

An exploration of the life of Percy Ludgate

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Why is he important ?

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- 2nd person in history to design *general-purpose* computer
General-purpose computer == analytical machine & vice-versa
In theory can solve any solvable problem

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- Two *mechanical* designs before the electronic computer era:
 - 1843: Charles Babbage's analytical engine
 - 1909: Percy Ludgate's analytical machine – very different

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- Two *mechanical* designs before the electronic computer era:
1843: Charles Babbage's analytical engine
1909: Percy Ludgate's analytical machine – very different
- Subsequently:
c.1914: *Electromechanical* designs begun
c.1937: *Electronic* designs begun

Percy Ludgate: why is he important ?

- He was *Irish*
1883-1922: born, lived, died in Ireland

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1883-1922: born, lived, died in Ireland
- Worked in Dublin, published in Scientific Proc. Royal Dublin Society
1991: *Ludgate Prize* Computer Science at Trinity College Dublin
- He was born in Skibbereen
2016: *Ludgate Hub* opened in Skibbereen

Mysteries

Percy Ludgate: mysteries

- Percy Ludgate died young and single in 1922 aged 39
By 1987 there were *no other descendants* of his parents

So records are scant. Randell said:

“an archivist stated that by all normal criteria, it was clear that he had never existed”

Percy Ludgate: mysteries

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“an archivist stated that by all normal criteria, it was clear that he had never existed”

- Yet he did exist, with large number of *relatives and acquaintances*

First objective == related documents, photos, memories

Do they still exist ? If so, *where* ?

Percy Ludgate: mysteries

- His 1909 paper explains key principles of his machine, but said:
*“not possible in a short paper ... any detail as to the mechanism
... therefore, confine myself to a superficial description,
touching only points of particular interest or importance”*
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- In 1909 he said: *“many drawings of the machine and its parts”*
In 1914 he said: *“Complete descriptive drawings of the machine exist, as well as a description in manuscript”*

Ultimate objective == those drawings & manuscript

Do they still exist ? If so, where ?

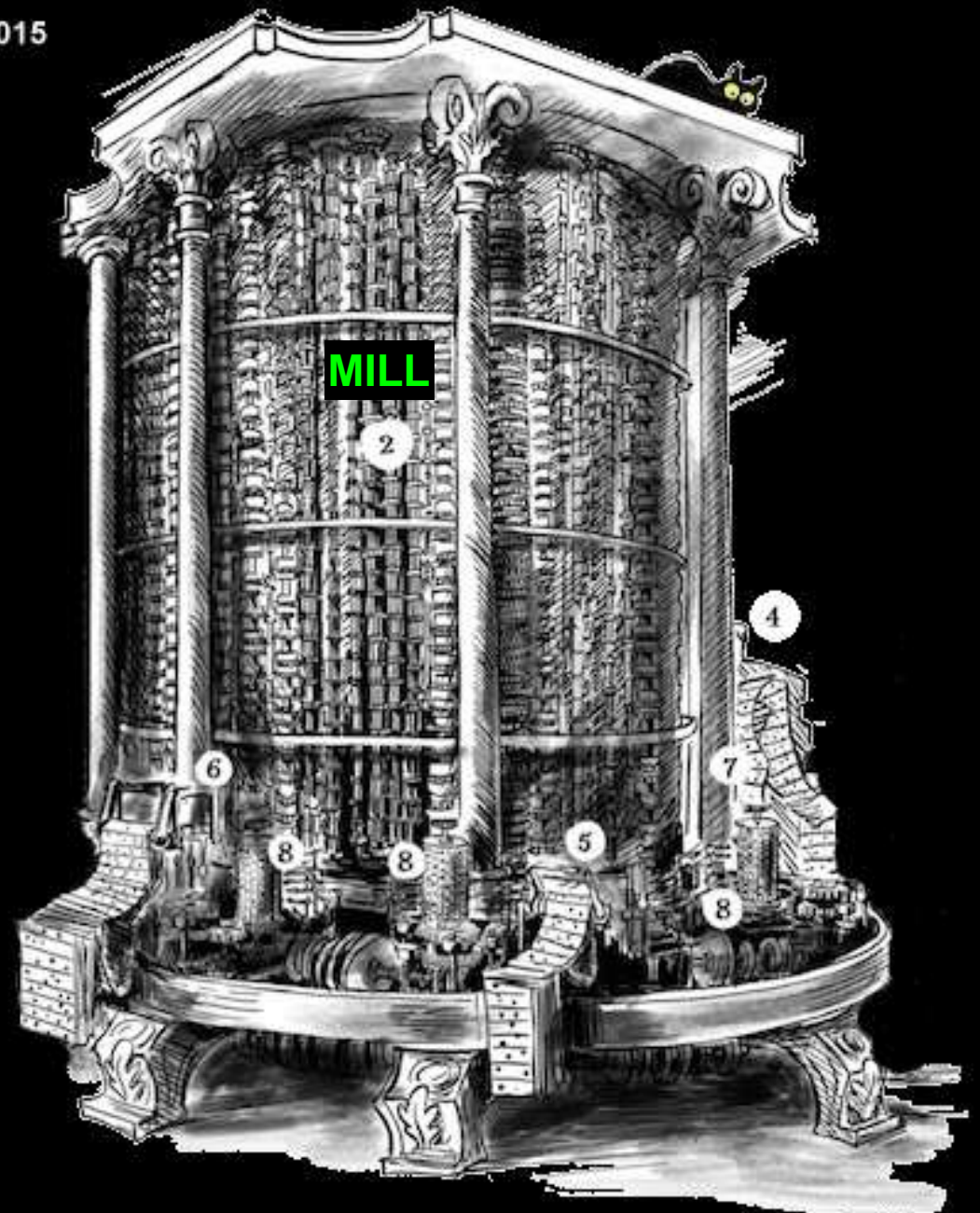
Babbage's Analytical Engine



THE LATE MR. BABBAGE.

The
**ANALYTICAL
ENGINE**
Plan 25.

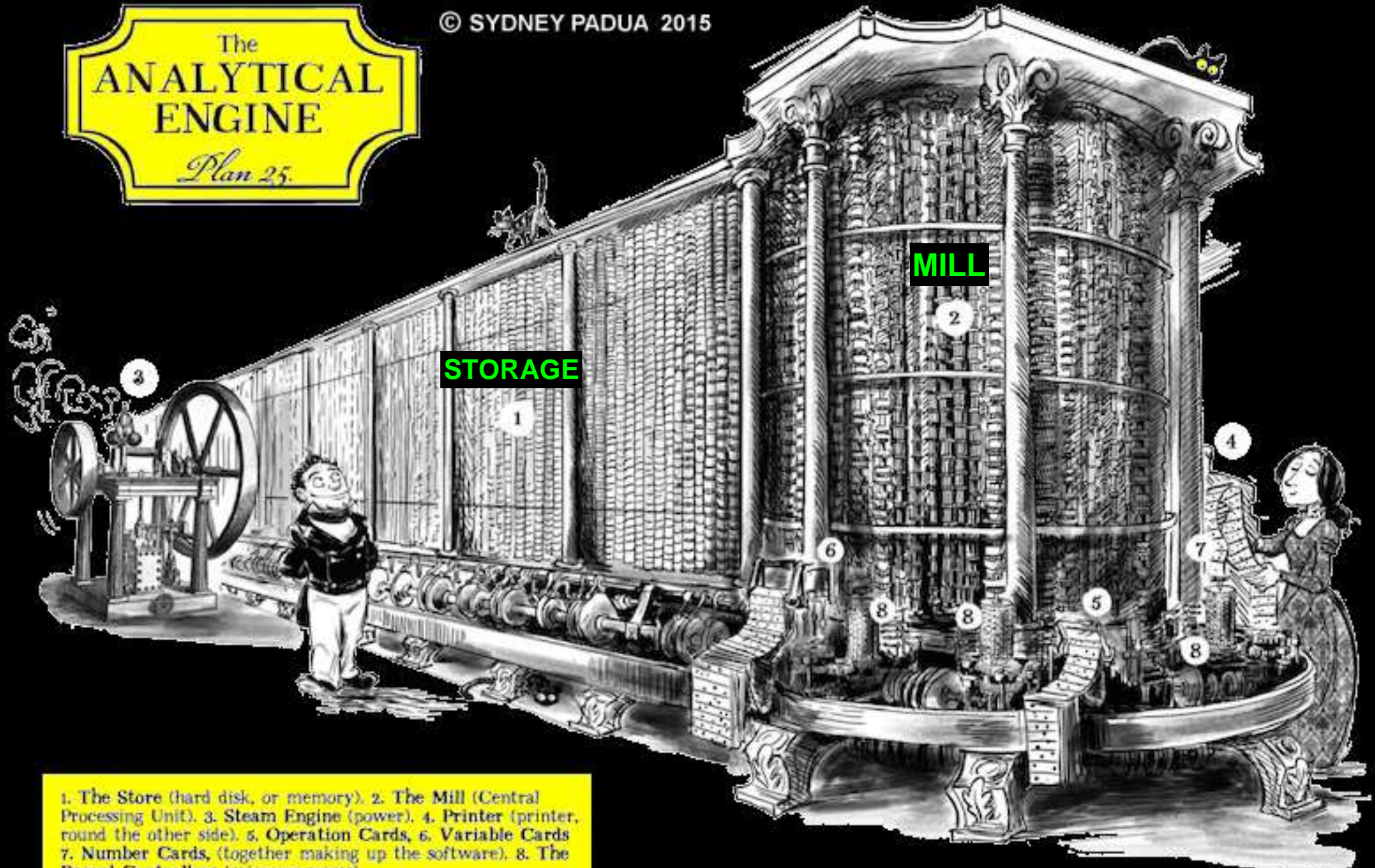
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1. The Store (hard disk, or memory). 2. The Mill (Central Processing Unit). 3. Steam Engine (power). 4. Printer (printer, round the other side). 5. Operation Cards, 6. Variable Cards 7. Number Cards, (together making up the software). 8. The Barrel Controllers (microprograms).

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Just about realizable at the time, and ***BIG***

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- Very novel concept at the time
Processing done in MILL based on addition
MILL + STORAGE via clockwork cogs & gears [*Liebniz c.1671*]
Programming + Input + Output via punched cards [*Jacquard 1801*]

Babbage's Analytical Engine:

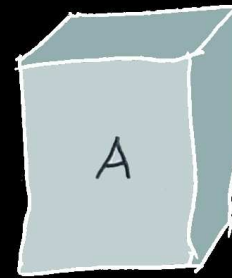
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MILL + STORAGE via clockwork cogs & gears [*Liebniz c.1671*]
Programming + Input + Output via punched cards [*Jacquard 1801*]
- Never built, but Babbage left extensive drawings
These are now being put into modern engineering software

So perhaps it will yet be built

Ludgate's Analytical Machine

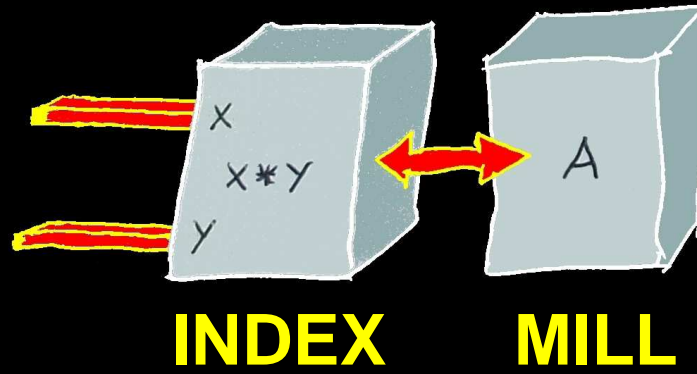


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Univ. Newcastle, UK
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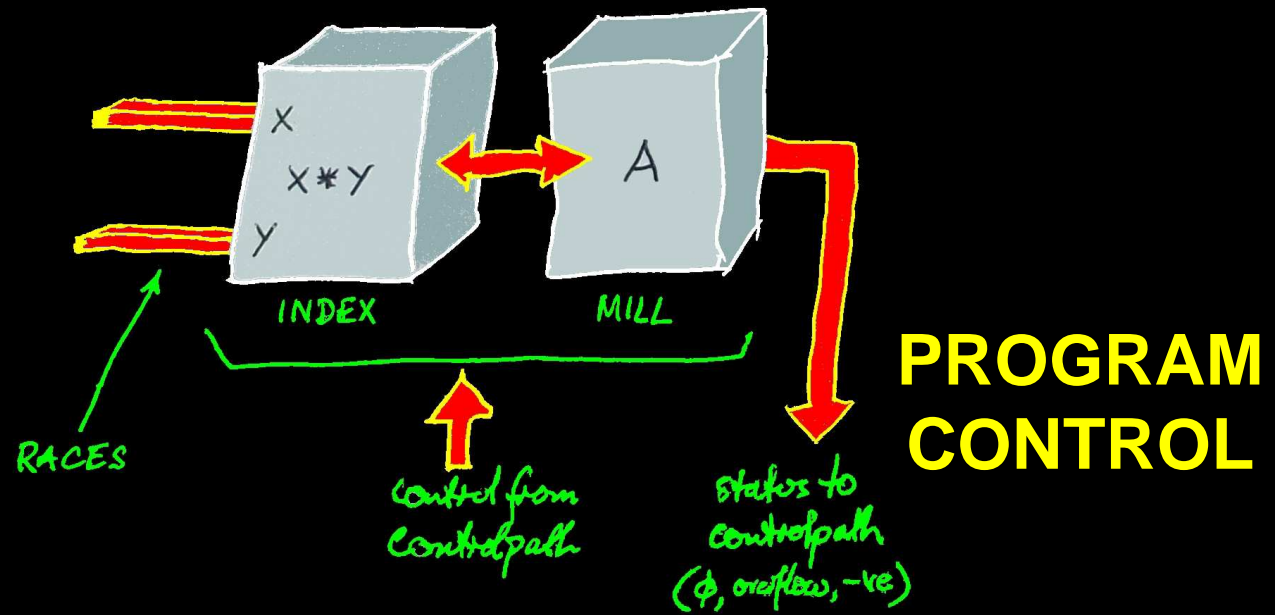


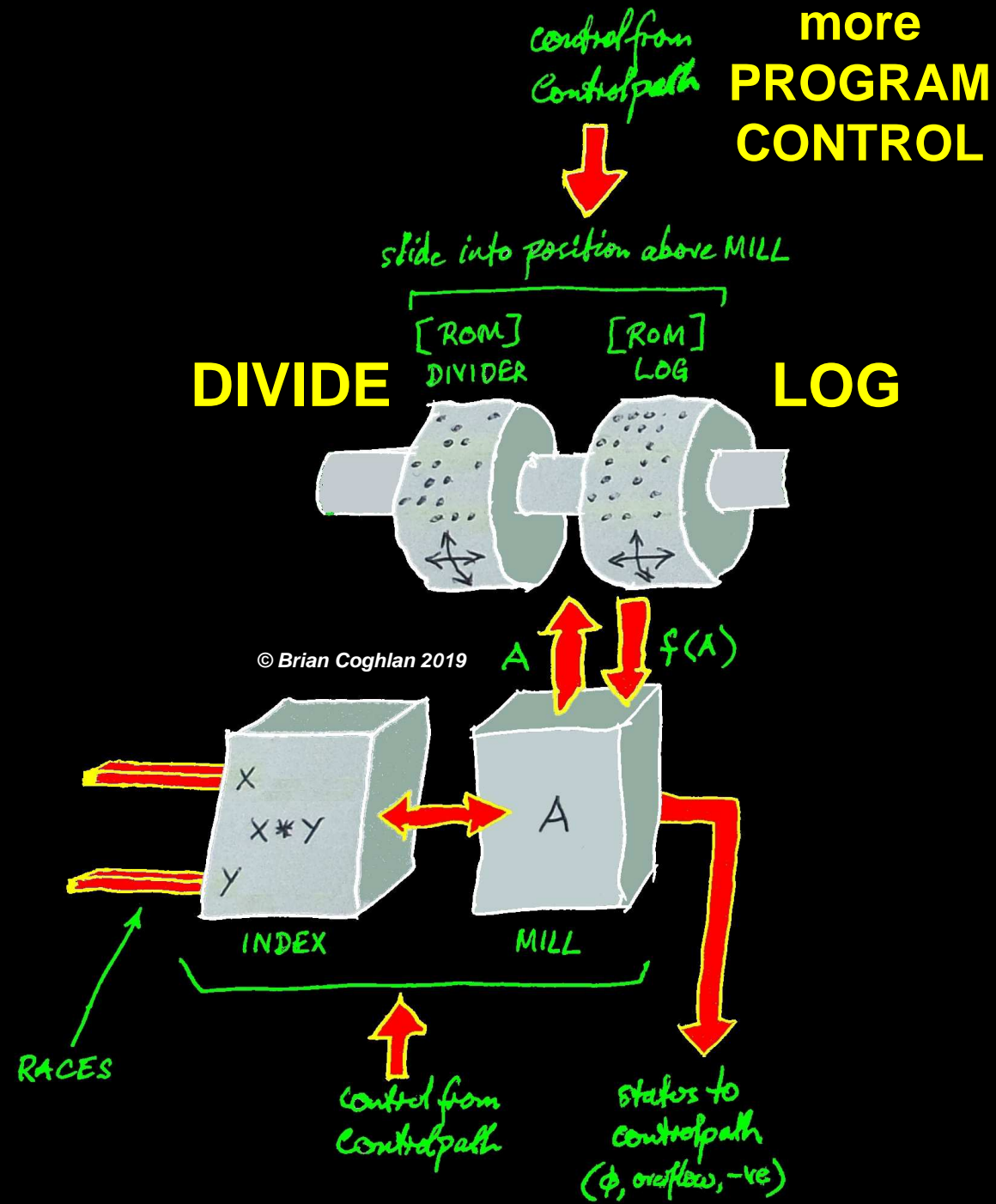
MILL

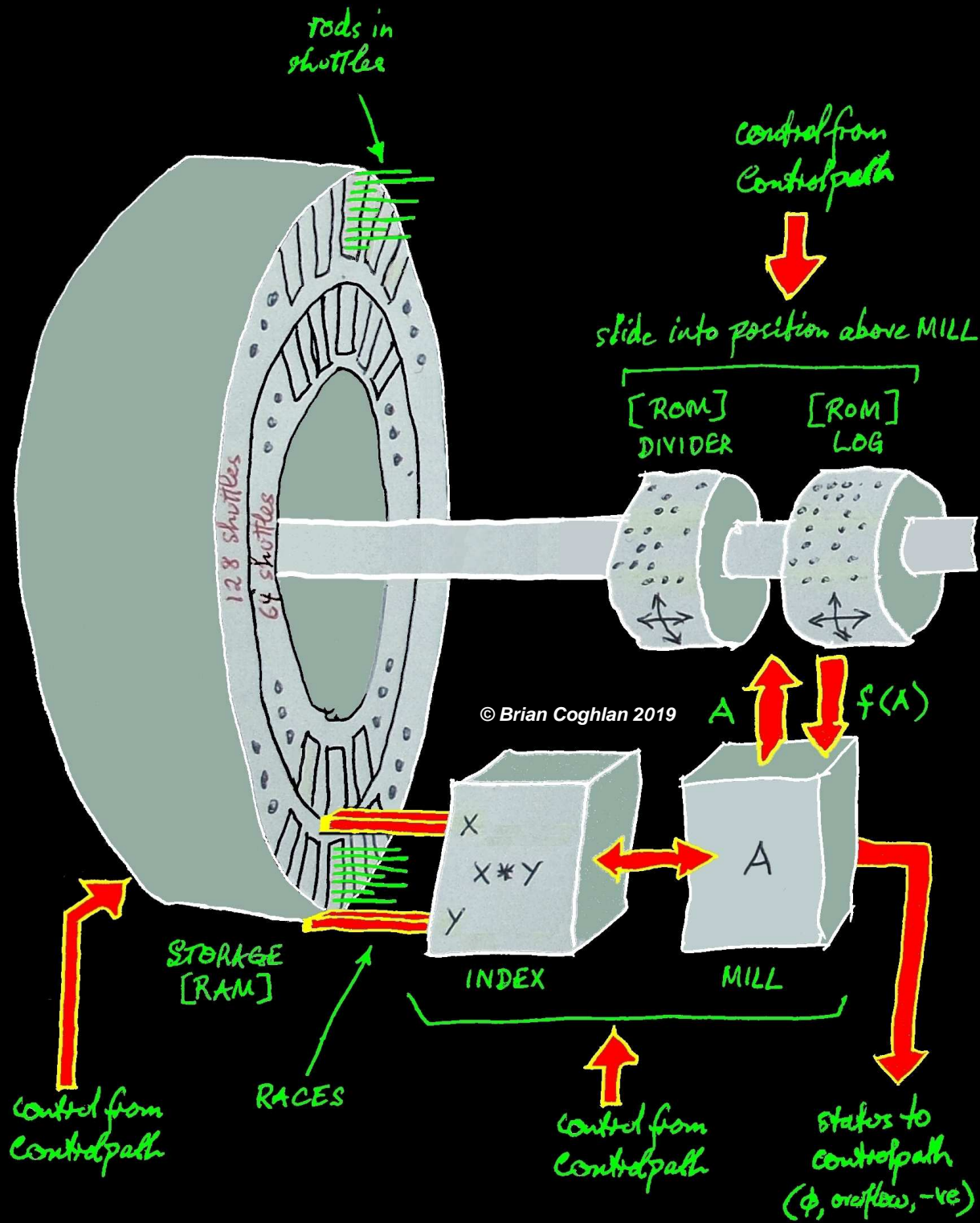
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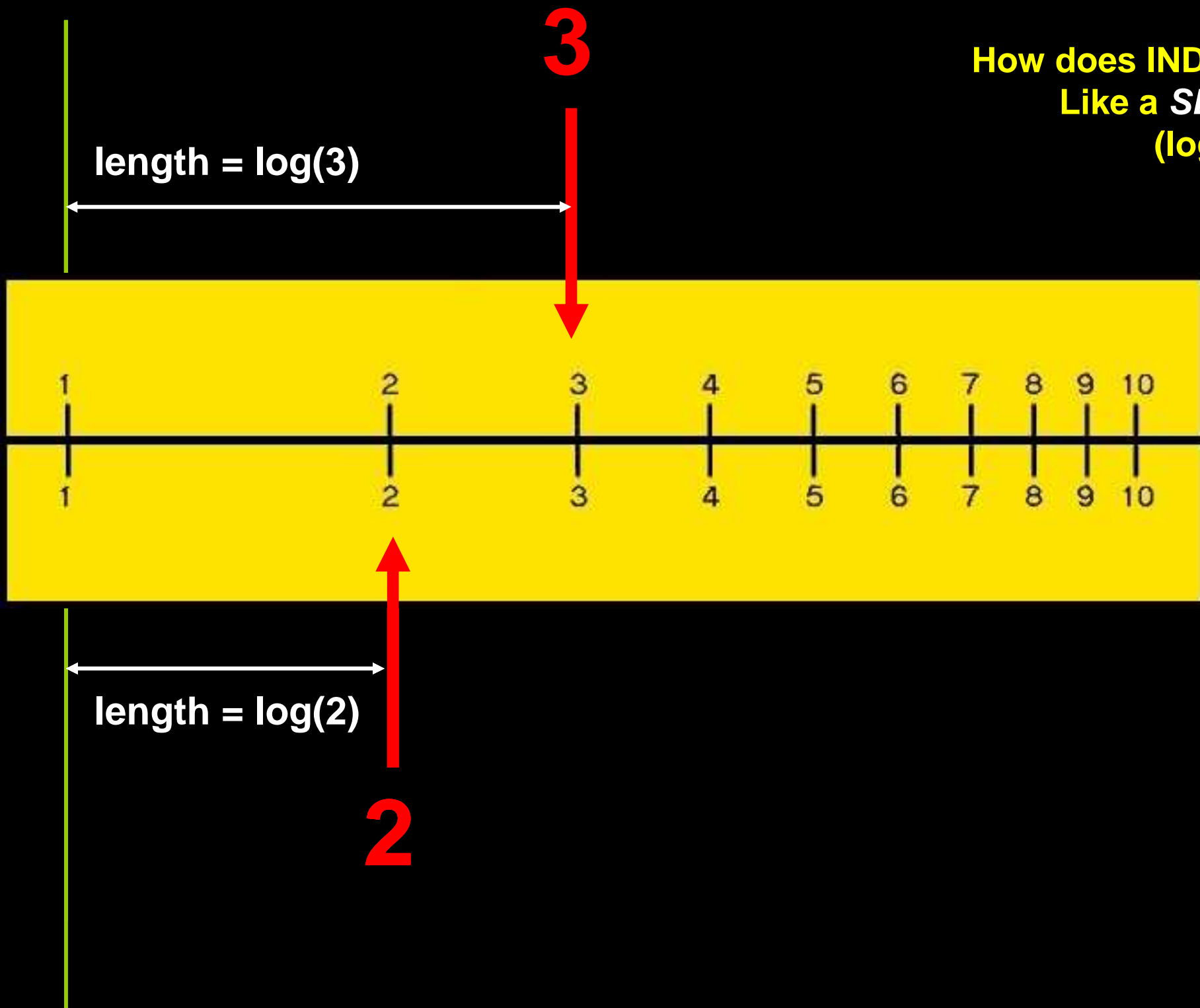
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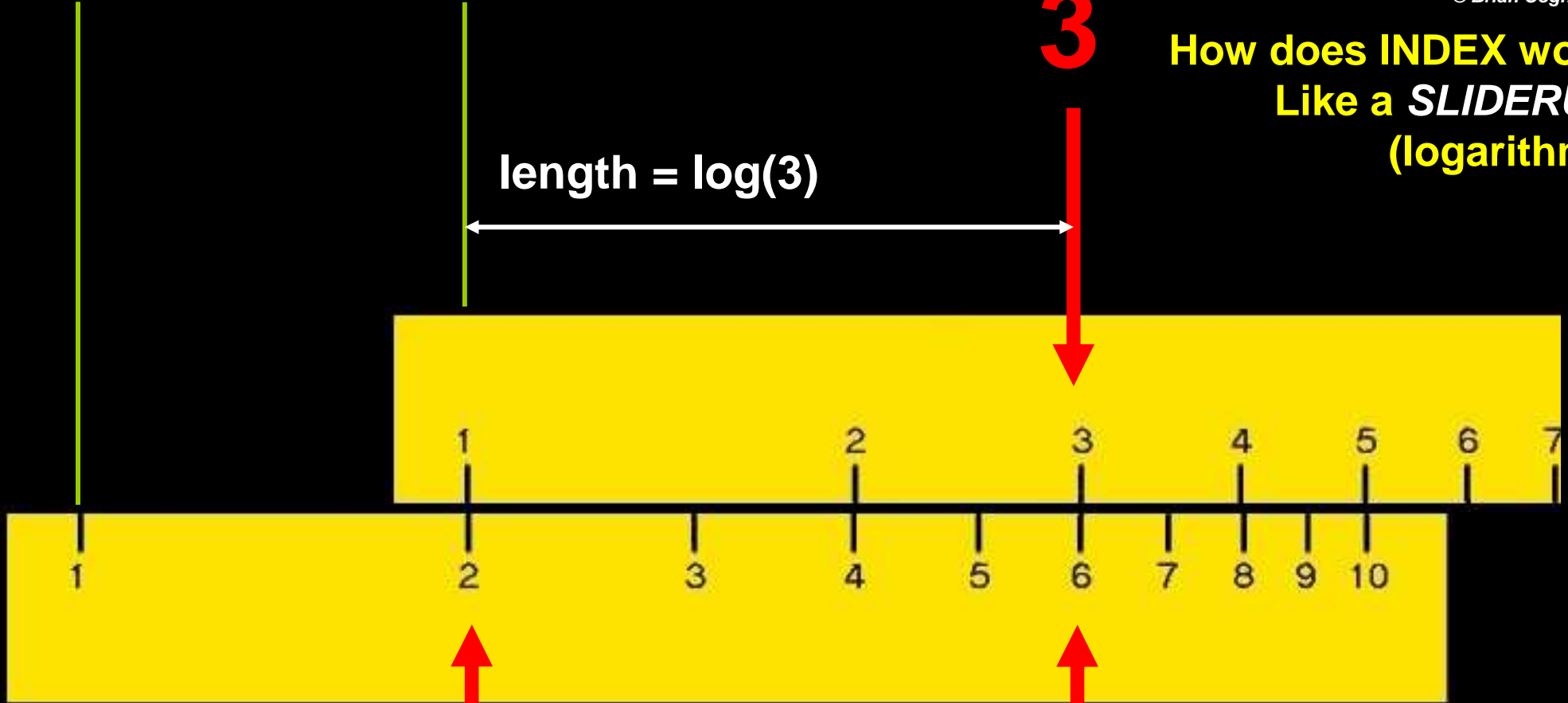
How does INDEX work?
Like a *SLIDERULE*
(logarithmic)



How does INDEX work?
Like a *SLIDERULE*
(logarithmic)

3

length = $\log(3)$



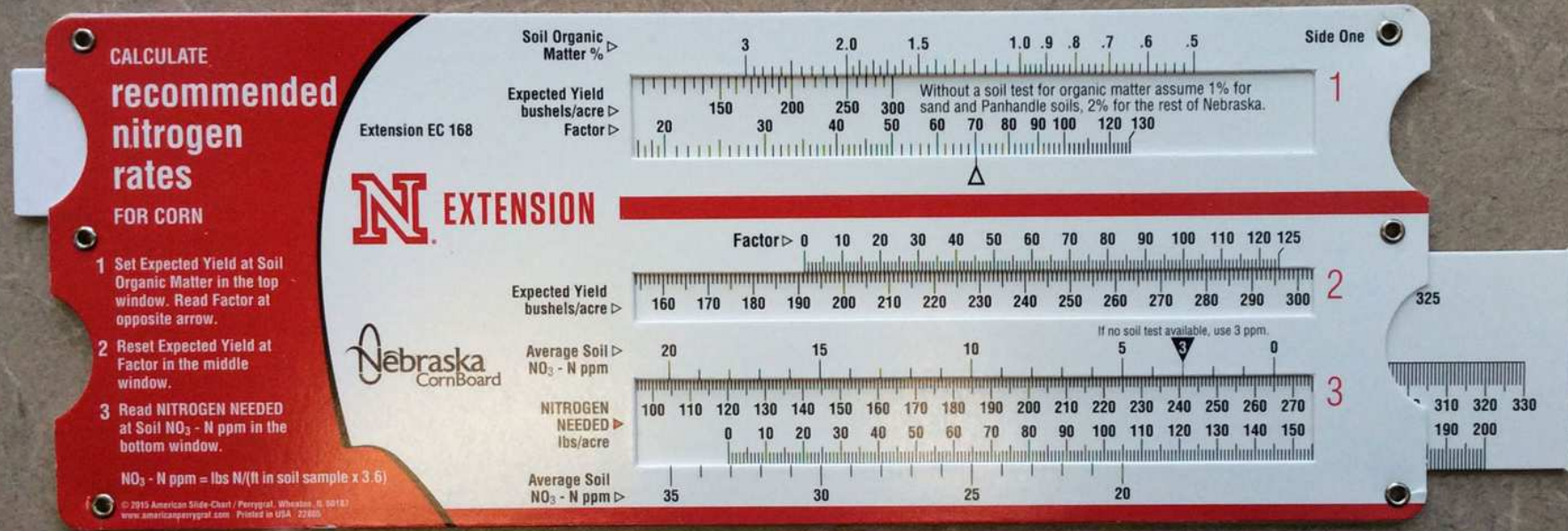
length = $\log(2)$

2

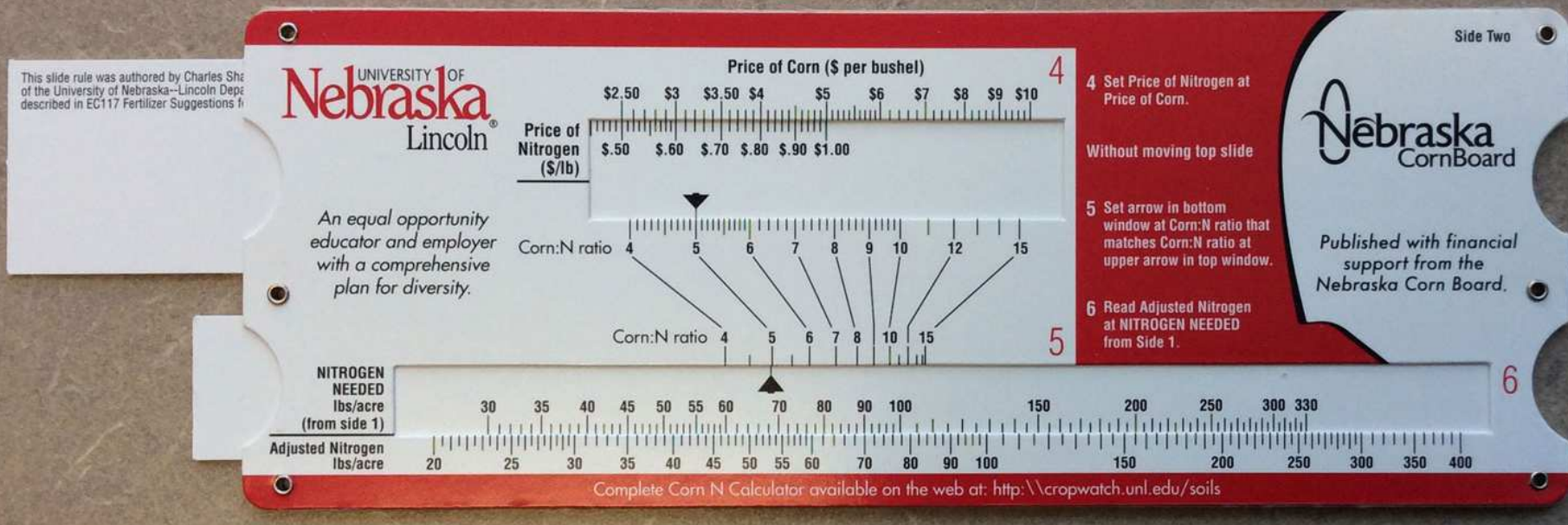
2 x 3 = 6

length = $\log(2) + \log(3) = \log(6)$





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Ludgate's Analytical Machine:

- Entirely mechanical, realizable with technology of time, ***SMALL***

Ludgate's design was ***VERY*** different to Babbage's

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- MILL to add like Babbage [*Liebniz c.1671*]
INDEX to multiply via *Irish Logs* [*Ludgate 1909*]
STORAGE via *rods & shuttles* [*Ludgate 1909*]
Programming + Input + Output via punched paper [*Jacquard 1801*]

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- Never built, Ludgate's drawings never found
We are trying to "re-imagine" his design

Difficult to say if it can ever be built

Ludgate's Analytical Machine: features

- Only a few features are stated in Ludgate's 1909 paper
The rest (¥) must be deduced by contextual analysis of the paper

- Base operation is multiply not addition
- Multiply is done with Irish Logarithms by INDEX
- Long multiply starts at left digit of multiplier
- Numbers must be fixed-point ¥
- Multiply result accumulation units first, then tens by MILL
- Timing implies pipelining tens carryadds with following multiplies ¥
- Instruction set: ADD, SUB, MUL, DIV, LOG, STO, BN, BZ, BV, NOP ¥
- Two-operand addressing for load
- Two-operand addressing for store ¥
- Fast for 1909: add/sub 3 sec, mul 20sec, div 90sec
- Storage of 192 variables implies (64 inner + 128 outer) shuttles equi-spaced ¥
- Hence storage size implies binary storage addressing ¥
- Numbers stored via rod for sign & every digit protruding 1-10 units
- Data input/output via punched number-paper (or upper keyboard)
- Program input/output punched formulae-paper (or lower keyboard), one instruction per row
- Manual preemption ¥
- Small size: 0.5m H x 0.7m L x 0.6m W

Ludgate's Analytical Machine: unknowns

- Almost everything on construction is unknown

- How numbers were stored on rods (digits or ordinals)
- How storage cylinders were rotated to select a shuttle
- How a shuttle was moved to the processing unit
- Exactly how the INDEX logarithmic mechanism worked
- Exactly how the MILL add/sub mechanism worked
- Where fixed-point decimal point was
- How pipelining carryadds was done
- Exactly how the result was written back to a shuttle
- Whether divide/log cylinders interfaced with INDEX or MILL
- The timing of substeps in executing instructions
- How many number-paper rows per variable
- Almost everything about program control (*controlpath*)
- Almost everything else about input & output
- The shape and size of anything
- And most other details ...

Historical perspective

Ludgate's Analytical Machine: perspective

- **X** == no influence on modern computers
Perhaps yet to be felt, in radically different computers (Nano ...)

X	(a) Mechanical not electronic:- very different design concerns
X	(b) Programming, processing, storage, input/output:- just like modern computers? BUT modern architecture was from 1946 report by John von Neuman
?	(c) Babbage basis was addition (as in modern computers)
X	(d) Ludgate basis was multiplication via logarithms
X	(e) Babbage called his processing unit a MILL (as in Victorian factories) This term was inherited by influential 1960s Manchester computers BUT the modern term is Arithmetic/Logic Unit (ALU)
X	(f) Ludgate included a MILL, but no obvious influence from Babbage
X	(g) Ludgate program control, subroutines, preemption like modern computer BUT did not influence those
X	(h) Ludgate input/output via punched paper rolls & keyboards Punched tape & keyboards used in modern computers to mid-1980s BUT influenced by telegraph not Ludgate

Ludgate's Analytical Machine: perspective

- Historically, there are four *Fathers of Computing*:
 - 1843: Charles Babbage, analytical engine
 - 1854: George Boole, logic [UCC]
 - 1936: Alan Turing, theory of computing
 - 1937: Claude Shannon, digital logic
 - 1948: Claude Shannon, information theory

Ludgate's Analytical Machine: perspective

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 - 1948: Claude Shannon, information theory
- Boole, Turing & Shannon impact all aspects of modern society
Babbage does not
 - ... BUT is *very notable for 1st analytical machine in history*
His importance is historical
 - He raised idea of *thinking machines* (controversial, like AI today)

Ludgate's Analytical Machine: perspective

- Historically, there are four *Types of Analytical Machines*:
 - 1843: Babbage (*mechanical, novel*)
 - 1909: Ludgate (*mechanical, very different*)
 - 1920: Torres y Quevedo & successors (*electromechanical*)
 - 1949: 6 x 1st modern computers & successors (*fully electronic*)

Ludgate's Analytical Machine: perspective

- Historically, there are four *Types of Analytical Machines*:
 - 1843: Babbage (*mechanical, novel*)
 - 1909: Ludgate (*mechanical, very different*)
 - 1920: Torres y Quevedo & successors (*electromechanical*)
 - 1949: 6 x 1st modern computers & successors (*fully electronic*)

- Ludgate is *notable for 2nd analytical machine in history*
 - AND: *Irish Logarithmic indexes*
 - AND: *1st multiply-accumulator (MAC) in a computer*
 - AND: *1st division by convergent series in a computer*
 - AND: *very novel concepts for storage & programming*

Like Babbage, his importance is historical

Ludgate's Life

childhood

Ludgate's Life: childhood

- 2-Aug-1883: born in Townshend St, Skibbereen
Father: Michael Edward Ludgate, Kilshannig, Mallow, ex soldier
Mother: Mary Ann Ludgate née McMahon, Iden, Sussex
1883-89: Gap of 7 years – *where were they ?*



© The Skibbereen Eagle

Ludgate's Life: childhood

- Thom's Directory for 28 Foster Terrace, Dublin (no longer exists)
1890: Ludgate, Michael Edward, teacher of shorthand
1891: Ludgate, Michael Edward, Fred, Augusta, teacher ...
1892-98: Ludgate, Michael Edward, sons & daugh, teachers ...

24 Foster Terrace
(**NOT** no.28)



24 Foster Terrace, Dublin
© Google Streetview 2019

Ludgate's Life: childhood

- Percy's schooling:
 - 1890-91: St. George's Infants School (age 7-8)
 - 1892-95: said to be North Strand National School (age 8-12)

© Science Museum London
St. George's Church from Hardwicke Street 1843



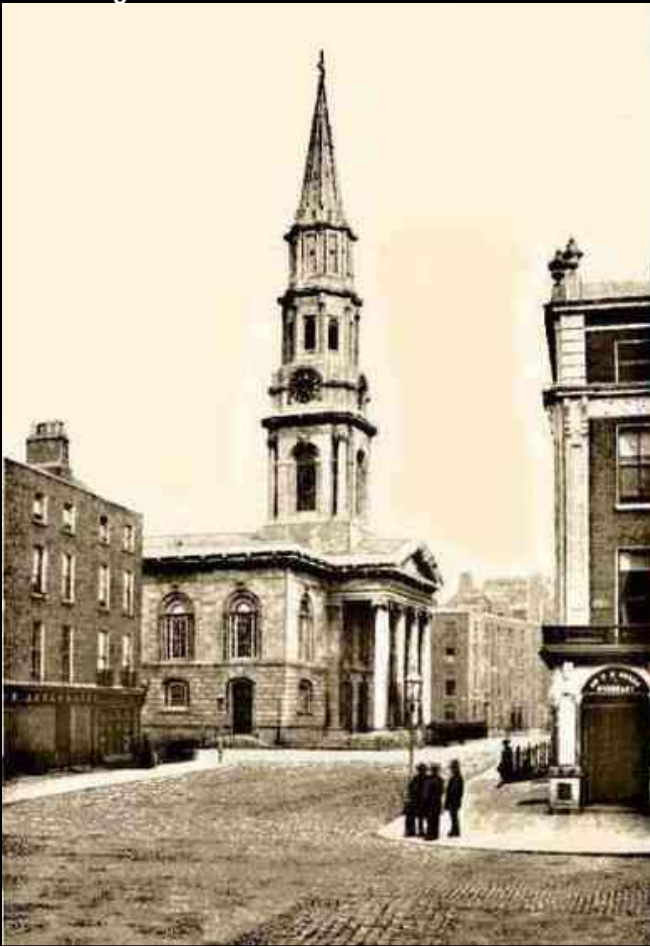
© Google Streetview 2019
St. Columba's Infant National Schools, North Strand, Dublin



Ludgate's Life: childhood

- Family were Episcopalian (branch of Anglican Church)
Attended St. George's Church, Temple Street, Dublin

© National Library Ireland
St. George's Church from Dorset Street 1890



© National Library of Ireland
St. George's Church from Hardwicke Street 1912



adolescence

Ludgate's Life: adolescence

- Percy's schooling:
1896-98: secondary school (must have excelled) – *where ?*

Ludgate's Life: adolescence

- 1898: London Gazette: Percy appointed "Boy Copyist" age 15
- 1899: Ludgate family moved to *30 Dargle Rd, Drumcondra, Dublin*
father Michael in Kilmainham Prison (non-payment of debt)
- 1900: brother Frederick married Alice Walshe



30 Dargle Road,
Drumcondra, Dublin
© Brian Coghlan 2017

Ludgate's Life: adolescence

- 1898: London Gazette: Percy appointed "Boy Copyist" age 15
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- 1901 Census:
 - Frederick & Alice moved to 24 Dargle Rd
 - father Michael in Balbriggan (28kms from family)
 - Percy as Civil Servant National Education Office (Boy Copyist)

Ludgate's Life: adolescence

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- 1901 Census:
Frederick & Alice moved to 24 Dargle Rd
father Michael in Balbriggan (28kms from family)
Percy as Civil Servant National Education Office (Boy Copyist)
- Mar-1903: top Irish candidate in exam for Assistant Clerks
MUST have excelled at Classics & Maths at school – *where ?*
Passed medical
Was not appointed to a position (others were) – *why ?*
- Aug-1903: Boy Copyist post expired (at age 20)

Ludgate's Life: adolescence

- 1903: started work on Analytical Machine
1909 paper (submitted Dec-1908): “six years’ work”
Private hobby: “work nightly, until small hours of the morning”

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BUT failed medical

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- Oct-1904: passed exam for Clerkships 2nd Division of Civil Service
BUT failed medical
- Feb-1905: “Case of Mr. Percy Ludgate – Irish Civil Service”
in House of Commons
by Timothy Harrington MP (owned *United Ireland & Kerry Sentinel*)
Negative response → end of Civil Service career (at age 21)

adulthood

Ludgate's Life: adulthood

- From 1903 (age 20) what did he do ?
1911 Census: Percy as Commercial Clerk (Corn Merchant)
Question: *when did this begin ? (1903 ...)*
Corn & Potato Factors were mostly in old buildings near Smithfield



Little Britain Street 1913
© Dublin City Council

Ludgate's Life: adulthood

- Dec-1908: submitted paper to RDS
- Apr-1909: "*On a Proposed Analytical Machine*" in *Sci.Proc.RDS*
- Jul-1909: review of paper by Prof.C.V.Boys published in *Nature*

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Jul-1909: review of paper by Prof.C.V.Boys published in *Nature*
- 1914: *"Automatic Calculating Machines"*
Edinburgh 24-27th July (*WW1 started 28th July*)
focussed on Babbage
Mentioned Ludgate's 1909 design, and his difference engine design

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- 1914-18: War Office committee (production/sale of oats for cavalry)
led by T.Condren-Flinn, Kevans & Son accountants
Planning/organisation on vast scale, *Ludgate greatly praised*

mature student

Ludgate's Life: mature student

- 1914-17: studied accountancy at Rathmines College of Commerce

Rathmines College of Commerce (NOW)



Rathmines College of Commerce,
Rathmines, Dublin
© Rathmines College of Commerce

Ludgate's Life: mature student

- 1914-17: homeward bound

Rathmines College of Commerce (THEN)



U. S. Series 138/4.

Rathmines, Dublin

Rathmines Road Lower
Rathmines, Dublin
© Dublin City Council

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Patrick Street

© National Library of Ireland
Patrick Street 1898



Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Christchurch



Christchurch, Dublin, c.1900
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Dame Street



Dame Street c.1900
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: O'Connell Bridge



Sackville Street, Dublin, c.1900
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Sackville Street



General Post Office, Dublin
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Rotunda Room



Rotunda Room, Dublin
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

Enroute: Dorset Street



Dorset Street, Dublin
© National Library Ireland

Ludgate's Life: mature student

- 1914-17: homeward bound

HOME: 30 Dargle Road



30 Dargle Road,
Drumcondra, Dublin
© Brian Coghlan 2017

Ludgate's Life: mature student

- Also he would have seen Easter 1916 ...

Enroute: O'Connell Bridge and Eden Quay



O'Connell Bridge, Dublin
© National Library Ireland

Ludgate's Life: mature student

- Also he would have seen Easter 1916 ...

Enroute: General Post Office and Sackville Street looking north



General Post Office, Dublin
© National Library Ireland

Ludgate's Life: mature student

- Also he would have seen Easter 1916 ...

Enroute: Metropole Theatre and Sackville Street looking south

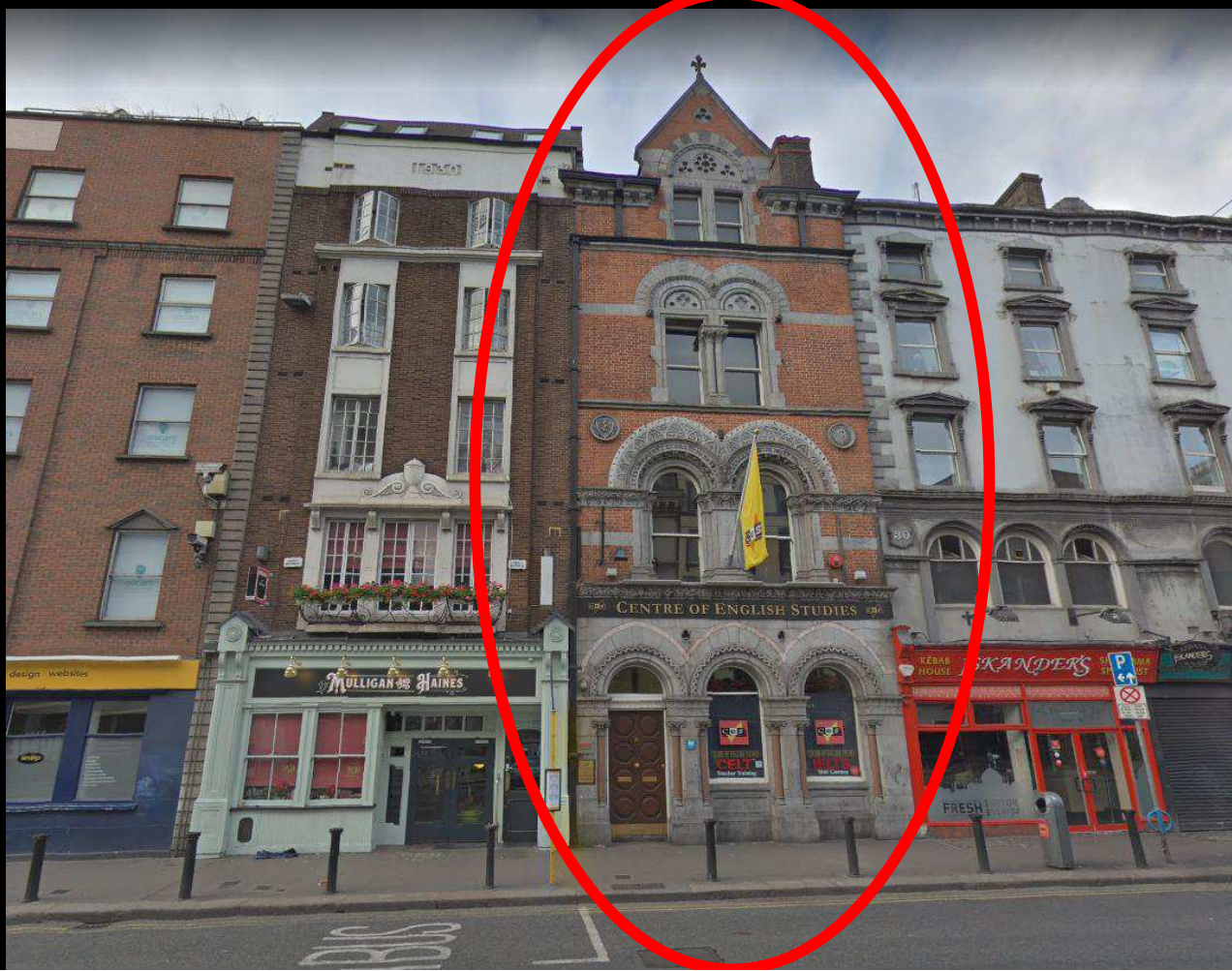


Sackville Street, Dublin
© National Library Ireland

maturity

Ludgate's Life: maturity

- 1917: honours in *Accountancy* (gold medal)
- 19xx-1922: accountant. **Kevans & Son**: “possessed characteristics one usually associates with genius, ... he was so regarded by his colleagues on the staff ... humble, courteous, patient and popular”



31 Dame Street, Dublin
© Google Street View 2019

Ludgate's Life: maturity

- 1917-1922: the daily merry-go-round

Circular Route Tram No.27



College Green – Drumcondra
Circular Route Tram No.27
via Capel Street & Dorset Street
© National Library Ireland

Ludgate's Life: maturity

- 1918: WW1 ends

Peace Day Parade 1919, College Green



*Peace Day Parade 1919
Dame Street, Dublin
© RTÉ Stills Library
Cashman Collection*

Ludgate's Life: maturity

- *“Percy ... took long solitary walks ... gentle, modest simple man”*
- *“... never heard him make a condemning remark about anyone”*
- *“... a really good man, highly thought of by anyone who knew him”*
- *“... Always appeared to be thinking deeply”*



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Ludgate's Life: maturity

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- *“... never heard him make a condemning remark about anyone”*
- *“... a really good man, highly thought of by anyone who knew him”*
- *“... Always appeared to be thinking deeply”*

- **Never married**



tragic end

Ludgate's Life: tragic end

- Dec-1921: brother Frederick died of TB
- Oct-1922: pneumonia after holiday in Lucerne
- 16-Oct-1922: *Percy Edwin Ludgate died aged 39*
- 22-Oct-1922: Frederick's wife Alice died (having nursed Percy)

Ludgate's Life: tragic end

- Dec-1921: brother Frederick died of TB
Oct-1922: pneumonia after holiday in Lucerne
16-Oct-1922: Percy Edwin Ludgate died aged 39
22-Oct-1922: Frederick's wife Alice died (having nursed Percy)
- By 1953 he, his parents and siblings had died
Those living in Dublin were all buried in the same grave
By 1987 his only niece Violet died

Ludgate's Life: tragic end

- *Unmarked* grave, occupants: Frederick, Percy, Alice, Mary, Alfred
Owned by Alfred, who made no Will
Can only be marked by close descendants
BUT there are *no descendants*



Mount Jerome Cemetery
© Brian Coghlan 2017

Ludgate's Life: unknowns

- Do any family letters/photos/documents exist ?
Where the family were from 1883 to 1890 ?
Do any Drumcondra locals remember them ?
- Was he at North Strand National School ?
Did he attend secondary school ?
- When did he join Corn Merchant ?
When did he start accountancy ?
When did he join Kevans & Son ?
Do his tax returns exist ?
- Where is evidence of praise for WW1 efforts ?
- What ill health caused rejection by Civil Service (was it TB) ?
Did he go to Lucerne for treatment ?
Was he in poor health when he contracted pneumonia ?
What did he actually die of ?
- Was there a relationship with Timothy Harrington MP ?
Does his civil service file still exist in UK ?
- ...

Ludgate's Family

Ludgate's Family: origins

- **17xx: MATTHEW & MARY LUDGATE**
leased Marble Hill, Kilshannig (5km west of Mallow)
original 18th century house (except portico) with 4ft-thick walls



Ludgate's Family: origins

17xx: *MATTHEW LUDGATE* married *MARY Xxxx*

Elizabeth	David	Jane	Anne	Mary	Mary	John	Robert	Mary
1736	1736/7	1740	1743	1746	1747	1752	1755	1759
				d.1747	d.1748			

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				d.1747	d.1748			

17xx: *Robert Farmar* m. *Elisabeth Eeee*

Elizabeth
17xx

1778: *JOHN* married *ELIZABETH FARMAR*

Mary	Katherine	Matthew	Michael	Robert	Elizabeth	
1779	1781	1784	1786	1788	1790	
John	Jane	David	John	Margaret	Robert	Thomas
1793	1795	1797	1799	1801	1802	1804
d.1794						

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John	Jane	David	John	Margaret	Robert	Thomas
1793	1795	1797	1799	1801	1802	1804
d.1794						

17xx: **Xxxx Willis** m. **Yyyy Zzzz**

Suzanna
1814

1837: **ROBERT** married **SUZANNA WILLIS**

Thomas	Michael	Mary	Elizabeth	Robert	Richard
1838	1839	1842	1843	1845	1847
		David	William		
		1849	1853		

Ludgate's Family: origins

17xx: **MATTHEW LUDGATE** married **MARY Xxxx**
 Elizabeth David Jane Anne Mary Mary John Robert Mary
 1736 1736/7 1740 1743 1746 1747 1752 1755 1759
 d.1747 d.1748

17xx: **Robert Farmar m. Elisabeth Eeee**
 Elizabeth
 17xx

1778: **JOHN** married **ELIZABETH FARMAR**
 Mary Katherine Matthew Michael Robert Elizabeth
 1779 1781 1784 1786 1788 1790
 John Jane David John Margaret Robert Thomas
 1793 1795 1797 1799 1801 1802 1804
 d.1794

17xx: **Xxxx Willis m. Yyyy Zzzz**
 Suzanna
 1814

1837: **ROBERT** married **SUZANNA WILLIS**
 Thomas Michael Mary Elizabeth Robert Richard
 1838 1839 1842 1843 1845 1847
 David William
 1849 1853

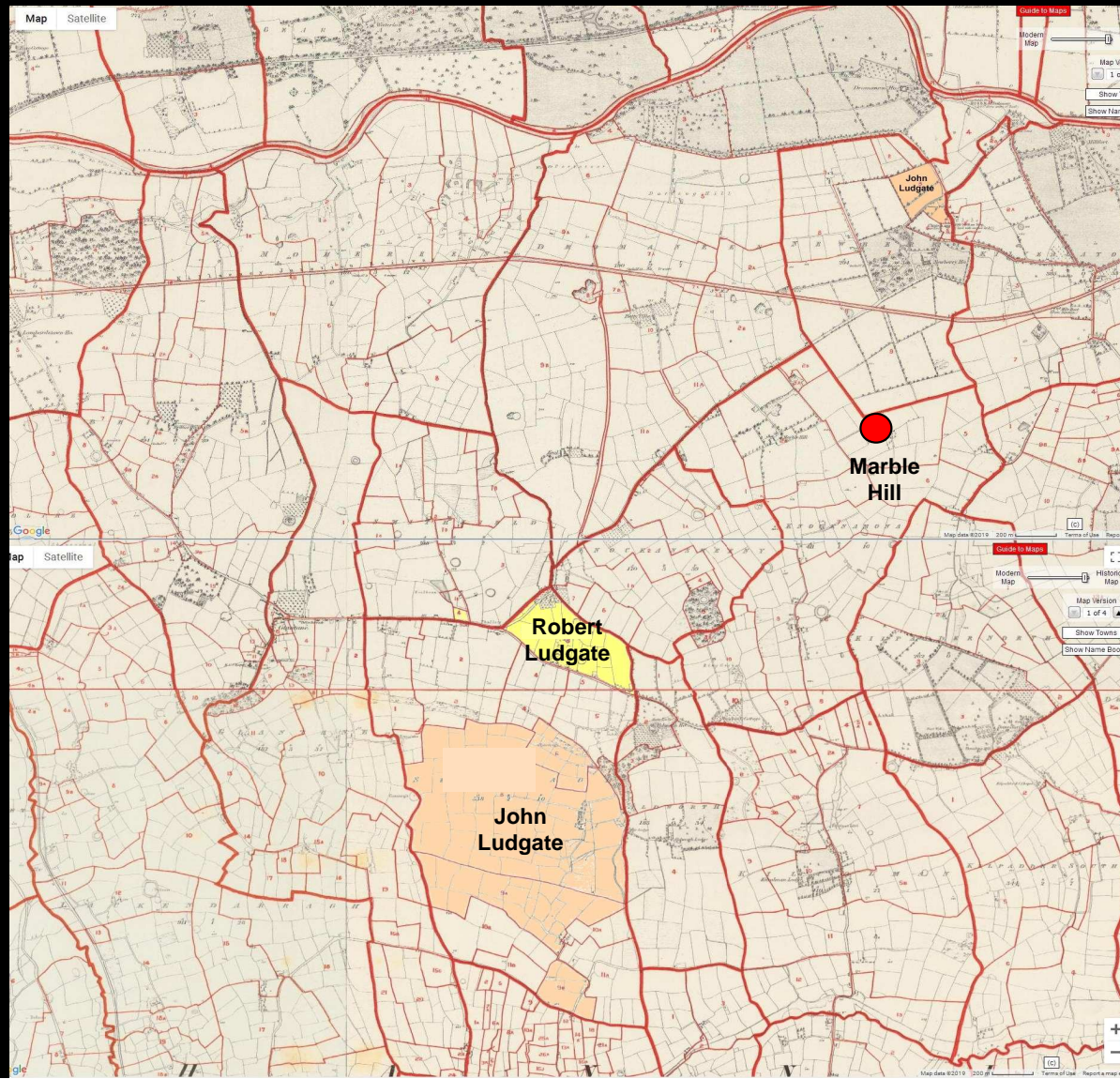
Felix Reed
Ann Cropley
 1834: **Thomas McMahon m. Frances Reed**
 Augusta Thomas Arthur Mary Robert
 1834 1836 1838 1840 1843

1863: **MICHAEL** married **MARY ANN McMAHON**
 Arthur Thomas Walter Albert Augusta Frederick Alfred
 1864 1865 1867 1868 1871 1875 1881
 d.1864 d.1868 d.1870

Percy
1883

Ludgate's Family: origins

- 1st generation (MATTHEW LUDGATE) farmed at MARBLE HILL
- 2nd generation (JOHN LUDGATE) farmed at SKARRAGH
- 3rd generation (ROBERT LUDGATE) farmed at SKARRAGH too



from
Griffith
Valuation

Ludgate's Family: unknowns

- Did his parents own 30 Dargle Road ? (and did separation indicate an unhappy marriage ?)
Only two (Thomas & Frederick) married:
Thomas & Bedelia's son died in infancy – did they actually live in Peacehaven ?
Frederick & Alice's 2 sons died in infancy – does anyone remember surviving daughter Violet ?
- Large number of *relatives and acquaintances*
Paternal: 5 uncles + 3 aunts + at least 7 cousins
Maternal: 3 uncles + 1 maternal aunt + (presumably) cousins
In-Laws: Bedelia Buckley & Alice Walshe's relatives (1 uncle + 3 aunts + 3 cousins)
- Where are his *relatives and acquaintances* ? For example, where are his Cork relatives ?

1877: *William Joseph Ludgate married Mary Alice Ferris* (uncle William was Cork journalist)
 William Charles Isabella Joseph Robert Arthur Edward (cousins of Percy)
 1878 1879 1881 1885 1883 1887 1889

1908: *Robert Willis Ludgate married Mary Barrett* (cousin Robert also Cork journalist)
 Richard Gerald Margaret Mary
 1910 1913

1941: *Margaret Mary Ludgate married John Joseph Coleman*
 Mary P. Coleman
 1942

Where is Mary P. Coleman (Cork city) ?

- Where are his mother Mary Ann née McMahon's relatives ?
Where are his sister-in-law Alice (Alicia) née Walshe's relatives (Dublin city) ?
Where are his sister-in-law Bedelia (Bridget) née Buckley's relatives (Doneraile, Mallow) ?
...

Recent discoveries

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 - That by 1953 his parents and siblings had died
 - That by 1987 his only niece Violet died
 - That there were *no other descendants* of his parents

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 - 1936: Barbara was privately adopted and renamed
 - And was brought up overseas

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 - 1935: Violet gave birth to a daughter *Barbara*
 - 1936: Barbara was privately adopted and renamed
 - And was brought up overseas
- Barbara married and moved to America
 - then gave birth to and raised 6 children
 - now has 7 grandchildren and 6 great-grandchildrenCircumspect DNA matching has found various ancestral branches
AND the grandchildren are allowed to erect a grave marker ...

THE END

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Ludgate Team:

- Dr.Brian Coghlan, Trinity College Dublin (*computer science*)
- Prof.Brian Randell, Univ.Newcastle, UK (*1970s papers ++*)
- Paul Hockie, London, UK (*genealogy ++*)
- Trish Gonzalez, Florida, USA (*genealogy*)
- David McQuillan, Wokingham, UK (*maths & mechanical*)
- Reddy O'Regan, Skibbereen (*records & legalities*)

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- Prof.John Tucker, Univ.College Swansea, UK (*Riches thesis*)
- Canon Eithne Lynch, Mallow Church of Ireland (*records*)
- Dr.Susan Hood, RCB Library, Dublin (*records*)
- *National Archives of Ireland* (*records*)
- *www.irishgenealogy.ie* (*records*)

PUBLIC CALL FOR INFORMATION

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Joint Public Call:

- Brian Coghlan, Trinity College Dublin <coghlan@cs.tcd.ie>
Adrienne Harrington, Ludgate Hub <adrienne@ludgate.ie>
- Public Call for information about Percy Ludgate:
 - about *relatives*
 - about *acquaintances*
 - related *documents*
 - related *photos*
 - related *memories*
 - Ludgate's *drawings*
- The smallest snippet can often be a key !
- Also see: <https://scss.tcd.ie/SCSSTreasuresCatalog/> (click on *Ludgate*)