Florence Nightingale: A role model in the XXIst century

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Seminar Series
Sociedad Española de Bioestadística

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Brief facts about Florence

- Nurse and statistician. **In the XIXst century?**

  Remarkable indeed for both professions

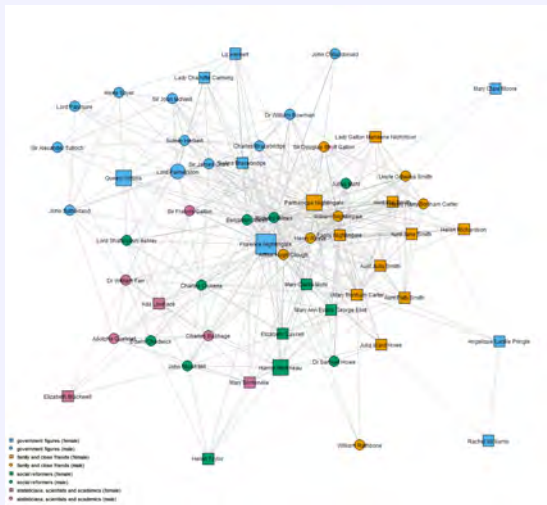- 1st female fellow of Royal Statistical Society elected in 1858

  ROYAL
  STATISTICAL
  SOCIETY

- Honorary member of American Statistical Association from 1874.

  ASA
  AMERICAN STATISTICAL
  ASSOCIATION

  WHATTTT? This was MORE than 150 years ago

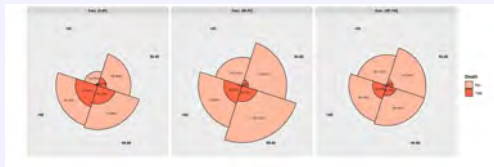# Florence built a very large social network

HOW??

Taking very good care of her relationships
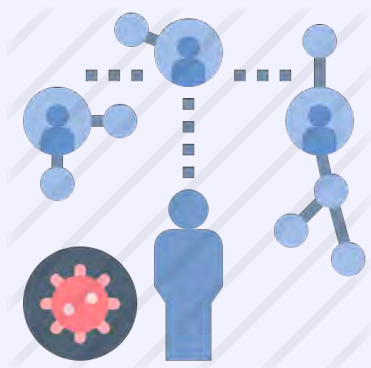
Keeping a very active and written communication

Courtesy of Altea Lorenzo-Arribas and Pilar Cacheiro. Map of FN social network. *Significance* 17 (2), 2020

Florence was a PIONEER

Pioneer of data visualization and communication.

Courtesy of Jordi Cortés

Pioneer in the organization of sanitary work
Forerunner of Epidemiological Surveillance

Public Health Prevention!!! So relevant then, still hugely relevant now in the COVID era

Florence Nightingale

No doubt she is TODAY a role model ... BUT
a REVOLUTIONARY role model

Florence Nightingale

No doubt she is TODAY a role model ... BUT a REVOLUTIONARY role model

FN promoted a revolutionary idea:
A social phenomenon can be objectively measured and mathematically analyzed

William Smith Thomson, maternal grandfather

- Sat in the House of Commons for 50 years
- Abolitionist of slavery
- Supporter of the French Revolution

Florence Nightingale in her historical context

Florence Nightingale (May 12, 1820- August 13, 1910)

- ◇ Born in Villa Colombaia, Florence (Italy)
- ◇ Parthenope: Her sister
- ◇ William and Fanny Nightingale: parents and free thinkers. Part of the intellectual avant garde. They endorsed:
  - Women's education
  - Public Health
  - Prison's reform
  - The abolition of slavery

Her education

MOTHER: Plan Parthe and Florence's education including sport, drawing, piano, .

TUTORS: Arithmetic, Botany, French,geography, ...

FATHER: Latin, Greek, philosophy and MATHS

Brilliant powers of exposure:She could write 6 pages about **how to make Tea !!!**

AUTODIDACT

James Joseph Sylvester (1814-1897): HER TUTOR

Statistics was in her DNA: At 9 years old she was already organizing in a tabular format the data from garden fruits and vegetables

Fights for the privilege to study Mathematics $\Longrightarrow$

Accomplished mathematician who made contributions in algebra. He invented terms such as matrix, graph and discriminant

Mary Somerville (1780-1872): HER INSPIRATION

◇ Mathematician and Astronomer
◇ Scientific Queen of XIXth century
◇ First female member of the *Royal Astronomical Society* (1835)

◇ Translates (1831) *Mécanique Céleste* of Laplace.
I translated Laplace's work from algebra into common language

◇ Florence and her cousin Henry study Somerville's books
  Like everything FN undertook, she was deep and worked hard

von Bunsen: HER HUMANISTIC INFLUENCE

◇ 1837: *Divine Call* while walking in Embley Park Park

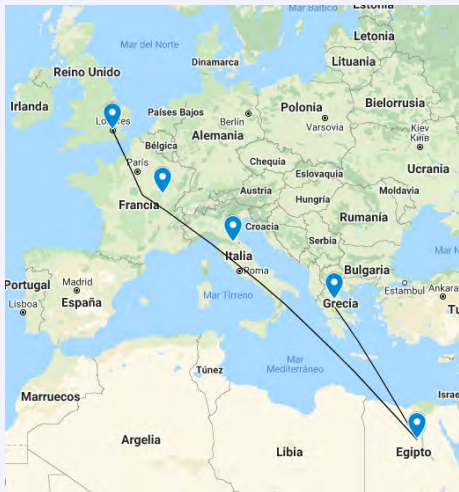◇ 1842: Florence meets Christian von Bunsen (1791-1860)
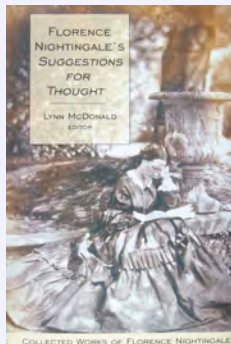
Diplomat. Leading scholar of religion and comparative philology

Suggestions for Thought **(1846-1860).** Her radical spiritual view

◇ Bunsen, through his humanitarian efforts, gave Florence a **meaningful role in life**

GREAT TRAVELLER: Rome Oct 1847- Ap 1848
Greece and Egypt Oct 1849- July 1850

Trips with Selina and Charles Bracebridge

Rome: Meets Sidney Herbert

Visits hospitals and health institutes

Learns about hospital management

Cares about social conditions

A FIGHTER!!! Fights for the rigth to be a nurse

25 years: Decides to be a nurse and to improve hospital sanitary conditions

XIXth **century!!!**: Nursing was an immoral profession

- 1850: Inst. St. Vincent of Paul (Alexandria, Egypt)
- 1850: Visit Pastor Theodor Fliedner's hospital in Kaiserwerth (Germany)
- 1851: *Kaiserswerther Diakonie Hospital*
- 1852: Hôpital Dieû, Paris
- Collects patient data and cares about the design of buildings and its ventilation

1853: Paris and London

Hôpital Lariboisière, Paris

She is impressed by its pavilions and its rooms designed to receive light and fresh air

Establishment for Gentlewomen during Temporary Illness

August 1853: Superintendent. Turns the house into a hospital. Plans everything: hot water, elevator, rings, cleaning.
Her reputation grows

Florence Nightingale

and

the Crimean War

Crimean War (Oct 1853-Feb 1856)

1854: Superintendent of the Female Nursing Establishment of the English General Hospitals in Turkey. Upon the request of Sidney Herbert, British Secretary of War

Nightingale and a team of 38 nurses to lead the Sanitary Reform at Barrack Hospital in Scutari (Constantinople)

✓**Alarming conditions:** Lack of medical supplies, scarce food, water, unwashed men,

✓Typhus, cholera, and dysentery: the top three causes of death
✓**War wounds: sixth reason for death**

Florence Nightingale Interventions in Crimea

✓Laundry
✓Kitchen
✓Triage: serves the most serious, not those of more range
✓24/7 surveillance system
✓Lessons on pathology for surgeons and laboratory in Scutari
✓Military medical education. Reading rooms

✓and meanwhile SHE DOCUMENTS EVERYTHING

✓She returns in 1856 in very fragile health

Florence Nightingale: A LEGEND

Her methods have been successful:

- 1st year: Mortality rate in hospital drops from 60% to 42.2%
- 2^{ond} year: drops to 2%

National Hero: Queen Victoria grants her the Cross of Saint George

and then, in 1856, their contributions to STATISTICS began

1857: Promotes a Royal Commission to investigate the work of the military hospitals during the war.

1860: *Nightingale Training School for Nurses* in London. 550 Nightingale nurses in 1887

# The Lady and the Lamp: Florence Nightingale's main lesson

"... that society has a collective responsability for the heath of all its members..."

Wood engraving, published 24 February 1855, at National Portrait Gallery, London

Nightingale's accomplishments

Rose Diagram

FIGURE 1 Florence Nightingale's polar area chart, "Diagram of the causes of mortality in the army in the East".
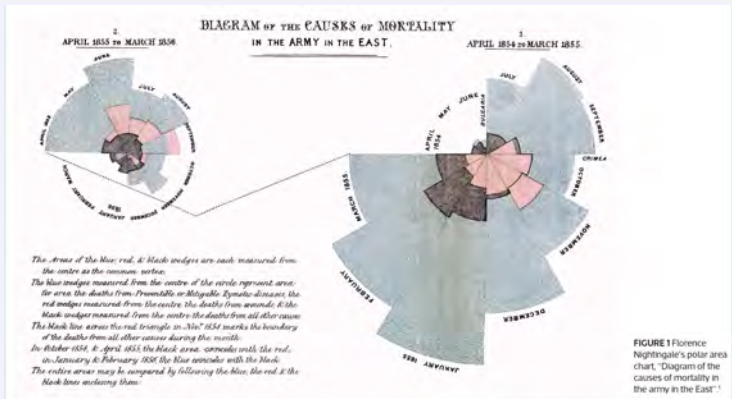
Designed by Nightingale and Farr, based on statistical plots by William Playfair (Scottish engineer, 1759-1823)

1858: *Notes on Matters Affecting the Health, Efficiency, and Hospital Administration of the British Army.*
1859: *A Contribution to the Sanitary History of the British Army During the Late War with Russia*

Improving Public Health on a large scale in India

1858: *Notes on Hospitals:* construction of hospitals and impact on the care of the sick

- Johns Hopkins in Baltimore
- Madras General Hospital

1858: Royal Commission. Standardized forms

- distribution of land ownership
- patterns of disease and malnutrition
- caste system and the position of women

1863: *How People May Live and Not Die in India* led to massive reforms in the Administration.

1873: Mortality among soldiers in India declined from 69 to 18 per 1,000

Hospital for Tropical Diseases in Ho Chi Minh City, Vietnam
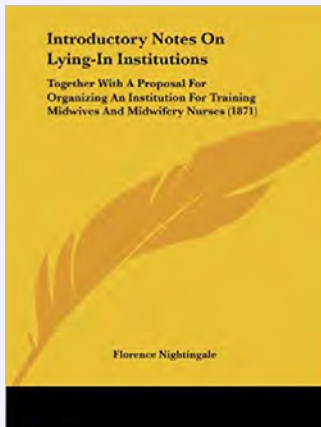
Epidemiological surveillance

1859: *Notes on Nursing* on ventilation, nutrition, patient comfort

1860: International Statistical Congress. Stand. statistical form

- nomenclature for diseases
- systematization of data collection: relative mortality, age-segmented study, frequency of occurrence

Forerunner of Epidemiological surveillance

Midwifery

Introductory Notes On Lying-In Institutions

Together With A Proposal For Organizing An Institution For Training Midwives And Midwifery Nurses (1871)

Florence Nightingale

1871: *Introductory Notes on Lying-in Institutions* on advice on obstetric care after analyzing mortality data during hospital deliveries.

Excess mortality rate: Incidence of puerperal fevers killed

- 33 women in 1,000 who gave birth in hospitals,
- 5 women in 1,000 who gave birth at home

"There should be no deaths in childbirth since it is not a DISEASE".

Established **NORMAL DEATH-RATE**

Dissapearance of Aborigens in Australia

Form of Return from England
by Miss Nightingale

1860: Mortality rates of indigenous children attending native colonial schools across the British Empire (joint collaboration with Sutherland, Farr, Chadwick and Grey).
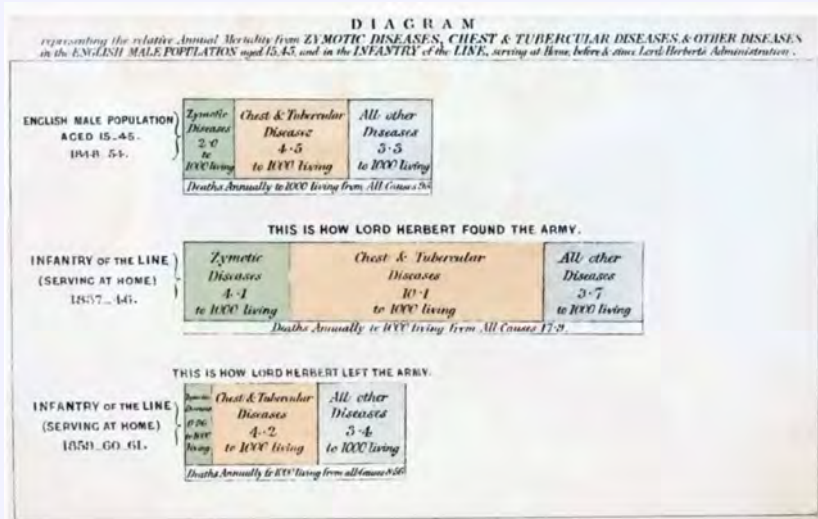
Questionniares were sent out.
She showed that **their death rates were twice what they should be**

Use social statistics to support that Aborigines would survive the admittedly risky process of civilisation

Tribute to Lord Herbert: her friend and supporter

1858: Comparative study between civilian and military mortality in times of peace

DIAGRAM

representing the relative Annual Mortality from ZYMOTIC DISEASES, CHEST & TUBERCULAR DISEASES & OTHER DISEASES in the ENGLISH MALE POPULATION aged 15..45, and in the INFANTRY of the LINE, serving at Home, before & since Lord Herbert's Administration.

ENGLISH MALE POPULATION AGED 15..45.
1848..54.

| Zymotic Diseases 2·0 to 1000 living | Chest & Tubercular Disease 4·5 to 1000 living | All other Diseases 3·5 to 1000 living |

Deaths Annually to 1000 living from All Causes 9·9

THIS IS HOW LORD HERBERT FOUND THE ARMY.

INFANTRY OF THE LINE (SERVING AT HOME) 1837..46.

| Zymotic Diseases 4·1 to 1000 living | Chest & Tubercular Diseases 10·1 to 1000 living | All other Diseases 3·7 to 1000 living |

Deaths Annually to 1000 living from All Causes 17·9

THIS IS HOW LORD HERBERT LEFT THE ARMY.

INFANTRY OF THE LINE (SERVING AT HOME) 1859..60..61.

| Zymotic Diseases 0·76 to 1000 living | Chest & Tubercular Diseases 4·2 to 1000 living | All other Diseases 3·4 to 1000 living |

Deaths Annually to 1000 living from all Causes 8·56

Applied Statistics: FN coined the name

## Statistics should be to legislator what the compass is to the navigator

She pleaded "for some teaching how to use statistics in order to legislate for and to administrate our national life with more precision and experience".

Pearson founded in 1911 the first department of Applied Statistics

Polar Area Diagram

or

The Rose of Nightingale

or

Coxcomb

Polar Area Diagram or Rose diagram or Coxcomb
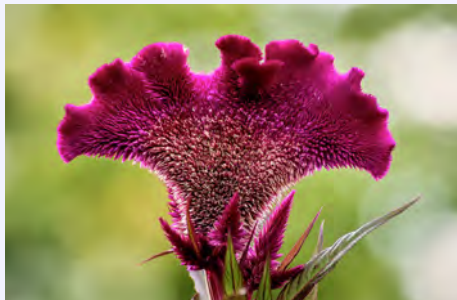
ETIMOLOGY: Middle English 1573

HER STATISTICAL TEACHERS AND COLLEAGUES

William Farr (1807-83)

✓Official Medical Statistcian
✓Fellow Royal Society (1855)
✓System for recording the causes of death
✓Organizes International Statistical Congress $\implies$ **FN meets Quételet**

Adolphe Quételet (1796-1874)

✓Founder of Social Statistics
✓Introduces *The Average Man*
✓'Father" of the BMI: Body Mass Index
✓Influencer of FN

Building a Coxcomb

We divide the circle into as many parts as necessary. Here 12
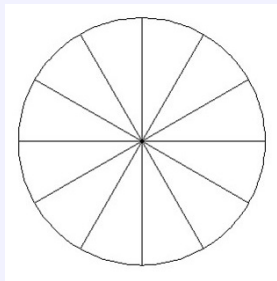
Area circle $= \pi r^2$

We draw in each portion the quantities that we want to represent proportionally to the area
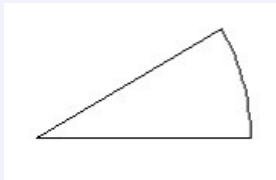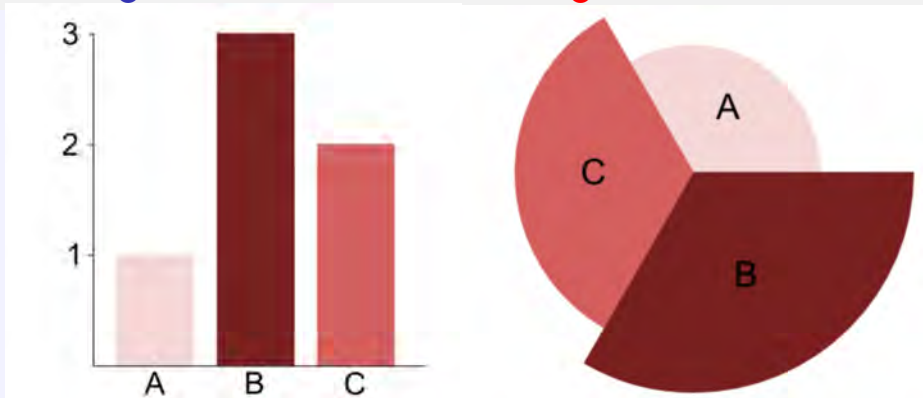

Area each sector $= \pi r^2/12$

Computing the radius

Areas: they must be proportional to the amount we want to represent

- Let's start from two categories A and B
- Quantities to represent in each category: n_A and n_B
- It must hold:

$$\frac{n_A}{n_B} = \frac{area\ sector\ A}{area\ sector\ B} = \frac{\pi r_A^2/12}{\pi r_B^2/12} = \frac{r_A^2}{r_B^2}$$

Building a Coxcomb with 3 categories

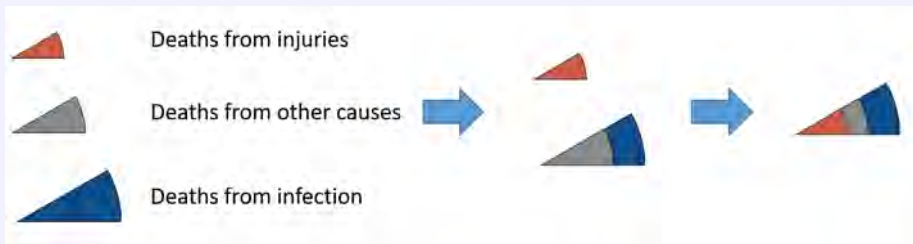- **Area:** $a_A = \pi r_A^2/3 = 1$, $a_B = \pi r_B^2/3 = 3$, $a_C = \pi r_C^2/3 = 2$.
- **Radius:** $r_A^2 = 3 * a_A/\pi = 3 * 1/\pi = 3/\pi$
  $$r_B^2 = 3 * a_B/\pi = 3 * 3/\pi = 9/\pi$$
  $$r_C^2 = 3 * a_C/\pi = 3 * 2/\pi = 6/\pi$$

Building Florence Nightingale's Coxcombs

We will use a color code

Amounts to represent each month m

- $S_m =$ Average number of soldiers at the front in month m

- $D_m =$ Total number of deaths in month m from infectious diseases, injuries or other causes

  1. $D_{m,I} =$ Number of deaths in month m due to infectious diseases

  2. $D_{m,H} =$ Number of deaths in month m from injuries

  3. $D_{m,OC} =$ Number of deaths in month m from other causes

$$D_m = D_{m,I} + D_{m,H} + D_{m,OC}$$

Monthly mortality per 1000 soldiers

- S_m = Average number of soldiers in month m

- $M_{m,T}$ = Total mortality in month m per 1000 soldiers

$$M_{m,T} = \frac{D_m}{S_m} \times 1000$$

1 $M_{m,I}$ =Mortality due to infections $M_{m,I} = \frac{D_{m,I}}{S_m} \times 1000$

2 $M_{m,H}$ = Mortality due to injuries $M_{m,H} = \frac{D_{m,H}}{S_m} \times 1000$

3 $M_{m,OC}$ = Mortality from OC $M_{m,OC} = \frac{D_{m,OC}}{S_m} \times 1000$

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UPC

Mortality in Jan. 1855 ($m = 10$) in the Crimean War

- Average number of soldier: $S_{10} = 32393$
- Total Number of Deaths: $D_{10} = 3168 = 2761 + 83 + 324$
- Deaths due to infections: $D_{10,I} = 2761 \Longrightarrow$

$$M_{10,I} = \frac{D_{10,I}}{S_{10}} \times 1000 = \frac{2761}{32393} \times 1000 = 85,23$$

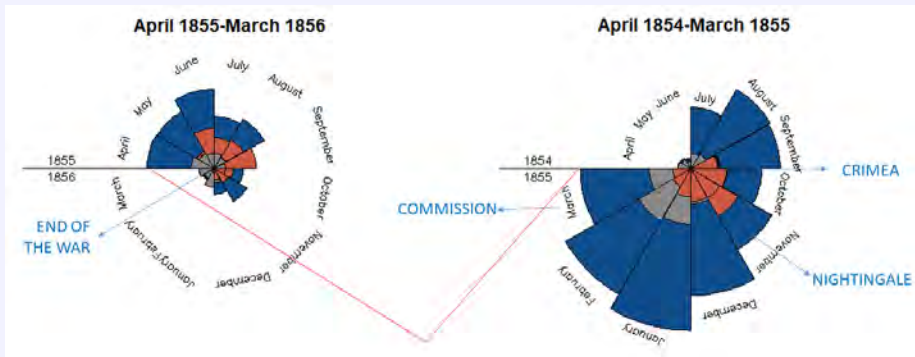- Deaths from injuries: $D_{10,H} = 83 \Longrightarrow$

$$M_{10,H} = \frac{D_{10,H}}{S_{10}} \times 1000 = \frac{83}{32393} \times 1000 = 2,56$$

- Deaths from other causes:: $D_{10,OC} = 324 \Longrightarrow$

$$M_{10,OC} = \frac{D_{10,OC}}{S_{10}} \times 1000 = \frac{324}{32393} \times 1000 = 10$$
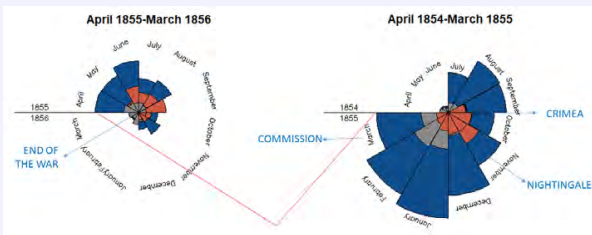
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Diagram of the Causes of Mortality in the Army of the East

The significance of the Sanitary Reform from a medical-statistical point of view

- **Rose diagram:** large open clinical trial, designed, conducted and analyzed by FN
- **Treatment studied:** Sanitary reform of the army hospitals

Bef. Sanitary reform (right):
239 per 1,000 per year

After Sanitary reform (left):
22 per 1,000 per year

Reduction of annual mortality: 91%

Florence Nightingale... her philosophy

◇ **A real statistical thinker**, loving reasoning and taking care of the logical process to reach conclusions. If you change the causes you get better results
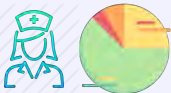
◇ Very critical

◇ Clear ideas. Practical, visionary but her feet on earth

◇ **Future progress is possible**. We have the power to continuously improve ourselves through observation and the use of reason.

◇ Always work with **TOP experts** of each field.

Florence Nightingale's final shots

✓**INTERDISCIPLINARY**: Nurse, statistician, writer
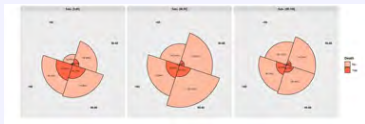

✓**INTERNATIONAL**

✓ **LARGE SOCIAL NETWORK**

✓**DISTINGUISHED MEMBER**
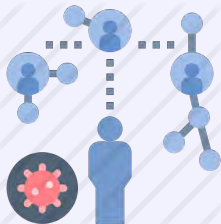
Florence Nightingale's main contributions

✓ **Innovative** in the collection, tabulation, interpretation and graphic representation
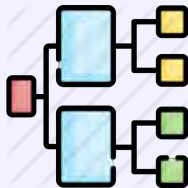

✓**Founder** of Modern Nursing
✓**Pionneer** in health management
✓**Forerunner** of Epidemiological Surveillance

✓**Statistical Thinking**
Showed how statistics provide an organizing framework for monitoring and learning, and can lead to relevant improvements
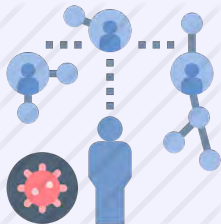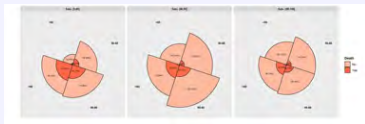
REVOLUTIONARY   ACTIVIST!!!!

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GRBIO

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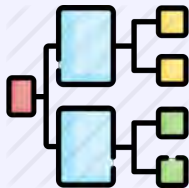

✓**Founder** of Modern Nursing
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REVOLUTIONARY   ACTIVIST!!!!

THE NEW FLORENCES

Amanda Gorman: American poet and activist against oppression, racism and marginalization (22 yo)

Marta Borrell: Spanish UN representative on educational inequalities (18 yo)

Greta Thunberg: Swedish Activist against climate change (18 yo)

THANKS A LOT–MUCHAS GRACIAS–MOLTES GRÀCIES–ESKERRIK ASKO–MOITAS GRAZAS

HAPPY International Year of Women in Statistics and Data Science

Readings

1. **Nightingale. A special issue**. Significance. April 2020. Vol 17, issue 2 (6 papers pages 16-37)

2. **Florence Nightingale. The woman and her legend.** Mark Bostridge, 2008

3. **The Statistical thinking and ideas of Florence Nightingale and Victorian politicians** by M. Eileen Magnello. Radical Statistics, Issue 102

4. **Speaking of Graphics. Chap 5. Florence Nightingale and Polar Area Diagrams.** Paul Lewi, 2006

5. **Florence Nightingale and her colleagues: using statistics to save lives**. Professor Lynn McDonald. Talk at RSS International conference (online Sep 8, 2020).