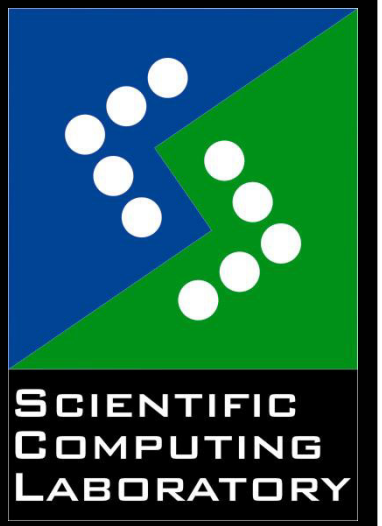
Institute of Physics, Belgrade
Scientific Computing Laboratory
Training and Outreach Program for Young Scientists



Variations on the themes of Nobel and the Nobel Prize

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Petnica
October 26, 2005

Variations on the themes of Nobel and the Nobel Prize

- *Introduction*
- *Part 1: Competition*
- *Part 2: Individuality*
- *Part 3: Intelligence*
- *Part 4: Geneology*

Introduction

- "Genius is one per cent inspiration, ninety-nine per cent perspiration."

  Thomas A. Edison

Testament

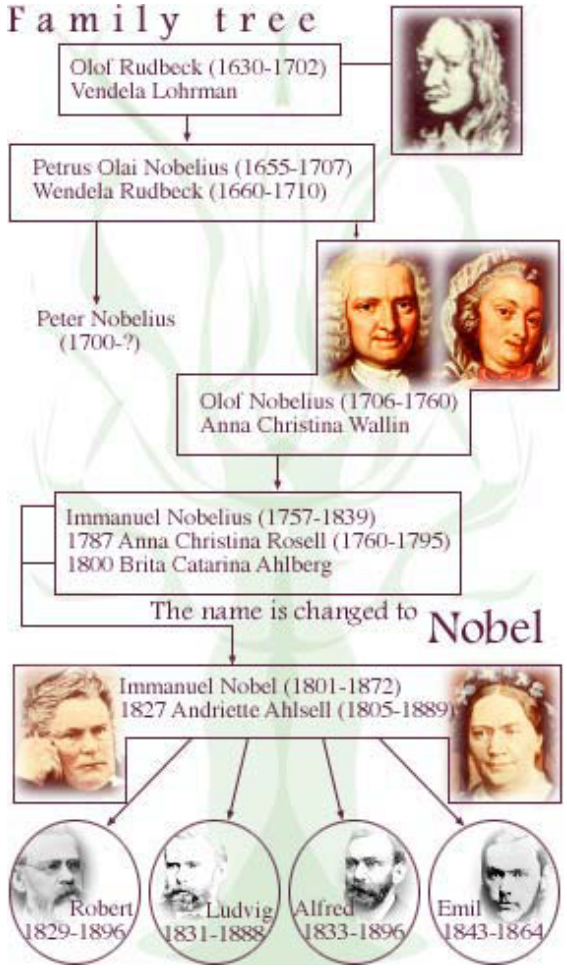
"The whole of my remaining realizable estate shall be dealt with in the following way: the capital, invested in safe securities by my executors, shall constitute a fund, the interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have **conferred the greatest benefit on mankind**.

The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature the most outstanding work in an ideal direction; and one part to the person who shall have done the most or the best work for fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses.

The prizes for physics and chemistry shall be awarded by the Swedish Academy of Sciences; that for physiology or medical works by the Karolinska Institute in Stockholm; that for literature by the Academy in Stockholm, and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting (Parliament). It is my express wish that **in awarding the prizes no consideration be given to the nationality of the candidates, but that the most worthy shall receive the prize**, whether he be Scandinavian or not."

Alfred Nobel (1833–1896)

Alfred Nobel



Timeline

1833-1841	Alfred Nobel is born in Stockholm in 1833. Father Immanuel goes bankrupt and moves to St. Petersburg. Family stays in Stockholm.	0-8
1842-1849	Family moves to St. Petersburg. Father becomes wealthy building mines for Tsar. Alfred and brothers get first class education by private teachers. Fluent in Swedish, Russian, French, English and German. Primary interests English literature, poetry, chemistry and physics.	9-16
1850-1852	Alfred spends year in the laboratory of Pelouze in Paris. Learns about nitroglycerine. Travels to Italy, Germany and the US.	17-19
1853-1862	The Crimean War rages. Father's business first flourishes, but then undergoes bankruptcy as war ends. Zinin, Alfred's chemistry teacher, reminds him of nitroglycerine. Starts first experiments with nitroglycerine at 27. Indigestion, headaches, depression.	20-29
1863-1872	Obtains first patent on nitroglycerine as industrial explosive. Develops and patents an igniter for triggering the explosion. Moves to Stockholm. Brother Emil is killed during the preparation of nitroglycerine. Nobel founds companies in Sweden, Germany, US. Discovers "dynamite". New companies in France, UK…	30-39
1873-1890	Moves to Paris as a wealthy man. More patents, more companies… Friendship with Victor Hugo and other writers. Advertises for a housekeeper/personal secretary and hire Countess Bertha Kinsky who later becomes a leading peace activist.	40-57
1891-1896	Leaves Paris and settles in San Remo, Italy after dispute with the French government. Alfred Nobel dies in 1896.	58-63

Credits: http://www.nobelprize.org/

Part 1: Competition

- “I can forgive Alfred Nobel for having invented dynamite, but only a fiend in human form could have invented the Nobel Prize.”

  George Bernard Shaw

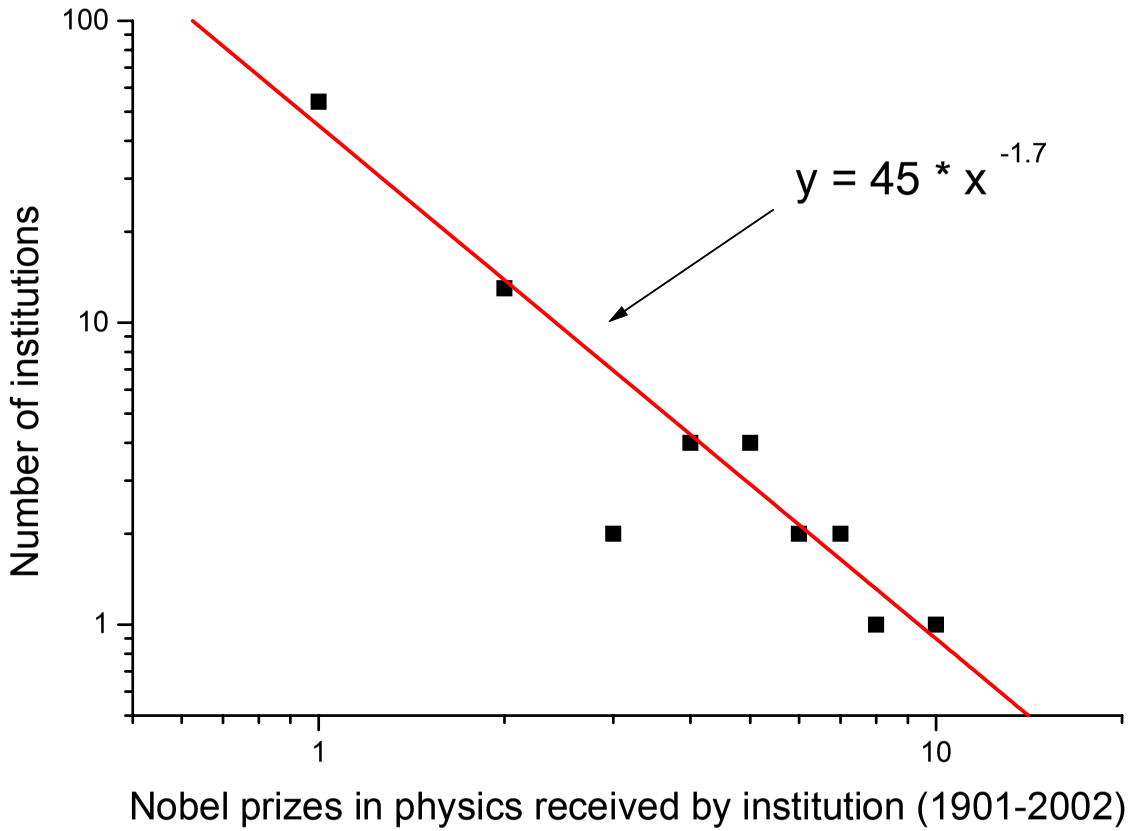
- “In accordance with our principles of free enterprise and healthy competition, I'm going to ask you two to fight to the death for it.”

  Monty Python

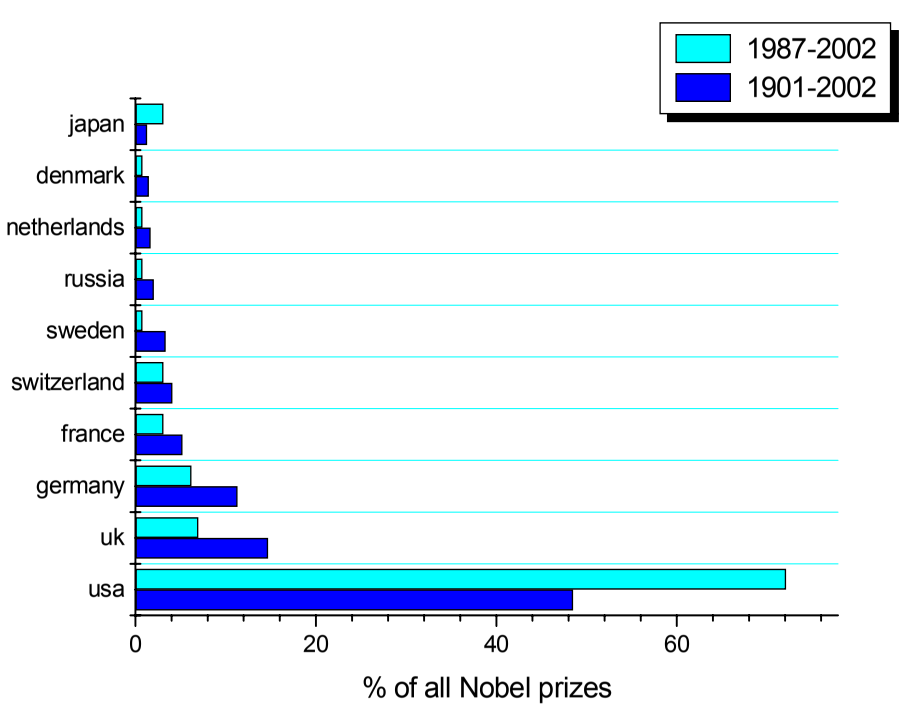
Top institutions

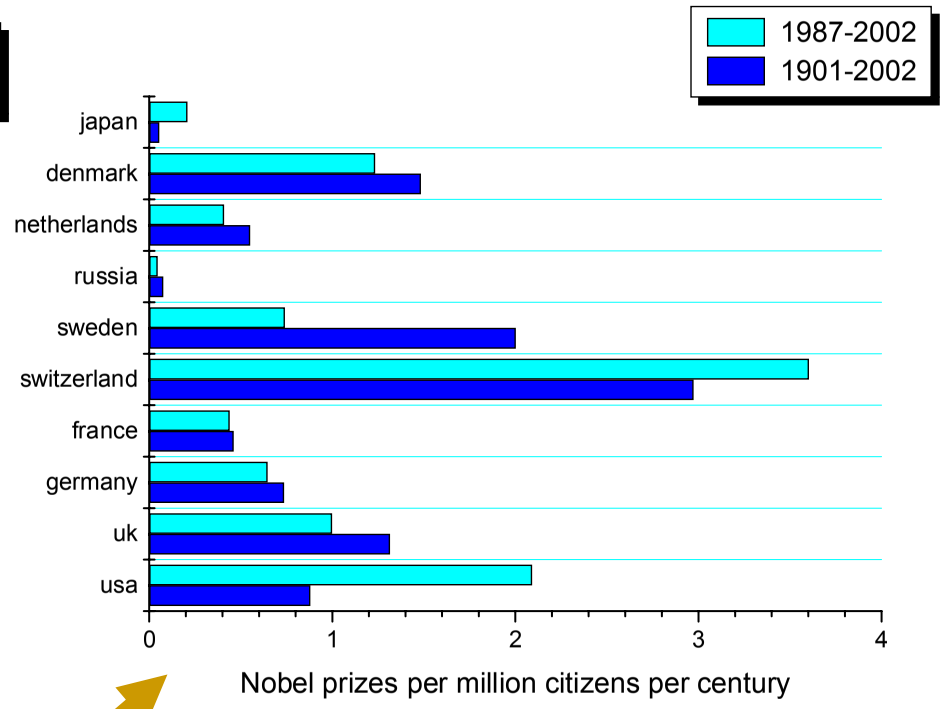
	1901-2002	last 25 years	last 15 years
1. Harvard	**5.2%**	**4.9%**	**2.33%**
2. Cambridge	**4.28%**	**2.45%**	**3.1%**
3. Max-Plank	**3.35%**	**3.92%**	**4.65%**
4. Stanford	**3.16%**	**5.39%**	**6.2%**
5. London	3.16%	0.98%	0.775%
6. MIT	**2.79%**	**4.9%**	**5.43%**
7. Chicago	**2.79%**	**4.9%**	**4.65%**
8. Caltech	**2.6%**	**2.45%**	**2.33%**
9. Berkeley	**2.6%**	**2.45%**	**2.33%**
10. Columbia	**2.23%**	**2.45%**	**3.88%**
11. Princeton	**2.04%**	**3.92%**	**4.65%**
12. Rockefeller	**1.67%**	**1.47%**	**1.55%**
13. Oxford	1.67%	0%	0%
14. Cornell	**1.49%**	**1.96%**	**1.55%**
15. Russian Academy	1.12%	0.49%	0%
16. Sorbonne	1.12%	0%	0%
17. Heidelberg	1.12%	0.49%	0%

Power laws everywhere



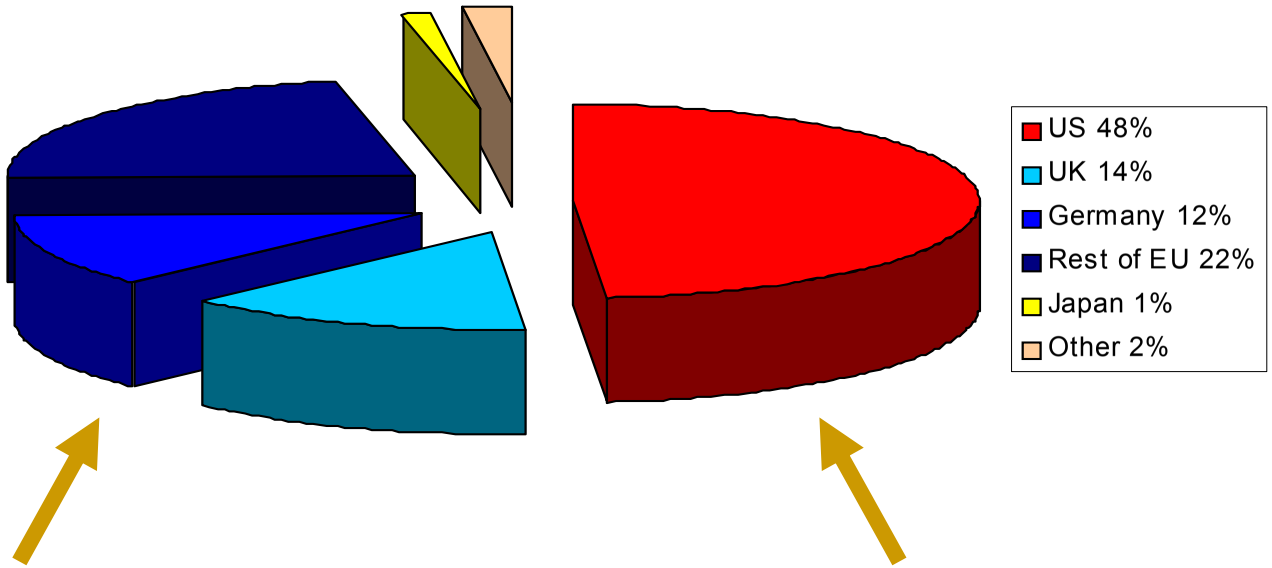
Countries





The annual number of prizes has increased to almost 3 per field (maximum allowed). Also number of fields has increased with the addition of the Economy prize.

US vs. EU

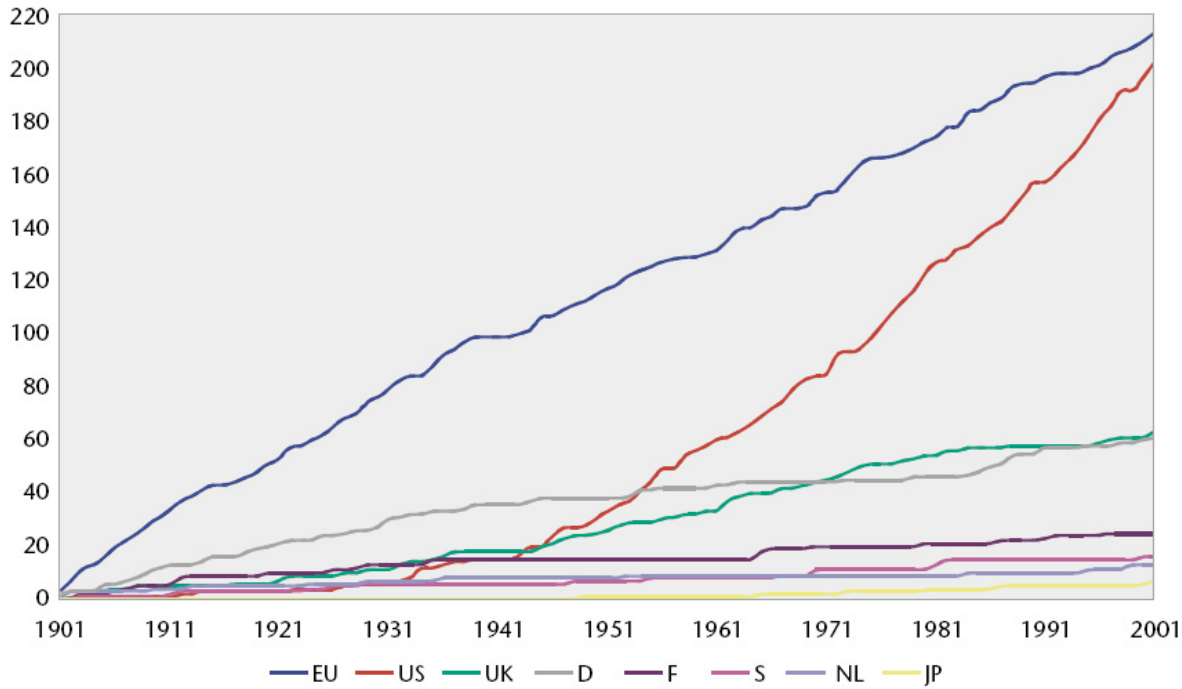


EU ~ 48%

US ~ 48%

The time dimension

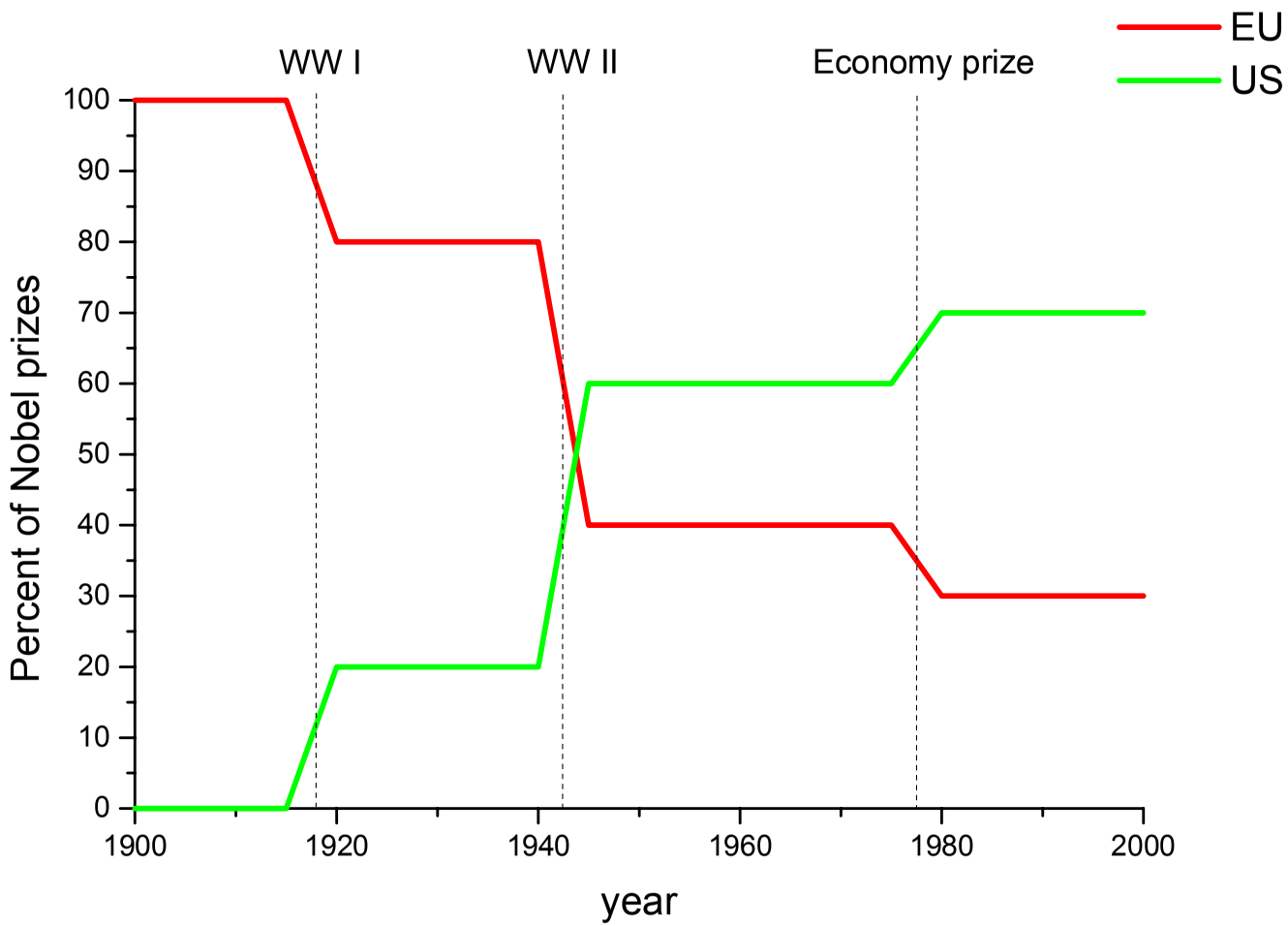
Figure D4.5.1 Distribution of Nobel Prizes in three scientific disciplines (Chemistry, Physics and Medicine) by selected countries (1901-2001) – cumulative total



Source: DG Research
Data: Nobel Prize Foundation
Note: No Nobel Prizes have been awarded between 1940 to 1942.

Third European Report on S&T Indicators, 2003

Rough phenomenology



Part 2: Individuality

- "The Nobel is a ticket to one's own funeral. No one has ever done anything after he got it."

  T. S. Elliot

- "Some men are born great, some achieve greatness and some have greatness thrust upon them.

  William Shakespeare

What does it take?

- What it takes: hard work, great teachers, great contemporaries at great university, great students, luck.
- Nature does not define a unique hierarchy of achievement: Newton, Darwin, ...
- Nobel's original purpose has not been realized (hoped prize would subsidize and support young winner's research efforts for the rest of life).
- Subsequent careers not necessarily sterile.

Paul A. Samuelson, 1970 Nobel prize in economics

How to get a Nobel

- Live long, don't smoke or drink too much alcohol, eat a balanced diet and take holidays, because it may take 50 years for your discovery to be recognized by the Nobel committee.
- Don't tell too many people about your idea or it may be stolen.
- Write good English because your discovery needs to be a memorable story if it's to be deemed worthy of a Nobel.

How to get a Nobel

- Try to solve major problems [though] people intelligent enough to identify a major problem at Nobel level are [extremely] rare.
- Make really big discoveries [easier]. Nobody can decide to discover something, but there are ways of making a discovery and results. Accept nothing at face value and get in the habit of thinking unconventionally. Work hard, work smart and, with a bit of luck...
- Have fun, behave like a winner.

Peter Doherty, 1996 Nobel prize in medicine

Top nominees

The top 10 most nominated physicists 1901 - 1950

Rank and name	Nominations	Years nominated	Prize and year of award	Working nationality
1 Otto Stern	81	1925 - 1944	Physics 1943	American
2 Arnold Sommerfeld	81	1917 - 1950		German
3 Max Planck	74	1907 - 1919	Physics 1918	German
4 Albert Einstein	62	1910 - 1922	Physics 1921	German
5 Henri Poincaré	51	1904 - 1912		French
6 Vilhelm Bjerknes	48	1923 - 1945		Norwegian
7 Friedrich Paschen	45	1914 - 1933		German
8 Clinton Joseph Davisson	44	1929 - 1937	Physics 1937	American
9 Percy Williams Bridgman	41	1919 - 1946	Physics 1946	American
10 Erwin Schrödinger	41	1928 - 1933	Physics 1933	Austrian

Controversy

- Johannes Fibiger was a Danish scientist who won the 1926 Nobel prize for medicine. Fibiger had claimed to find an organism he called Spiroptera carcinoma that caused cancer in mice and rats. Later, it was shown that this organism was not the primary cause of the tumors.
- Jocelyn Bell first noticed the stellar radio source which was ultimately recognized as a pulsar but did not get the prize. Instead the 1974 prize went to her supervisor Antony Hewish (developed technique and designed equipment).
- Charles Best first isolated insulin, but was excluded from the Nobel prize in favor of associate John Macleod. This so incensed Best's colleague, Frederick Banting that he later voluntarily shared half of his 1923 Nobel prize money with Best.

Controversy

- Fred Hoyle was denied a share of the Nobel prize for physics in 1983, although the winner William Fowler acknowledged Hoyle as the pioneer of the concept of stellar nucleosynthesis.
- Chien-Shiung Wu disproved the law of the conservation of parity but did not share 1957 Nobel prize for physics with theoretician colleagues T. D. Lee and C. N. Yang.
- Egas Moniz received the Nobel prize for medicine in 1949 for his development of prefrontal lobotomy. The technique turned out to have little objective benefit to patients, and was instituted in highly unethical manner. It is no longer used.

Part 3: Intelligence

- "If we knew what it was we were doing, it would not be called research, would it?

  Albert Einstein

Rationally about IQ

- It is maybe natural that a talk about the Nobel prize meanders off into a discussion about intelligence and IQ. The fact that no one knows what intelligence really is doesn't make the discussion less enjoyable. Still, we would like to approach the topic rationally.
- IQ tests give the "soft sciences" such as psychology a taste for quantifiable data. Herrnstein & Murray's book "The Bell Curve", published in the early nineties, uncovered a host of interesting phenomenology concerning IQ measurements. It also sparked a rather heated debate in the wider public.
- This in turn lead to public statement signed by 52 internationally known scholars (experts in intelligence and related fields) first published in The Wall Street Journal, Tuesday, December 13, 1994. The researchers spelled out the position of "mainstream researchers" in this field.
- This public statement is a nice starting point for a rational discussion about intelligence and IQ. In the next four slides we present a minimally shortened and edited version of the statement.

Statement:

Color coded to underline the fact that these are the opinions of researcher in the "soft sciences"

Intelligence and IQ

- Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings – "catching on," "making sense" of things, or "figuring out" what to do.
- Intelligence, so defined, can be measured, and intelligence tests measure it well. They are among the most accurate of all psychological tests and assessments. They **do not measure creativity, character, personality, or other important differences among individuals**.
- While there are different types of intelligence tests, they all measure the same intelligence. Some use words or numbers and require specific cultural knowledge (like vocabulary). Others do not, and instead use shapes or designs and require knowledge of only simple, universal concepts (many/few, open/closed, up/down).
- The spread of people along the IQ continuum, from low to high, can be represented well by the bell curve (Gaussian). Most people cluster around the average (IQ 100). Few are either very bright or very dull: About 3% of Americans score above IQ 130 (threshold for giftedness), with about the same percentage below IQ 70 (threshold for mental retardation).
- Intelligence tests are not culturally biased against American blacks or other native-born, English-speaking peoples in the US. Rather, IQ scores predict equally accurately for all such Americans, regardless of race and social class. Individuals who do not understand English well can be given either a nonverbal test or one in their native language.
- The brain processes underlying intelligence are still little understood.

Statement:

Practical importance

- IQ is strongly related, probably more so than any other single measurable human trait, to many important educational, occupational, economic, and social outcomes. Its relation to the welfare and performance of individuals is very strong in some arenas in life (education, military training), moderate but robust in others (social competence), and modest but consistent in others (law-abidingness). Whatever IQ tests measure, it is of great practical and social importance.
- A high IQ is an advantage in life because virtually all activities require some reasoning and decision-making. A low IQ is often a disadvantage, especially in disorganized environments. Of course, a high IQ no more guarantees success than a low IQ guarantees failure in life. There are many exceptions, but the odds for success in society greatly favor individuals with higher IQs.
- The practical advantages of having a higher IQ increase as life settings become more complex (novel, ambiguous, changing, unpredictable, or multi-faceted). A high IQ is generally necessary to perform well in highly complex or fluid jobs (the professions, management); it is a considerable advantage in moderately complex jobs (crafts, clerical and police work); but it provides less advantage in settings that require only routine decision making or simple problem solving (unskilled work).
- Differences in intelligence certainly are not the only factor affecting performance in education, training, and highly complex jobs but intelligence is often the most important.
- Certain personality traits, special talents, aptitudes, physical capabilities, experience, and the like are important (sometimes essential) for successful performance in many jobs, but they have narrower (or unknown) applicability or "transferability" across tasks and settings compared with general intelligence. Some scholars choose to refer to these other human traits as other "intelligences."

Statement:

Group differences (in the US)

- Members of all racial-ethnic groups can be found at every IQ level. The IQ curves of different groups overlap considerably, but groups often differ in where their members tend to cluster along the IQ line. The IQ curves for some groups (Jews and East Asians) are centered somewhat higher than for whites in general. Other groups (blacks and Hispanics) are centered somewhat lower than non-Hispanic whites.
- The IQ curve for whites is centered roughly around IQ 100; the IQ curve for American blacks roughly around 85; and those for different subgroups of Hispanics roughly midway between those for whites and blacks. The evidence is less definitive for exactly where above IQ 100 the IQ curve for Jews and Asians are centered.
- There is no persuasive evidence that the IQ curves for different racial-ethnic groups are converging.
- Racial-ethnic differences in IQ curves are essentially the same when youngsters leave high school as when they enter first grade. As large national surveys continue to show, black 17-year-olds perform, on the average, more like white 13-year-olds in reading, math, and science, with Hispanics in between.
- There is no definitive answer to why IQ bell curves differ across racial-ethnic groups.
- Racial-ethnic differences are somewhat smaller but still substantial for individuals from the same socioeconomic backgrounds. To illustrate, black students from prosperous families tend to score higher in IQ than blacks from poor families, but they score no higher, on average, than whites from poor families.

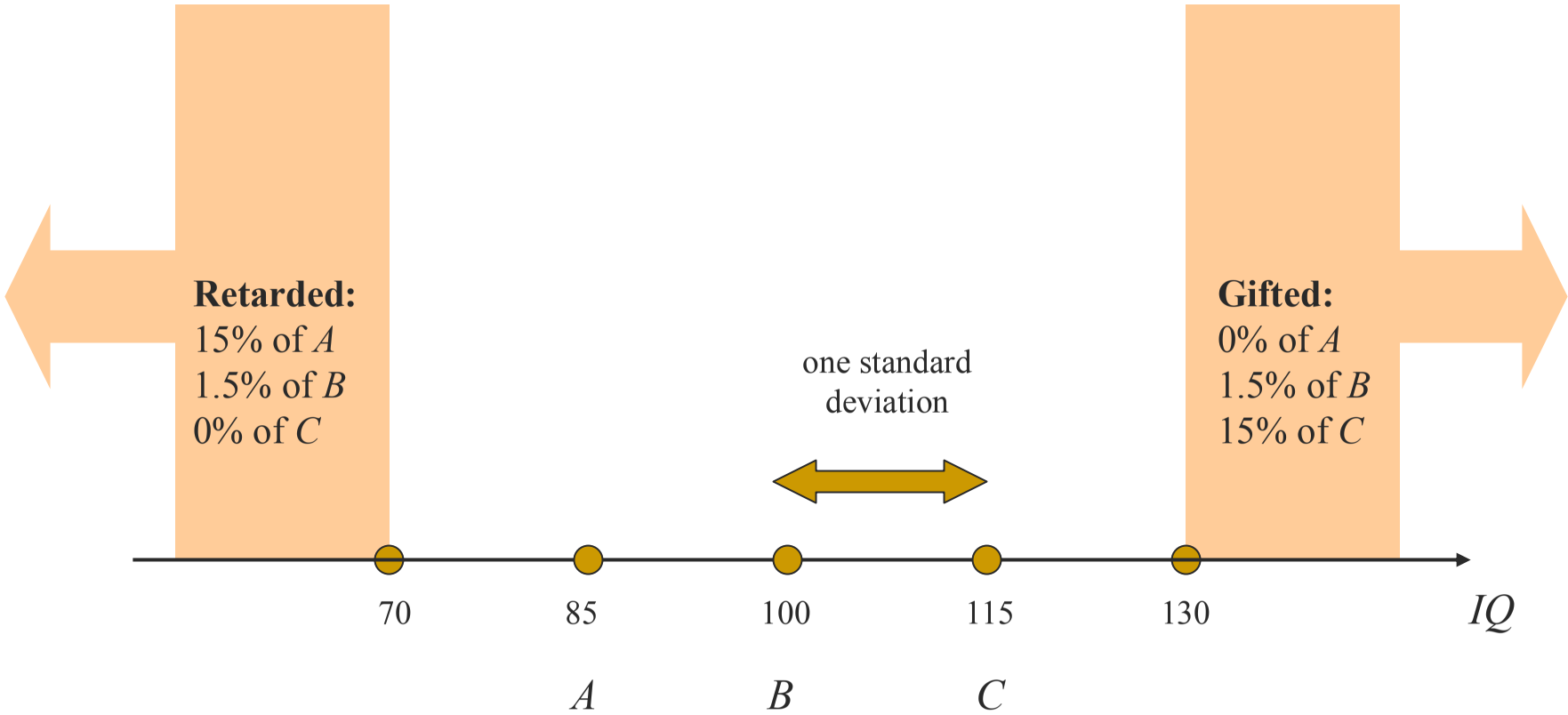
Statement:

Within-group differences

- Individuals differ in intelligence due to differences in both their environments and genetic heritage. Heritability estimates range from 0.4 to 0.8 (on a scale from 0 to 1), most thereby indicating that genetics plays a bigger role than does environment in creating IQ differences among individuals.
- Members of the same family also tend to differ substantially in intelligence (by an average of about 12 IQ points) for both genetic and environmental reasons. They differ genetically because biological brothers and sisters share exactly half their genes with each parent and, on the average, only half with each other. They also differ in IQ because they experience different environments within the same family.
- That IQ may be highly heritable does not mean that it is not affected by the environment. Individuals are not born with fixed, unchangeable levels of intelligence. IQs do gradually stabilize during childhood, however, and generally change little thereafter.
- Although the environment is important in creating IQ differences, we do not know yet how to manipulate it to raise low IQs permanently.

Conclusion: These research findings neither dictate nor preclude any particular social policy, because they can never determine our goals. They can, however, help us estimate the likely success and side-effects of pursuing those goals via different means.

Harsh implications



average IQs of three groups

But are they correct?

- The statement tries to downplay some of the most extreme responses to the Bell Curve book stating the opinions of "mainstream science". The statement that IQ tests are *among the most accurate of all psychological tests and assessments* doesn't necessarily say that they should be trusted – psychology is far from being a hard science. Also, one has to be extremely careful with predictions that have the potential of having such a great impact on humanity. It is **not enough** to say that *these findings should not dictate or preclude any particular social policy*.
- The phenomenology given is at best valid for the mentioned groups as parts of US society, i.e. they say nothing of the performance of the same racial-ethnic groups living in other parts of the world.
- The "overachiever" group is made up of Jews and East Asians. A couple of decades ago US citizens of East Asian origin were certainly not considered overachievers (judging, for example, by enrollment quotas at US Universities). Did social scientists and psychologists of the 80's purposefully give squewed results, or were the tests then significantly poorer, or did the IQ results of the East Asians change in those two decades? The self-esteem, educational and economic level of this group has certainly markedly increased in that time – is this the cause of the change?
- Similarly, going back a little further in time, we may see that pre World War II society in the US certainly did not consider Jews as overachievers. Racial bigotry could be a very plausible explanation of this.

Emergent behavior

- The numbers do mean something even if we have reason to be less sure of the underlying theories and interpretations.
- It is interesting to look at **what is common to the two overachiever groups**. Both groups value hard work. Both groups have gone through times of extreme crisis after which they became overachievers. For Jews this was the result of the Holocaust. For the US Vietnamese this came as the aftermath of the Vietnam war. A similar crisis effected the Korean population in the US.
- **Hard work, renewed group self-esteem and optimism, a belief that high quality education is the only way to a better future** – couldn't these be the explanations of these groups overachiever status? If so then the existing ideas about intelligence and IQ's are all wrong.
- If this is the case then it is extremely important to study the details of how a group crisis can trigger such a positive catharsis.
- The renewal of group optimism, focus and ambition is not the result of the vision of one man or of some group, rather it is a form of **emergent collective behavior** that is at the heart of many interesting dynamical systems treated by physics. Modern physics studies many interesting social models – this may be an extremely important new one to ponder. Might it be possible to look at the next crisis region and to predict if that crisis will lead to catharsis or not?

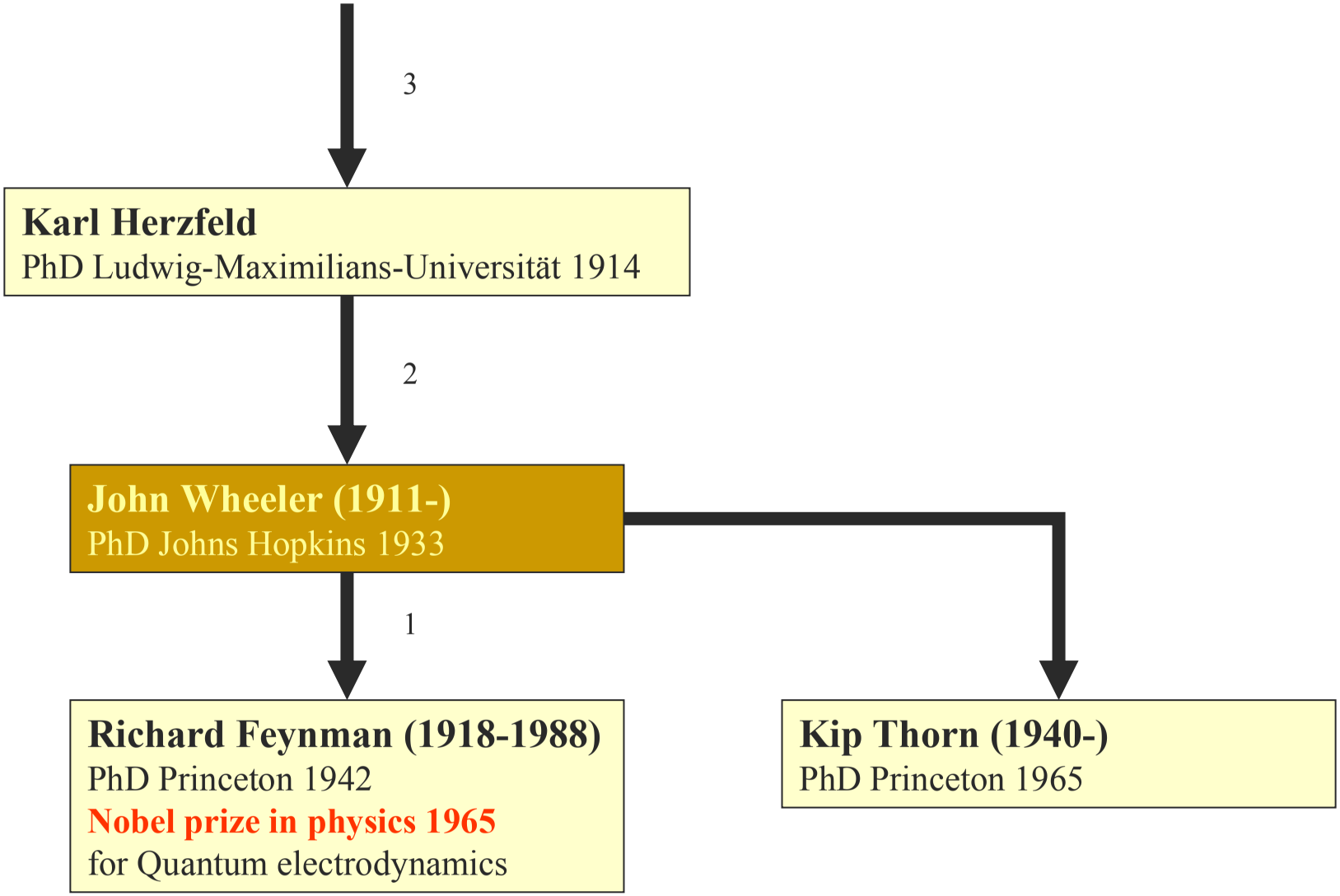
Part 4: Geneology

- “How wonderful that we have met with a paradox. Now we have some hope of making progress.”

  Niels Bohr

The making of a genius

- We know how to teach facts, skills, work habits, but not creativity. We don't even know how to specify what makes up creativity.
- However, there are many cases of the clustering of creative people in a given place and time.
- Paradox: although we don't know what creativity is, through the centuries some people have known how to nurture creativity.
- A creative researcher may be influenced by many people (parents, teachers, colleagues) however in all cases one of the key influences is that of mentor (thesis advisor).
- The student/mentor relation forms a hierarchical network, an academic genealogy.
- Illustrative example: Richard Feynman.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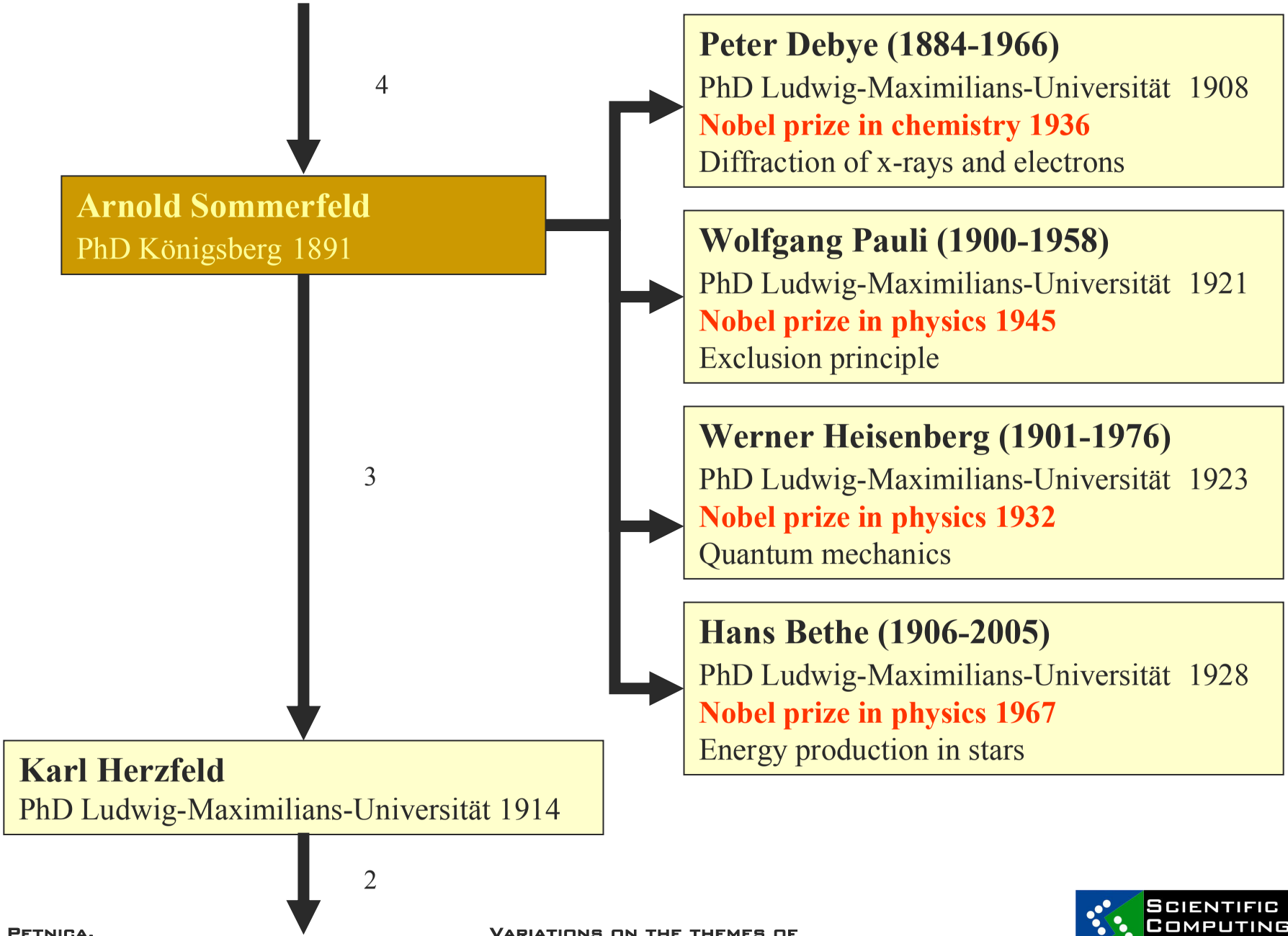
Karl Herzfeld
PhD Ludwig-Maximilians-Universität 1914
2
John Wheeler (1911-)
PhD Johns Hopkins 1933
1
Richard Feynman (1918-1988)
PhD Princeton 1942
Nobel prize in physics 1965
for Quantum electrodynamics
Kip Thorn (1940-)
PhD Princeton 1965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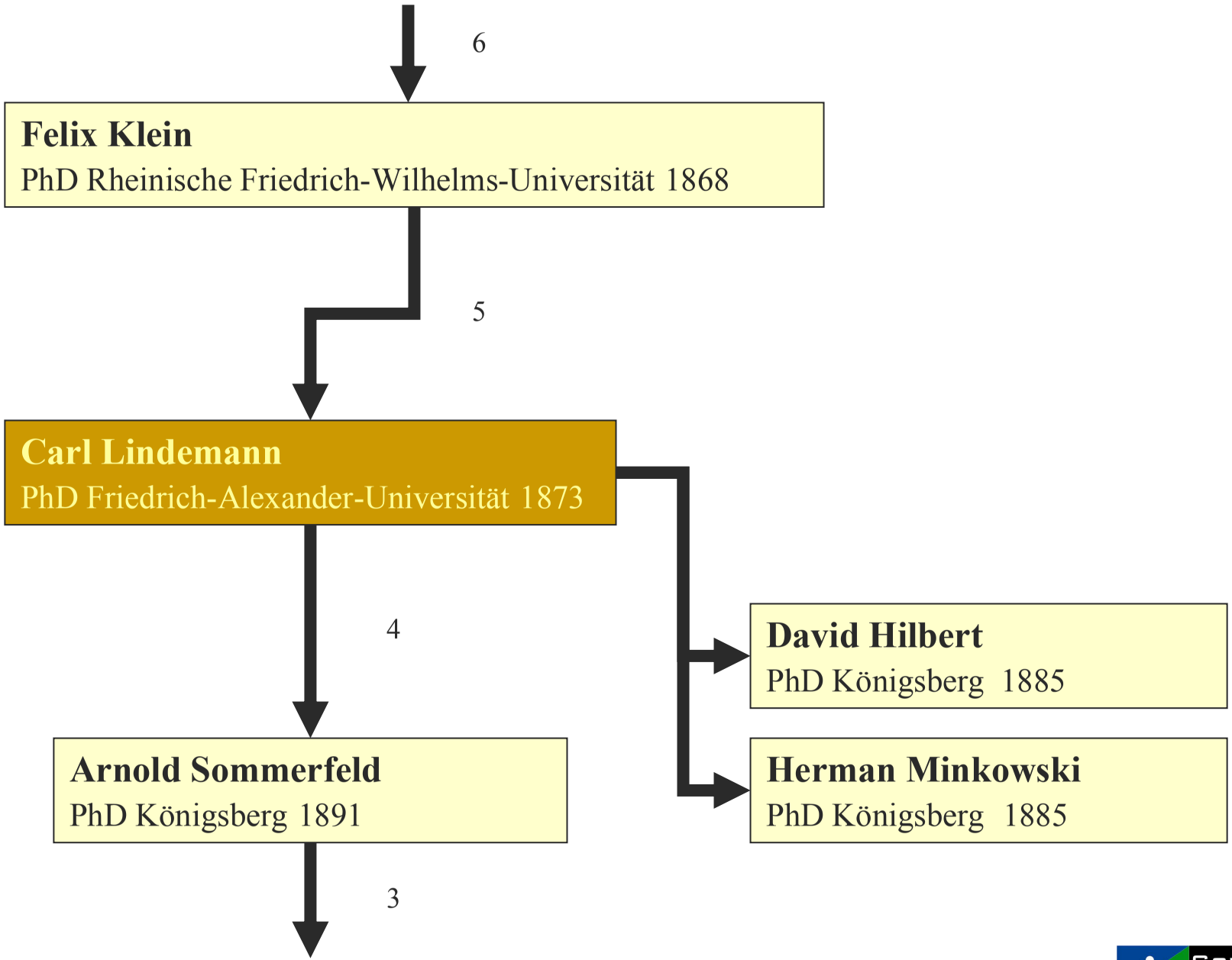
Arnold Sommerfeld
PhD Königsberg 1891
3
Karl Herzfeld
PhD Ludwig-Maximilians-Universität 1914
2
Peter Debye (1884-1966)
PhD Ludwig-Maximilians-Universität 1908
Nobel prize in chemistry 1936
Diffraction of x-rays and electrons
Wolfgang Pauli (1900-1958)
PhD Ludwig-Maximilians-Universität 1921
Nobel prize in physics 1945
Exclusion principle
Werner Heisenberg (1901-1976)
PhD Ludwig-Maximilians-Universität 1923
Nobel prize in physics 1932
Quantum mechanics
Hans Bethe (1906-2005)
PhD Ludwig-Maximilians-Universität 1928
Nobel prize in physics 1967
Energy production in stars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Carl Lindemann
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David Hilbert
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Arnold Sommerfeld
PhD Königsberg 1891
Herman Minkowski
PhD Königsberg 1885
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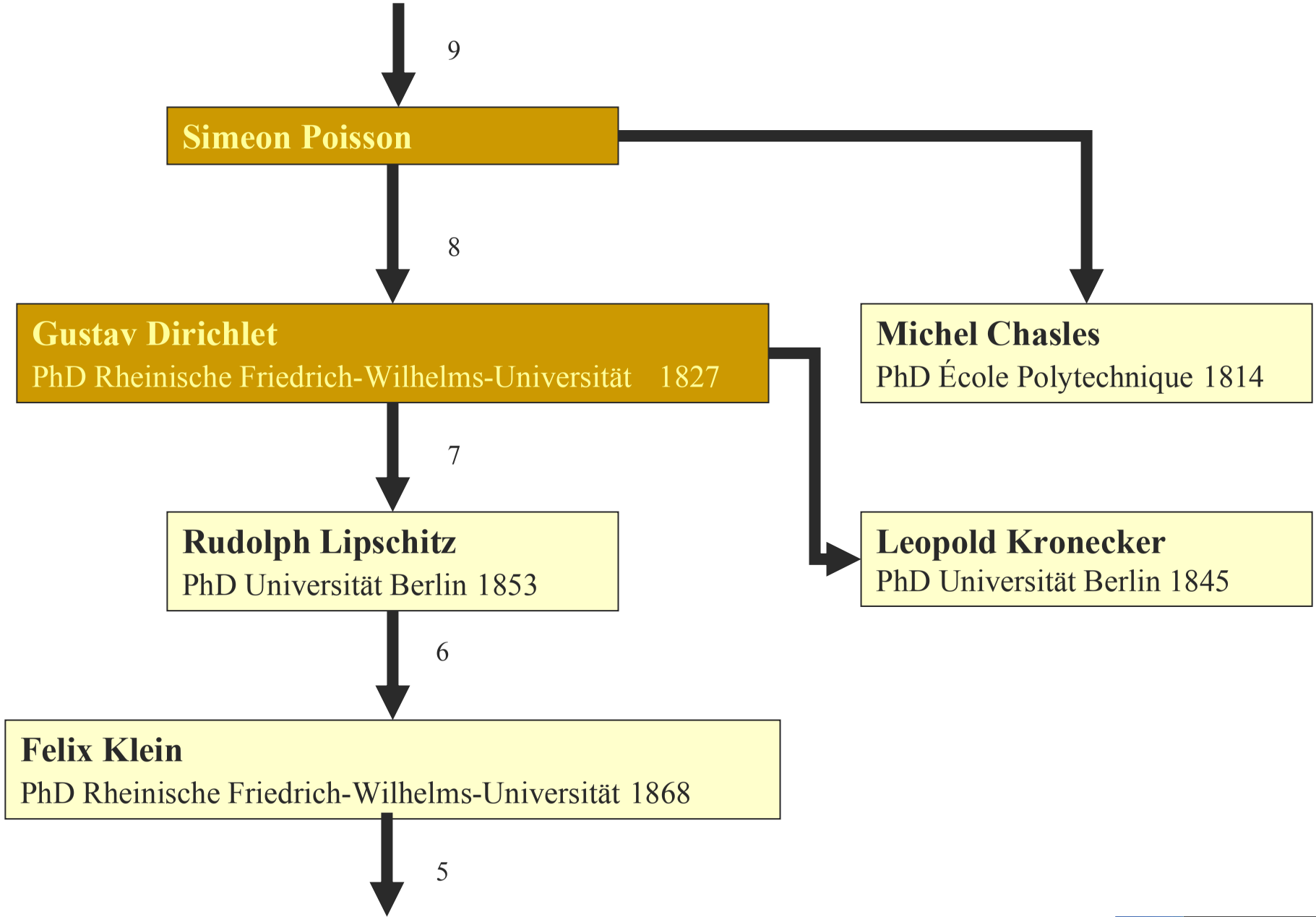
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Gustav Dirichlet
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Michel Chasles
PhD École Polytechnique 1814
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Rudolph Lipschitz
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Leopold Kronecker
PhD Universität Berlin 1845
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Felix Klein
PhD Rheinische Friedrich-Wilhelms-Universität 1868
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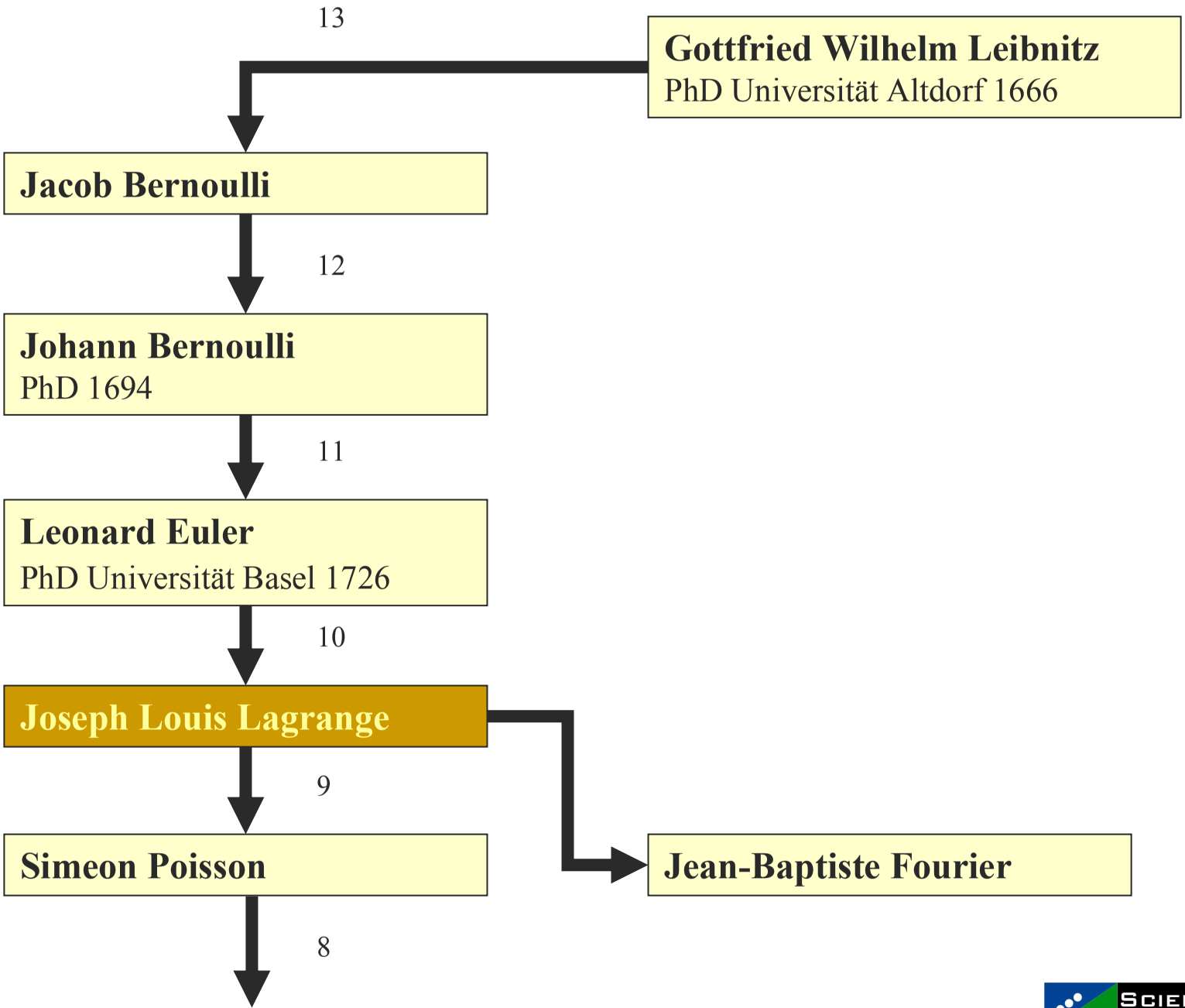
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Gottfried Wilhelm Leibnitz
PhD Universität Altdorf 1666
Jacob Bernoulli
12
Johann Bernoulli
PhD 1694
11
Leonard Euler
PhD Universität Basel 1726
10
Joseph Louis Lagrange
9
Simeon Poisson
Jean-Baptiste Fourier
8