

Alfred Tarski (1901–1983)¹

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Abstract. This paper presents the life and work of Alfred Tarski, one of the most distinguished and influential logicians in the entire history.

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Alfred Tarski (AT hereafter) was born in Warszawa on January 14, 1901. His family was Jewish – Teitelbaum (Polish spelling: Tajtelbaum) was the original name of AT; Waclaw, AT's brother was born two years later. Their parents, Ignacy Teitelbaum and Rosa Prussak, belonged to Jewish business families. Rosa's family was rich and involved in the textile industry in Łódź. The Teitelbaums were not particularly religious people, although decisively keeping Jewish identity; especially, they celebrated Jewish holidays. On the other hand, they wanted to be partially assimilated. The family lived outside Jewish settlements in Warszawa and spoke Polish. Consequently, both boys attended an elementary school with teaching in Polish or Russian (Warszawa was in the Russian Empire at that time). However, Alfred and Waclaw also went to cheder (a Jewish school) where they studied Hebrew and Torah. Thus, AT was fairly familiar with Jewish culture and tradition. After years, Czesław Miłosz, AT's colleague in Berkeley, told the present author that when he translated a fragment of Torah into Polish, he was convinced that he did the first translation. However, AT explained to him that the entire Hebrew Bible was much earlier (in the years 1883–1914) translated into Polish by Izaak Cylkow. This story documents that AT was fairly versed in Jewish religious literature published in Poland. On the other hand, his general attitude toward religion was quite flexible. As I already noted, the Teitelbaums preserved Jewish tradition, but AT celebrated in his family home Easter and Christmas (the main Catholic holidays) as well. It can be considered as his early inclination toward Polish identification. This attitude did not save him against anti-Semitism. He and his brother frequently heard offending anti-Jewish remarks of their contemporaries. These unpleasant experiences from the youth made persistent traces in AT's consciousness.

AT entered high school in Warszawa. He studied languages (Latin, German, French), Polish literature, science, mathematics, religion and history. He ended high school with very

¹ Tarski's life is extensively described in [3] and [13]. According to the character of the present volume I concentrate on the years 1901–1939, that is, Tarski's life in Poland. His postwar *curriculum vitae* is treated less extensively. I mention dates of birth and death in the case of Polish people only.

good results in 1918. The high school years of AT happened to be very stormy from the political points of view. World War I began in 1914. German troops attacked Warszawa very soon and Russian army had to step back. What was extremely important for young Polish patriots (AT decisively belonged to them) consisted in great hopes that Poland would recover its independence lost at the end of the 18th century. It happened in the autumn of 1918, exactly on November 11. AT began his university study four weeks before this date; his matriculation (a celebrated nomination as a student) occurred on October 15. As far as the matter concerns his nationality, he considered himself as a Pole, although he did not deny his Jewish origin. As many others Jews living in Poland, AT considered full assimilation as the only possible defense against anti-Semitism. He stressed his “Polonization” by preferring the form Tajtelbaum over Teitelbaum; the latter looked too German for him. AT’s political views were close to socialism at that time.

AT began his university education as a student of biology. Due to the difficult political situation in Poland (the problem of fighting for the borders of the country) the University of Warsaw was closed just after AT’s matriculation. He was taken to army and served in a unit doing military logistic work. AT returned to his studies in 1919, but he decided to study mathematics. This change was related to his participation in a course in logic conducted by Stanisław Leśniewski, who had just started his teaching as the Professor of the Philosophy of Mathematics. Leśniewski informed his students on one open problems in set theory, concerning the concept of ordered set, and AT solved it. Leśniewski immediately suggested AT to switch from biology to mathematics, particularly mathematical logic. The result achieved by AT was published in his first scientific paper, published in *Pogląd Filozoficzny* (Philosophical Review) in 1921; the subtitle of this work has the subtitle “From the seminar of prof. Stanisław Leśniewski in the University of Warsaw”. It was the very beginning of AT’s spectacular scientific career as one of the greatest logicians in the entire history of logic.

Entering into the territory of logic, AT was probably not aware that he would inscribe himself to a fast growing superpower in mathematical logic and the foundations of mathematics. How did it happen that a country without a specially strong tradition in logic so quickly (during one generation in the years 1918–1939) became a real stronghold in this field? In particular, this qualification concerns the Warsaw School of Logic. This school was established by philosophers and mathematicians. In philosophy, everything goes to Kazimierz Twardowski, a student of Brentano and the founder of the Lvov-Warsaw School. Twardowski (1866-1938) was appointed professor of philosophy at Lvov University in 1895. He wanted to introduce Brentano’s metaphilosophical program in Poland. In particular, he demanded clarity

language and thought and believed in scientific philosophy. Following his teacher, Twardowski maintained that philosophical method is (or can be) exactly the same as that executed in so-called special sciences. Twardowski was not a logician and did not consider himself as such. On the other hand, his metaphilosophical views formed a very friendly environment for logic *sensu largo*, that is, covering formal logic (the term “mathematical logic” was rarely used at that time), semantics and the methodology of science. Twardowski lectured on elementary algebra of logic in the academic year 1899/1900; in fact, it was the first university course on this topic in Poland (more precisely in the part of Poland belonging to the Austro-Hungarian Empire) . Jan Łukasiewicz (1878-1956) participated in this class and very soon became attracted by logic (originally, he studied law, but switched to philosophy under Twardowski’s influence). Łukasiewicz began systematic courses in advanced algebra of logic and other logical topics. He trained many young philosophers with explicit interests in logic, including Kazimierz Ajdukiewicz (1890-1963), Tadeusz Czeżowski (1889-1981), Tadeusz Kotarbiński (1886-1981) and Zygmunt Zawirski (1882-1948); all of them also studied mathematics, mostly under Waław Sierpiński (1882-1969), who acquainted his students with set theory. Stanisław Leśniewski (1886-1939) joined this circle in 1910. Although this group, the Lvov Collegium Philosophicum, as Leśniewski used to say, cannot be regarded as a logical school, logic played a distinguished role in this circle of scholars. Hence, Twardowski insisted that his students should know philosophical novelties, for instance, logical works of Gottlob Frege and Bertrand Russell were well-known in Lvov.

Warszawa appeared on the logical stage exactly in 1915, when the University of Warsaw was reopened; it was closed in 1831 and functioned in 1862-1869 as the Warsaw Main School. The academic staff was mainly imported from Lvov. Łukasiewicz was appointed professor of philosophy. He began lectures in logic and attracted many young mathematicians. When Poland recovered its independence in 1918, this also resulted in a great debate about the tasks and prospects of Polish science and culture (in fact, these discussions began about 1916). Scholars in every field discussed how to develop their disciplines in the new expected political situation and what should be done in order to catch up with world science. Particularly important was the discussion among mathematicians. In fact, it had already started in Lvov, but was rather as a private enterprise, involving Sierpiński and Zygmunt Janiszewski (1888-1920). Both were disappointed by a lack of a common language and interests among Polish mathematicians and both were convinced that set theory and topology should play a fundamental role in mathematics. The national discussion about science, its needs and perspectives, was a good occasion for manifesting views about the future of mathematics in

Poland. Janiszewski became the main exponent of the project, later known as the Janiszewski program, which defined the ideological fundament of the Polish Mathematical School.

Roughly speaking, according to Janiszewski, Polish mathematicians should concentrate on chosen mathematical fields and work in one strong circle. The second point was very soon abandoned, but the first was adopted. Although Janiszewski did not mention any concrete topic to be cultivated in Poland, most Polish mathematicians understood it as favouring set theory, topology and their applications to other branches of mathematics. Janiszewski also postulated that Poland should have a special mathematical journal published in international languages. This idea found its realization in *Fundamenta Mathematicae* (the first volume appeared in 1920). Janiszewski's program attributed a great role to mathematical logic and the foundations of mathematics. The placement of logic and the foundations at the heart of mathematics required definite steps in the sphere of organization. The University of Warsaw had the Faculty of Mathematical and Natural Sciences. The Department of the Philosophy of Mathematics was very soon organized and Leśniewski became its head; Łukasiewicz left the University in 1918 in order to serve as the Minister of Religious Denominations and Education in the government under Ignacy Paderewski. He returned to the academic staff in 1919 and the University established for him a special position in philosophy at the Faculty of Mathematics and Natural Sciences. Both professors began intensively teaching mathematical logic, mostly among mathematicians but also among philosophers; Ajdukiewicz taught at this faculty in the years 1926–1927. The first project of *Fundamenta Mathematicae* divided the journal into two series, one devoted to set theory, topology and their applications, and second to logic and the foundations. This project was finally abandoned, but the significance of mathematical logic in the eyes of the founders of the Polish mathematical school found its impressive manifestation in the composition of the Editorial Board of *Fundamenta*: Mazurkiewicz, Sierpiński, Leśniewski and Łukasiewicz. Logic was also popularized among students of philosophy by Kotarbiński.

Generally speaking, the logical circle in Warszawa, known as the Warsaw School of Logic, was a child of two movements, namely the Lvov-Warsaw Philosophical School and the Polish Mathematical School. Both determined the scientific environment in which AT grew as a logicians. In fact, he opened the list of young mathematicians and philosophers attracted by logic in Warszawa. This group included (in alphabetical order and covering the whole interwar period): Stanisław Jaśkowski (1906-1965), Adolf Lindenbaum (1904-1941?), Andrzej Mostowski (1913-1975), Moses Presburger (1904?-1943), Jerzy Słupecki (1904-1984), Bolesław Sobociński (1904-1980; a philosopher by training) and Mordechaj Wajsberg

(1902-1942?). The names of three other of logicians who graduated shortly before 1939 or studied during War World II and began their academic work after 1945 should be added to this list, namely Jan Kalicki (1922-1953; a mathematician), Czesław Lejewski (1913-2001; a classicist and philosopher) and Henryk Hiż (1917; a philosopher).

AT studied mathematics at the University of Warsaw from 1919 to 1923. He attended courses and seminars by (*inter alia*) Leśniewski (the foundations of mathematics), Kotarbiński (logic), Sierpiński (set theory), Mazurkiewicz (analysis), Kazimierz Kuratowski (topology) and Leon Petrażycki (sociology). AT also met his student fellows interested in logic, namely Lindenbaum and Wajsberg. The former became his close friend and collaborator; Bronisław Knaster (1893–1990), a mathematician was another close friend of AT. Working with Leśniewski, AT obtained important results concerning prothotetic (an extended propositional calculus), one of three logical systems constructed by Leśniewski. These results constituted AT's doctoral dissertation supervised by Leśniewski, defended in 1924. AT was the only person who did a doctorate under Leśniewski and the latter used to say that he had a 100% of genius doctoral students. AT's PhD dissertation was published in two papers which appeared in *Fundamenta Mathematicae*. In 1923, AT acted as the secretary of the logic section of the 1st Polish Philosophical Congress in Lvov. On that occasion he met Stefan Banach (1892-1945). At the same year they published (1892-1945) a famous paper on the paradoxical decomposition of a ball. This result, called the Banach-Tarski paradox shows some surprising consequences of the axiom of choice. In 1925, AT obtained his habilitation on the base of a dissertation on the concept of finite set and became the youngest docent (a scholar who had *veniam legendi* and thereby could lecture at university) in the entire history of mathematics in Poland. After his doctorate, AT was mostly involved in set theory. His deep and numerous results (partly achieved together with Lindenbaum) ensured him a distinguished place in the Polish Mathematical School.

AT all the time was thinking how to strengthen his Polonization. He decided to change his surname, following advices of Leśniewski and Łukasiewicz, AT and Waclaw, his brother (he studied law), adopted the name Tarski. Firstly, it was added to Tajtelbaum. For instance, AT's mentioned paper published in *Przegląd Filozoficzny* is signed by Tajtelbaum-Tarski, but his PhD diploma is for Alfred Tarski. AT also converted to Catholicism. These moves were motivated by his intention to be recognized as a Pole. In 1929, AT married Maria Witkowska; they had two children; Jan born in 1934, and Ina born in 1938. Although changing name and converting to Catholicism helped to some extent, AT (and Waclaw as well) were stigmatized as Jews by Polish anti-Semitic activists. In the late 1930s. a booklet ap-

peared with a list of dangerous Jews, that is, such who changed names and converted. Both Alfred and Waław were included into this infamous register. As far as the issue concerning AT's style of life, he belonged to a group of friends who met in cafes and used alcohol or even drugs; he was a heavy smoker until the end of his life. One of AT's friends deserves a special attention. It was Stanisław Ignacy Witkiewicz (1885–1939), called Witkacy. He was a writer, painter, philosopher and a very eccentric person. Witkacy made portraits of Alfred and Maria. The head of the former is presented inside spikes. A very accurate picture. AT and Maria frequently went to Zakopane, a very popular resort in the Tatra mountains, where they climbed.

The professional career of AT was not easy. Having *veniam legendi*; he could lecture and conduct seminars at university. He delivered many advanced courses, for instance, on set theory, methodology of deductive sciences, geometry or arithmetic of natural numbers, in order to mention a few. In 1929, he officially became an assistant of Łukasiewicz in the Department of Philosophy existing at the Faculty of Mathematics and Natural Sciences (this chair was especially established for Łukasiewicz). AT, in order to earn money needed for his family had to find a job outside the university. He worked as a teacher of mathematics in the Żeromski Secondary School in Warszawa and the National Pedagogical Institute, which organized training for teachers of mathematics; he had to resign from the latter for his Jewish origin. Perhaps AT's teaching of elementary geometry should be especially mentioned, because it resulted in his involvement into writing textbooks for schools and inventing problems. AT also published a textbook on mathematical logic (see [27]). This small book was written for students of secondary schools, particularly interested in logic. It was translated into German in 1937 and, in a revised and extended version, into English in 1941 (see [28]), and reprinted many times (translations into other languages were published as well). When I told one of my American colleagues that the book in question was written for secondary schools, he replied with a surprise that it is too difficult for most students of American universities. In a guide for students of mathematics in Warsaw University published in 1926 after a list of textbooks of elementary logic, we find information that the 1st volume of *Principia Mathematica* is recommended of advanced students. These facts illustrate how logic was taught in Poland, particularly in Warszawa in the interwar period.

AT's academic ambitions went further than to occupy the position of a docent or assistant. He intended to be a university professor. The first opportunity appeared in 1928, when the Lvov University decided to establish the professorship in mathematical logic at the Faculty of Mathematics and Natural Sciences. Leon Chwistek (1884–1944) and AT were

competitors. The former had a strong support of mathematicians, also Banach, who was in a difficult personal situation due to his mentioned work with AT. Philosophers, particularly Twardowski, acting in the name of Leśniewski and Łukasiewicz, preferred AT. The University invited Luitzen Brouwer, David Hilbert and Bertrand Russell as referees. These names show how serious was this competition. It is not surprising for the great prestige of logic in the interwar period. In fact, Poland had 5 professorships in logic in the years 1918–1939. How many were there outside Poland? The answer is surprising: just one, in Münster, in Germany.

Chwistek won this rivalry. AT was convinced that his Jewishness played the decisive role in this issue. However, one should be very careful in evaluation of what was going on in the competition in question. Doubtless, Tarski's Jewish origin did not help. In fact, not many Jews became full professors in the interwar Poland, but some succeeded; for instance Hugo Steinhaus (1887–1972), a distinguished mathematician and very powerful professor in Lvov. Since his sister married Chwistek, Steinhaus' support for AT's rival was natural. On the other hand, Jewishness of Mrs. Chwistek did not do a favor to her husband, because anti-Semites did not like persons with Jewish spouses. Importantly, Chwistek was older, better known at that time and supported by Jagiellonian University in Kraków. According to Polish academic rules, universities had a right to opt for candidates for professorships. In his case, Warsaw University supported AT, but Cracow University voted for Chwistek. Last but not least, Russell wrote a well-known letter in which he recommended Chwistek (opinions of Brouwer and Hilbert are unknown). Russell explicitly said that since he knew Chwistek and his work, the choice of Chwistek would be a good decision. However, he added that his recommendation was not based on a comparison of both rivals, because "The work of Mr. Tarski I do not at the moment remember and do not have access to at present". Ironically, Russell quoted AT's papers in the second edition of *Principia Mathematica*. According to recollections of some people (I heard this story from Hiż), the second opportunity for AT to be appointed as professor appeared in Poznań in 1937, when Zawirski moved to Kraków; but Poznan University cancelled the professorship in logic, apparently to block Tarski as a Jew. This affair is not testified by existing documents, but if it actually happened, anti-Semitic attitude, strong in Poznan, played the decisive role in rejecting Tarski. Tarski as a docent could not supervise doctorates. However, he was the doctor father of Mostowski (1938) – Kuratowski acted as the official supervisor. There is also a very surprising story about Presburger. He proved the completeness of so-called Presburger arithmetic (theory of natural numbers with addition as the sole operation). Presburger asked AT whether this theorem is sufficient for obtaining the doctoral

degree. The answer was entirely negative – AT considered this result as too trivial. He made a mistake, because Presburger’s result is presently considered as a very serious achievement.

Tarski intensively worked in the 1930s. He continued his work in set theory, but was more and more involved in logic and metamathematics. In a series of papers, he defined several notions used by logicians (and mathematicians as well) rather in an intuitive way. For instance, he axiomatized the concept of logical consequence and deductive system. His most important work concerned the concept of truth. In 1930, AT delivered a talk about the concept of truth in deductive science. His famous monograph *Pojęcie prawdy w językach nauk dedukcyjnych* (The Concept of Truth in Languages of Deductive Sciences) appeared in 1933 (see [25]). Its German translation *Der Wahrheitsbegriff in den formalisierten Sprachen* (The Concept of Truth in Formalized Languages) was published in 1935 (see [26]) and English version in 1956 (see [29]). Since this idea is extensively presented in another paper in this volume, I only mention it in this place. At the moment let me add that the semantic definition of truth (it is, so to speak, the official label for AT’s approach to truth) is (a) the most important result of AT; (b) one of the most important achievements in analytic philosophy; (c) the idea which originated model theory as one of the most important parts of contemporary logic; (d) the most important achievement in the entire history of Polish philosophy. Even if someone will say that there are no clear criteria of what belong to the most important philosophical achievements, sociological measures support the opinion expressed in (b) and (d).

In the interwar period, AT active participated in scientific life, mathematical and philosophical, in Poland, and on the international scale, in particular in all Polish Philosophical Congresses (Lvov – 1923, Warszawa – 1927, Kraków – 1936), in many mathematical congresses (for example, the 8 Mathematical Congress in Bologna, the 1 Congress of Mathematicians of Slavic countries), in the 8 International Philosophical Congresses (Prague 1934) and in the 1st Congress for Scientific Philosophy (Paris 1935). AT’s participation in the last event was remarkable. He, invited by Karl Menger, visited Vienna in 1930. Menger introduced AT to many philosophers, directly or indirectly associated with the Vienna Circle. In particular, AT met Rudolf Carnap and Kurt Gödel for the first time. In the next years, AT visited Vienna several times and had discussions with Viennese philosophers, particularly with Karl Popper. AT’s reported his semantic ideas in discussions in Vienna. As it is known, the Vienna Circle was skeptical about semantics and its significance for philosophy. AT convinced Carnap and Popper (he was not a member of the Circle) to semantics. Carnap insisted that AT should deliver a talk on semantics at the Paris Congress in 1935. Tarski agreed, although he expected a criticism of semantics, and delivered one lecture on the foundations of semantics and the sec-

ond on the concept of logical consequence. These talks were recognized as the most important scientific events of the Congress. The other paper about semantics was read by Maria Kokoszyńska (1905–1981), a close friend of AT. All these contributions caused a very hot discussion. The Poles (or the Polish camp as it was called) and Carnap definitely defended the role of semantics in philosophy, but Otto Neurath radically opposed to using semantic tools in philosophical analysis. He was afraid that semantics could introduce bad metaphysics into philosophy. The controversy over semantics was continued in the next years. Although Neurath (he died in 1945) never accepted semantics as a legitimate part of philosophy, the Polish camp finally won. Thus, AT became one of the most influential thinkers in contemporary philosophy. Even if someone were to say that contemporary anti-realistic semantics rejected the semantic theory of truth, it is still semantics.

In the 1930s several philosophers visited Poland, for instance, Carnap, Joseph Woodger, Willard van Orman Quine, and Heinrich Scholz. They appreciated very positively the philosophical situation in the country, particularly AT and his achievements. Scholz said once that he was surprised that AT had not been promoted to the professor position. A new possibility appeared after Leśniewski's death in May 1939. AT hoped to be his successor. Yet the political situation in Europe became more and more dangerous. Quine urged that AT should leave Poland. The Congress for Scientific Philosophy to be organized at the Harvard University, created a good opportunity. AT had mixed feelings. On the one hand, he liked to participate in scientific events, also because his ambitions were satisfied by his position as a great star in logic; but on the second hand, he wanted to be present in Warszawa, when the succession after Leśniewski would be decided; it was expected to happen in the autumn of 1939. Finally, he decided to go to USA. On August 11, AT embarked on a ship sailing to America. He took only a small suitcase, as he planned to return very soon. He landed in New York on August 24. The war began exactly one week later. Maria Tarski with two children remained in Poland. She left Warszawa and survived. Maria was Aryan, but Jan and Ina, the children, satisfied the condition of Jewishness introduced by the Nürnberg statutes. AT's parents were murdered by the Nazis in Auschwitz, and Wacław, his brother was killed in Warszawa just before the end of the war. If AT were to remain in Poland, his fate would probably be tragic. One of the chapters in the Feferman's book (see [3]) has "How the "Unity of Science" Saved Tarski's Life" as its title. Very proper, indeed. Several Polish logicians of Jewish origin, including Lindenbaum and Wajsberg, perished in the Holocaust.

AT participated in the Harvard Congress. However, the question "What then?" was urgent. Quine arranged a research appointment at Harvard for AT. He temporarily lectured at

Columbia University for undergraduate students of Ernest Nagel. Then, he became a visiting professor at the City University of New York. Russell tried to help AT in getting a permanent position at Columbia, but these attempts were unsuccessful. Some support came from the Young Men's Hebrew Association in New York. The Guggenheim Fund gave a fellowship for AT; he used it to stay in Princeton where he met Gödel once again. Important things happened at Harvard in 1940–1941. A discussion group of logic was formed, including Carnap, Quine, AT and Russell as main participants (see [4]). Moreover, AT gave several talks in many places in the USA from the East Coast to the Midwest. Besides troubles with getting a permanent job, AT was terribly worried about his family in Poland. He was, of course, fully conscious of the danger for the life of Maria and children. From time to time, he had indirect news obtained with the help of Father Józef M. Bocheński (1902–1995) and Anders Wedberg. The problems with job ended in 1942, when the University of California at Berkeley offered a position for AT as a lecturer. AT became a USA citizen in 1945. In the early 1945, he received a letter from Maria informing him that she and the children survived. They arrived to Berkeley on January 6, 1946. This day ends AT's Odyssey from Warsaw to Berkeley.

AT became the full professor at the age of 45 in 1946. Perhaps it should be noted in the Guinness book as a world record in the category of eminent scientists waiting for the professorship. He was elected to the National Academy of Sciences, the Royal Netherlands Academy of Arts and Sciences and the British Academy, served as President of the Association of Symbolic Logic (1944–1946) and the International Union for the History and Philosophy of Science in 1956–1957; initiated the International Congresses of Logic, Methodology and Philosophy of Science (the 1st Congress took place in Stanford in 1960). He received honorary degrees from the Catholic University of Chile (1975), the University of Marseilles (1977) and the University of California (1982). He travelled all over the world and, as before the war, participated in many scientific congresses and conferences. He visited once Poland; it happened in 1959. He had a permanent sentiment to his first homeland, although he considered himself as American after 1945. When a conference was organized to celebrate AT's one hundredth anniversary in Warszawa, Leon Henkin wrote to me that Alfred's heart remained in this city for ever. The family spoke Polish in the daily life and his house in Berkeley was always opened to guests from Poland. AT, remembering his youth, was always very sensitive to all signs of anti-Semitism. He rejected an invitation to Poland in 1968, protesting against anti-Semitic campaign executed by Polish authorities at that time. On the other hand, AT supported the "Solidarity" movement in 1981–1982 and offered a considerable amount of money for the Kościuszko Fund, giving scholarships for Polish scientists. He maintained

close contacts with Polish friends. AT's famous collection *Logic, Semantics, Metamathematics* (see [29]), published in 1956 has the dedication "To His Teacher Tadeusz Kotarbiński – the Author". AT had many distinguished teachers, but he decided to celebrate just Kotarbiński, as a pattern of humanity. And AT changed his earlier socialist political views to more social-democratic. Alfred Tarski died in Berkeley on October 26, 1983.

AT was a great teacher. Although he was very demanding and not always nice to his students, he attracted many people to logic. As a result, he supervised 24 doctoral dissertation. The list of his students includes (in the chronological order): Bjarni Jonsson, Louise Chin Lim, Julia Robinson, Wanda Szmielew, Frederick Thompson, Anne Morel, Robert Vaught, Cheng-Chung Chang, Solomon Feferman, Richard Montague, Jerome Keisler, Donald Monk, Haim Gaifman, William Hanf, John Doner, Robert Bratford, Haragauri Gupta, Donald Pigozzi, George McNulty, Charles Martin, Roger Maddux, Benjamin Wells and Kan Ng. AT also directly influenced the work of such logicians as John MacKinsey, Dana Scott and Steven Givant. He created the California School of Logic, the most powerful logical circle in the USA. The number of mathematicians and philosophers indirectly influenced by AT and his ideas is enormous. His writings appeared at least in the following languages: Bulgarian, Czech, Dutch, English, French, German, Georgian, Hebrew, Hungarian, Italian, Polish, Portuguese, Romanian, Russian, Serbian-Croatian, Spanish and Swedish.

AT research in his American period is complex. Perhaps his contributions to the model theory are most important. AT and his students developed so-called Western (Californian) model theory. Its main idea consists in investigations of the relation between languages and mathematical structures. The former are regarded as the starting point. By contrast, the Eastern model theory, developed by Abraham Robinson, generalizes algebraic concepts. Roughly speaking, the former approach is more logical, but the latter – more mathematical, although these differences are rather vague at the present. Generally speaking, AT continued the ideology of the Warsaw School of Logic. Although he considered mathematical logic as a part of mathematics, he considered it as a relatively autonomous. In particular, he did not agree that logic is servant of mathematics. The most important feature of his approach to logic consisted in admission of all mathematically accepted methods, regardless whether they were constructive or not. For instance, AT had no scruples in using the axiom of choice. This attitude was very characteristic for the Polish Mathematical School. More specifically, philosophical controversies around this axiom are entirely independent of its mathematical applications. On the other hand, there is tension between a free use of infinitistic methods by AT and his explicit predilections toward nominalism as a philosophical position rejecting abstract objects; he also

accepted empiricism in epistemology. AT, asked how he reconciled his private philosophy with his mathematical practice, answered that he felt like a tortured nominalist. AT added that there exist various tale-stories, set theory belongs to this variety, but it is very useful. In his early years, AT understood logic relatively widely as covering set theory, but, according to his later views, he favored first-order, logic as *the* logic. As far as the issue concerns the plurality of logical systems, although AT obtained important results in non-classical logics, particularly, many-valued and intuitionistic, he preferred the classical system as *the* logic. On the other hand, he was ready to investigate every logical system provided that such a research was interesting from the mathematical point of view.

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