



Data Mining for Bee Micro-sensors

Laboratorio Nacional de Análisis y
Síntesis Ecológica

Framework Developed by:

Ulises Olivares, Gloria Ruiz, María J. Aguilar, Oliverio

Delgado, Francisco J. Balvino, 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

1	Introduction	5
2	Analysis of Raw Data	7
3	Analysis of Clean Data	17
4	Analysis of Foraging Behavior	27



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 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 Figure 1.1).

Relation: Active VS Non-active Days

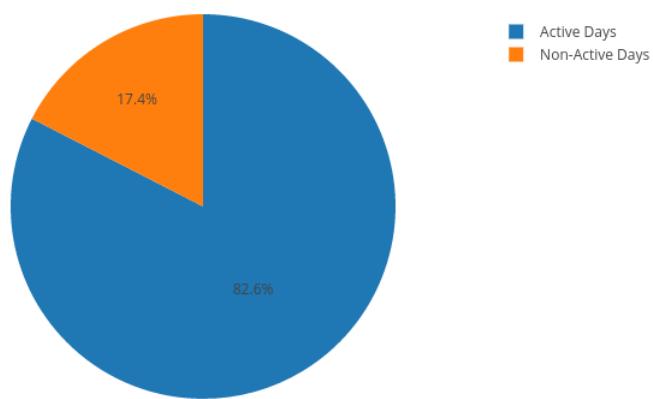


Figure 1.1: Days with and without Empty Reads



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	2016-07-01	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

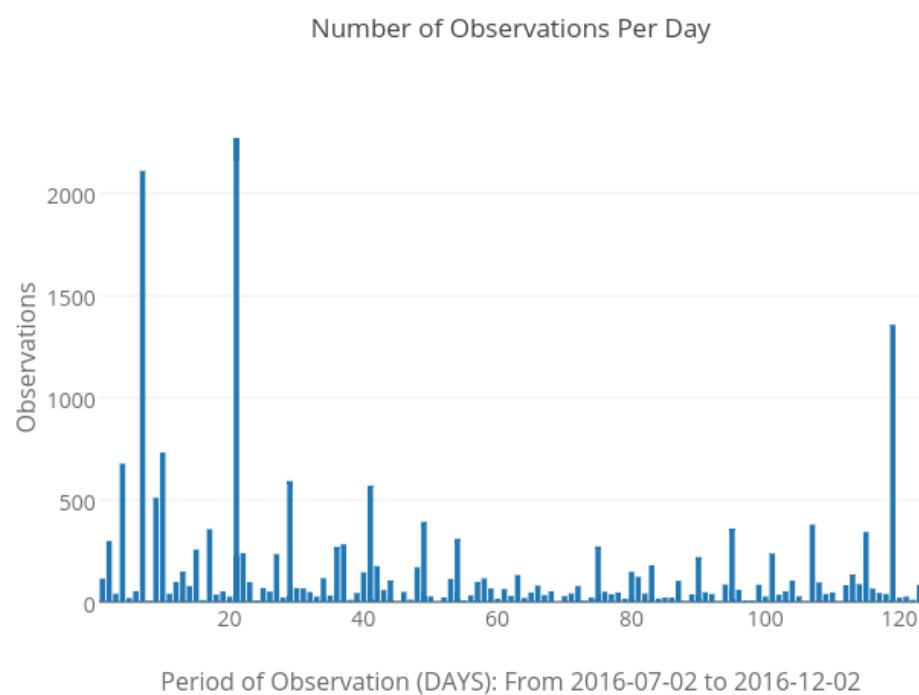


Figure 2.1: Number of Observations per Day

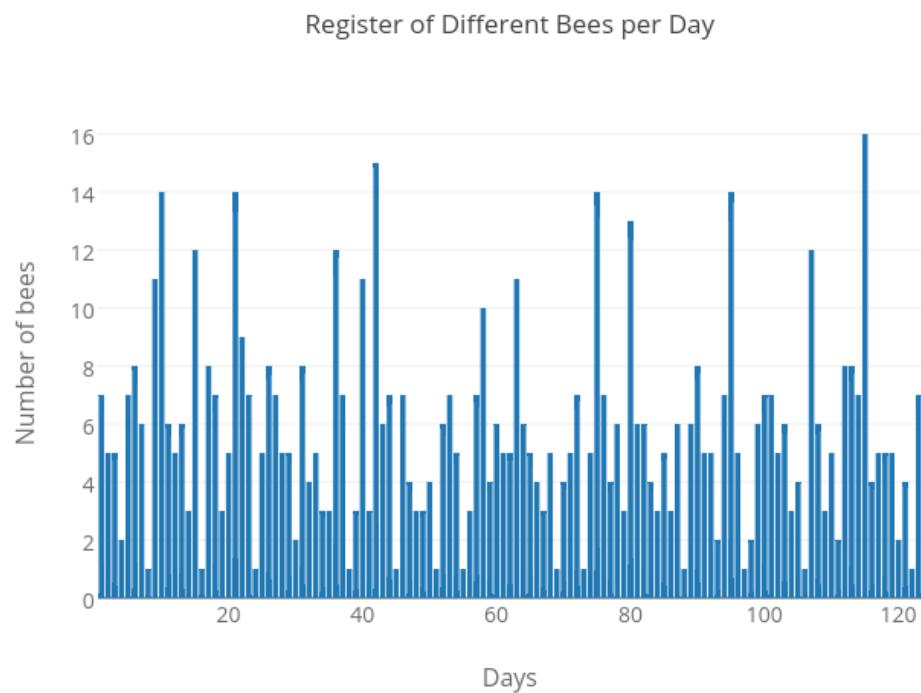


Figure 2.2: Different Bees Per Day

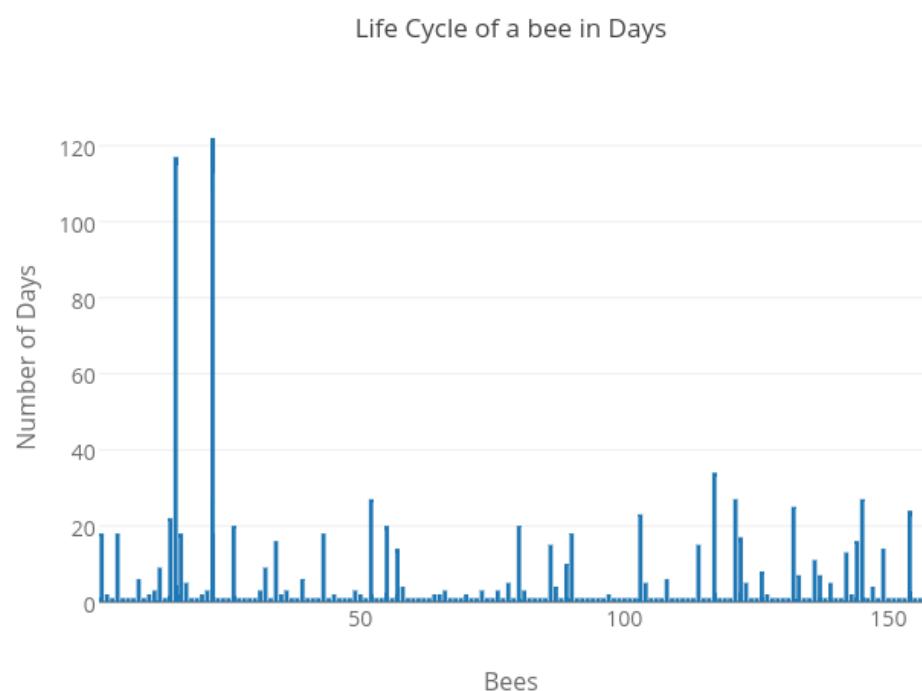


Figure 2.3: Bee Life cycle in days

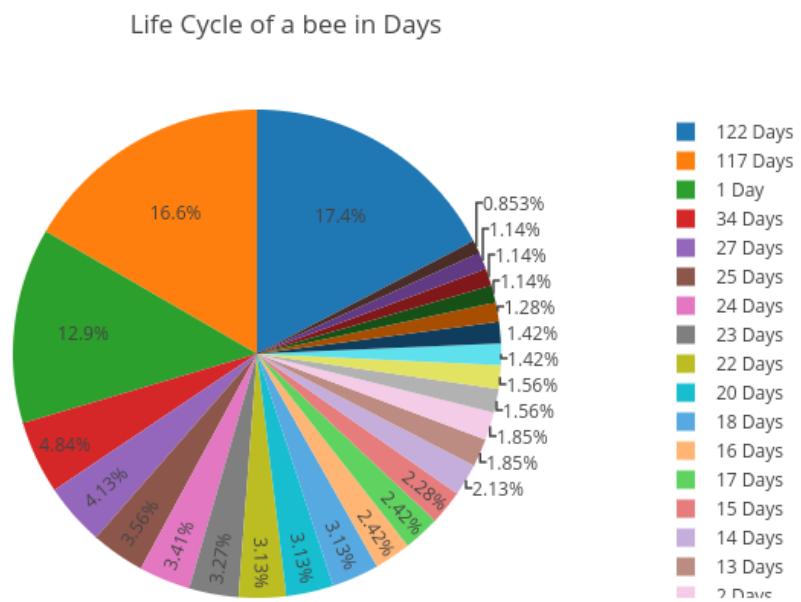


Figure 2.4: Bee Life cycle in days

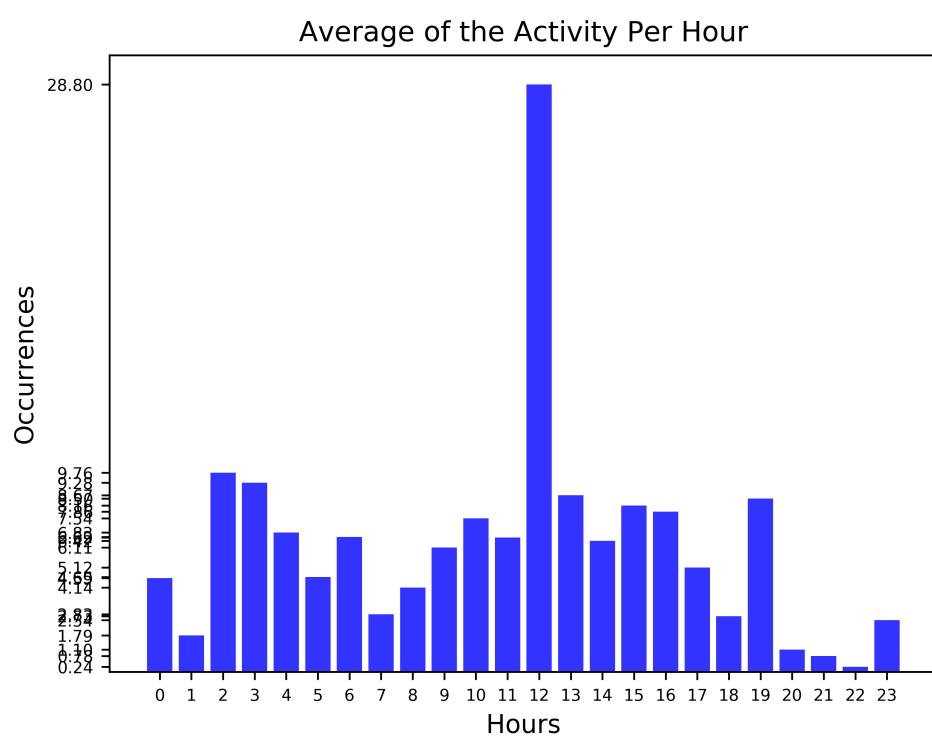


Figure 2.5: Histogram of frequencies per hour

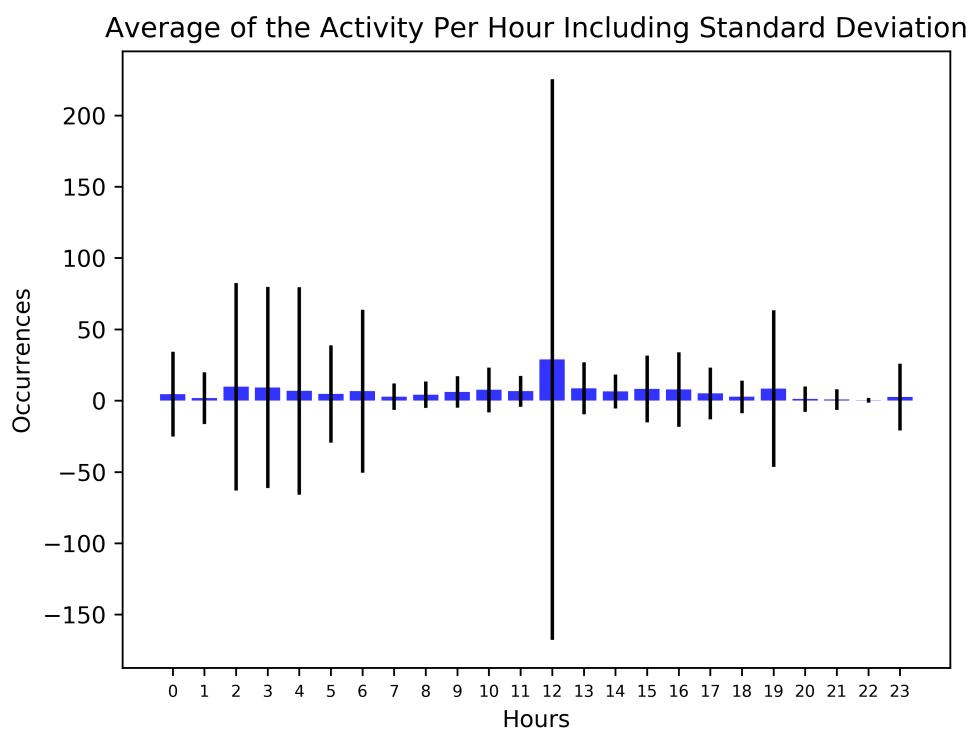


Figure 2.6: Histogram of frequencies per hour. It includes standard deviation



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	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
----	---------	---

Analysis of Activity per Hour

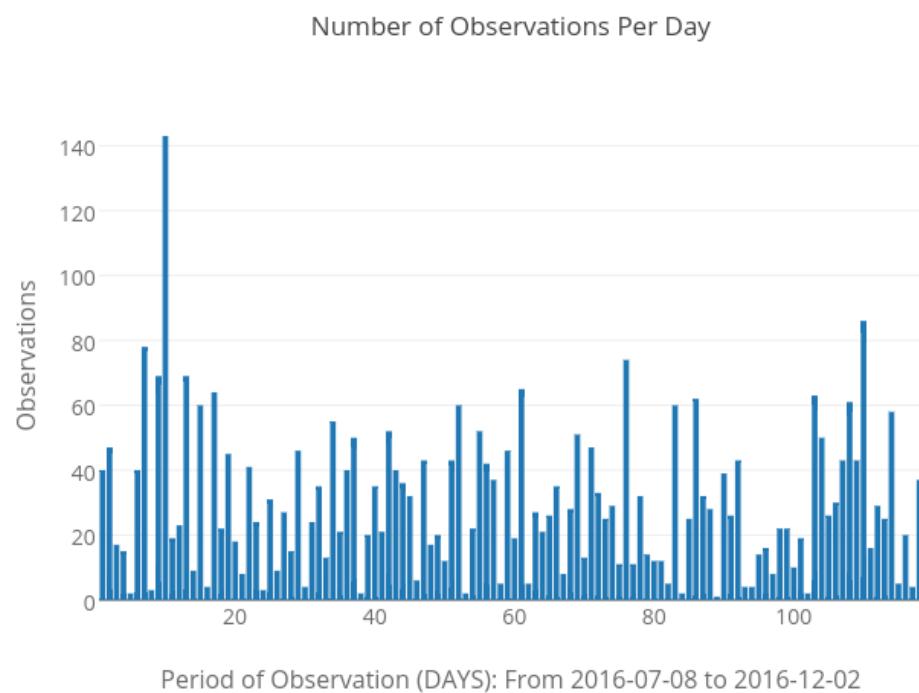


Figure 3.1: Number of Observations per Day

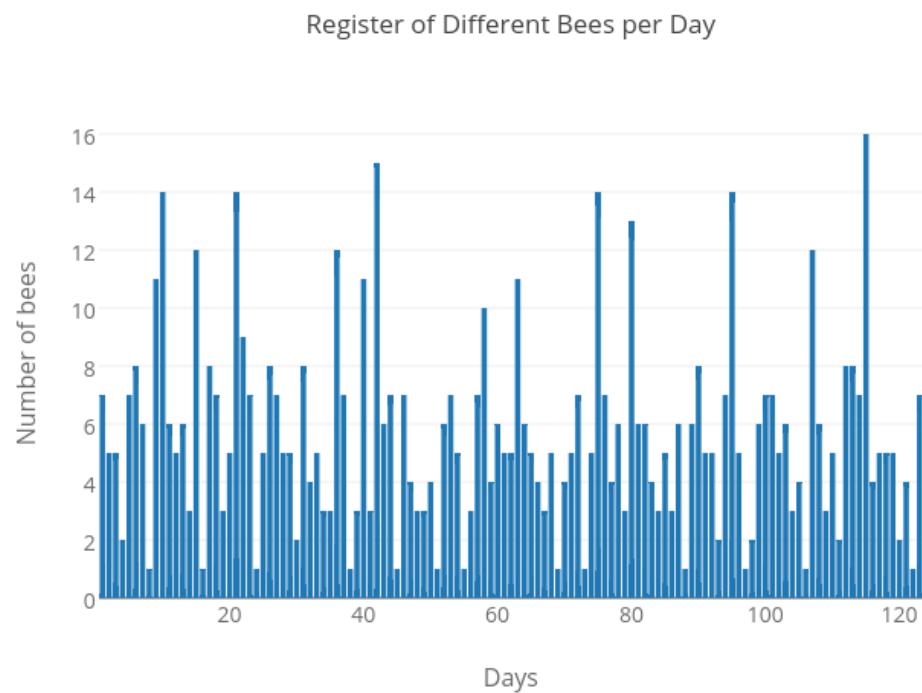


Figure 3.2: Different Bees Per Day

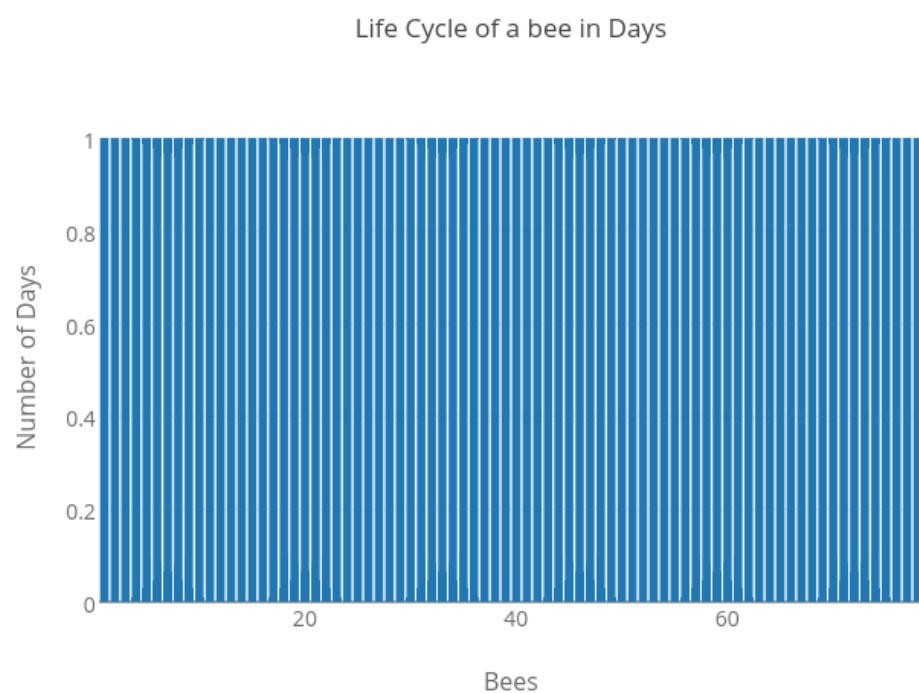


Figure 3.3: Bee Life cycle in days

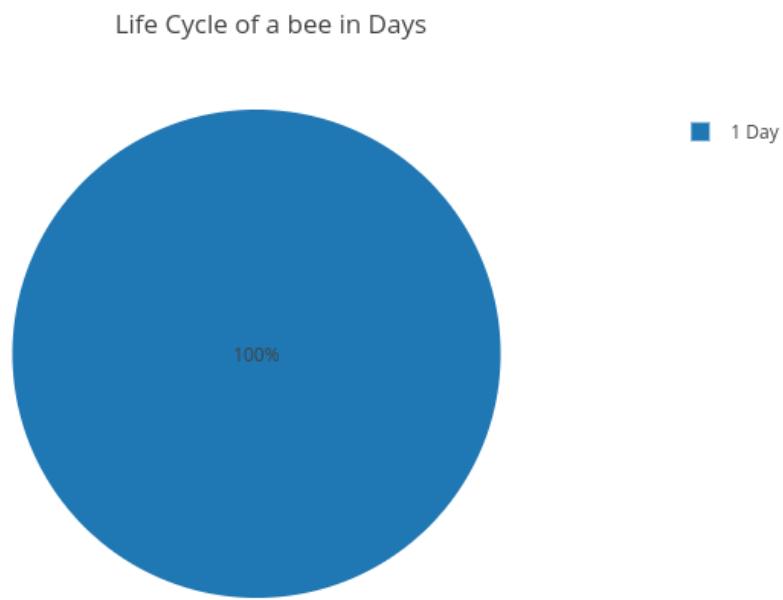


Figure 3.4: Bee Life cycle in days

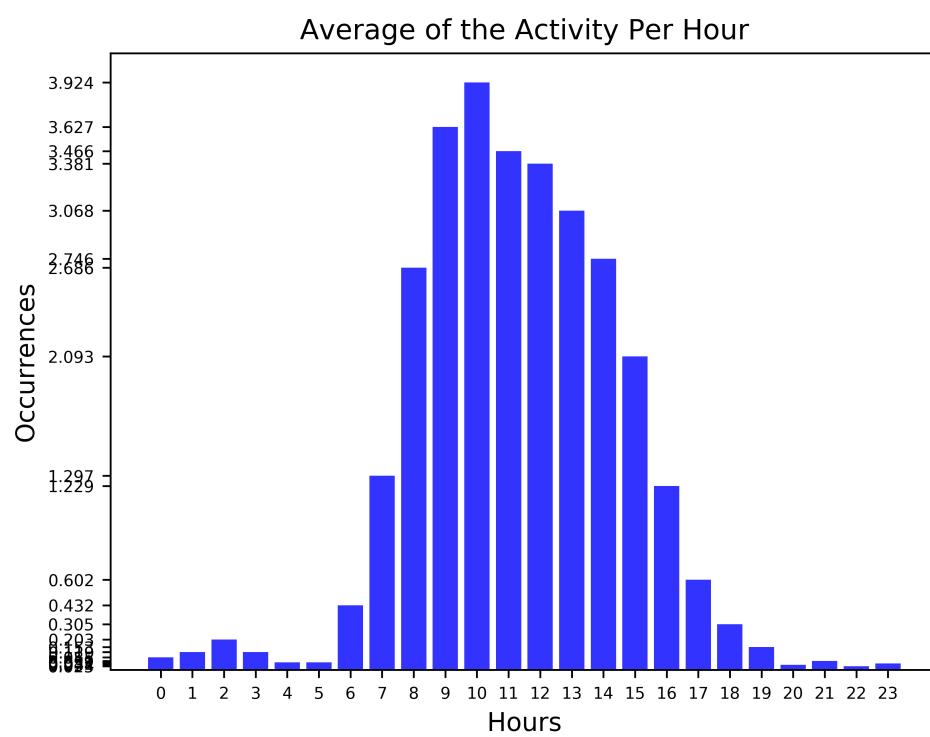


Figure 3.5: Histogram of frequencies per hour

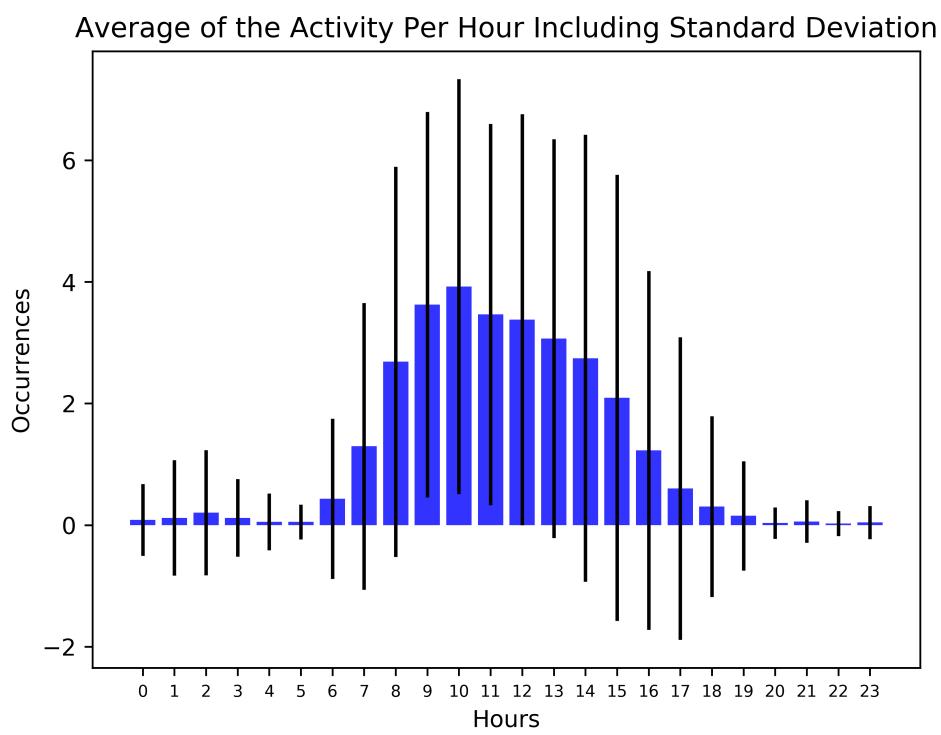


Figure 3.6: Histogram of frequencies per hour. It includes standard deviation



4. Analysis of Foraging Behavior