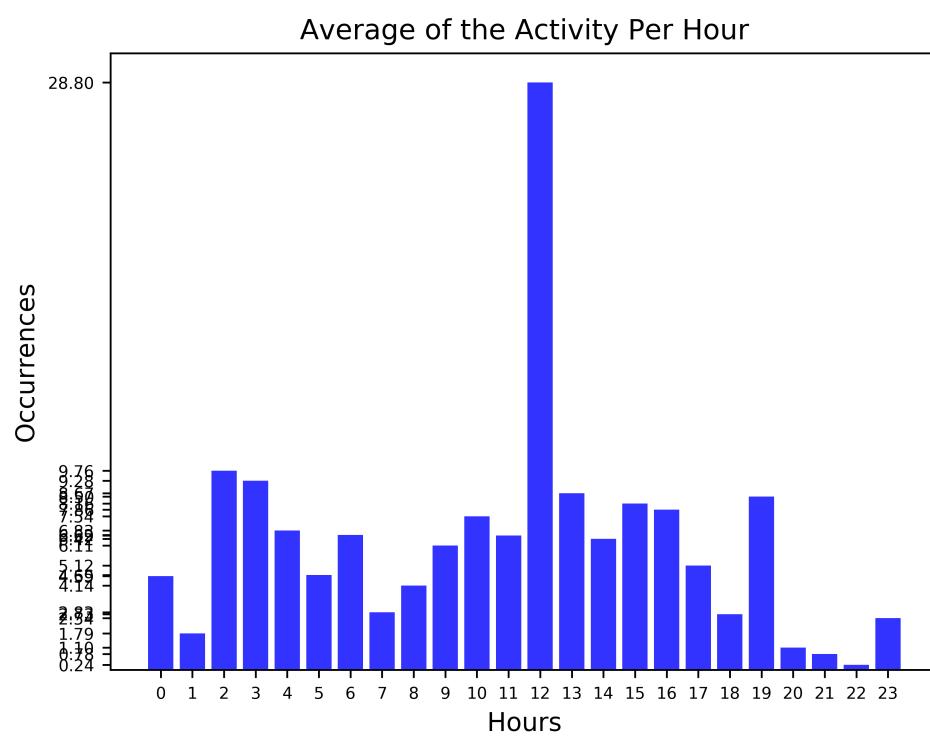


Figure 6.5: Histogram of frequencies per hour

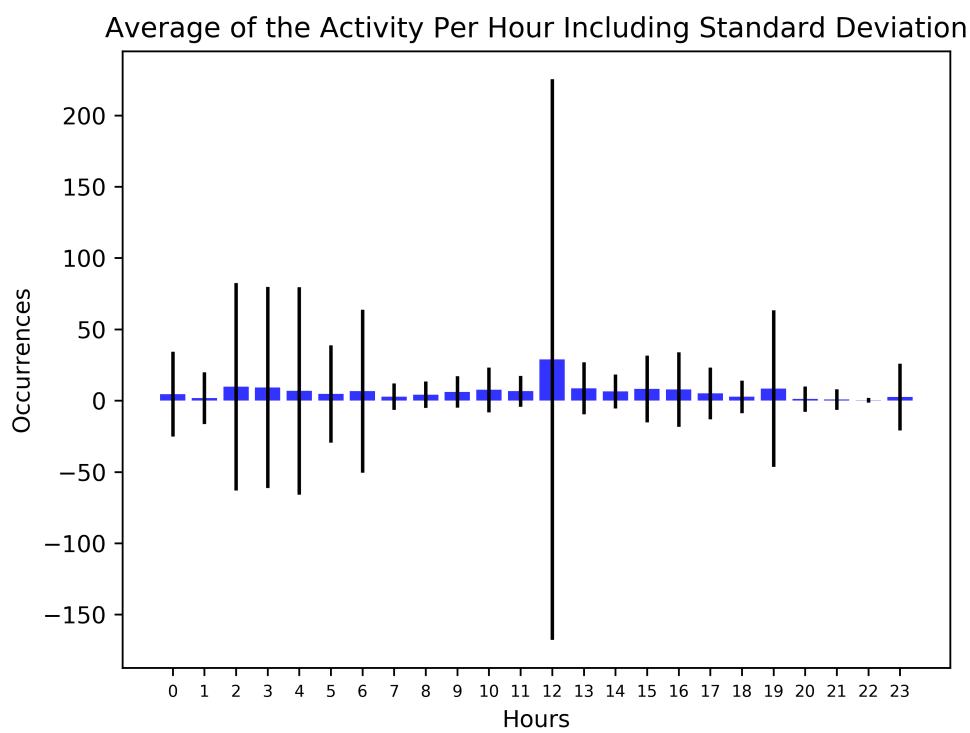


Figure 6.6: Histogram of frequencies per hour. It includes standard deviation



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
22	2016-08-01	104	2
23	2016-08-02	60	3
24	2016-08-03	209	2
25	2016-08-04	246	3
26	2016-08-05	185	2
27	2016-10-10	2	2
28	2016-10-11	1	1
29	2016-10-12	2	2
30	2016-10-13	3	2
31	2016-10-16	2	2
32	2016-10-18	4	1
33	2016-10-19	1	1
34	2016-10-20	6	2
35	2016-10-21	1	1
36	2016-10-22	1	1
37	2016-10-23	1	1
38	2016-10-24	1	1
39	2016-10-25	5	2
40	2016-10-26	2	1
41	2016-10-27	5	1
42	2016-10-28	2	1
43	2016-10-29	7	1
44	2016-10-31	2	2
45	2016-11-01	1	1
46	2016-11-03	3	2
47	2016-11-04	4	2
48	2016-11-05	1	1
49	2016-11-08	5	1
50	2016-11-09	2	1
51	2016-11-10	3	1
52	2016-11-16	16	1
--	Average	60	2

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	0046	1
7	0053	1

8	0054	2
9	0065	1
10	0066	1
11	0072	10
12	0077	4
13	0080	2
14	0111	1
15	0114	1
16	0116	3
17	0119	6
18	0125	2
19	0126	1
20	0128	1
21	0129	1
22	0136	4
23	0145	1
24	0151	8
25	0160	6
26	0167	1
27	0170	2
28	0176	14
29	0178	1
30	0187	1
31	0189	13
32	0201	2
33	0203	4
34	0204	5
35	0208	2
36	0213	4
37	0217	2
38	0222	1
39	0223	1
40	0228	1
41	0231	3
42	0234	2
43	0243	1
44	0244	1
45	0246	1
46	0453	1
47	0533	4
48	0537	14
49	0541	26
50	0581	13

--	Average	3
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Analysis of Activity per Hour

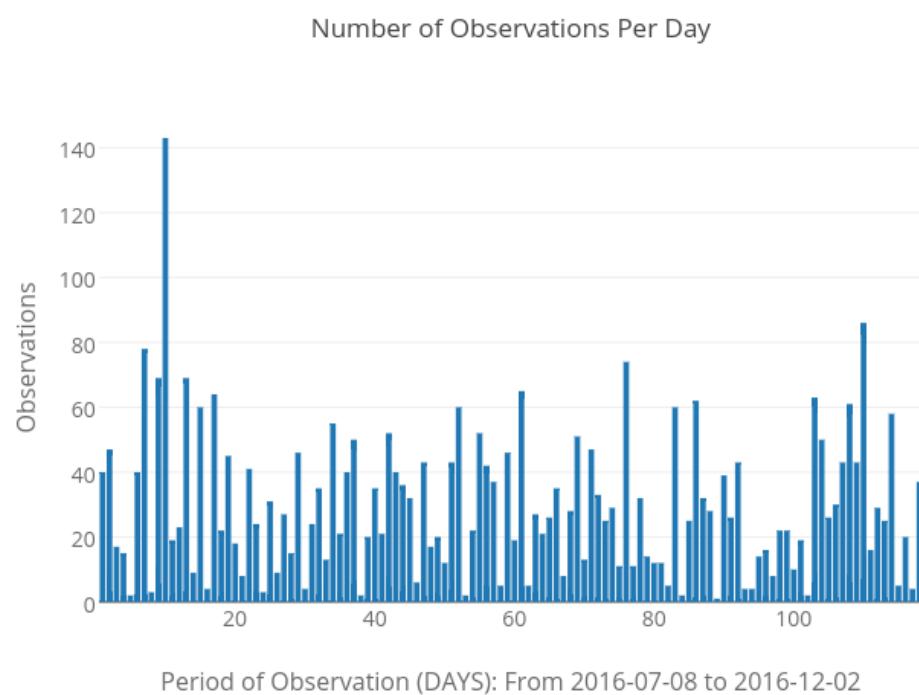


Figure 7.1: Number of Observations per Day

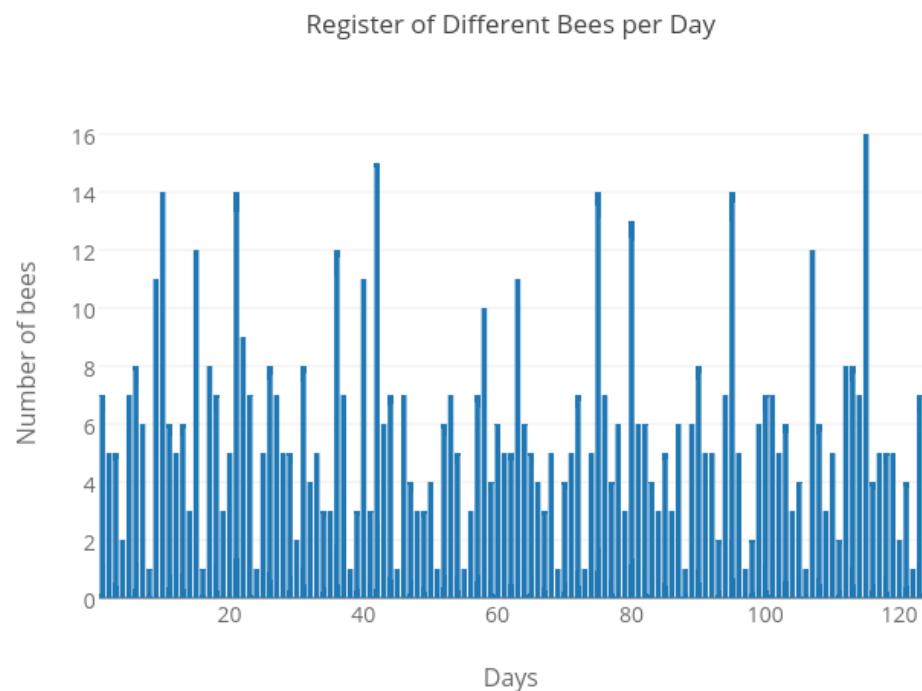


Figure 7.2: Different Bees Per Day

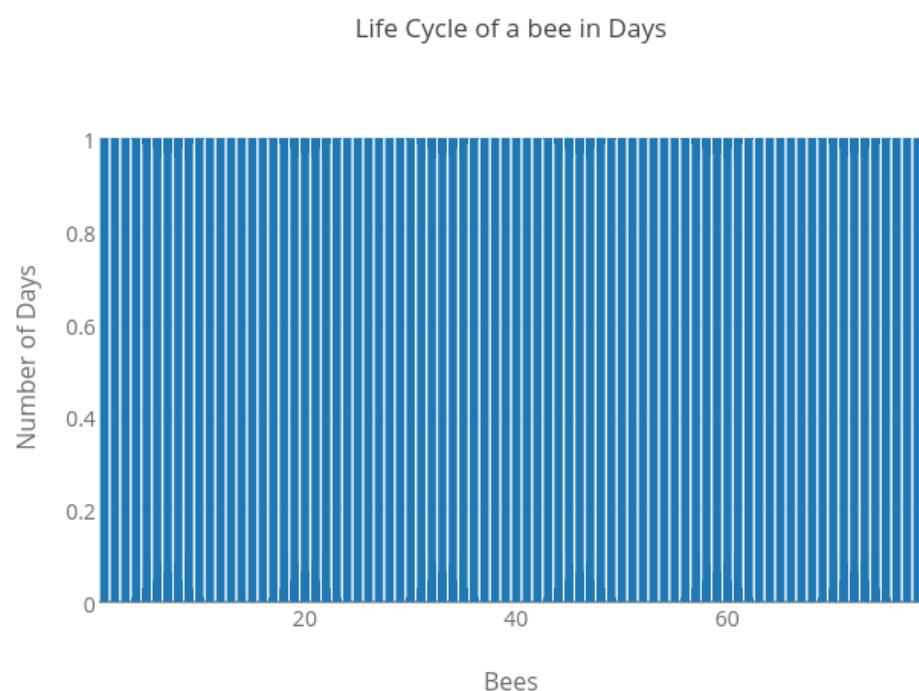


Figure 7.3: Bee Life cycle in days

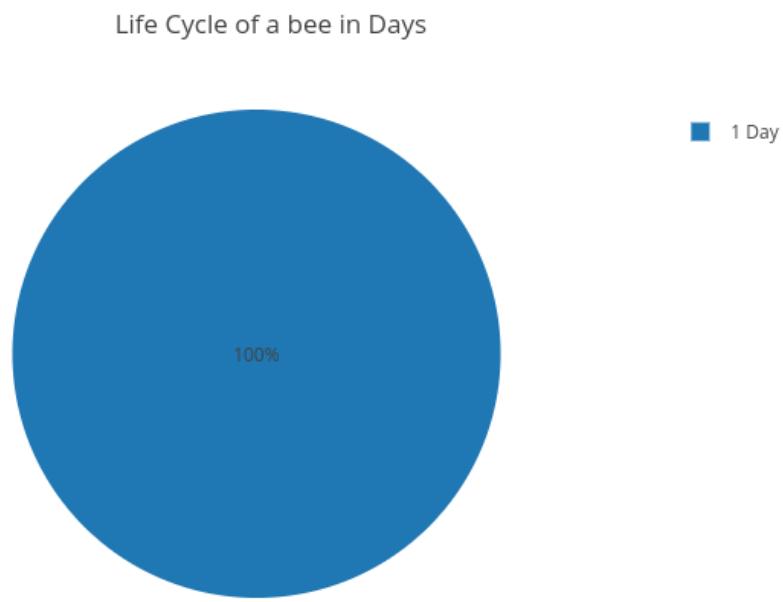


Figure 7.4: Bee Life cycle in days

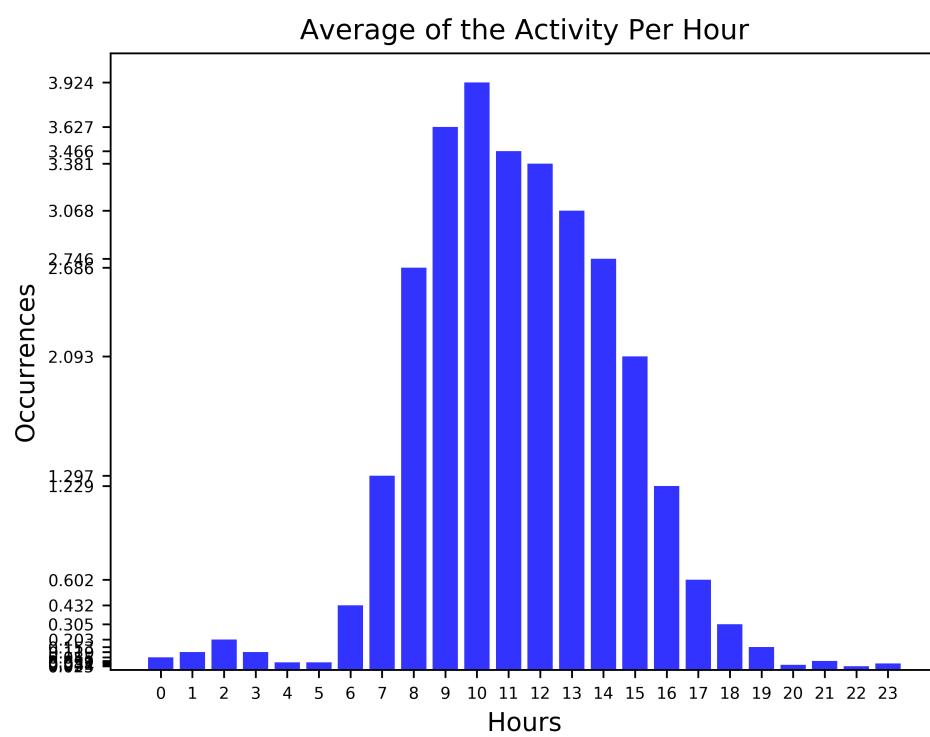


Figure 7.5: Histogram of frequencies per hour

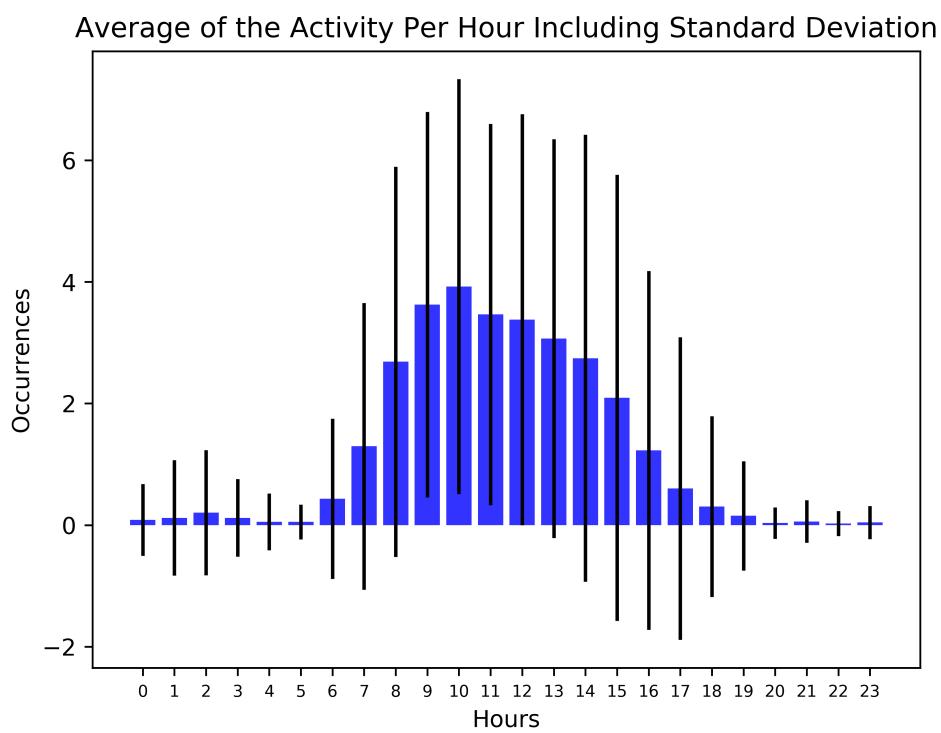


Figure 7.6: Histogram of frequencies per hour. It includes standard deviation



8. Analysis of Foraging Behavior