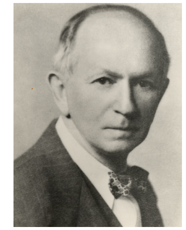
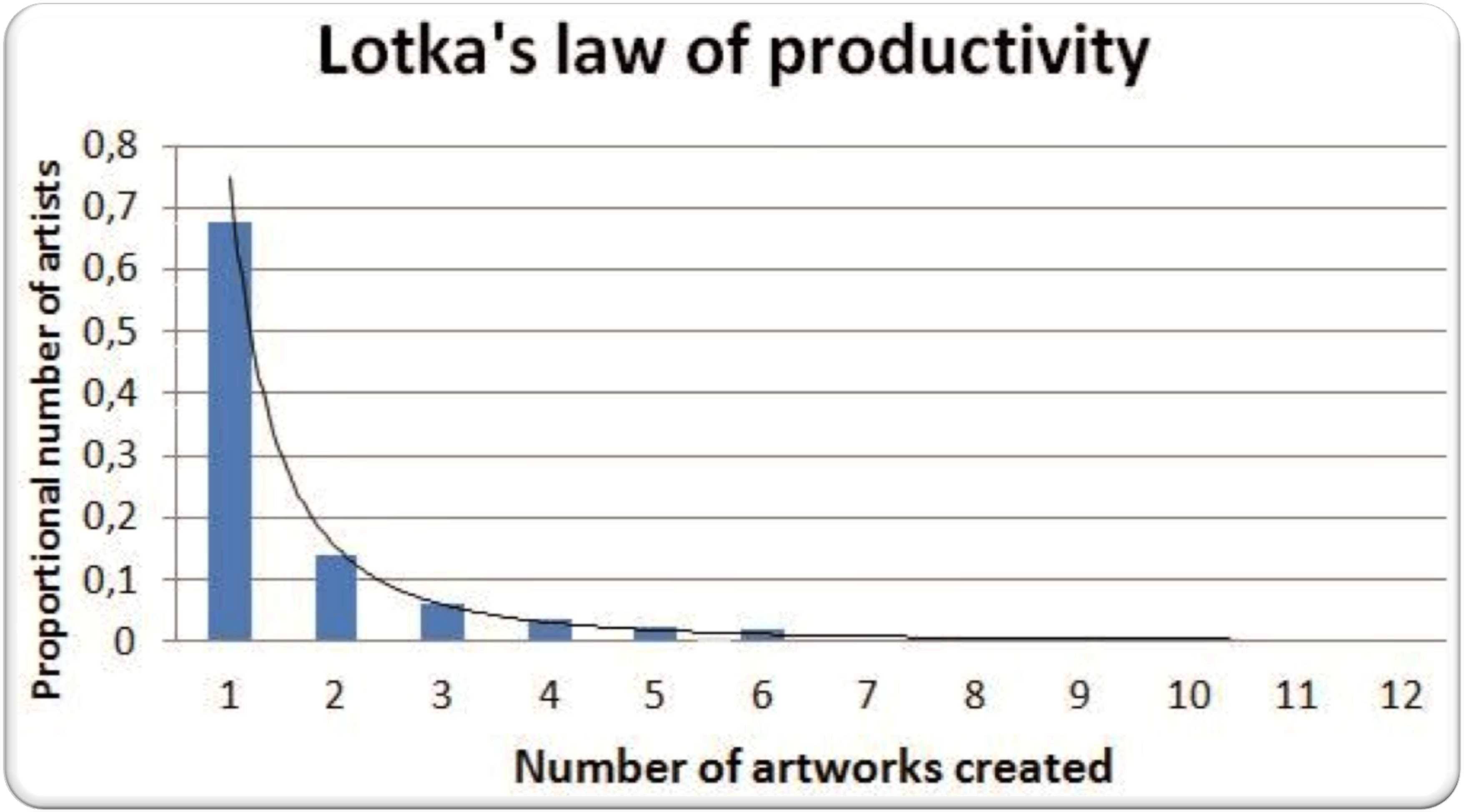
# Lotka’s Law package

Alon Friedman, PhD
School of Information
UNIVERSITY OF SOUTH FLORIDA

# A.J. Lotka



- The science of processing data for storage and retrieval, also known as informatics, investigates three components: the source of data, author productivity and word count.
- An important aspect for any academic or professional researcher is measuring the impact of their scientific productivity.
- In 1926, A. J. Lotka examined author publication productivity by looking at two conference proceedings in the fields of Chemistry and Physics.
- In his findings, he provided a predictable pattern for the the relative contributions of a body of authors to a body of literature.
- He reported that **60%** of authors make **a single contribution** during a given time period, 15% ( $1/2^2$ times .60) of the authors publish two articles, and 7% ($1/3^2$ times .60) of the authors publish three articles.
- That means only 6% of the authors in a subject field and at a given time, produce more than ten articles.



Lotka's law of productivity
Proportional number of artists
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1
2
3
4
5
6
7
8
9
10
11
12
Number of artworks created

# Lotka's Law

- Lotka's Law is based on the formula:
  $X^nY = C$

- X = the number of publications

  Y = the relative frequency of authors with X publications

  n and C are constant depending on the specific field ($n \approx 2$)

# Finding the values of n and C

- Exponent of n

The formula of estimation of the exponent n

$$n = \frac{N\sum XY - \sum X \sum Y}{N\sum X^2 - (\sum X)^2}$$

*N* = number of pairs of data

*X* = logarithm of x, i. e. number of publications

*Y* = logarithm of y, i. e. number of authors

# Finding the values of n and C

- The constant C

If we accept Lotka's conclusion that the proportion of all authors making a single contribution is about 60%, then the value of C can be computed by the simple formula $6/\pi^2$. However, if n equals 2, C is the inverse of the summation of the infinite series: the limit of each equals to $\pi^2/6$.

- The formula:

$$c = \frac{1}{\left[\sum_{1}^{p-1} \frac{1}{x^2} + \frac{1}{(n-1)(p^{n-1})} + \frac{1}{2p^n} + \frac{n}{24(p-1)^{n-1}}\right]}$$

# *Kolmogorov-Smirnov (K-S) test*

- Pao (1985) suggests the K-S test, a goodness-of-fit statistical test to assert that the observed author productivity distribution is not significantly different from a theoretical distribution:

$$D = \max \left| F_0(x) - S_n(x) \right|$$

$$F0(x) = \text{theoretical cumulative frequency}$$

$$S_n(x) = \text{observed cumulative frequency}$$

# The package

- The package holds 12 steps that allows us to calculate: C, N , K-S test and D valve (D = max/f0(x) - Sn (x)
- **Step # 1**

  CV <- function(Sums)
- **Step # 2**

  CVm <-

  function (value, Sums)
- **Step # 3**

  **LotkasC**

```
 <- function(N)
  {
    P <-20
    increm <- c(1:(P-1))
    sum <- sum(1/increm^N)
    part1 <- sum
    part2 <- 1/((N-1)*(P^(N-1)))
    part3 <- 1/(2*(P^N))
    part4 <- N/(24*(P-1)^(N+1))
    result <-(part1+part2+part3+part4)
    result <- 1/result
    return(result)
  }
```

- **Step 4**

  **LotkasN**

```
<- function(Sums,FullTable)
    {
      N <- nrow(FullTable)
      lx <- Sums[3]
      ly <- Sums[4]
      xy <- Sums[5]
      x2 <- Sums[6]
      lx2 <- lx^2
   top <- (N*xy) - (lx*ly)
   bottom <- (N*x2) - (lx2)
   Nfinal <- top/bottom
  return(Nfinal)
   }
```

# The package

- **Step 5**
  results <- function(KSTable)

```
{
  percent <- function(x, digits = 2, format = "f", ...) {
    paste0(formatC(100 * x, format = format, digits = digits, ...), "%")
  }
value1 <- KSTable[1:1,3:3]
  cat(KSTable[1:1,2:2], " Authors made ", percent(value1))
  cat("\n")
  value1 <- KSTable[2:2,3:3]
  cat(KSTable[2:2,2:2], " Authors made ", percent(value1))
  cat("\n")
  value1 <- KSTable[3:3,3:3]
  cat(KSTable[3:3,2:2], " Authors made ", percent(value1))
}
```

- **Step 6**
- **Step 7**
- **Step 8**
- **Step 9**
- **Step 10**
- **Step 11**
- **Step 12** Calculation of D value

```
LotkasXYfunction(Table){    value <- (Table[,3:3] * Table[,4:4])    return(value)}
```

# What’s Next?

- The ability to handle multiple data sources.
- The ability to isolate single author vs. co-authors.
- New adaptations to Lotka's law.

# Thank you

You can find the package at:
https://github.com/KCIV/LotkasLaw