

APPROXIMATE REASONING AND THE ETHNOMATHEMATICS OF COOKING

RAZONAMIENTO APROXIMADO Y ETNOMATEMÁTICA DE LA COCINA

O RACIOCÍNIO APROXIMADO E A ETNOMATEMÁTICA DA COZINHA

A Mani

(Indian Statistical Institute, India)

a.mani.cms@gmail.com

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ABSTRACT

Several methods of approximate reasoning are known and many remain to be discovered across domains. Some are tied to reasoning with uncertainty. The developments over the last fifty years or so in the development of approximate reasoning methods, and their application across multiple STEM domains suggest that it is necessary to introduce them early in school. While efforts towards building the infrastructure for the process have been limited, the bigger question is “What should be introduced?”. If concepts are always approximated in real life, then how should they be done mathematically? If the real numbers are not always necessary to approximate concepts or even quantities, then how should they be approximated, and what should be taught in schools? Specifically, functional representations of approximate reasoning are not introduced early. This additionally impedes diversity, ethnomathematical explorations, learning from experience, and through models. The objective of this research is to explain the problem with a focus on the ethnomathematics of cooking, and associated haptic methods. Further, it is argued through the context that of the many approaches to approximate reasoning, intrusive methods are best avoided, and that general rough sets is better suited for modeling such knowledge. Intrusive methods such as those based on fuzzy or probability theory are those that indulge in an excess of unjustified numeric assumptions. This builds on earlier work of the present author on modeling approximate reasoning. Her axiomatic approach to granularity are additionally applicable to approximate recipes that possess desired properties. In the contexts of ethnomathematical discourse involving haptic reasoning (as in cooking), it is shown that such an approach can model the essence of context without oversimplifications or outright dismissal of the efforts involved. Further, it has the potential to help in inventing expressive structured languages for the ethnomathematics, and associated model eliciting activities. Distinct facets of three specific contexts are theoretically explored to illustrate aspects of the reasoning, and meta aspects.

Keywords: approximate reasoning. ethnomathematics. haptic methods.

RESUMEN

Se conocen varios métodos de razonamiento aproximado y muchos quedan por descubrir en todos los dominios. Algunos están ligados a razonar con incertidumbre. Los desarrollos durante los últimos cincuenta años más o menos en el desarrollo de métodos de razonamiento aproximados y su aplicación en múltiples STEM dominios sugieren que es necesario

introducirlos temprano en la escuela. Mientras los esfuerzos para construir la infraestructura para el proceso han sido limitados, la pregunta más importante es "¿Qué se debe introducir?". Si los conceptos son siempre aproximados en la vida real, entonces, ¿cómo deberían hacerse matemáticamente? Si los números reales no siempre son necesarios para aproximar conceptos o incluso cantidades, entonces, ¿cómo se deben aproximar y qué se debe enseñar en ¿escuelas? Específicamente, las representaciones funcionales del razonamiento aproximado no son introducido temprano. Esto además impide la diversidad, etnomatemática exploraciones, aprendiendo de la experiencia y a través de modelos. El objetivo de este investigación es explicar el problema con un enfoque en las etnomatemáticas de cocción y métodos hápticos asociados. Además, se argumenta a través del contexto que de los muchos enfoques del razonamiento aproximado, los métodos intrusivos son es mejor evitarlo, y que los conjuntos generales generales son más adecuados para modelar tales conocimiento. Métodos intrusivos como los basados en la teoría difusa o de probabilidad son aquellos que se entregan a un exceso de suposiciones numéricas injustificadas. Este se basa en trabajos anteriores del presente autor sobre el modelado del razonamiento aproximado. A ella enfoque axiomático de la granularidad también es aplicable a aproximaciones recetas que poseen las propiedades deseadas. En los contextos del discurso etnomatemático que implica el razonamiento háptico (como en cocinar), se muestra que tal enfoque puede modelar la esencia del contexto sin simplificaciones excesivas ni desestimación directa de los esfuerzos involucrados. Además, tiene el potencial de ayudar en la invención de lenguajes estructurados expresivos para el etnomatemáticas y actividades asociadas de generación de modelos. distintas facetas de Se exploran teóricamente tres contextos específicos para ilustrar aspectos de la razonamiento y metaaspectos.

Palabras clave: razonamiento aproximado. etnomatemáticas. métodos hápticos.

RESUMO

São já conhecidos vários métodos de raciocínio aproximado, mas ainda muitos se encontram por descobrir em diversos domínios. Alguns estão ligados ao raciocínio com incerteza. Os desenvolvimentos ao longo dos últimos cerca de cinquenta anos no que se refere a métodos de raciocínio aproximado e a sua aplicação em vários domínios das STEM (ciência, tecnologia, engenharia e matemática) sugerem que é necessário introduzi-los cedo na escola. Enquanto os esforços para construir a infra-estrutura para este processo têm sido limitados, a grande questão que se coloca é "O que deve ser introduzido?". Se os conceitos são sempre aproximados na vida real, então como é que eles devem ser feitos matematicamente? Se os números reais nem sempre são necessários para aproximar conceitos ou mesmo quantidades, então como devem eles ser aproximados, e o que deve ser ensinado nas escolas? Em particular, a introdução de representações funcionais de raciocínio aproximado não é realizada primitivamente. Isso também impede a diversidade, as explorações etnomatemáticas, a aprendizagem por experimentação e baseada em modelos. O objetivo desta pesquisa é explicar o problema com foco na etnomatemática do ato de cozinhar e métodos hápticos associados. Para além disso, argumenta-se, através do contexto, que das muitas abordagens para o raciocínio aproximado, os métodos intrusivos devem ser evitados, e que os conjuntos brutos gerais são os mais adequados para modelar tal conhecimento. Métodos intrusivos, como os que são baseados em teoria difusa ou da probabilidade, são aqueles que se entregam a um excesso de suposições numéricas injustificadas. Este trabalho baseia-se num anterior, da presente autora, sobre modelagem de raciocínio aproximado. A abordagem axiomática da granularidade também é aplicável para aproximar receitas que possuam as propriedades desejadas. No contexto do discurso etnomatemático que envolve raciocínio háptico (como em cozinhar) é mostrado que tal abordagem pode modelar a essência do contexto sem simplificações excessivas ou rejeição total dos esforços envolvidos. Adicionalmente, tem o potencial de ajudar na invenção de linguagens estruturadas expressivas para a etnomatemática e respetiva extração de modelos. São

exploradas, do ponto de vista teórico, facetas distintas de três contextos específicos para ilustrar aspectos do raciocínio e meta-aspectos.

Palavras-chave: raciocínio aproximado. etnomatemática. métodos hápticos.

Approximate Reasoning

Approximate reasoning, broadly encompasses reasoning about vague objects, uncertainty, ambiguity, and drawing approximate inferences of a relatively well-defined reality. In fact, skills in approximate reasoning are essential for handling complexity of human diversity, and to avoid harmful reductionist dualities such as those between the mind and body, and biology and culture. In other words, it is essential for critical inquiry.

A fuzzy model of ‘*she is very good*’ would involve subjective valuations like ‘*very*’ is 0.9’ that intrude into the data by changing its intended meaning. There are other methods of approximate reasoning that proceed with unjustified assumptions (especially of a numeric nature) about the context, objects and associated attributes, and there are ones that proceed with a minimum of additional assumptions. Fuzzy sets, probability theories, real-valued subjective probability theories, possibility, objective/subjective Bayesian decision-making, and evidence theory are examples of the former, and are intrusive in many senses. General rough set methods (Mani, 2020a; Mani, 2012; Pagliani & Chakraborty, 2008; Duntsch & Gediga, 2000; Pawlak, 1991), on the hand, are less intrusive, and more so when numeric measures are avoided. Applications to education research are considered in (Mani, 2020b; Mani, 2020c; Mani, 2021a; Mani, 2021b; Mani, 2022b) by the present author. Key aspects of the axiomatic framework are explained by her in (Mani, 2020a). Possibility theories without the burden of numeric valuations may additionally be less intrusive.

The problems and issues of teaching uncertainty from a probabilistic (frequentist, combinatorial or subjective) is explored by many authors in the literature (Greer & Mukhopadhyay, 2005; Jolliffe, 2005; Tarr & Lannin, 2005). However, the point of data intrusion or simply the act of making large excesses of assumptions in modeling (in the education-research sense) or in general is apparently not explicitly considered. Subjective probabilities may take values in a partially ordered set or the set of reals. The latter style of doing it is more common. While humans can argue for a high likelihood of an event, it is well-known that human reasoning does not cohere with the task of estimating numeric probabilities (Teigen, 1994), and this has led to numerous proposals for handling conflicting assignments in the AIML literature.

Numeric measures owe their origin to assignments of weights that specify degrees of truth or of confidence (or degrees of belief) to propositions. These assignments lead to distinct mathematical theories. For example, a statement like “This glass is half-full” can be interpreted from the fuzzy perspective as the degree of truth of “This glass is full” is some value corresponding to ‘half’. There is no probabilistic or possibility reasoning involved here unless one has a suitable sensor or agent. From a classical perspective, either the glass is full or it is not full (reading ‘half-full’ as a single predicate leads to the same situation). Fuzzy truths involve both a gradation of truth-value and of uncertainty as is shown in the example. As such values are very subjective, it is more important to concentrate on ontological aspects towards reducing or explaining the subjective aspect. While the paper (Dubois and Prade 2001) highlights the issue of compositionality (or preservation of valuations relative to standard logical connectives such as conjunction and disjunction) in a few approaches, the possibilities through generalized connectives are not explored.

Statistical methods, always involve making assumptions about the dataset(s) under consideration – this makes them ill-suited for handling connections between concepts that cannot be associated with simple valuations. Descriptive (or exploratory) statistics additionally involve assumptions (though of a relatively milder nature). The positivist approach to descriptive statistics as the ‘one pure statistics’ suffers from a pathetic idea of causality, and the ontological commitments to numerical valuations, and

measures of observed quantities. On the other hand, Bayesian model tests, parametric and non-parametric statistical decision-making are too intrusive, require sufficiently large datasets, robust and predictable contexts, and are of limited value. Abuse or conceptually flawed application of statistical decision-making, probabilistic and subjective probabilistic reasoning is not uncommon in research practice (Bruns & Ioannides, 2006; Collaboration, 2015). Intrusive aspects can additionally be traced to suggested teaching practices as in (Lehrer & English, 2018).

The points mentioned above suggest that an adaptation of non-intrusive reasoning practices, and associated minimalism to learning contexts in school can be useful for clarity in mathematical thinking, and intuitive decision procedures that are less likely to go wrong. Ethnomathematics of different types can provide accessible representations for the purpose.

In the present paper, the nature of reasoning modeled by these theoretical approaches is not comparatively explored in detail. Instead, a few defects of the intrusive approaches are mentioned, and the reason for favoring non-intrusive approaches are pointed out in greater detail. The latter is shown to be relevant for representations of ethnomathematical practices, related modeling, and necessary for a good understanding of the logical complexities involved from a philosophical perspective.

General Rough Sets and Reasoning

From a modern perspective, general rough sets is the study of approximations of an object by others in a set-theoretical, mereological or category-theoretical setting. The approximations may be constructed on the basis of qualitative or quantitative or mixed modal considerations. Technicalities will be omitted here as they are not explicitly used in this paper. The references suggested earlier refer to different facets of rough sets. One reason for its widespread adoption is its applicability to tabular data (Mani, 2021b).

The lower approximation of an object is another object (or a collection of relatively definite properties) that have most or all of the relatively definite properties of the object (possibly a collection). The concept of lower approximation may be a mere description and need not correspond to a new object. Thus, in a farm, suppose a cow X is older than three years, is capable of producing 300 Kg of meat and has no other adverse features. X can be regarded as a lower approximation of another hornless cow that is three and half years old and weighs 360Kg. Approximations naturally depend on the collection of properties considered in a context.

It is however possible to define lower approximations abstractly without actually evaluation every attribute possessed by collections of objects. Specific properties such as the lower approximation of a collection must be a part of the collection, the lower approximation of a sub-collection must necessarily be a part of the lower approximation of the collection can be imposed. Specific potential approximations may be explored for such properties.

Likewise, upper approximations can be viewed from the perspective of possible properties satisfied by a vague object as an object corresponding to the set of properties possibly satisfied by it. The context necessarily determines the perspective. The set of all bovines may be read as an upper approximation of the set of cows provided such an approximation is useful. That cows share the defining properties of bovines is not the only way the mentioned approximation may be constructed.

In the contexts of cooking, lower and upper approximations, additionally come into play in the following way:

A typical recipe should be treated as a clue,

Its lower approximations are recipes that interpret the essence of the recipe subject to chemical constraints without additional ingredients or processes, and

Its upper approximations are recipes that build over the recipe with additional ingredients or processes subject to chemical constraints.

Thus, recipes can have multiple lower and upper approximations. Relations such as “*is as good as*”, and “*is more nutritious than*” can be defined over them. Similar connections are “*is better than*”, “*is as tasty as*”, and “*is a poor version of*”. All these can be defined over sets of recipes and approximations thereof, and it can be checked that the relations are at least quasi orders.

Intrusive Reasoning

The following statements (due to the present author) are intended to illustrate different approximate reasoning strategies in a shopping context involving a shop selling a mix of partly ripe and unripe tomatoes:

- A. They sell half-ripe tomatoes.
- B. They sell unripe tomatoes.
- C. There is a 50% chance that the tomatoes will be half-ripe.
- D. It is very possible that their tomatoes are half-ripe.
- E. The possibility that their tomatoes are half-ripe is 0.5/0.6/0.9.
- F. The probability of their tomatoes being half-ripe is 0.5.
- G. Some/Most/Many of their tomatoes are likely to be unripe.
- H. The ripeness of a heap of tomatoes provided by them is approximated by a set of two ripe and an unripe tomato, or three ripe and an unripe tomato.
- I. Their tomatoes are mostly unripe.
- J. They sell at least two half ripe tomatoes.
- K. All their tomatoes are half ripe.

Readers may be familiar with at least some of the above. The statements have or can be assigned entirely different ontologies. For example, the linguistic hedge ‘mostly’ in statement-I can be assigned values in the unit interval and thus interpreted through a fuzzy function. Statement-F is grounded in some subjective probabilistic interpretation or perhaps in bad mathematics? It is obviously very intrusive as it assumes a lot about the context. Rough interpretations can be considered for ‘A, E, G, I’ and ‘H’, and extended with additional concepts. The lower approximation of ‘A’ can be ‘J’ and its upper approximation may be ‘K’ or ‘B’ or ‘G’ depending on half-ripe tomatoes being necessarily unripe.

Ethnomathematics and Haptic Perception

The generally accepted definition of ethnomathematics (D’Ambrosio, 2006; Mukhopadhyay & Greer, 2015) is that of the mathematics practiced by at least part of cultural groups, such as urban and rural communities, groups of workers, professional classes, children in a given age group, indigenous societies and other groups that are identified by the objectives and traditions common to these groups. Thus, practitioners of such mathematics may be cooks, and painters. These people need not uniformly practice the same kind of mathematics, and wide variations may be common. Ethnomathematics lacks a precise formal definition because it is additionally part of cultures, and affordances of objects in

distinct contexts. In fact, definitions, and proofs of so-called mainstream mathematics involve similar aspects – proofs are because of a culture.

The perception of objects by touch and proprioception in non-verbal communication is referred to as haptic perception. While research on haptic perception is known to the brain research, psychology, and specific machine learning communities, it is not actively employed in fields such as pure or applied mathematics or education. This can be attributed to the complexity of associated mathematical models, and haptic perception being mostly employed in informal contexts. Further, the importance of approximate reasoning as opposed to approximate computation has only been recognized during last few decades. Even in recent papers, haptic perception is seen as a potential aid in visualization or understanding of concepts rather than as a means towards achieving goals. This can be observed in the overview on embodied design and math learning (see for example, (Abrahamson, 2019)).

Ethnomathematical practices involve haptic perception and cognition. In this research, the focus is on mass, number, volume, and density perception in the context of cooking by different classes of people.

Mass, Volume and Density estimation

It is well-known that people are likely to judge the mass of an object better if they actively lift it. In fact, it was demonstrated and confirmed by others that observers were better at discriminating among the masses of objects when they were actively lifted rather than passively rested in the hand (Amazeen, 1999). This proved that the muscles of a person are capable of perceiving the weight of an object. Further, it was observed that the object would be discernible by its mass provided its discernibility ratio is greater than a person-specific fixed constant. The ratio being determined as the ratio of the absolute difference of the mass of an object from that of a standard object to that of the standard object. Learning processes may be associated with such perception. Research over tens of decades has led to a few well-supported conclusions such as:

People are capable of making accurate statements about the length of unseen objects in their hands,

Haptically perceived heaviness is independent of haptically perceived size (Amazeen, 1999), and this unsettles traditional claims about the two being coupled by the brain, and

A person presented with objects of exactly the same weight but different volumes perceives the objects to decline in weight as volume increases.

In fact, the so-called size-weight illusion means that a person's perception of the heaviness of an object does not refer to the object's weight (Jones, 1986; Stevens & Rubin, 1970).

Mathematical models for the hypothesis that a person's haptic perception of the heaviness of an object refers to neither an ordinary physical property of the object nor to a derived mental state are proposed in the paper (Turvey Et. Al., 1999). The tensor-based model assumes that an object's affordances (interpreted as the resistance of the object to translation and rotation, perceivable through a person's muscles) constrain the perception of its heaviness. However, the model (Turvey Et. Al., 1999) follows a more modern understanding of affordances as it is not tied to perception alone (the authors however claims that their theory is based on Gibson's ideas).

Gibson's theory of affordances (Wagman, 2019; Gibson, 1977) in the context of shape perception can be stated as follows: *people tend to pay attention to (and therefore devote more resources for reasoning about) physical shapes and features of objects that are mechanically relevant (or useful for actions) for themselves*. Further it is claimed beyond these affordances, they do not necessarily bother about building a taxonomy of objects based on their shape and attributes. However, Gibson's theory ties affordances to perception, and fails to connect it with the environment. The aspect has been subsequently developed by others (Wagman, 2019). In the present authors' opinion, the notion of affordances is necessary to

describe the relationship between people and material objects as it can specify the mutual dependence between their goals and action, and specifies potential facilities offered by the environment towards performing those actions.

The connection of affordances involved in creativity (in relation to eggs, art, and geometry) is explored in the paper (Glaveanu, 2012), and it is asserted that:

As such, we can conclude that what we mean by creativity and what we mean by affordances often overlaps and creativity can be defined as the process of perceiving, exploiting, and “generating” novel affordances during socially and materially situated activities.

Ethnomathematics of Cooking

This ethnomathematical context is related to concepts such as volume, volume estimation, dynamic volumetric reasoning, density estimation, reasoning about covariance, and three-dimensional transformations. However, the language of models in the literature are unlikely to be the language of practitioners (especially from South-East Asian countries) of such ethnomathematics of any educational attainment.

While, Geogebra is the main tool that enables dynamic volumetric reasoning in the empirical contexts of (Panorkou, 2019) or spatial reasoning abilities in (Seah & Horne, 2020), cooking situations involve granules of different types deployed through bottom up or top-down strategies. The second part of the statement is explained below.

Loosely speaking, granules in the context of approximate reasoning, may be seen as units of reasoning that when combined in appropriate ways lead to approximations of concepts or objects. The reader may refer to (Mani, 2020a) for formal aspects of related theories (the axiomatic approach to granular computing is followed in this research.) When a practitioner adds spices directly from polypacks in increments, then they make use of a top-down granular strategy relying on haptic reasoning about decrease in weight of the poly-pack with unreliable visual feedback about volume. Such an inference is suggested by empirical studies on visual and haptic perception. However, they use a bottom-up strategy while adding spices or salt with bare hands.

Professional cooks including so-called home-makers effectively make use of apparently ill-defined quantitative measures of ingredients. For example, they might add a certain quantity of salt or spice straight from packets into the cooking pot or cauldron. In cultures or scenarios where it is permissible to use one’s hands to touch the spices directly, such people tend to demonstrate finer levels of precision. The approximate reasoning employed in quantitatively estimating the ingredients need not be simple enough for constructing formal models. It is however not too difficult if the goal is restricted to merely compute and add the necessary amount of spices or salt. In fact, current machine learning practices tend to focus on simplified goals, and process to achieve apparent ‘results’.

A proper understanding of such cooking procedures can be useful for reasons such as a need for improved speed, a need to save space and energy, the recognition that greater accuracy may not make a significant difference, and that variations in the measures may actually be helpful for the end consumers. Perspectives of experienced or specialist cooks on the process can additionally lead to multi-criteria decision-making problems of great value in application contexts.

Eggs in a Recipe

Typically, recipes themselves refer to vague, and imprecise quantities of ingredients. For example, the term three eggs refers to three eggs of variable mass, and volume. The volume of an egg can be computed from its external dimensions through many formulas (Hoyt, 1979; Narushin & Romanov et. Al, 2021).

However, they are not easy to use without a specialized small appliance. Optionally, computer vision techniques with the necessary tools may be used. At least three lengths need to be determined for a proper volume estimation (two suffices in some cases). Further, not all chicken eggs are geometrically similar. Haptic perception may lead to reasonable solutions. Additional rules such as the following are often used:

If the eggs appear small, then it is all right to use four eggs instead of three standard ones in a cake.

The desired fluffiness of the cake is better approximated with four small eggs (rather than by three).

The desired fluffiness of the cake is achievable with four small eggs rather than three.

An egg is an egg irrespective of its price.

If the recipe book says three then three it shall be as smaller eggs seem to weigh more.

The first three rules are based on an understanding of the variability of the size of eggs in the context of the cake recipe. However, they are based on different perspectives of the context, and are methodologically different. The first is somewhat opaque about the underlying reasoning, the second refers to a level of fluffiness of the cake (that has a complex nonlinear relationship with the volume of eggs added) and of approximating it closely. Readers may note that chicken eggs typically weigh about 50g without their shell, while the figures for smaller and larger eggs are closer to 40 and 60g respectively. Further, cakes may lose their structural integrity and become dense when suboptimal amount of eggs are used. The last is therefore unjustified, and is confounded by illusions generated by human proprioception.

This case illustrates the use of partial order relations, and upper/lower approximations based on qualitative features. Formally, these can be exactly described through sets and relations or through rules relating to the partial order and attributes. Practitioners of ethnomathematics can derive the advanced rules that they make use of in multiple ways, and it would be useful to study these. A critical cook would also reflect on the recipe and procedures because the chemical composition of an egg changes drastically with cooking time (Provost Et. Al, 2016). That said, it does happen that invalid rules and inappropriate approximations may be part of ethnomathematical practice. The last rule about the use of eggs is an example.

Commercial Biryani

A large pot of biryani (typically prepared with beef, rice, spices, oil, and vegetables) may require at least 1.5Kg of salt to taste. In many large restaurants in the Indian subcontinent, the cooks add most spices directly from polythene packets of different sizes. Salt is sold in packs of 1 Kg, and so cooks are likely to add a packet, roughly half of another, and a little more. The same methodology is used for other spices. Apparently, this would save about 10 minutes relative to a method that relies on a precise weighing scale. The lack of sufficient infrastructure/space for weighing may be another reason – the addition of this constraint to the problem leads to the view of the strategy as an approximate optimal solution. In fact, such conditions are normal in congested cities where space is overpriced. The granular approximation strategy mentioned earlier applies to the tasks mentioned. However, the haptic evolution is not too clear, and requires expression in a new language.

The above illustrates an important aspect of ethnomathematical situations – that of identifying the original vague issues solved. Relevant questions that relate to the context are: ‘does it even lead to any quality control on the end product?’, ‘is it possible to indicate hierarchies on the nature of applied knowledge?’, and ‘how embodied are such skills?’. These questions and possible answers require a more

detailed explanation of the processes mentioned. While detailed theory for specific contexts are not known, partial mathematical models do exist in the discourses.

Deprivation and Cooking

Often, people cook with insufficient resources, and this leads to lack of nutrients, and food that is lacking in taste, and quality. While many classes do remain hungry, those that can afford a little more, make foods full of fillers (consisting mostly of cheaper carbohydrates). Their eating styles further relate to the effects of man-made famines in countries with enduring aspects of old and new colonialism such as India. A relevant question in this context is “How do these aspects express themselves in approximate reasoning?”

Recipes are approximated from both qualitative and quantitative perspectives during the process. Often people may not be aware of the history, the nature of, the nutritive value, and are governed by rules such as ‘it is necessary to stuff one’s stomach with rice’. Such rules and context determine the approximations of the concept of a meal. Meat and salad with a few carbohydrates may not be seen as a proper meal by many communities – this means that the composition of granules (components of a meal) does not follow Boolean disjunction.

Remarks

In this research, approximate reasoning of different types that have formal methodologies associated are reflected upon, connected with haptic reasoning, and distributed cognition. It is argued that general rough sets can be non-intrusively applied to model associated reasoning without indulging in often poorly justified use of real numbers that pervade practical approximate decision-making. The nature of ethnomathematics of cooks is explored, and it is suggested that the context has the potential for explorations of uncharted territories of approximate reasoning. Related modeling activities for learners that focus on non-intrusive reasoning and haptic perception are thus strongly motivated.

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