

# The Temporal (Hyper)Graph of The Andy Warhol Diaries

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# Table of Contents



► I. Counting Diaries, Dates and Persons



► II. Time-Series and the Life Cycling of Persons

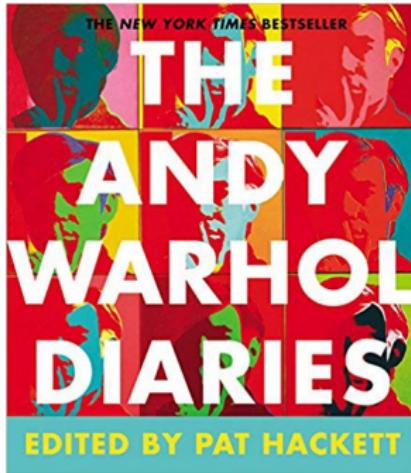


► III. The Temporal Hyper(Graph)



► IV. Examples of Plots of Graphs of Co-Ocurring Persons in Andy Warhol Diaries

# I. Counting Diaries, Dates and Persons



- ▶ The book “The Andy Warhol Diaries” has been edited by Pat Hackett, Andy Warhol’s long-time friend.
- ▶ The book was first published by Warner Books in January 1991.
- ▶ Through the 807 pages of the book, the diaries follow the life of Warhol for almost 12 years, starting from November 1976 and continuing to February 1987, right before his unexpected death.

From Katie Fricas' sketchbook in The New York Times, Nov. 15, 2019

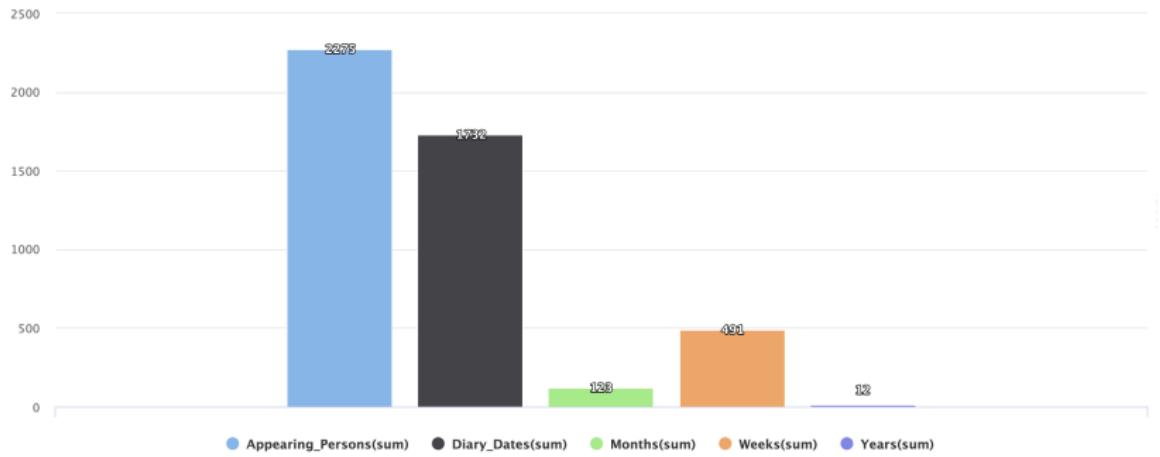
MONDAY, APRIL 23, 1984  
CABBED DOWNTOWN (\$7). CALLED JEAN-  
MICHEL [BASQUIAT] AND HE CAME UP  
AND ORDERED CHINESE FOOD FROM A  
PLACE ON SIXTH  
AVE.



## Extraction of Names of Persons from the Text

- ▶ Tokenize unprocessed text.
- ▶ Remove stopwords (in lower-case letters).
- ▶ Separate out capitalized tokens (starting with an upper-case letter).
- ▶ Remove those tokens among the previous which are:
  - ▶ stopwords when uncapitalized,
  - ▶ are tagged in any other POS tag than NP (i.e., keep only proper nouns),
  - ▶ title-tokens as Mr., Ms., Dr. etc. (but *not* Lord and Princess).
- ▶ Remove title-tokens as Mr., Ms., Dr. etc. (but *not* Lord and Princess).
- ▶ Combine pairs of filtered tokens and sieve those 2-grams occurring in the text.
- ▶ Combine pairs of 2-grams ("2-with-1" and "1-with-2") and sieve those 3-grams occurring in the text.

### Total Counts of Diary Dates and Persons (from 1976-11-24 to 1987-02-16)



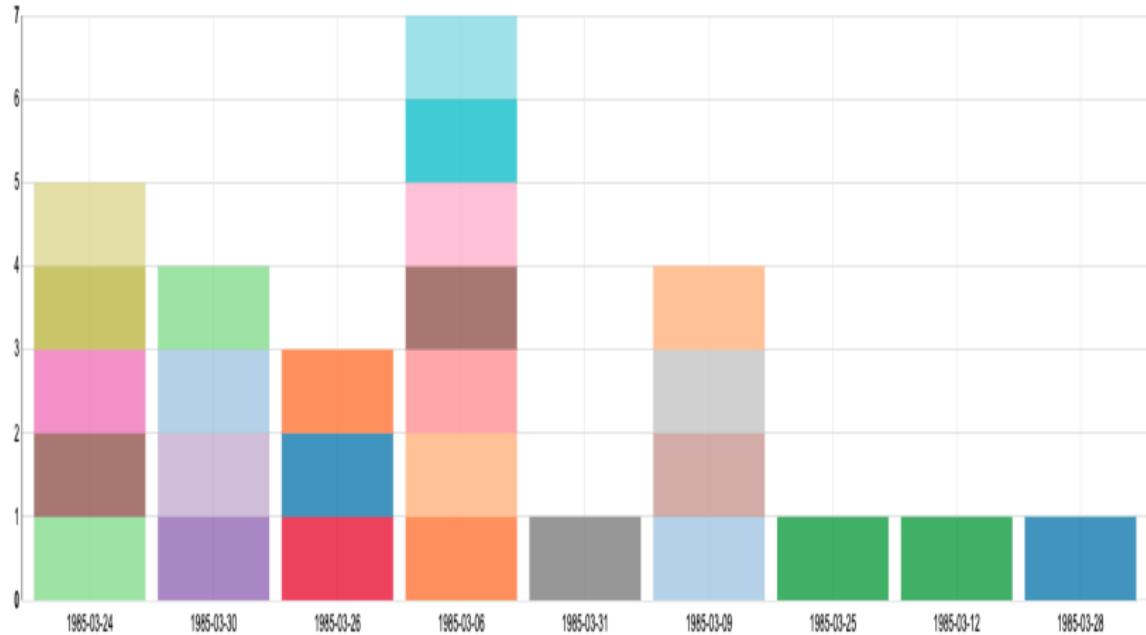
# The Dataframe

| Date       | Year | Year_Month | Year_Week | Month | Day | Week | Person               |
|------------|------|------------|-----------|-------|-----|------|----------------------|
| 1976-11-24 | 1976 | 1976-11    | 1976-48   | 11    | 24  | 48   | Ahmet Ertegun        |
| 1976-11-24 | 1976 | 1976-11    | 1976-48   | 11    | 24  | 48   | Stuart Pivar         |
| 1976-11-24 | 1976 | 1976-11    | 1976-48   | 11    | 24  | 48   | Jean Michel Basquiat |
| 1976-11-24 | 1976 | 1976-11    | 1976-48   | 11    | 24  | 48   | Truman Capote        |
| 1976-11-24 | 1976 | 1976-11    | 1976-48   | 11    | 24  | 48   | Marsha May           |
| 1976-11-25 | 1976 | 1976-11    | 1976-48   | 11    | 25  | 48   | Thomas Ammann        |
| 1976-11-25 | 1976 | 1976-11    | 1976-48   | 11    | 25  | 48   | Charlie Chaplin      |
| 1976-11-25 | 1976 | 1976-11    | 1976-48   | 11    | 25  | 48   | Ron Wood             |
| 1976-11-25 | 1976 | 1976-11    | 1976-48   | 11    | 25  | 48   | Keith Richards       |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Sally Kirkland       |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Susan Tyrrell        |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Earl Wilson          |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Diahnne Abbott       |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Julia Scorsese       |
| 1976-11-27 | 1976 | 1976-11    | 1976-48   | 11    | 27  | 48   | Robert Hayes         |
| 1976-11-28 | 1976 | 1976-11    | 1976-49   | 11    | 28  | 48   | Neil Sedaka          |
| 1976-11-28 | 1976 | 1976-11    | 1976-49   | 11    | 28  | 48   | Neil Sedakas         |
| 1976-11-28 | 1976 | 1976-11    | 1976-49   | 11    | 28  | 48   | John O'Shea          |
| 1976-11-28 | 1976 | 1976-11    | 1976-49   | 11    | 28  | 48   | Hugh Hefner          |
| 1976-11-30 | 1976 | 1976-11    | 1976-49   | 11    | 30  | 49   | Eugenia Sheppard     |
| 1976-11-30 | 1976 | 1976-11    | 1976-49   | 11    | 30  | 49   | Princess Grace       |
| 1976-12-01 | 1976 | 1976-12    | 1976-49   | 12    | 1   | 49   | Shirley Goldfarb     |

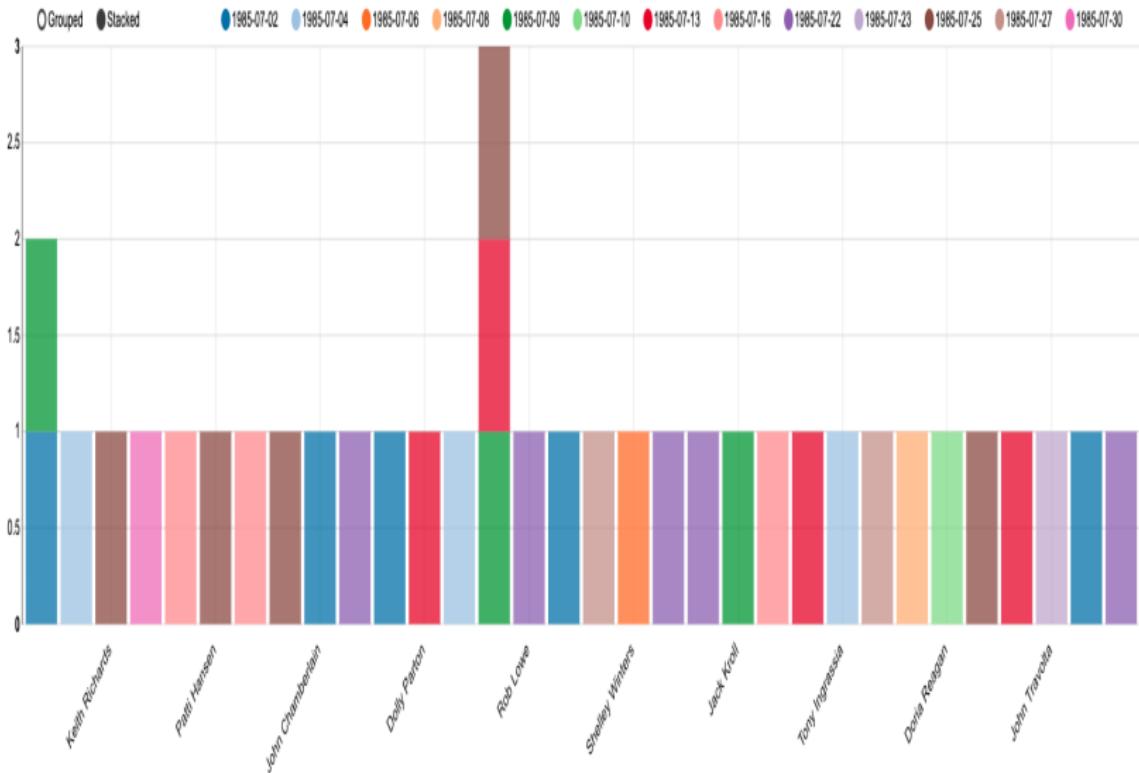
# Persons in a Sample of Diaries/Dates

Grouped   Stacked

- Andre Leon Talley   ● Ann Magnuson   ● Averil Meyer   ● Bill Pitt   ● Bob Colacello   ● Catherine Guinness   ● Chris Isham   ● Stuart Lichtenstein   ● David Sales   ● David Whitney
- Diana Vreeland   ● Dustin Hoffman   ● Jean Michel Basquiat   ● John Scribner   ● Jon Goud   ● Karen Burke   ● Keith Haring   ● Marilyn Monroe   ● Mick Jagger   ● Nastassja Kinski
- Nima Isham   ● Peter Brant   ● Rick Li Brizzi   ● Sean Penn   ● Thomas Ammann   ● Vito Giallo



## Diaries/Dates in a Sample of Persons



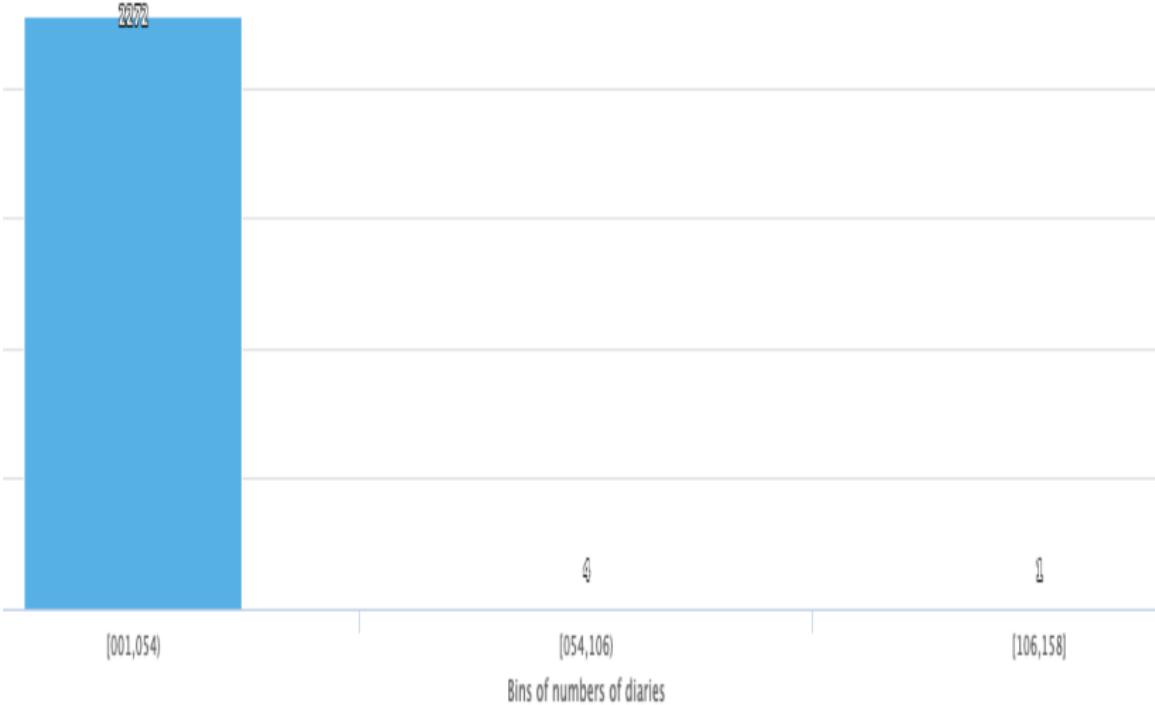
# Top Persons

| Person                | Number_of_Diaries |
|-----------------------|-------------------|
| Jean Michel Basquiat  | 158               |
| Steve Rubell          | 91                |
| Barbara Allen         | 68                |
| Chris Makos           | 59                |
| Diana Vreeland        | 55                |
| John Reinhold         | 53                |
| Stephen Sprouse       | 46                |
| Richard Weisman       | 44                |
| Robert Hayes          | 43                |
| Doc Cox               | 43                |
| Thomas Ammann         | 40                |
| Jane Holzer           | 39                |
| Jerry Hall            | 37                |
| Bob Colacello         | 36                |
| Suzie Frankfurt       | 36                |
| David Whitney         | 35                |
| Paul Morrissey        | 34                |
| Peter Beard           | 34                |
| Jon Gould             | 33                |
| Diane Von Furstenberg | 33                |

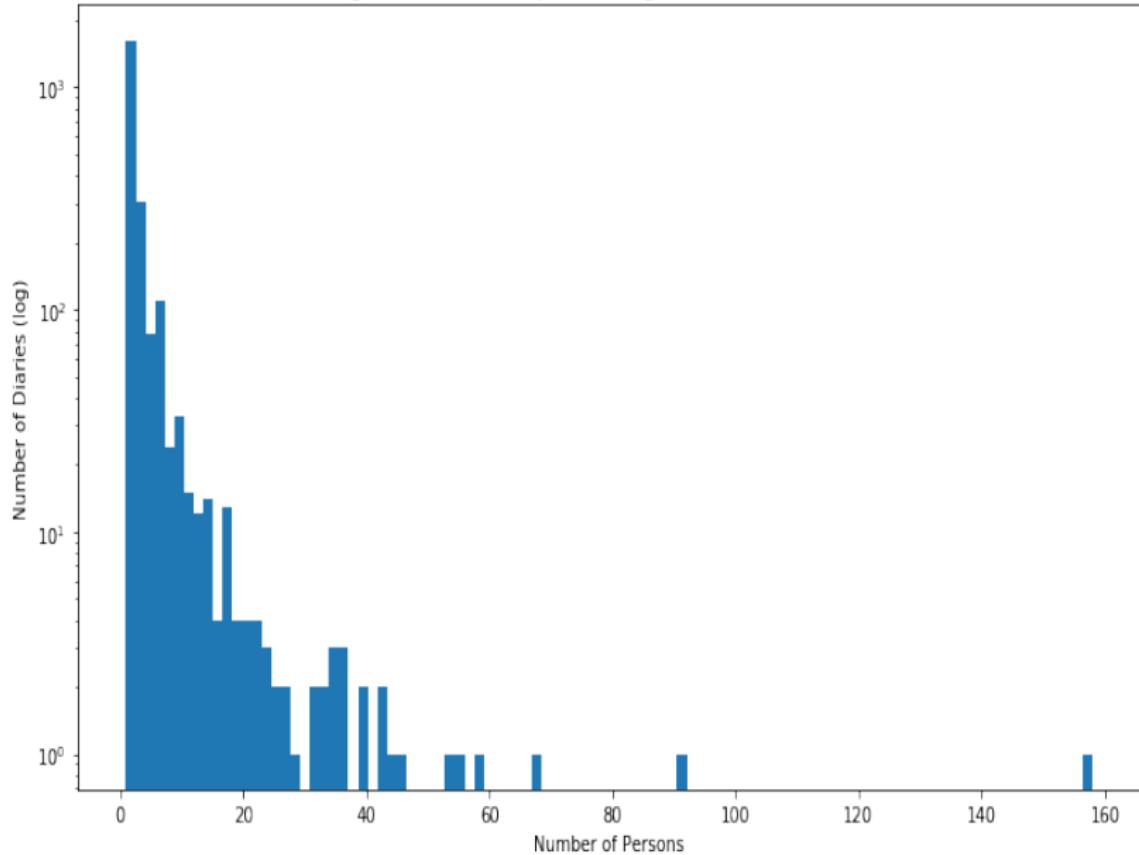
## Wordcloud of Persons in Andy Warhol's Diaries (size proportional to occurrences in number of diaries)



## Histogram of Number of Persons per Diaries



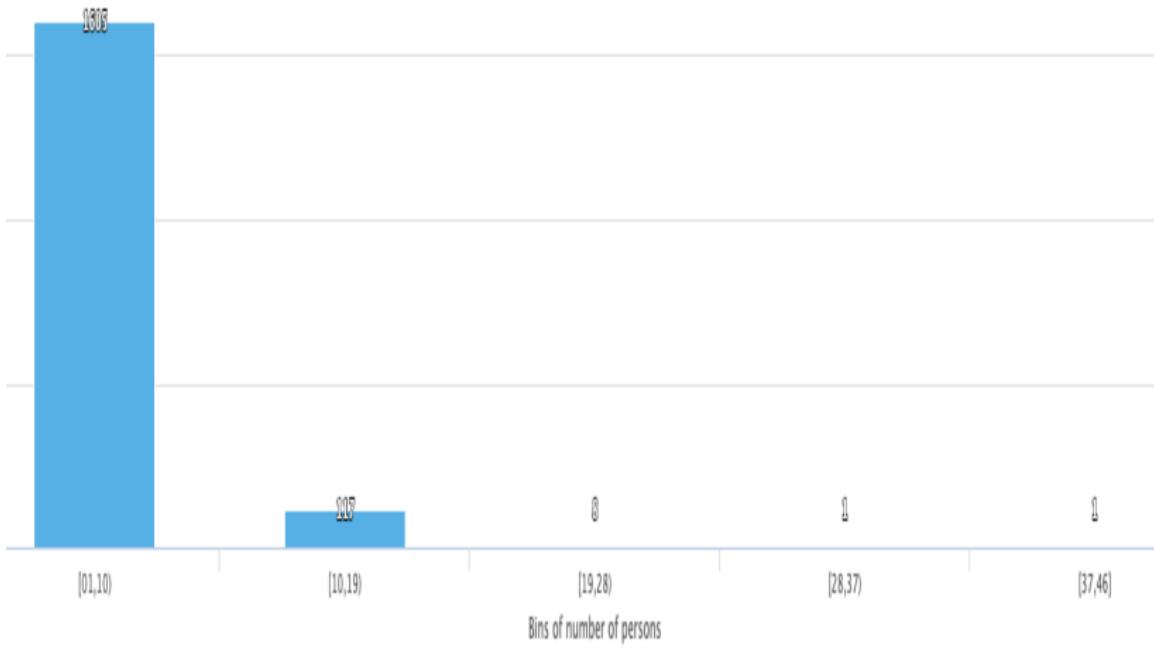
Histogram of number of persons (log scale) in number of diaries



# Top Diaries

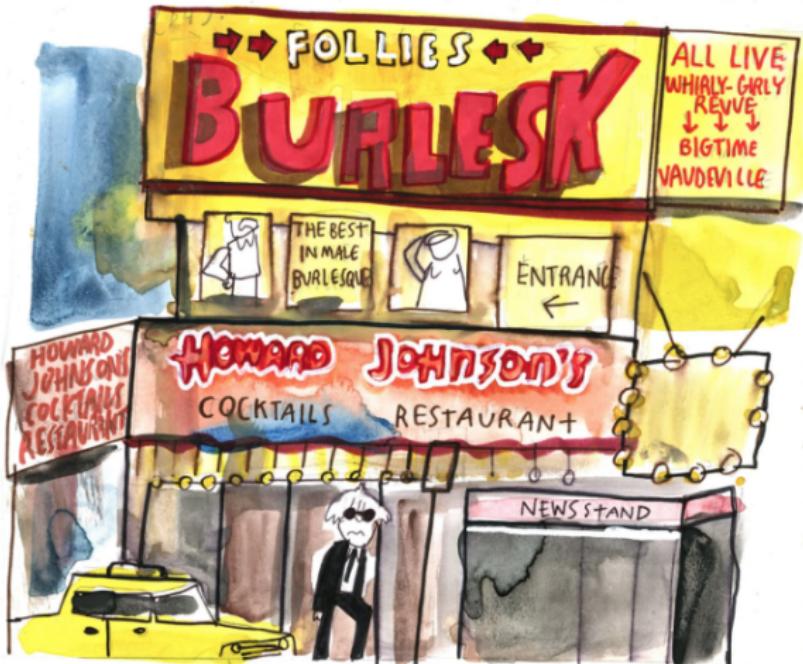
| Diary      | Number_of_Persons |
|------------|-------------------|
| 1981-08-06 | 46                |
| 1980-02-10 | 31                |
| 1978-06-11 | 26                |
| 1981-10-01 | 23                |
| 1984-12-19 | 22                |
| 1983-05-16 | 22                |
| 1984-09-17 | 21                |
| 1979-02-17 | 21                |
| 1978-09-03 | 19                |
| 1984-01-04 | 19                |
| 1977-07-16 | 18                |
| 1981-08-31 | 18                |
| 1980-03-06 | 18                |
| 1978-01-22 | 18                |
| 1983-07-28 | 17                |
| 1985-12-19 | 17                |
| 1986-12-07 | 17                |

### Histogram of Number of Diaries per Persons



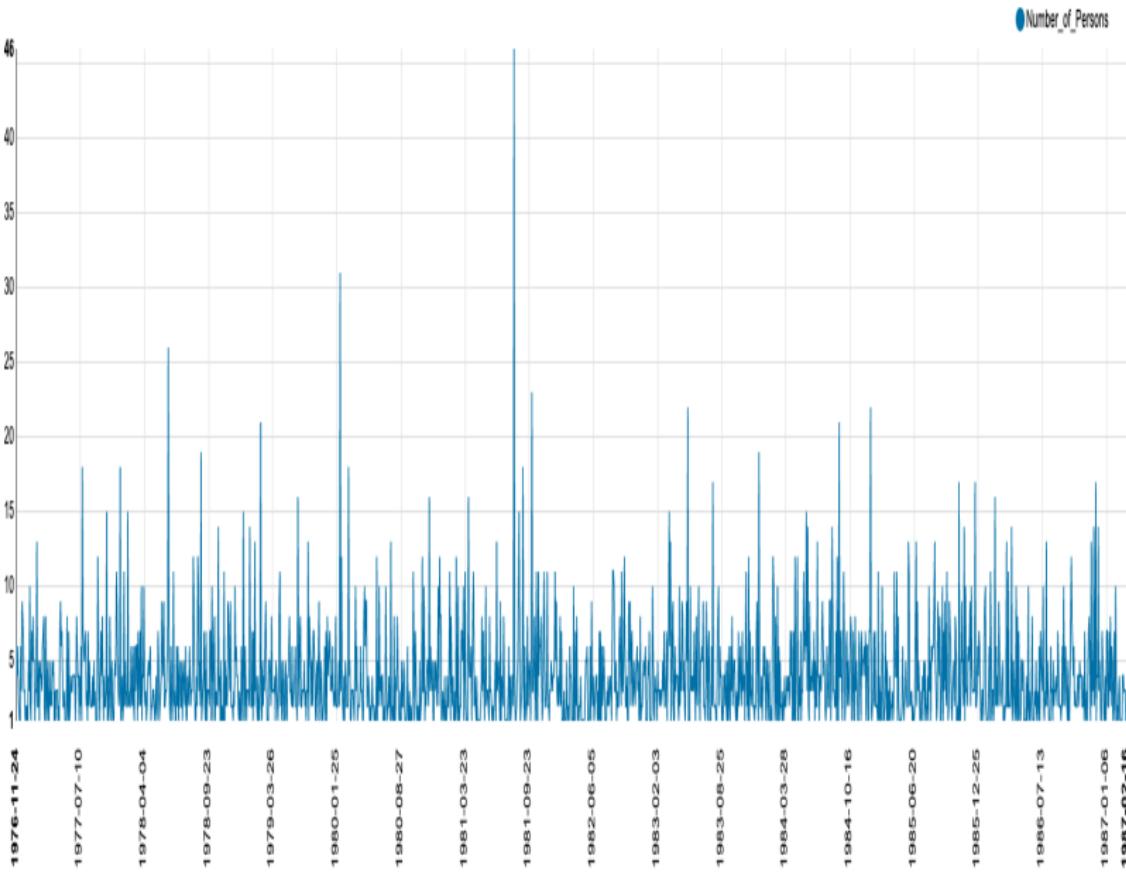
From Katie Fricas' sketchbook in The New York Times, Nov. 15, 2019

MONDAY, JULY 18, 1977  
ON MY WAY HOME, A CAB STOPPED AND I  
REALLY WANTED ONE, BUT SINCE IT HAD  
STOPPED FOR ME I WAS SUSPICIOUS TO GET  
IN AND DIDN'T. WENT TO A MAGAZINE STORE (\$4).

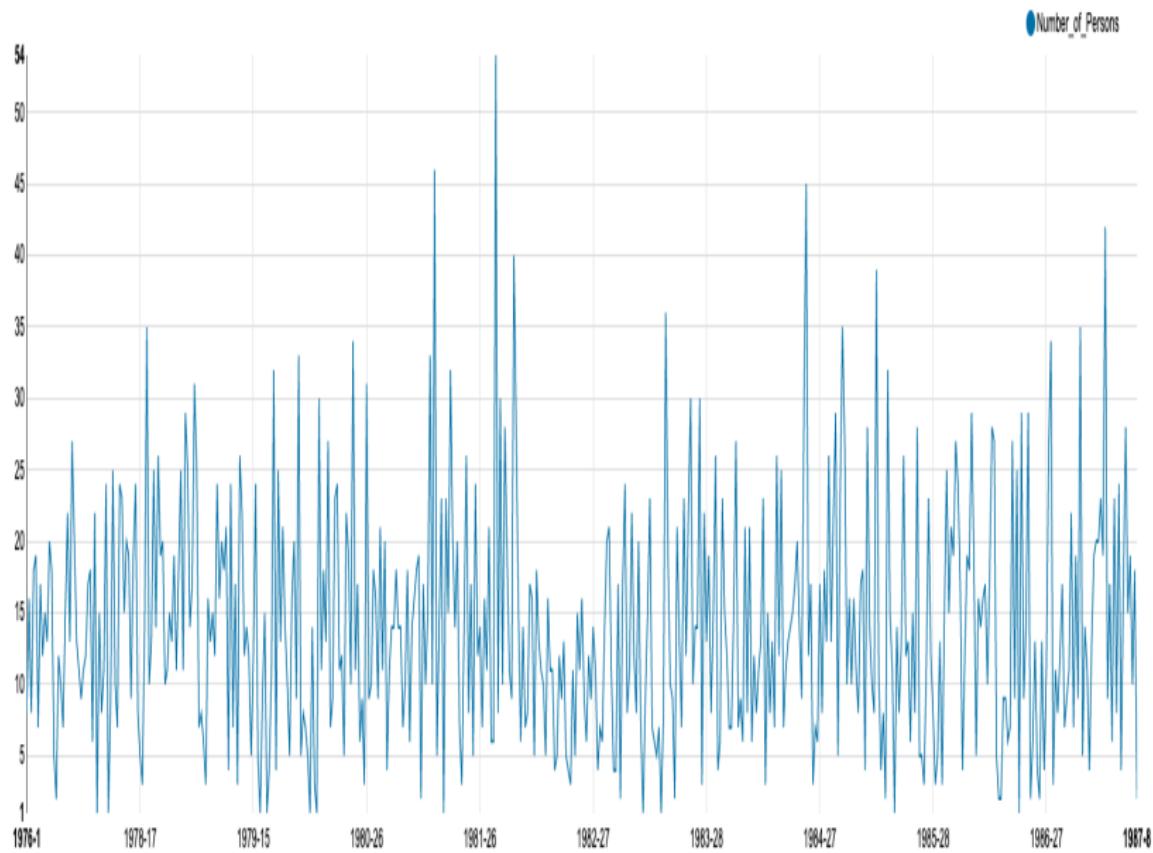


## II. Time-Series and the Life Cycling of Persons

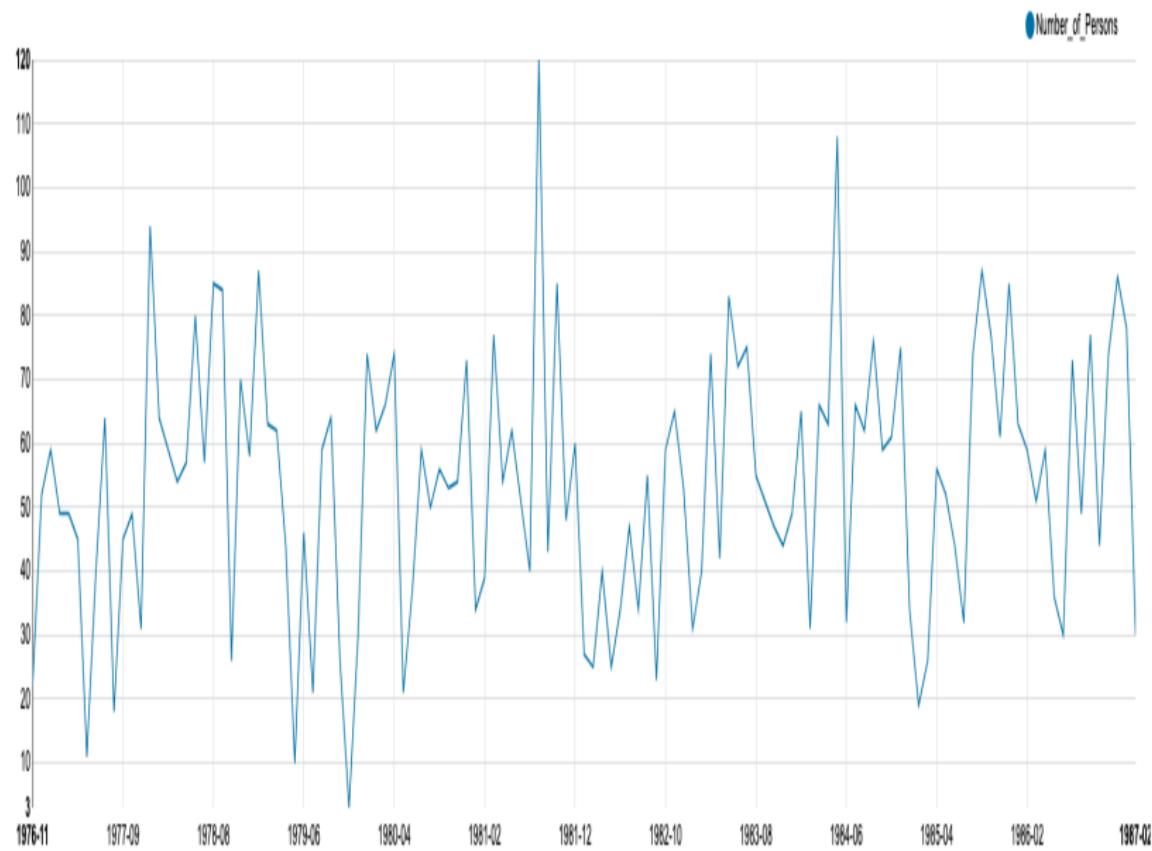
# Numbers of Persons per Day (mean = 4.02, std = 3.52)



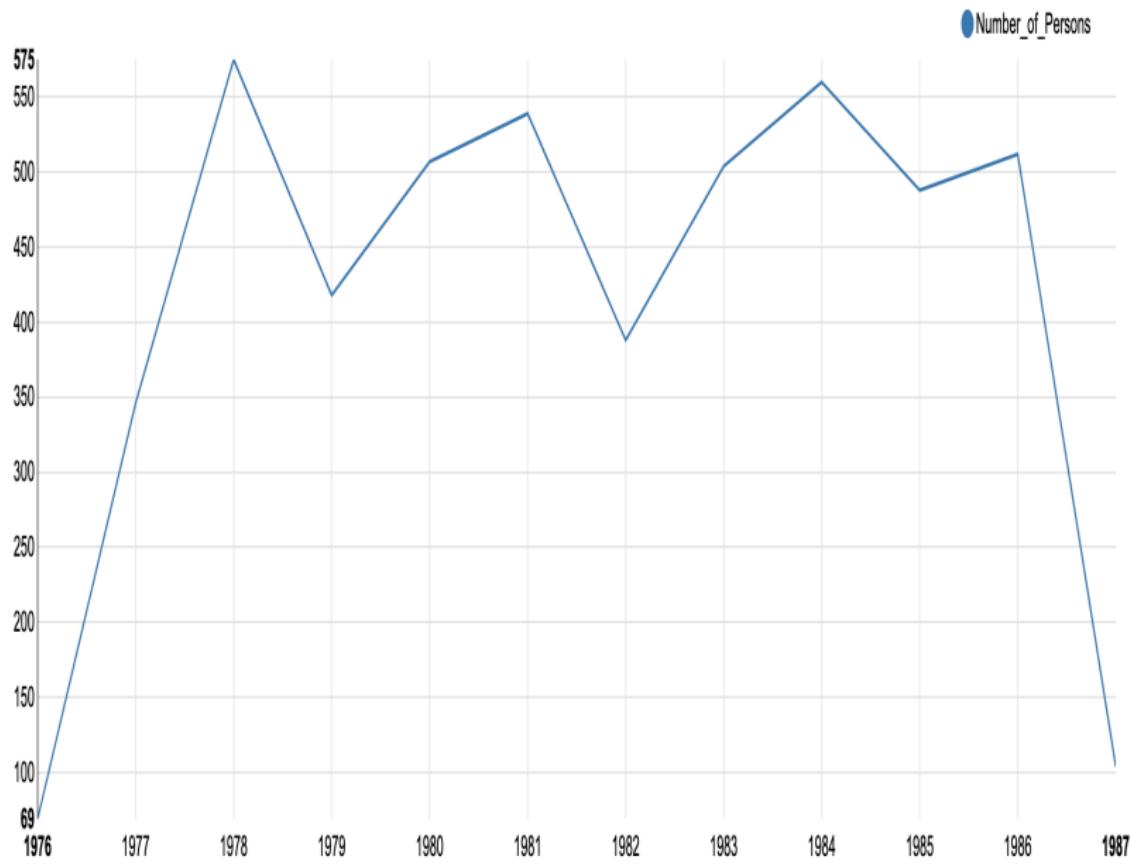
# Numbers of Persons per Week (mean = 14.05, std = 8.46)



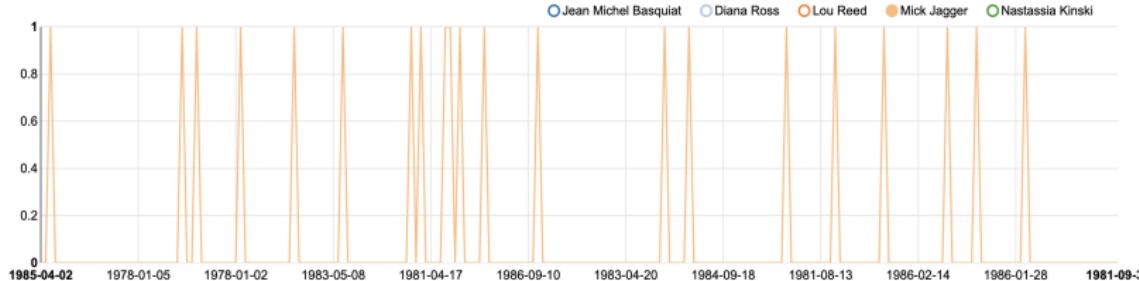
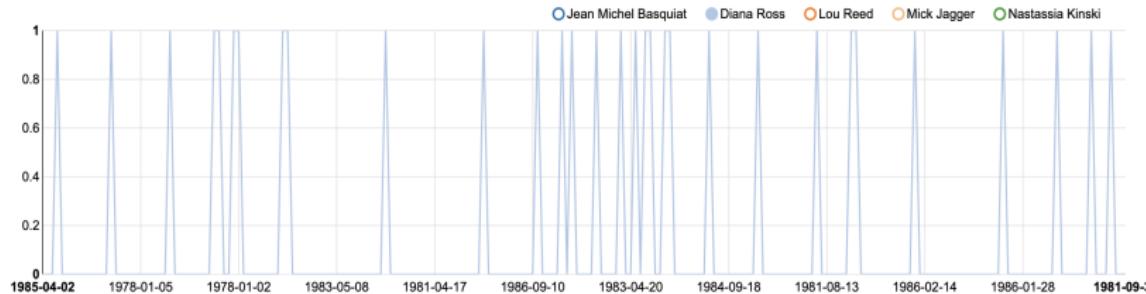
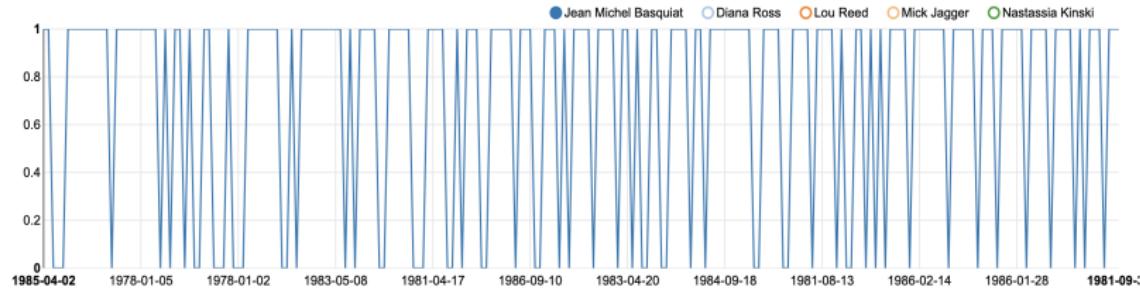
# Numbers of Persons per Month (mean = 53.6, std = 20.75)



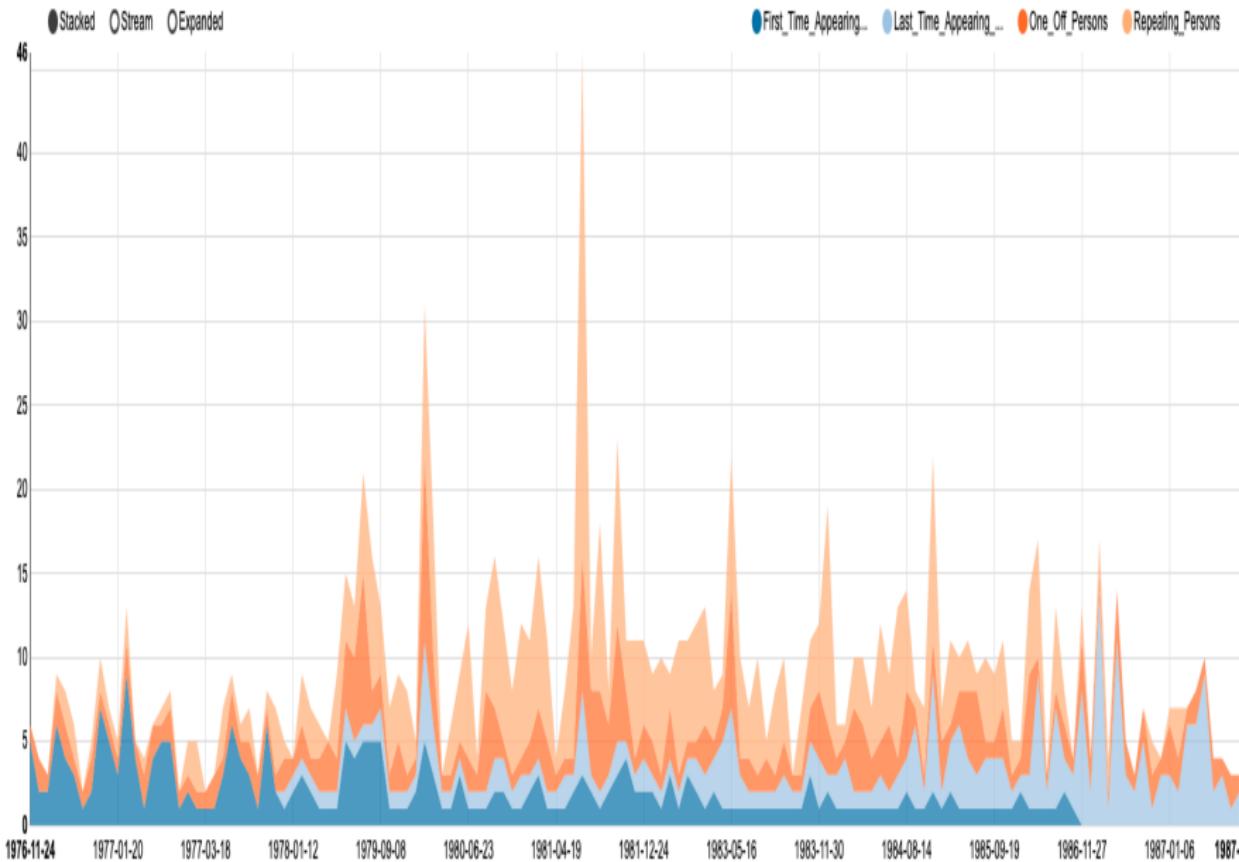
# Numbers of Persons per Year (mean = 417.5, std = 169.21)



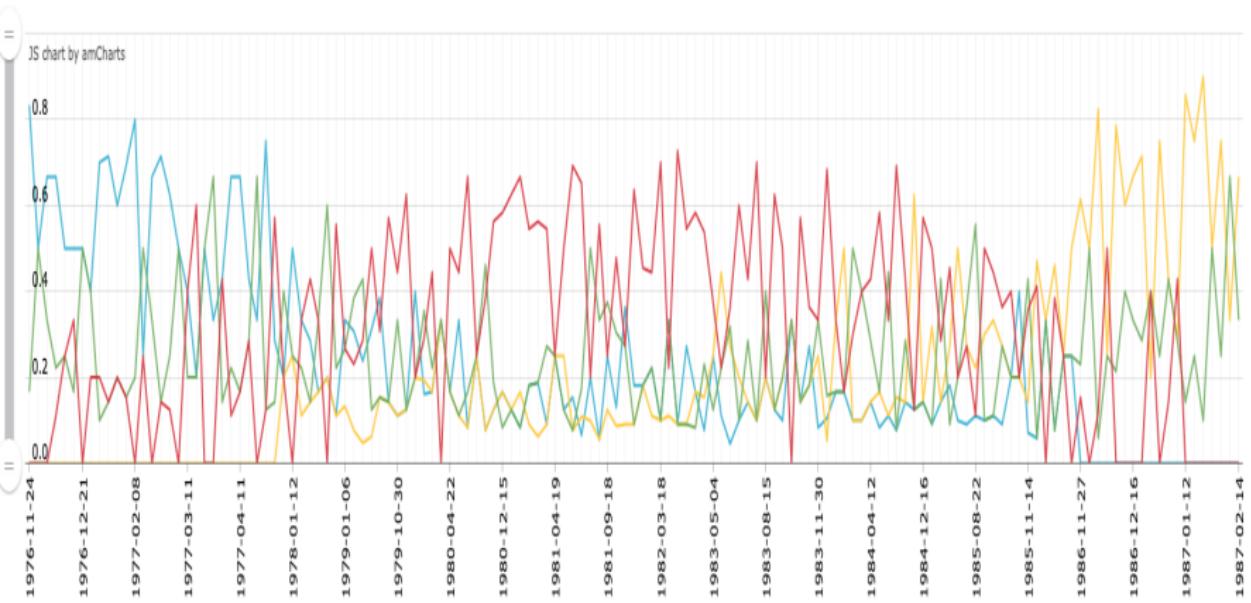
# Timelines of Particular Persons



# Time-Series of the Life Cycling of Persons



# Time-Series of the Life Cycling of Persons (Percentages)



First\_Time\_Appearing\_Persons\_Ratio(sum)

Last\_Time\_Appearing\_Persons\_Ratio(sum)

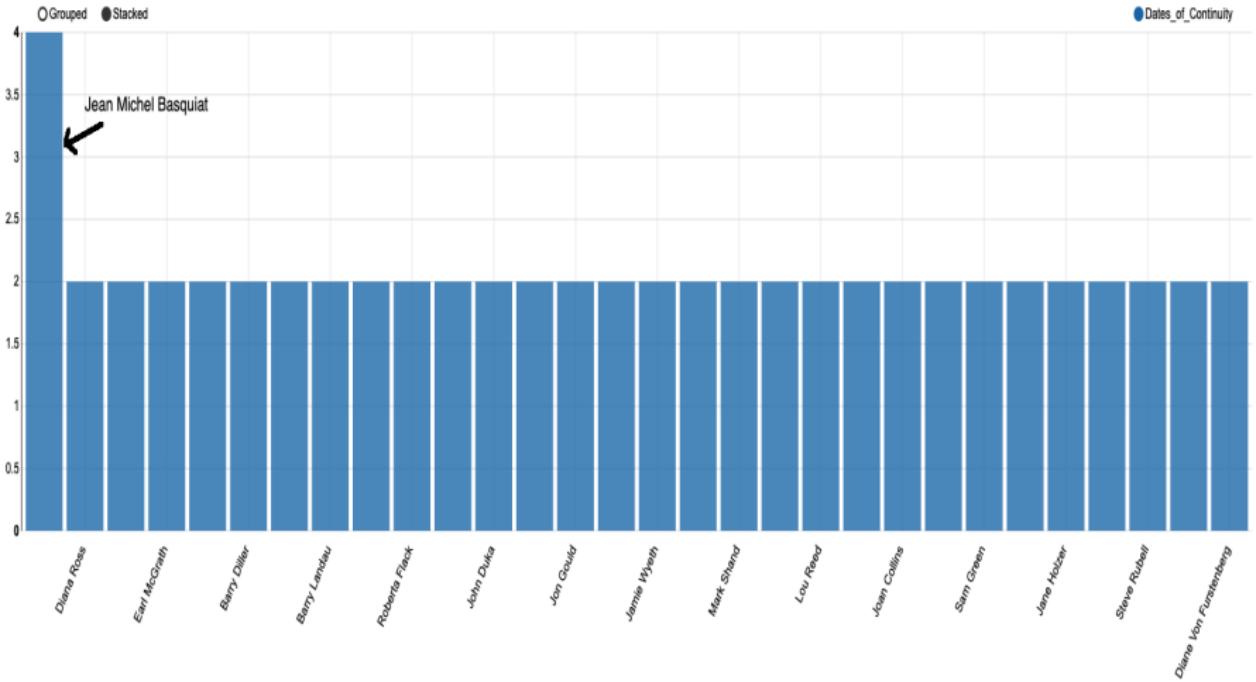
One\_Off\_Persons\_Ratio(sum)

Repeating\_Persons\_Ratio(sum)

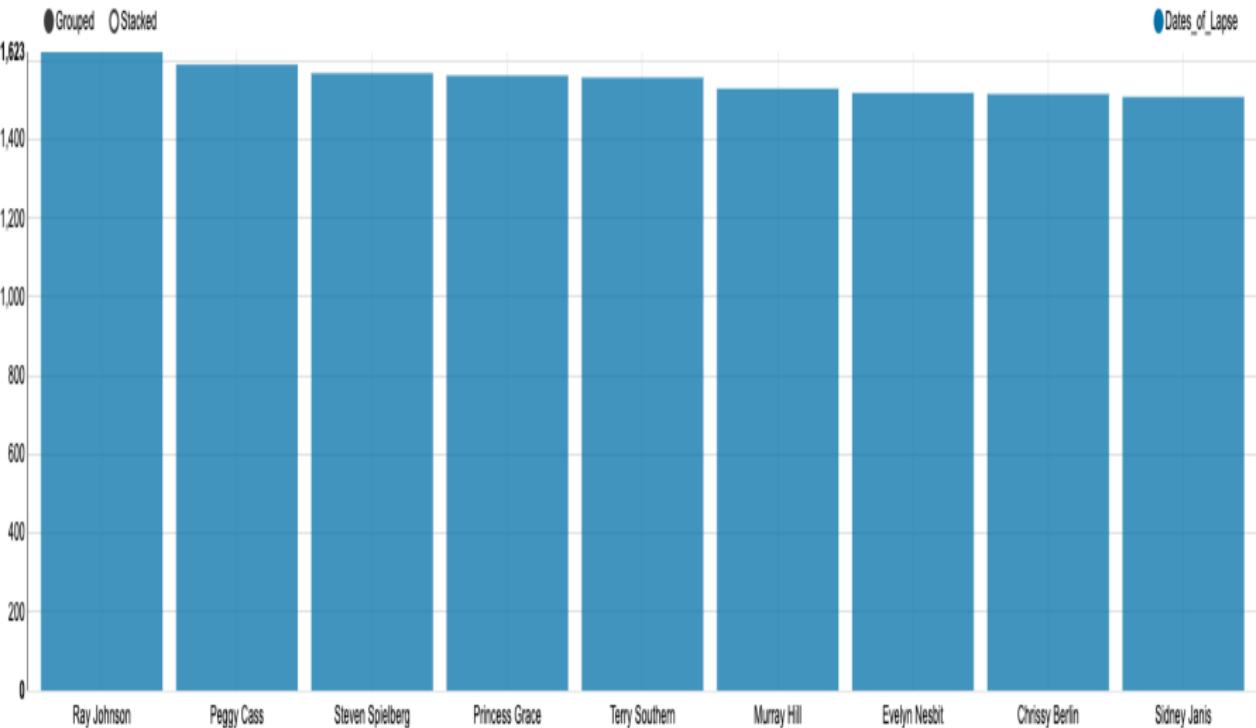
# Maximum Intervals of Continuity and Interruptions

- ▶ Let  $\mathfrak{T}$  denote a set of dates, strictly totally ordered wrt " $<$ ", and let  $T \subset \mathfrak{T}$  be such that  $|T| \geq 2$ .  $T$  is called **continuous** if, for any  $t, s \in T$  such that  $t < s$ , there exists no  $\tau \in \mathfrak{T}$  such that  $t < \tau < s$ .
- ▶ Let  $\mathfrak{P}$  denote a (finite) set of persons. The **activity timeline of person**  $p \in \mathfrak{P}$  is defined as a function  $\alpha_p : \mathfrak{T} \longrightarrow \{0, 1\}$ . The set  $\mathfrak{A}_p = \{t \in \mathfrak{T} : \alpha_p(t) = 1\}$  is called **activation period of person**  $p$  and the set  $\mathfrak{D}_p = \{t \in \mathfrak{T} : \alpha_p(t) = 0\}$  is called **intermittent period of person**  $p$ .
- ▶ If there exists a continuous subset  $A_p$  of  $\mathfrak{A}_p$  having maximum cardinality,  $A_p$  is called **maximum interval of continuous activation of**  $p$ .
- ▶ If there exists a continuous subset  $D_p$  of  $\mathfrak{D}_p$  having maximum cardinality,  $D_p$  is called **maximum interval of continuous interruption of**  $p$ .

# Maximum Intervals of Continuous Activation



# Maximum Intervals of Continuous Intermission



From Katie Fricas' sketchbook in The New York Times, Nov. 15, 2019

TUESDAY, MARCH 18, 1980  
CABBED TO DIANE VON FURSTENBERG'S  
(\$4). I HAD A FIGHT WITH THE CAB  
DRIVER, HE WANTED TO GO THE WAY  
HE WANTED TO GO.

I'D REALLY  
PREFER TO  
AVOID THE  
F.D.R. TONIGHT.

LOOK, PAL, WHO'S  
DRIVIN' HERE -  
YOU OR ME?



# III. The Temporal (Hyper)Graph

# Hypergraphs

- ▶ A **hypergraph** is a pair  $H = (V, E)$ , where  $V$  is a (finite) set of **vertices** and  $E$  is a (finite) set of **hyperedges** such that  $\bigcup_{e \in E} = V$  and, for all  $e \in E$ ,  $e \neq \emptyset$ .
- ▶ A hypergraph  $H = (V, E)$  such that  $|e| = 2$ , for all  $e \in E$ , is a graph.
- ▶ Any hypergraph  $H = (V, E)$  is represented by a bipartite graph  $B(H) = (V, E, F)$ , where the set of edges  $F$  of the bipartite graph  $B(H)$  is defined as  $F = \{(v, e) \in V \times E : v \in e\}$ .

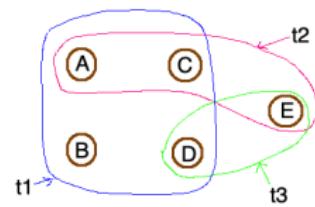
# Temporal Hypergraphs

- ▶ Let  $\mathfrak{T}$  denote a set of integers, understood as (discrete) time. Then a **temporal hypergraph** is a hypergraph  $H = (V, E, \mathfrak{T}, \varepsilon)$  equipped with an one-to-one mapping  $\varepsilon: \mathfrak{T} \longrightarrow E$  such that, for all  $e \in E$ ,  $e = \varepsilon(t)$ , for some  $t \in \mathfrak{T}$ . In other words, each hyperedge  $e \in E$  of a temporal hypergraph is labelled by a **time step**  $t \in \mathfrak{T}$ .
- ▶ Projecting the bipartite graph corresponding to a temporal hypergraph  $H = (V, E, \mathfrak{T}, \varepsilon)$  on the set of vertices  $V$  gives a temporal graph  $G = (V, C, \mathfrak{T}, \varepsilon)$ , where, for  $v, u \in V$ ,  $(v, u) \in C$  whenever there exists a hyperedge  $\varepsilon(t)$  such that  $v, u \in \varepsilon(t)$ , for some  $t \in \mathfrak{T}$ . The projection  $G$  of the temporal hypergraph  $H$  on  $V$  will be called **temporal graph of co-occurring vertices**.

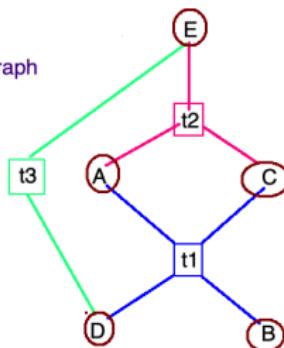
# Hypergraphs vs. Temporal Hypergraphs

Diary/Time Persons

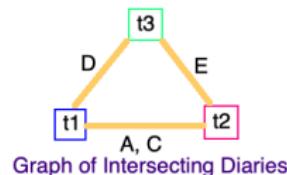
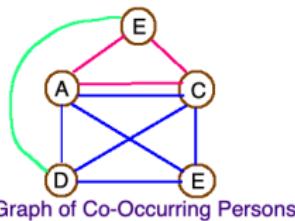
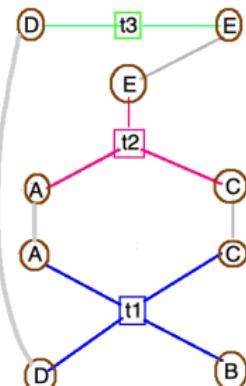
- t1 A B C D
- t2 A C E
- t3 D E



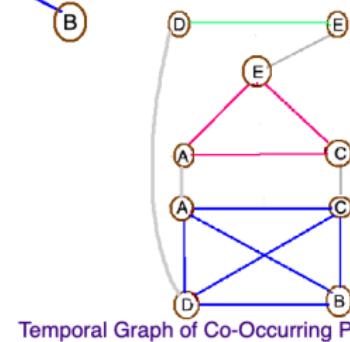
Hypergraph



Temporal Hypergraph



Graph of Intersecting Diaries



Temporal Graph of Co-Occurring Persons



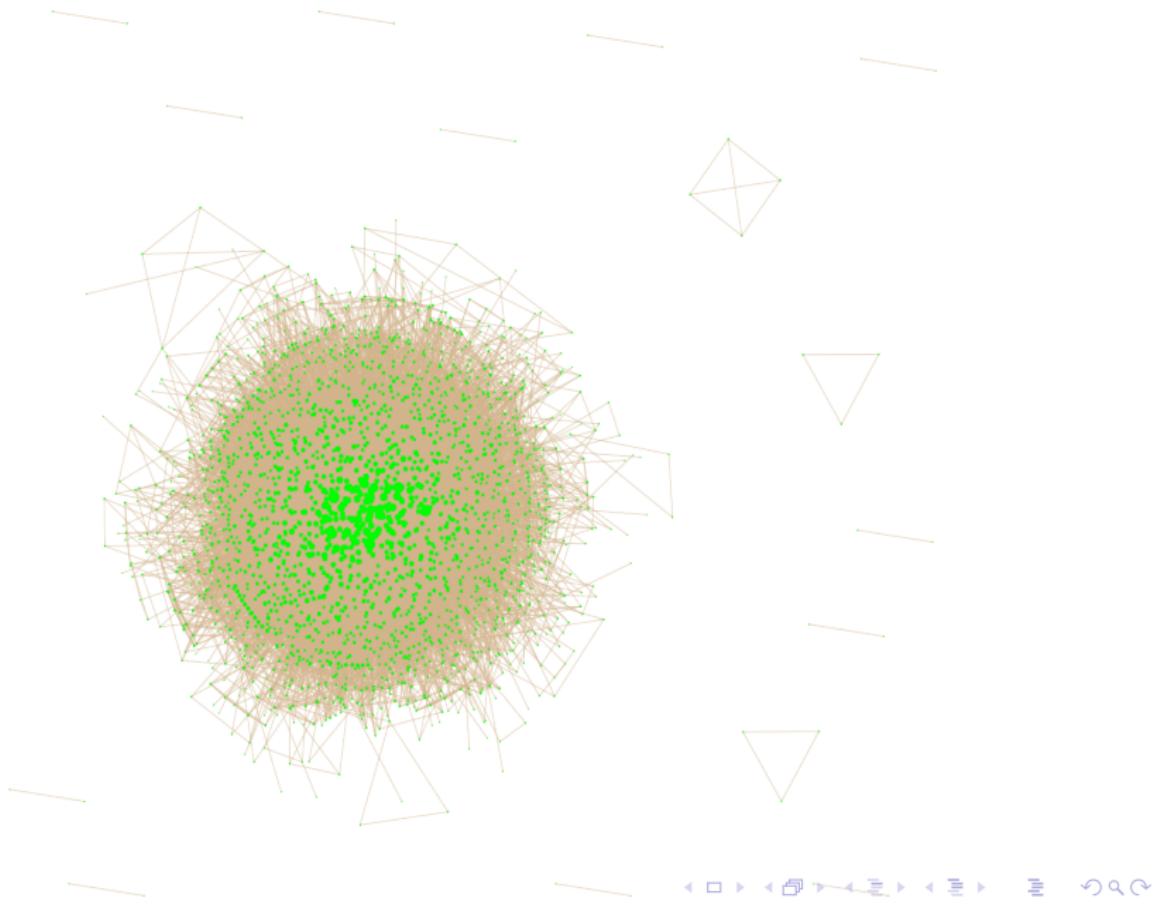
From Katie Fricas' sketchbook in The New York Times, Nov. 15, 2019

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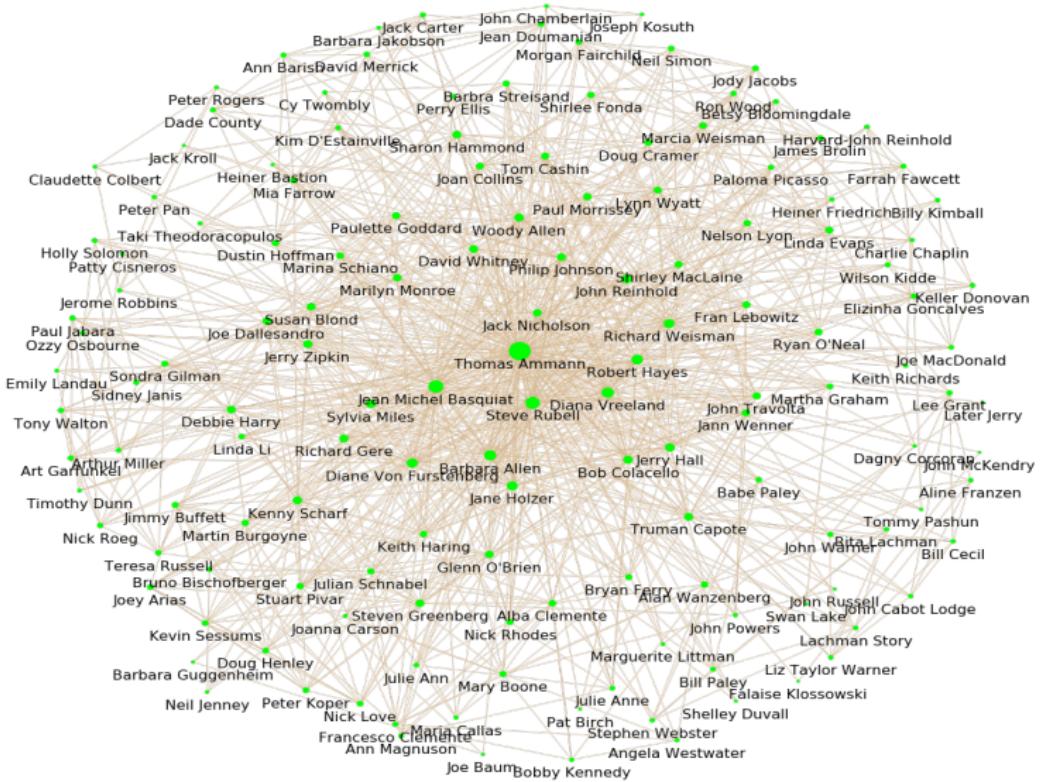


# IV. Examples of Plots of Graphs of Co-Occurring Persons in Andy Warhol Diaries

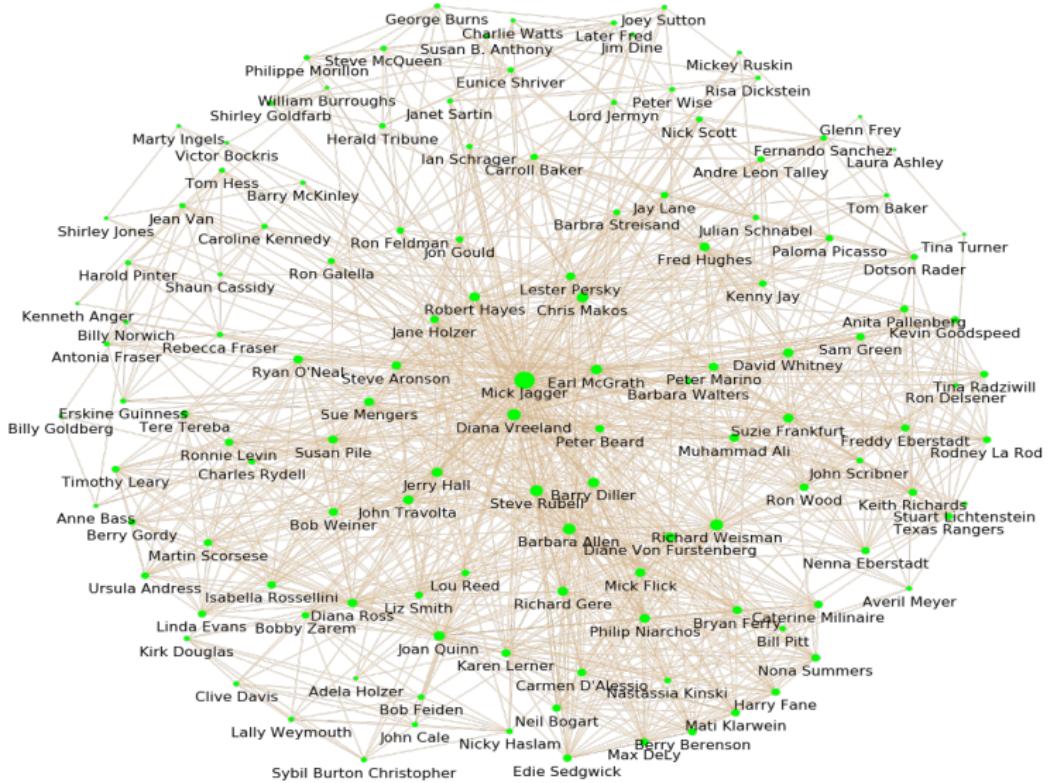
The Graph of 2200 Persons with 19861 Co-Occurrences in Diaries  
(19 connected components the largest with 2180 nodes and 19834 edges)



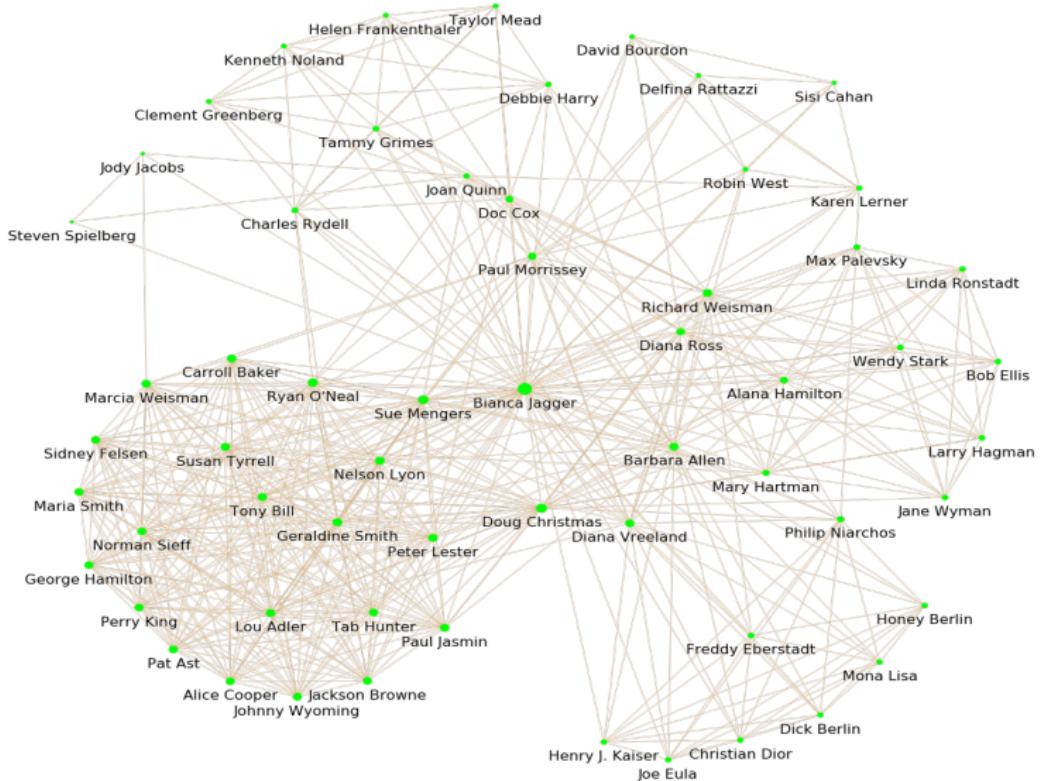
# The egocentric subgraph of co-occurring characters around Thomas Ammann in Andy Warhol Diaries



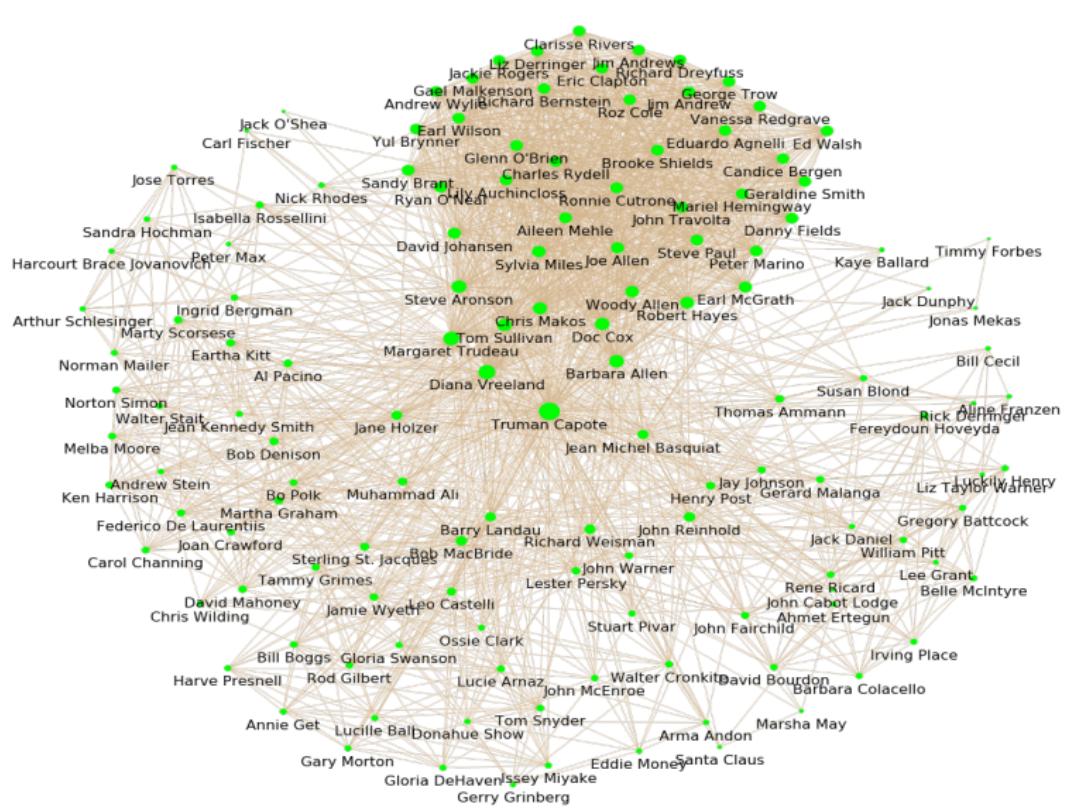
# The egocentric subgraph of co-occurring characters around Mick Jagger in Andy Warhol Diaries



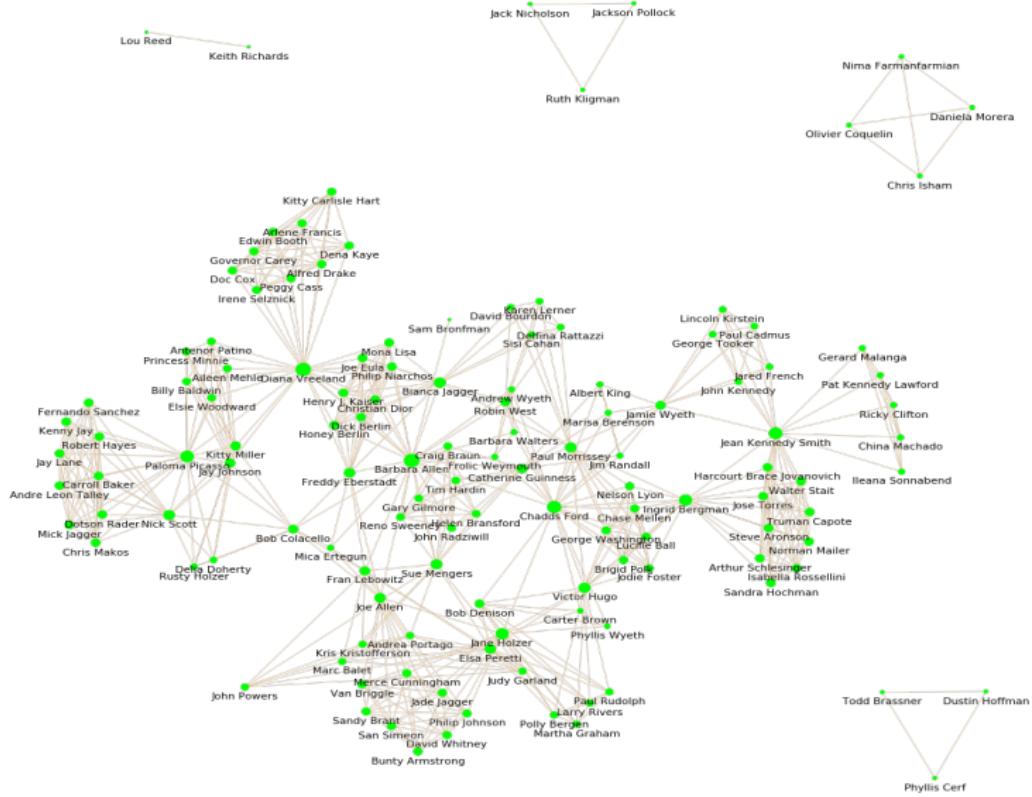
## The egocentric subgraph of co-occurring characters around Bianca Jagger in Andy Warhol Diaries



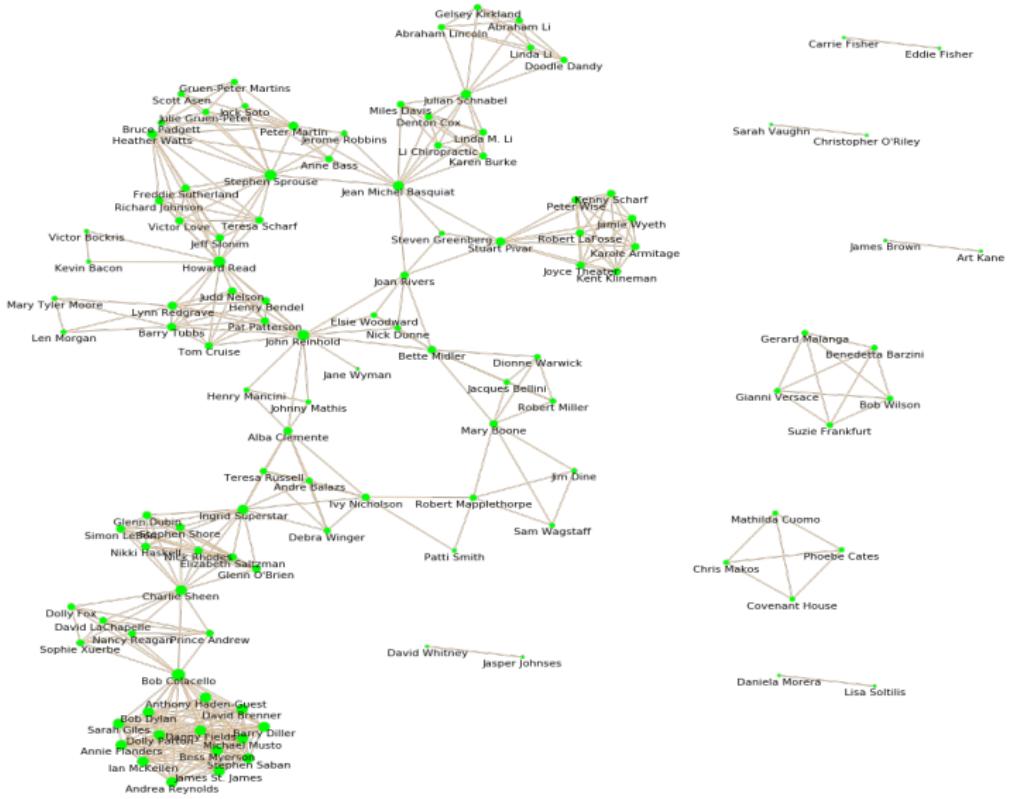
# The egocentric subgraph of co-occurring characters around Truman Capote in Andy Warhol Diaries



# The graph of co-occurring characters during 1976 in Andy Warhol Diaries



## The graph of co-occurring characters during 1987 in Andy Warhol Diaries



Special Thanks:

Sergios Lenis

Nas Gopee

From Katie Fricas' sketchbook in The New York Times, Nov. 15, 2019

THURSDAY, DECEMBER 8, 1983  
WENT UP TO FIORUCCI TO "SIGN" "INTERVIEWS"...  
WHEN I GOT THERE (CAB \$6) IT WAS SO  
NUTTY BECAUSE IT WAS "ANDY WARHOL  
LOOK-ALIKES DAY" AND THERE WERE



FIVE GUYS AT THE STORE DRESSED IN  
WHITE WIGS AND CLEAR PINK-FRAMED  
GLASSES AND IT REALLY LOOKED FUNNY.