Israel Moiseevitch Gelfand and the Search for an Adequate Language for Medical Diagnosis

bf Casimir Kulikowski

Seventeen years ago, Saul Amarel and I received an unexpected invitation to meet Israel Moiseevitch Gelfand. It was arranged by Felix Browder, then VP for Research at Rutgers. Amarel and I had explored artificial intelligence in medicine; with Sholom Weiss we developed one of the first expert systems for clinical diagnosis and treatment based on the causal reasoning of specialists about diseases, like glaucoma. Most memorable from that first meeting was the laser look Israel Moiseevitch fixed on us as we presented our medical work. I learned Gelfands work in functional analysis and integral geometry in graduate school; his research was fundamental to medical image reconstruction. We were surprised to hear that he had been collaborating with top medical experts in the Soviet Union for more than 20 years; he called this research Diagnostic Games. He developed ways to elicit expert knowledge from clinicians explaining how they solved specific patient diagnoses. As our meeting ended Israel Moiseevitch gave us a copy of his Kyoto Prize lecture from 1989 entitled Two Archetypes in the Psychology of Man. In it he contrasted mathematical archetypes to natural archetypes of human thinking and action, and emphasized the need to develop adequate languages for bridging the two. Shortly after that he invited me to work with him in diagnostic games involving cardiology and other specialties. I realized that Gelfand was looking for a way to characterize the essential elements of diagnostic reasoning anchored on specific clinical cases rather than statistical abstracts from groups of cases. The language had to be adequate in embracing both the selection of concepts and their interrelationships to capture most economically a specific doctors description of the patient he is examining. Israel Moiseevitchs deep insights in this field have not been widely recognized. Although related to protocol analysis methods developed in psychology since the 1960s, Gelfands approach significantly differs from these by requiring the mathematician or computer scientist to use a protocol that elicits and modifies basic structural concepts– in his Kyoto address he called these structural units. These are now termed the components of a formal ontology. His structural concepts are based on the specific guidance from an individual case as it is being solved dynamically. Although it has some relation to case-based reasoning in artificial intelligence, Gelfands method preceded this, and introduced a formal, mathematical systematization absent from most heuristic-based methods .

After working with Israel Moiseevitch on a number of clinical problems, we moved on to biological problems like the algorithmic extraction of the geometrical core of several immunoglobulin domains with Alex Kister, Ognyan Stoyanov, and Cyrus Chothia. I am sorry that we never had the opportunity to return to work together on the problem of diagnostic games, because recent developments of computational ontologies might provide an opportunity for applying his methodology to build what he had envisioned; an adequate language for describing expert clinical decisions by intertwining individual human-biological contextual insights to help bias whatever mathematical or statistical techniques we use to model groups or populations of patients. All in a principled, systematic manner.

I will miss Israel Moiseevitch not only for his most generous advice on scientific and mathematical matters, but for his kindness and empathy with me and my wife during her

protracted illnesses over the past decade. He exemplified a true depth of understanding for those who suffer. I will miss his deep humanity, and while mourning his passing with you, I am sure that his memory will continue to inspire us in bridging the two archetypes he spoke of and practiced so eloquently.