
<p>Appel à projets franco-allemand en sciences humaines et sociales</p>	<p>Ausschreibung eines deutsch-französischen Programms in den Geistes- und Sozialwissenschaften</p>
<p>Programme non-thématique</p>	<p>Ohne thematische Vorgaben</p>
<p>2016</p>	<p>2016</p>
<p>Titre du projet Collective Attitude Formation</p>	<p>Projekttitel Collective Attitude Formation</p>
<p>Acronyme : ColAForm</p>	<p>Kennwort : ColAForm</p>
<p>Mikaël COZIC Université Paris-Est Créteil & Institut Universitaire de France</p>	<p>Olivier ROY Universität Bayreuth</p>

1. FICHE D'IDENTITÉ DU PROJET

1.1. Partenariat et participants

French team : (in blue: people with a permanent position ; in red: people with non-permanent position)

Prénom	NOM	Statut	Rattachement(s)	Coordonnées	Rôle dans le projet	Temps d'engagement
Mikaël	COZIC	Maître de conférences	Université Paris-Est Créteil & Institut Universitaire de France	61 av. du Général de Gaulle 94000 Créteil	Coordinateur	18
Jean	BACCELLI	ATER	Université de Cergy-Pontoise, Département d'économie	33, bvd du Port 95000 Cergy-Pontoise	Participant direct au projet	6
Denis	BONNAY	Maître de conférences	Université Paris-Ouest Nanterre	200 avenue de la République, 92001 Nanterre Cedex	Participant direct au projet	12
Franz	DIETRICH	DR CNRS	Centre d'économie de la Sorbonne (UMR 8174)	Maison des Sciences Economiques 106-112 Boulevard de l'Hôpital 75647 Paris Cedex 13	Participant direct au projet	5
Isabelle	DROUET	Maître de conférences	Université Paris-Sorbonne	1 rue Victor Cousin - 75230 Paris cedex 05	Participant direct au projet	9
Paul	EGRE	CR CNRS & Maître de conférences attaché à l'ENS	Institut Jean Nicod (UMR 8129)	29, rue d'Ulm 75005 Paris	Participant direct au projet	4
Marc	FLEURBAEY	Professeur	FMSH (Collège d'études mondiales)	190, avenue de France CS n° 71345	Participant direct au projet	6

				75648 Paris, Paris (75)		
Brian	HILL	CR CNRS	GREGHEC (UMR 2959)	1, rue de la Libération 78351 Jouy-en-Josas cedex France	Participant direct au projet	6
Reza	LAHIDJI	Directeur de programme	GREGHEC (UMR 2959), membre associé	International Law and Policy Institute PO Box 1619 Vika NO-0119 Oslo Norvège	Participant direct au projet	5
Philippe	MONGIN	DR CNRS	GREGHEC (UMR 2959)	1, rue de la Libération 78351 Jouy-en-Josas cedex France	Participant direct au projet	8
Cédric	PATERNOTT E	Maitre de conference	Paris IV, Sorbonne		Participant direct au projet	8
Marcus	PIVATO	Professeur	Université de Cergy-Pontoise, Département d'économie	33, bvd du Port 95000 Cergy-Pontois e	Participant direct au projet	8
Stéphane	ZUBER	CR CNRS	Centre d'économie de la Sorbonne (UMR 8174)	Maison des Sciences Economiques 106-112 Boulevard de l'Hôpital 75647 Paris Cedex 13	Participant direct au projet	6

Autres contributeurs de l'équipe française : (in green)

Prénom	NOM	Statut	Rattachement(s)	Coordonnées
Christian	LIST	Professor of Political Science	Departments of Government and Philosophy, London School of Economics	Houghton Street, London,

		and Philosophy		WC2A 2AE
Carl	WAGNER	Professor of Mathematics and Adjunct Professor of Philosophy	The University of Tennessee	Ayres 217 1403 Circle Dr. Knoxville, TN 37996-1320

Equipe allemande :

Prénom	NOM	Statut	Rattachement(s)	Coordonnées	Rôle dans le projet	Temps d'engagement
Olivier	ROY	Professor	Universität Bayreuth	Lehrstuhl für Philosophie I, Universitätstr . 30, D-95440 Bayreuth	Coordinateur	12
Seamus	BRADLEY	Postdoctoral fellow	LMU Munich	Munich Center for Mathematical Philosophy Geschwister-Scholl-Platz 1 D-80539 München	Participant direct au projet	6
Marcel	KIEL	Doctoral Student	Universität Bayreuth	Lehrstuhl für Philosophie I, Universitätstr . 30, D-95440 Bayreuth	Participant direct au projet	6
Dominik	KLEIN	Postdoctoral fellow	Universität Bamberg and Universität Bayreuth	Lehrstuhl für Politische Theorie, Feldkirchensstraße 21. Bamberg	Participant direct au projet	6
Aidan	LYON	Associate Prof./Post doctoral fellow	UMD Maryland/LMU Munich	Munich Center for Mathematical Philosophy Geschwister-Scholl-Platz 1	Participant direct au projet	6

				D-80539 München		
Johannes	MARX	Professor	Universität Bamberg	Lehrstuhl für Politische Theorie, Feldkirchensstraße 21. Bamberg	Participant direct au projet	6
Gregory	WHEELER	Assistant	LMU Munich	Munich Center for Mathematical Philosophy Geschwister-Scholl-Platz 1 D-80539 München	Participant direct au projet	6

Autres contributeurs de l'équipe allemande : (in green)

Prénom	NOM	Statut	Rattachement (s)	Coordonnées
Richard	BRADLEY	Professor of Philosophy	Department of Philosophy, Logic and Scientific Method, London School of Economics	Houghton Street, London, WC2A 2AE
Jan-Willem	Romeijn	Professor	Groningen University	Faculty of Philosophy University of Groningen Oude Boteringestraat 52 9712 GL Groningen The Netherlands
Vincent	Hendricks	Professor	University of Copenhagen	Department of Media, Cognition and Communication/Section for Philosophy University of Copenhagen Njalsgade 80, DK2300 Copenhagen S, Denmark

1.2. Title of the project and acronym

Title: **Collective attitude formation**

Acronym: **ColAForm**

1.3. Disciplines and research fields

Philosophy : theories of rationality, formal philosophy, philosophy of economics

Economics: social choice theory, welfare economics

1.4. Temporal extension of the project: 36 months

1.5. Abstract

The project aims at bridging the gap between the two main paradigms in formal philosophy and economics on the formation of collective attitudes: the deliberative and the aggregative views. Preferences and beliefs are routinely attributed to groups. A jury can believe the accused to be guilty, and a professional board can officially voice its disapproval of certain practices by its members. On the deliberative view, group attitudes stem from a consensus reached after a structured exchange of opinions. On the aggregative view, group attitudes are formed by putting together the possibly diverging views of individuals, through a formal voting procedure for instance.

Deliberation and aggregation are two stages in the process of collective attitude formation. We cannot deliberate endlessly. When disagreements persist, aggregating, e.g. by voting, might be the only way to arrive at a group opinion. So deliberation and aggregation are not competing, but complementary approaches. Up to now, however, they have mostly been studied separately. This is an important limitation, at many authors have defended the view that deliberation and aggregation can enhance each other: Deliberation can help aggregation, for instance by preventing preference cycles. And aggregation can take heed of the fact that, for instance, an opinion cluster can form through deliberation.

The goal of the project is to understand how, and when, deliberation and aggregation can be conjoined in order to arrive at better processes of collective attitude formation. We will study how deliberation can be better geared towards aggregation, and how to enrich current models of belief and preference aggregation to make them more amenable to the results of deliberation.

There is currently an extraordinarily high concentration of leading scholars working in France and Germany on aggregation and deliberation. By bringing them together, the project will seize the opportunity of bridging the two research communities. This will involve three main tasks combining researchers from both countries. The first two tasks will be devoted to deliberation and aggregation respectively, and the third task will be to synthesize the findings of the first two, from a philosophical perspective and with respect to applications.

2. STATE OF THE ART & PREVIOUS WORKS

2.1. STATE OF THE ART

2.1.1. General Background of the Project. We often attribute beliefs, preferences and intentions to groups. One can say that a panel of experts believes that deflation is likely to occur next year, that Parisians prefer to reduce speed limits in school areas, or that Die Mannschaft intends to win the next World Cup. Such group attitudes have been extensively studied by philosophers (e.g., Lehrer &

Wagner 1981, List & Pettit 2011), economists (e.g., Arrow 1951/1963, Black 1958, Sen 1970, Brams & Fishburn 1983/2007, Fishkin, 1997) and other social scientists.

How are such group attitudes formed? The literature distinguishes two stages: **deliberation** and **aggregation**. A *deliberation stage* is a process of individual attitude change through public information exchange. Participants share and potentially revise their own views about certain issues, and sometimes try to influence the views of others as well. In democratic elections, for instance, voters exchange opinions and discuss preferences regarding the candidates during the campaign. This deliberation stage usually precedes voting, which by contrast is an *aggregation stage*. The individual attitudes, still possibly diverging, are then merged into group attitudes. As much as possible, the goal is to construct a complete and consistent group opinion that sufficiently reflects the opinion of its members.

The deliberation and aggregation stages have been mostly studied separately. Standard social choice theory is almost exclusively concerned with aggregation, ignoring the deliberative stage and taking the decision problem (i.e. the objects of interest) and the group members' attitudes as exogenously given. It does not take into account the fact that these attitudes might be heavily shaped by previous deliberation or simply by communication between voters. On the other hand, the theory of deliberative democracy in philosophy and political science (see e.g. Dryzek, 2000) often assumes or defends the unrealistic claim that deliberation will produce enough agreement among group members, so that aggregation is no longer needed. Looking at pure deliberation or pure aggregation considerably narrows the scope of these theories.

Furthermore, deliberation and aggregation can influence each other. Deliberation can help to avoid known aggregation paradoxes, but it can also break independence between voters. The outcomes of aggregating post-deliberative individual attitudes are thus *distinct* from those of aggregating pre-deliberative attitudes. They can *enhance* (e.g. Cohen 1989) but also *impair* each other. We call these views, respectively, the *Enhancement* and the *Degradation Theses*. One of the the main goal of the project is to make steps towards understanding when these theses hold true.

In order to do that we need a theory of collective attitude formation that integrates these two stages. In particular, first, we need to understand how to foster the positive effects and minimize the negative effects of deliberation on aggregation (**Task 1**). Second, we need to study and design aggregation mechanisms that are flexible enough to take into account the complexities of individual attitudes after public deliberation (**Task 2**). Together, those findings should result in a better understanding of the condition under which deliberation and aggregation *can* and *should* be fruitfully combined in the formation of collective attitudes. (**Task 3**). By putting together a broad Franco-German consortium of experts on deliberation and on aggregation, this project will make crucial steps towards the realization of these three tasks.

2.1.2. State of the Art: Deliberation. There is a marked asymmetry between the literature on aggregation (see 2.1.3.) and the one on deliberation. Whereas the mathematical study of aggregation methods is a well-established and mature area, the formal study of deliberative processes is comparatively much scarcer. This project will draw from two main models of deliberation from formal epistemology, logic and economics: deliberation as pooling and as interactive updating. We will also draw from the recent literature on socio-epistemic phenomena like information cascades,

belief polarization, and the creation of single-peaked preferences. Finally, we will use some recent attempts at designing online deliberative methods.

Deliberation as attitude pooling. For agents with graded attitudes, De Groot (1974) and Lehrer & Wagner (1981) have developed a model in which deliberation is seen as a repeated process of opinion pooling. This process results in a set of updated individual opinions. At each round the agents publicly disclose their opinion on a given issue. Then, they adjust their own beliefs in view of those of others. Mathematically, the updating of one's opinion in view of those of others takes the form of weighted averaging – the weights of one agent representing the extent to which she trusts the other members of the group. Assuming that these respective degrees of trust stay constant through the deliberation, this process eventually leads to a consensus. An extensive literature has been devoted to the technical and conceptual exploration of this model. Recently, it has been involved in one of the most disputed questions in social epistemology, viz. the question of knowing what the attitude of a rational agent should be upon learning the opinion of others (e.g. Hartmann, Martini & Sprenger 2009).

Deliberation as interactive updating. Building on Aumann's seminal agreement theorem (1976), Geanakoplos & Polemarchakis (1982) showed that agreements in groups can be reached through a repeated process of exchange of opinion and belief revision. Parikh & Krasucki (1990) showed that consensus can be reached even in groups in which information is not publicly shared, i.e. in organized communication networks such as social media. They have also shown that in networks, common knowledge of posterior beliefs, the condition used by Aumann, can never be achieved. Finally, a number of authors have investigated non-probabilistic version of the agreement results, from Bacharach (1995) to Degremont & Roy (2012). Such long-term or limit behavior of social information dynamics have also attracted a lot of attention in Dynamic Epistemic Logic (DEL), cf. Baltag & Smets (2009), Pacuit & Roy (2012) and Degremont & Roy (2012), who have shown that the outcome of public deliberation is highly dependent on the type of belief update mechanism that the agent uses: classical, "hard" belief revisions always stabilize, but "softer", more revisable ones do not. Furthermore, Liu, Seligman & Girard (2014) have studied social influence in organized networks. One of the crucial open questions in that literature is to understand, both philosophically and mathematically, the relationship between the pooling and the updating models of deliberation. **Task 1b** will address that question.

Negative and positive effects of deliberation. Authors such as Hendricks & Rendsvig (2015) have used both models of deliberation to analyze cases where the social dynamics go wrong. They have looked at information cascades and identified conditions under which they can be prevented. Hendricks & Lunderff-Rasmussen (2014) have applied similar analysis to the recent financial crisis, and Hansen & Hendricks (2014) showed that the DEL framework can be used to model and study ways to prevent a wide range of such undesirable socio-epistemic phenomena, including pluralistic ignorance (e.g. Fukui & Bicchieri 1999), i.e. where all members of a group end up believing one thing but thinking everyone else believes the opposite, belief polarization (e.g. Hegselmann & Krause, 2009, Olsson 2013) and the so-called "bystander effect" (c.f. Darley & Latané 1968). On the positive side, it has been claimed that deliberation can promote so-called single peakedness in group-preferences (Dryzek & List, 2003). This, in turn, prevents the emergence of preference patterns that lead to cycles when aggregated. Empirical research supports that claim (List *et al.*, 2013). So deliberation can have both positive and negative effects on aggregation. It remains open,

however, whether some methods or models of deliberation foster these positive effects, or are more prone to the negative one. This is what **Task 1a** will address.

Concrete deliberation methods. Iterated belief update is at the heart of the Delphi technique, which was designed at the RAND Corporation during the 1950s (for a recent review and assessment, see Rowe & Wright 1999). It has been shown that such a structured deliberation method can improve aggregated quantity estimates (Burgman et al. 2011) and there is evidence that they improve aggregated probabilistic forecasts (Wintle et al. 2013). A drawback to such methods is that they rely on individuals conducting a discussion and someone neutral moderating it. In some contexts this is not feasible. Structured deliberations often have to be conducted over an extended period of time, they require that all individuals are available for the discussion and have the time and inclination to participate, and they require the availability of a moderator. Such requirements are not always easily met. For example, there are now online intelligence systems devoted to tracking and forecasting disease outbreaks and environmental disasters (e.g., Lyon & al. 2013), which rely on people's opinions but which often have to form group opinions within days or even hours. As such, there is a need for methods that can quickly and easily pool information, but which also avoid the errors that can plague unstructured deliberation. This will be addressed by **Task 1b**.

2.1.3. State of the art: Aggregation

2.1.3.1 Aggregation of beliefs. The question of how beliefs of different group members should be aggregated has been analyzed in different ways, notably by philosophers, economists, statisticians, computer scientists. Distinct branches of aggregation theory study distinct notions of belief: (1) *degrees* of belief (probabilities), (2) *imprecise* beliefs (vague probabilities), or (3) *binary* beliefs (judgments). We look at these issues in turn.

Aggregating probabilistic beliefs. The most studied way to aggregate individual degrees of belief is *linear pooling*, going back to Stone (1961) or even Laplace. It consists in taking an arithmetic average of the individuals' distributions. Linear pooling has been characterized axiomatically by different authors, in particular Aczél & Wagner (1980, 1982/1985), McConway (1981), Aczél, Ng & Wagner (1984), Genest (1984b), Mongin (1995) and Chambers (2007). A popular alternative to linear pooling is so-called *geometric pooling*, which is based on taking a geometric average rather than a linear average. Unlike linear pooling, it has the attractive property of being *externally Bayesian*: if the individuals update their beliefs according to some commonly perceived information, then the aggregate beliefs change by being updated according to that same information (Madansky 1964, Genest 1984a). For a review of classic results, see Genest & Zidek (1986). Overall, the debate over the “right” way to aggregate probabilistic opinions is still open.

Aggregating imprecise probabilistic beliefs. The standard Bayesian representation of beliefs by a full-fledged probability function has been increasingly challenged, both on positive grounds (e.g., Ellsberg 1961) and normative grounds (e.g., Gilboa, Postlewaite & Schmeidler, 2009, Good 1952, Levi 1980, Walley 1991). A currently popular alternative is to represent beliefs by a *set* of probability functions, capturing imprecision or indeterminacy in beliefs (Bewley 2002, Bradley 2009, Gilboa & Schmeidler 1989, Joyce 2011, Levi 1980, Smith 1961). Other representations include non-additive probabilities such as Dempster-Shafer functions and capacities (Dempster 1967, Schmeidler 1989, Shafer 1976). For such non-standard beliefs, the question of how to aggregate the beliefs is re-opened. The only investigations of this question assume the specific case of Dempster-Shafer

belief functions (Wagner 1989) or the special albeit influential decision criterion of maximin expected utility (Crès, Gilboa & Vieille 2011, Gajdos & Vergnaud 2011).

Aggregating binary beliefs. There has been much recent work on the aggregation of *binary* beliefs, i.e., beliefs of a simple yes/no type (e.g. List & Pettit 2002, Dietrich 2007, Dietrich & List 2007a, Nehring & Puppe 2010, Dokow & Holzman 2010). Aggregation rules such as linear or geometric pooling are no longer available in the binary framework, essentially because one cannot take averages of yes/no beliefs. This complicates the aggregation problem. As a series of impossibility theorems has shown, the same type of axioms which lead to linear pooling in the probabilistic aggregation framework typically lead to dictatorial aggregation in the binary aggregation framework (see Dietrich & List 2010). The most recent development in the field is a shift towards the concrete construction of judgment aggregation rules, to some extent at the expense of the axiomatic approach.

2.1.3.2. Aggregation of Preferences. There is a long and well-known tradition of work on the aggregation of preferences in the social sciences. Here we focus on the aggregation of preferences under uncertainty (*lato sensu*, i.e., when the individuals are uncertain about the consequences of the options, which covers both risk – when a probability distribution is ‘given’ to all individuals – and uncertainty *stricto sensu* – when this is not the case.). It is one of the most open and active areas in the domain of preference aggregation (to which several members of our team are leading contributors). Besides, when dealing with aggregation under uncertainty, one has to distinguish beliefs and basic preferences on outcomes as distinct factors determining terminal preferences on options. This distinction is fundamental to anyone interested in the relationships between aggregation and deliberation: during deliberation, those attitudes typically are the objects of communication and revision.

The literature on social preference under uncertainty originates in a famous theorem by Harsanyi (1955): If (i) all individuals and whoever represents society (henceforth the "social observer") obey the axioms of expected utility theory on the set of lotteries; and (ii), whenever all individuals prefer lottery p to lottery q , the social observer also prefers p to q (the Pareto principle, here applied to lotteries); it follows that the social observer's expected utility function is a weighted sum of the individual expected utility function – here the objects of collective preferences are lotteries (mathematically: probability distributions) over the final social outcomes (e.g., income distributions). Harsanyi considered that his theorem was a key argument for utilitarianism. Indeed, being additive, the derived aggregation rule is formally similar to a utilitarian rule. Apparently, the only remaining step would be to make the individuals' weights equal, as in the two standard rules of utilitarianism, i.e., the utility sum and the average utility rules. Harsanyi's theorem has spawned a large literature. We focus here on two main lines.

Aggregation of preferences under uncertainty (stricto sensu): The original theorem was developed in a framework of risk. Several authors studied its extension to uncertainty. Hammond (1982) observed that, when individual beliefs on probabilities are not trustworthy, respecting individuals' ex ante preferences is not as compelling as in the case of full information. Hence the Pareto principle is not compelling when people have different subjective probabilities because common preferences may be grounded in unreliable beliefs. The related question of "*spurious unanimities*" was further studied by Mongin (1997) and Gilboa, Samet & Schmeidler (2004). They proposed to limit the use of the Pareto principle to cases where people have the same subjective beliefs. Mongin (1995) proved the

impossibility of consistently aggregating beliefs and tastes, when expected utility theory holds in the uncertainty version. Essentially, there is no solution if individuals differ in *both* respects of tastes and beliefs (unless one uses a weak version of the Pareto principle and accepts the dictatorship of some individual(s)). Mongin (1998) showed that a more general ("state-dependent") version of expected utility theory may restore possibilities, but only at the cost of being unable to define social beliefs. Chambers & Hayashi (2006) extended this insight in the case of non-expected utility preferences that do not satisfy the crucial postulate to obtain a subjective probability representation (Savage's "sure-thing principle").

Aggregation of preferences and ex ante and ex post fairness. Diamond (1967) criticized Harsanyi's weighted sum formula because it ran counter to ex ante fairness intuitions. Arguing from an example, he proposed rejecting the application of expected utility theory to the social observer. On the other hand, as e.g. Broome (1991) suggested, the weighted sum formula may be insensitive to some ex post inequalities. These criticisms gave rise to two distinct lines of research. First, a renewed ex ante approach emerged, following Diamond's suggestion, to replace the weighted sum formula with non-linear functions of individuals' expected utilities (Epstein & Segal; 1992; Grant, Polak, Kajii & Safra, 2010). It was however noted (Machina, 1989; Grant, 1995) that this could imply violations of two standard rationality properties (dynamic consistency and stochastic dominance). Second, a renewed ex post approach also emerged. For instance, Fleurbaey (2010) argued in favor of taking the expected value of an equally-distributed equivalent utility, that is a utility level such that, if all individuals enjoyed it, social welfare would be equivalent from the social point of view. The equally-distributed equivalent will always favour equal over unequal distributions of utilities for a given average level.

2.2. PREVIOUS WORKS

PAPERS MARKED WITH AN ASTERISK * WILL BE JOINED TO THE SCIENTIFIC DOCUMENT.

Previous works on Deliberation (Task 1)

After having worked on Bayesian epistemology and on its application to philosophy of science (Cozic 2011a, 2011b), Cozic is currently working with Bonnay on issues in social Bayesian epistemology (Bonnay & Cozic 2016a) including the revision of one's beliefs upon learning the opinion of others. In Bonnay & Cozic (2016b), they expose their first results about the rationalizability of weighted averaging (linear pooling) in terms of Bayesian conditionalization. This result is motivated by Bradley (2006)* who questions the relationships between the two families of models. In Bonnay & Cozic (2015c), they investigate the axiomatic justification of Jeffrey's Rule as a complement to weighted averaging. Beyond this common project, Cozic's research focuses primarily on the philosophy of economics (e.g., Cozic 2012, 2015) and formal theories of rationality (see Cozic 2011c). Bonnay's work pertains to "formal philosophy". He has been working in the philosophy of logic, inquiring into the nature of logic (Bonnay 2008, 2012, 2014), and in epistemology, on issues regarding knowledge, vagueness and reflection principles (Bonnay & Egré 2009, 2010).

Roy has worked for three years (2008-2011) on the project *Shared Commitment and Common Knowledge* (<http://www.philos.rug.nl/~olivier/SCCK/>) (Groningen, NL), relating to the epistemic foundations of deliberative democracy. He published on agreement theorems (Degremont & Roy 2012)* and started a collaboration with Romeijn (Groningen) on the connection between pooling and Bayesian models of deliberation (Romeijn, Manuscript, Romeijn & Roy, manuscript). They have

edited a special issue of *Economics and Philosophy* on the theme of public deliberation (Romeijn & Roy, 2015).

Marx is currently working with Klein, Roy and Kiel on the simulation of the emergence of trust in strategic interaction (Klein & Marx, 2014, Klein 2015)*. This work involves modelling of iterated Bayesian updating in groups, which will be of direct use in Task 1a.

Hendricks and his group have made numerous contributions to the theory of socio-epistemic phenomena and in particular to the pitfalls of public deliberation (Sub-task 1a), c.f.. Hansen & Hendricks (2014) and Hendricks & Rendsvig (2015)* for a recent synthesis.

Lyon extensively studied socio-epistemic phenomena and the so-called "wisdom of crowds" and the intersection between epistemology and psychology (Lyon 2011, Wintle & al, 2012, Lyon & al. 2012a,b, 2013, Lyon & Pacuit, 2013*, Lyon et al. 2015, Lyon, Forthcoming)). Paternotte has worked on the philosophy of groups and sociality in general (Task 1a). He has published on the definitions of cooperation and collective action (Paternotte, 2014), rational explanations of cooperation (Paternotte & Grose, 2013), epistemic aspects of cooperation (Paternotte, 2015) and social epistemology (Ivanova & Paternotte, 2013).

Previous works on Task 2 (Aggregation)

(1) *Probabilistic beliefs.* Dietrich has worked on the epistemic foundations of probabilistic belief aggregation. He explored the consequences of informational asymmetries between the individuals and introduced a new ('multiplicative') pooling operator (Dietrich 2010, Dietrich & List forthcoming). His findings show that the standard approaches are epistemically unwarranted if group members draw on different informational sources. In the context of so-called Bayesian aggregation, Mongin (1995) has provided a new axiomatic characterization of linear pooling, avoiding the normatively problematic 'independence' axiom.

(2) *Imprecise probabilistic beliefs.* Wheeler has worked on the philosophical and mathematical foundations of imprecise probability (IP) along with its application to contemporary problems in philosophy and statistics. In (Elkin and Wheeler, forthcoming) he proposed an IP approach to peer disagreement, which include a series of loss aversion arguments for an IP model over a standard Bayes model. In (Mayo-Wilson and Wheeler, forthcoming) the problem of proper scoring rules for IP was addressed, where a generalization of an impossibility result due to Seidenfeld, Schervish, and Kadane (2012) was given and a class of "almost-proper" scoring rules is characterized. In (Pedersen and Wheeler 2014, 2015) a characterization of dilation is given purely in terms of distance from independence, which resolved an open question about the necessary and sufficient conditions for dilating sets of probabilities, which also includes work on the properties of structural judgments in IP Models (Pedersen and Wheeler 2014; Elkin and Wheeler, forthcoming; Wheeler 2012). Hill has worked extensively on axiomatic foundations of imprecise beliefs and non-standard decision theory. In Hill (2013), he proposed and defended a model based on the agent's *confidence* in his own beliefs, and in Hill (2012a, 2012b) and Danan et al. (2014) he worked on the aggregation of imprecise preferences; the experience and methodology developed there will prove useful when turning to the aggregation of imprecise beliefs (rather than preferences).

(3) *Binary beliefs.* Dietrich and Mongin have each worked extensively on judgment aggregation theory. In 18 articles, Dietrich has, among other things, generalized Arrow's and Sen's Theorems to judgment aggregation (Dietrich & List 2007a, 2008), generalized judgment aggregation to propositions in non-classical logical languages (Dietrich 2007), studied agenda manipulation and strategic voting (Dietrich 2006, 2013, Dietrich & List 2007b, Bozbay, Dietrich & Peters 2014), studied aggregation by quota rules (Dietrich & List 2007c), and generalized Borda's aggregation rule to judgment aggregation (Dietrich 2014). Mongin has worked on the role of the unanimity principle in judgment aggregation (Mongin 2008) and, with Dietrich, on the premise-based approach (Dietrich & Mongin 2010*) and the political and legal dimension (Mongin & Dietrich 2010). Together with Dietrich & List, Egré will deal with vagueness and judgment aggregation. Egré has written extensively on vagueness and conducted an ANR funded project on this topic between 2008 and 2011 (Egré & Klinedinst, 2011; Egré *et al.*, 2012, 2013; Egré & Barberousse, 2014). Finally, Bonnay (forthcoming)* investigates the possibility results in judgment aggregation yielded by the combination of clustering axioms and aggregation principles.

2.2.2.2. *On the aggregation of preferences.* Beside providing more general proofs of Harsanyi's theorem (Coulhon & Mongin, 1989; De Meyer & Mongin, 1995), Mongin was the first to extend it to Savage's framework (Mongin, 1995; Mongin, 1998), in which he highlighted key impossibilities and paradoxes. Mongin also challenged the accepted view that Harsanyi's theorem is "just a representation theorem", and does not tell us anything about utilitarianism. Mongin & d'Aspremont (1998) introduce cardinal preferences to obtain a more genuine utilitarian interpretation of the theorem. Fleurbaey & Mongin (2014) reach the same conclusion more indirectly, assuming that an exogenously defined utilitarian observer evaluates social states by a sum of individual utilities, and then connecting this hypothetical observer's preferences with those of the actual observer.

Mongin, Fleurbaey & Zuber extended Harsanyi's theorem to non-expected utility models of preference, while maintaining the Pareto requirement. In a framework of given probabilities, Fleurbaey (2009) relaxes expected utility theory at the social level and instead only assumes a dominance property; but he sticks to expected utility for individuals. He derives Harsanyi's weighted sum formula, thus showing that the social observer cannot escape from expected utility theory. This conclusion had already been obtained by Blackorby, Donaldson & Mongin (2004) in a different framework, which allows the individuals *not* to obey expected utility theory. Mongin & Pivato (2015) prove a more powerful version of this early result; for instance, the now familiar "rank dependent utility" function of contemporary decision theory is explicitly permitted. Zuber (2016) has a related extension in Anscombe-Aumann's (1963) framework, which is a variant of Savage's. All these works converge towards the somewhat surprising conclusion that Harsanyi's weighted sum formula obtains even if the rationality assumptions put on the social observer and the individuals are weakened.

Mongin, Fleurbaey & Zuber also questioned the appropriateness of the Pareto principle in the context of uncertainty and even in the context of risk. Mongin (1997) provides three arguments against using it in these contexts: the impossibility of a consistent Bayesian aggregation. In the intergenerational case involving risk, Bommier & Zuber (2008) argue that society should care about correlated risks, and they proposed restricting the Pareto principle to the case of independent risks. Fleurbaey (2010) showed that when the risk is only about who will be given predefined social positions, society bears no risk, whereas individuals do. He proposes not taking individual preferences into account in that case, and restricting the Pareto principle to situations where all individuals face the same prospects

("Pareto for Equal Risk"). [Fleurbaey & Zuber \(2013\)](#)* explore this possibility by adding some technical separability requirements, and [Fleurbaey & Zuber \(2015\)](#) explore it by supposing different economic environments. Contrary to the literature, they do not work on utility numbers, but adopt a "fair social choice" approach, where individual welfare indices are derived from a combination of fairness principles and respect for preferences in non-risky situations.

Last, members of the group have explored non-consequentialist approaches to decision under risk and uncertainty. [Fleurbaey, Gajdos & Zuber \(2015\)](#) extend the analysis of social choice under uncertainty to a framework allowing ex ante equity considerations to play a role in the ex post evaluation. They find a richer configuration of social criteria.

Previous works on Task 3 (Philosophical foundations and case study)

Both Seamus [Bradley](#) and Isabelle [Drouet](#) have worked on probabilities and within formal philosophy. Seamus [Bradley](#) has worked with scientists from the Centre for the Analysis of Time Series at the London School of Economics; this collaboration has resulted in a paper on uncertainty in models of chaotic systems ([Frigg et al. 2014](#))*. Isabelle [Drouet](#) has written in particular on physical probabilities ([Drouet 2012a, 2011](#)) and on the probabilities that appear in causal decision theory ([Drouet 2012b](#)) and she is currently editing a collective book dealing with Bayesianism ([Drouet](#), to appear). In 2014-2015, Isabelle Drouet is the PI for a Convergence project (financed by the COMUE Sorbonne-Universités) which deals with the IPCC and will provide a description of the deliberation and aggregation procedures through which summaries for policy makers are extracted from the chapters of contributions to assessment reports. Reza [Lahidji](#) has worked on the use of assessment models as a support for public policy in situations of uncertainty, in particular in the area of nuclear safety ([Lahidji, 2012a and 2015](#)). He has also written on the assessment of the impact of climate change and the treatment of associated uncertainties ([Lahidji, 2012b](#)) and has been part of the panel of experts for the IPCC's Special Report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (2012).

[Bradley \(2006\)](#) discusses the deliberation-aggregation interface in the case of (graded) beliefs. [Pivato \(2016\)](#) tackles this issue, and more specifically the Degradation Thesis, but in the framework of epistemic social choice. The celebrated Condorcet Jury Theorem and similar results seem to rely heavily on the assumption that the voters' opinions are *stochastically independent*. Thus, deliberation could actually *degrade* the epistemic reliability of social choice rules, by causing voter opinions to become correlated. However, Pivato (2016) has somewhat assuaged this concern, by generalizing the Condorcet Jury Theorem and similar results to an environment with *correlated* voters ---including the patterns of correlation which could arise in the De Groot model of deliberation. These results show that deliberation does not necessarily *impede* the truth-tracking properties of aggregation rules.

3. OBJECTIVES AND WORK PROGRAM

3.1. Objectives

Main Research Question: How can and should deliberative and aggregative processes be articulated towards the formation of collective attitudes ?

This Research Question is the ultimate target of our proposal, and will be addressed in **Task 3**. To make some progress towards that goal, however, we need first to extend and deepen existing

theoretical work both on deliberative and aggregative views, and thus to answer the two following Questions:

Sub-Question 1: How can deliberation better prepare the aggregation phase?

Deliberation can prevent cycles in social preferences but also foster negative effects like polarization and information cascades. We need a better understanding of the conditions (e.g., the initial state of the individuals, the type of deliberative process) under which both the positive effects are promoted and the negative effects are prevented (**Task 1**).

Sub-Question 2: How to aggregate preferences and judgements from deliberation?

The aggregating method used after the deliberation needs to be able to deal, among other things, with imprecise beliefs, non-boolean agendas and uncertainty in preferences. Furthermore questions of fairness and more generally of the assessment of the aggregation methods remain (**Task 2**).

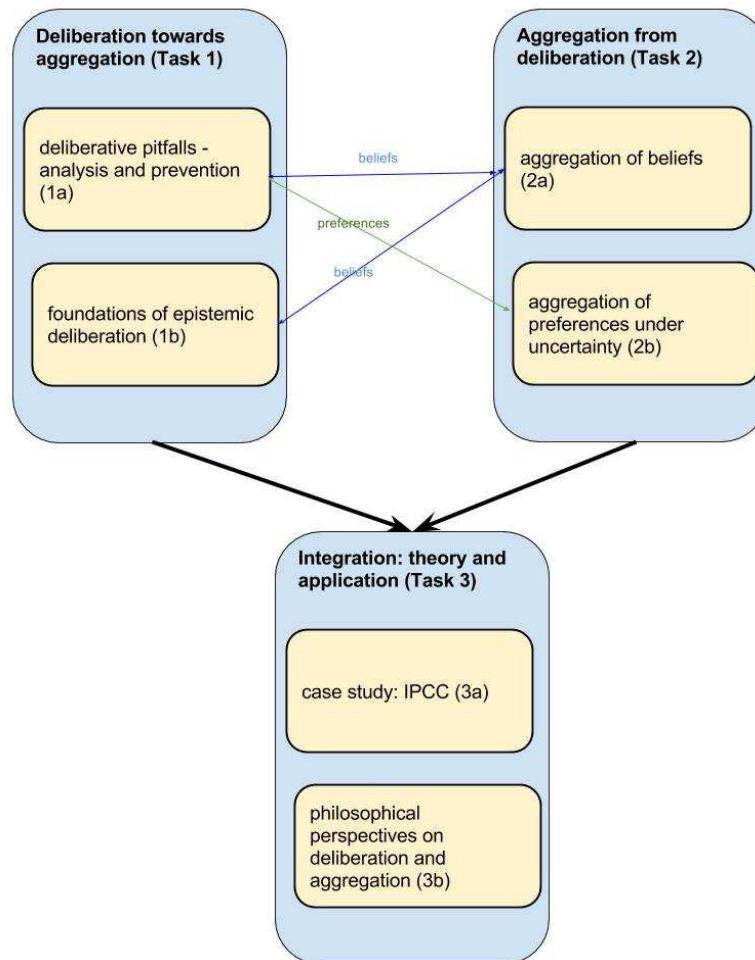
3.1.5. Added value of the French-German cooperation: This project builds on exceptionally strong expertise on aggregation and deliberation spread across the German and the French teams. Putting these experts together in a joint, coordinated research endeavor is a step forward in itself. This project also builds on a long-term collaborative network involving many of the participants. The two coordinators have been involved in joint scientific activities for more than 10 years now. They have been members of an informal group on the topic involving mainly French and German scholars, as well as Dutch and English participants. The group stemmed from the Dutch-funded (NWO) “Rationality and Decision Research Network”, which ran from 2009 to 2012, co-directed by Roy and Romeijn and involving many of the participants in this proposal. This group, mostly focused on deliberation, organized a symposium entitled “Learning from Others” at the *Philosophy of Science Association* 2014 Conference in Chicago. The DFG-ANR adds to it some of the world experts on aggregation, e.g. List, Dietrich, and Fleurbaey. This is a rare and timely opportunity both for the advancement of the field and for the strengthening of the Franco-German collaboration.

3.1.6. Expected extra-scientific impacts

The Project is mainly theoretical and conceptual in character, but it is **highly policy-relevant** since it is crucial to the better functioning of social institutions (among which we include notably political and judicial institutions and also institutions aimed at epistemic goals like the IPCC) that we understand how aggregation and deliberation both *do* and *should* interact. As a consequence, one of the main expected extra-scientific impacts of the Project is the improvement of the architectures (rules of deliberation and aggregation) on which the formation of collective attitudes is based.

3.2. Work Program, methodology and schedule

This is a project at the intersection of mathematical philosophy and economics. It aims at elaborating and analyzing *formal models* of collective attitude formation and assessing these *normatively*. This approach is influential in social choice theory, but also in philosophy and political science. In the modeling parts of the project we will rely on several formal approaches, most notably axiomatization and simulation.



Task 1. Deliberation towards aggregation.

The goal of Task 1 is to lay the ground for the development of a full-fledged, mathematical model of deliberation that is geared toward the aggregation phase. Most work on deliberation has been focused on conditions for the emergence of consensus. Consensus is not so important when deliberation is followed by aggregation. What matters more is to understand the effects, positive and negative, that deliberation can have on the participants's individual opinions (**O1**), and to understand how the two main models of deliberation relate to each other (**O2**), philosophically and mathematically.

Task 1a: Deliberative pitfalls - analysis and prevention.

Working group: **Paternotte** (manager, Paris-Sorbonne), **Lyon** (LMU Munich and UMD College Park), **Roy** (Bayreuth), **Klein** (Bamberg/Bayreuth), **Marx** (manager, Uni. Bamberg), **Hendricks** (associate, Copenhagen).

This task will study how deliberation can create problems for aggregation, and propose ways to avoid them. We will focus on two problems, pluralistic ignorance (objective **O1a**) and preference cycles

(O1b). The results will then be implemented into concrete, computational methods for more efficient group deliberation.

(O1a) Current models of pluralistic ignorance typically involve trend leaders and followers. The agents in these models are usually boundedly rational agents, or black boxes (Centola et al. 2005). In order to better understand how to prevent the phenomenon, this project will start by pinpointing conditions under which individual rational agents can be led to pluralistic ignorance. (O1b) It will then move to preference cycles. It is an empirical question whether voting cycles are a common but often unexposed feature of democracies given individual preferences (cf. Riker 1982: 122). It has been argued that elements of the democratic process itself diminish the probability of such cycles (List & Pettit 2002, Dryzek & List 2003). In the second step of this project we will assess this claim, using simulation methods. The findings of these two steps will then be integrated into the development of more effective deliberation methods that are also robust against such pitfalls of deliberation. We will develop what we shall call semi-automated deliberation methods: they can be implemented online through software, can be executed quickly, and they do not require the moderation of any one individual. It is expected that such methods would significantly enhance the quality of aggregated opinions, specifically those concerning disease outbreaks and environmental disasters.

Task 1b : Uniting and extending the foundations of epistemic deliberation.

Working group: Bonnay (UPON), Cozic (manager, UPEC), Egré (CNRS, IJN), Lyon (LMU Munich and UMD College Park), Roy (U. Bayreuth), and Bradley (associate, LSE), Romeijn (associate, U. Groningen), Wagner (associate, U. Tennessee).

Bradley (2006) questions the compatibility of the two main accounts of epistemic deliberation, the pooling and the updating account, and raises the issue of the normative justification of the former. Both models lead to *consensus* in idealized circumstances, but they view the targeted process differently. One is based on trust, the other, on higher-order reasoning. Steele (2012) vindicated weighted averaging against Bayesian-compatibility concerns but pointed out other problems for this revision method. The objective of this group (O2) is to clarify conceptually and theoretically the relationship between the Bayesian model and the De Groot-Lehrer-Wagner model. We will characterize formally under which conditions the two families of model coincide, and will generalize the preceding results by exploring other salient families of pooling rules (O2a). This brings us into a position to determine whether these two models should be seen as two alternative types of models of the very same deliberative process, or as models appropriate in distinct contexts. With this in hand, we will revisit the results of Task 1a in order to see whether one of these deliberative models fares better at the prevention of pluralistic ignorance and preference cycles (O2b).

Task 2. Aggregation from deliberation.

The second Task is to study aggregation methods, both for beliefs and preferences, in order to make them more amenable to deliberation. The sub-tasks and objectives extend previous and current work of the members. The goal here, apart from the importance of achieving each individual objective, is to create opportunities for cross-fertilization between these experts on aggregation through project-specific workshops, with those working on Deliberation in Task 1, and to integrate these advances, both theoretically and in a case study, in Task 3.

Task 2a: Aggregation of beliefs

Working group: [Bonnay](#) (UPON), [Dietrich](#) (manager, CNRS, CES), [Egré](#) (CNRS, IJN), [Hill](#) (CNRS, GREGHEC), [Mongin](#) (CNRS, GREGHEC), [Pivato](#) (Université de Cergy-Pontoise), [List](#) (LSE, associate)

This Task extends existing models of aggregation of graded beliefs by taking heed of possible homogeneous sub-groups, and applying aggregation methods to the question of vagueness (**O3**). In parallel we will study aggregation of graded beliefs in non-complete agendas, and aggregation of imprecise beliefs, i.e. graded beliefs represented by sets of probabilities (**O4**).

[Bonnay](#) is to investigate collective judgements for *subgroups* of a population, more precisely clustering techniques and their use in the attribution of collective attitudes (**O3a**). The hypothesis will be that bearers of collective attitudes are subgroups of individuals, which are identified as coherent doxastic units on the basis of the individual beliefs of their members, people sharing similar or at least compatible beliefs. This will result in *doxastic clustering*: partitioning a population and aggregating beliefs within each cluster. The task will be to develop an axiomatic theory laying down the desirable conditions which govern the partitioning and the aggregation of opinions within each cluster. Such a theory would enable practitioners to make more principled choices when they choose to go for a particular clustering strategy. Doxastic clustering will also provides a generalization of judgment aggregation theory, which assumes that the group is fixed in advance, and all members' opinions must be put together in order to produce a collective group opinion. Clustering techniques and clustering algorithms are extensively studied in the statistics literature (see Hartigan, 1975, and, for recent developments, Xu & Wunsch, 2009). However, the use of the axiomatic approach is quite recent, and it has never been pursued in relationship to the specific problem of clustering *opinions*. It is expected that clustering will provide a solution to some of the failures of deliberation and aggregation which the present project aims at identifying.

(O3b [Dietrich](#), [Egré](#), [List](#)) Supervaluationism about vagueness in natural language is based on the idea that some predicates have multiple rival interpretations or specifications. A sentence is deemed determinately true if and only if it is true according to all specifications; and determinately false if and only if it is false according to all specifications. In all other cases, the sentence is assigned no determinate truth value. Supervaluationism, however, is only one way of “aggregating” the verdicts of different specifications. Our project is to introduce insights from the theory of judgment aggregation to study a broad spectrum of different aggregation functions. This allows us to offer an axiomatic characterization of supervaluationism, which, in turn, locates it precisely within a larger logical space of possible approaches to vagueness.

Deliberation plays a central role in fleshing out the group's decision problem and generating its *agenda*. [Dietrich](#) and [List](#) will study probabilistic opinion pooling under more realistic assumptions by allowing that the agenda need not be closed under boolean operations (**O4a**). The group might care about the probability of ‘rain’ and that of ‘heat’ while ignoring that of ‘rain or heat’. This generalization is borrowed from judgment aggregation theory, which explains the close conceptual relation between this research project and those on judgment aggregation. In two working papers ([Dietrich](#) and [List](#) 2013a, b), Franz Dietrich has derived first results on linear pooling for general

agendas, which revealed surprising analogies and disanalogies to judgment aggregation. Numerous open questions remain.

(O4b) Hill and Wheeler will work on extending current knowledge about aggregation of Bayesian beliefs to the non-Bayesian case. There are two directions. One seeks to extend existing results to opinions represented by sets of probabilities (also called imprecise probabilities), or more generally incorporating confidence in beliefs. A first step will be to extend the standard result for linear opinion pooling in a multi-profile setup to opinions represented by imprecise probabilities. This will draw on Crès et al. (2011), who propose a “set of weights” generalisation of the linear pooling rule, in the context of preference aggregation for maxmin EU decision makers, and in the single profile case. We will examine whether a similar pooling rule can be obtained but with a weaker condition and then generalize these findings using axioms formulated directly on sets of probabilities. It should then be possible to extend these results to models incorporating confidence in beliefs (such as, Hill, 2013). A second direction will be to explore to what extent non-Bayesian representations afford the flexibility to overcome standard challenges in the Bayesian framework. A starting point will be the proposal of imprecise probabilities as an adequate summary of conflicting opinions (Walley, 1981, Levi, 1980), and the recent suggestion that it can offer a reply to the problems of independence preservation affecting linear pooling rules (Elkin & Wheeler, forthcoming).

Task 2b: Aggregation of preferences under uncertainty

Working group: Zuber (manager, CNRS), Baccelli (Université de Cergy-Pontoise), Fleurbaey (FMSH), Mongin (CNRS), Pivato (Université de Cergy-Pontoise).

The overall objective of the Task is to depart from the standard (ex ante) Pareto principle to define new social criteria to be used in situations of risk and uncertainty **(O5)**.

The first objective **(O5a)** will be to discuss the possible weakening of the Pareto principle. Fleurbaey & Zuber (2013) have already proposed such a weakening in situations of risk. An open question is to know how society’s beliefs should be formed in situations involving uncertainty. Existing weakenings of the Pareto principle may indicate how this could be done. For example, Gilboa, Samet & Schmeidler (2004) restrict it to those uncertain prospects that involve subjective probabilities on which the individuals happen to agree. Their criterion is *endogeneous* to the individuals' subjective probabilities, hence to the particular preferences they entertain. As an alternative suggestion, Mongin & Pivato (2016) propose to distinguish between two kinds of probabilities *exogeneously*, and define a weaker version of the ex ante Pareto principle based on this distinction.

The second objective **(O5b)** is to further develop the fair social choice approach to the social evaluation of risky and uncertain outcomes. Fleurbaey & Zuber (2015) need to characterize their fairness criteria, in particular to explore the extent of separability they can satisfy. The criteria exhibited in Fleurbaey & Zuber (2015) are indeed generally not expected utilities; they also depend on the risk preferences of all individuals. The pro and cons of separability will be discussed, and weakened notions proposed.

The third objective **(O5c)** is to reconsider the normative aspects of social rationality philosophically. According to Harsanyi and many others, standard decision theory sets rationality demands that apply both at the individual and social level (cf. Harsanyi 1975). This claim is compatible with the

suggestion that the probabilities have different spaces and interpretations when applied to the individuals or to the social observer. The former may entertain subjective probabilities in the sense meant by Savage while the latter may in fact bring about randomness artificially. [Mongin](#) and [Dietrich](#) will explore these ideas in connection with a philosophical interpretation of decision theory they have proposed ([Mongin 2011](#), [Dietrich & List 2013a, b](#)).

The fourth objective (**O5d**) is to explore non-consequentialist social criteria. One direction will be to include expected utility principles in the framework of [Fleurbaey, Gajdos & Zuber \(2015\)](#) to obtain more specific results. Another direction is to modify their framework to include a description of the economic environment. Another direction will be to examine the hypothesis that chances can matter intrinsically, rather than only instrumentally in virtue of the outcomes with which they are associated. This hypothesis raises various questions about how to aggregate goods. If chances are intrinsically valuable goods then we need to find a way of comparing chances against more conventional goods, in order to arrive at an overall evaluation of a social situation or a potential policy. Another way of looking at this problem is that we need to find a way of comparing opportunities for welfare against actual welfare, in order to arrive at an overall evaluation of a social situation or policy. The team members will also offer a critical discussion of non-consequentialist welfare criteria, based on on-going research by Jean [Baccelli](#) in his PhD dissertation.

Task 3. Integration: theory and application

This third and final task aims at integrating the findings of Task 1 and 2. We will first pitch the findings of Task 1 and 2 against a concrete process of collective attitude formation that combines deliberation and aggregation. We will then articulate the findings of these two tasks into a coherent philosophical view of how aggregation and deliberation should be geared to one another.

Task 3a. Case study: IPCC.

Working group: [Drouet](#) (Paris-Sorbonne, manager), [Baccelli](#) (Université Cergy-Pontoise), [Lahidji](#) (GRECHEC), [Bradley](#) (LMU Munich), [Lyon](#) (LMU Munich and UMD College Park)

This case study focuses on collective judgment formation in the IPCC. The IPCC “reviews and assesses the most recent scientific, technical and socio-economic information (...) relevant to the understanding of climate change.” It produces scientific reports based on existing published data and theories of climate and climate change. These reports include short “summaries for policy-makers”. Thus, the IPCC aggregates and summarizes scientific findings. The process from science to summaries for policy-makers is a complex one. It includes several deliberation and aggregation phases, many of which are regulated by methodological documents and guidelines. This constitutes a good testing ground for theories combining deliberation and aggregation. This sub-task focuses on the «working group I» of the IPCC, which deals with the physical science basis of climate change. Little philosophical attention has yet been devoted to the IPCC, with the exception of [Swart et al. \(2009\)](#). Our approach is close to [Swart et al.’s](#), but our goal is more ambitious. We want to know whether the procedures followed in the IPCC can be normatively justified in the light of the methods studied in Task 1 and 2. Climate science findings are uncertain in many respects. Our main objective is to identify how uncertainties are treated in the elaboration of reports, and to see if they are treated in accordance with some of the theories developed in Task 1 and 2 – notably those dealing with partial (probabilistic or otherwise) beliefs.

(O6a). The production of IPCC scientific reports requires aggregating assessments of various kinds of uncertainties, which often express distinct and conflicting methodologies (Bradley 2011). This is a difficult task, which is regulated by the “Guidance note for lead authors of the IPCC fifth assessment report on consistent treatment of uncertainties” (Mastrandrea et al. 2010). The recommendations in this note raise several questions. In this project, we will determine how the IPCC’s notions of confidence and likelihood compare with the concepts of uncertainty underlying or targeted by the methods developed in Task 2.

(O6b) Appendix A to the “Principles governing IPCC work” mentions that summaries for policy-makers are amongst the few IPCC documents to be approved by corresponding working groups. They are “subject to detailed, line by line discussion and agreement.” In this text, approval is distinguished from acceptance, which applies to cases in which “the material (...) presents a comprehensive, objective and balanced view of the subject matter.” This distinction is important and the guideline defines several approval procedures. However, this document is silent both on deliberation, or “discussion”, and on “agreement”. A reliable description of the deliberation and aggregation procedures governing the production of IPCC summaries for policy makers should be available soon, as an output of the DéciGIEC project led by Isabelle Drouet. Our plan is to confront the procedures thus described with the results of the research in Task 1.

Task 3b: Integration: Philosophical Perspective on deliberation and aggregation

Working group: **Cozic** (manager, UPEC), **Roy** (manager, U. Bayreuth), **Baccelli** (Université Cergy-Pontoise), **Bonnay** (UPON), **Pivato** (Université de Cergy-Pontoise).

This part is both conceptual and reflexive in character. The goal is to work towards an answer to our Main Research Question. To do so we intend to sketch the scope and limits of, and the key lessons to be drawn from, the formal models investigated in the previous Tasks and Subtasks.

(O7a) The first, preparatory question to answer is *which* collective attitudes are formed in the formal models that will have been built and studied in Tasks 1 and 2. There is an extensive philosophical literature on group intentionality, to which some of our members have contributed (e.g. Paternotte 2015). It has, however, paid little attention to such formal models. One of the few exceptions is the work of (List and Pettit 2011) and more recent work by List (2014) and Bonnay & Cozic (2016). They respectively distinguish three kinds of collective attitude (aggregate, corporate and common) and three kinds of aggregation processes of epistemic attitudes (statistical, attributive and advisory). The goal will be to examine the findings of previous Tasks from the perspective of these taxonomies, and amend or extend these categories if needed. This will allow to better situate our models within the broader philosophical literature on collective intentionality, and also highlight whether some families of phenomena involving our main concepts (e.g., some type of deliberation) are poorly represented - or not represented at all in these models.

With this in hand we will move towards an answer to our Main Research Question **(O7b)**: How and should deliberative and aggregative processes be articulated in order to best support the formation of collective attitudes? We will mainly focus on the comparison between aggregating pre- and post-deliberative individual attitudes, and notably on the assessment of the two polar views, the Enhancement and Degradations Theses. The main standards for evaluating and comparing the outcome of post-deliberation processes will be *rationality* of the post-aggregation collective attitudes, *responsiveness* and *fairness* with respect to the individual’s attitudes and, in the case of belief-like collective attitudes, their ability to *track the truth*. We will start by identifying contexts in which the

models of deliberation developed in Task 1 can *restrict the domain* of post-deliberative (individual) attitudes, and by doing so avoid classical difficulties for aggregation, as pointed out e.g. in List & Pettit (2002) and Dryzek & List (2003). The question will be whether, for instance, the non-consequentialist social criteria for aggregation under uncertainty identified in Task 2b are preserved or can be more easily achieved when restricting the domain of preference profiles to those resulting from the models developed in Task 1a. In parallel, we will study the truth-tracking properties of the relevant aggregation methods studied in Task 2, when they use post-deliberation judgments as input. Here the starting point will be Pivato's (2016) paper, which shows that from the point of view of truth-tracking, a pooling-like process of deliberation *does not degrade* pre-deliberative individual attitudes. However, it is still an open question whether (and how) deliberation can *improve* these truth-tracking properties. From these results we will obtain a better understanding of when deliberation and aggregation can be fruitfully integrated (and notably of the circumstances in which the Enhancement and Degradation Theses hold), and thus make an important step towards answering our Main Research Question.

3.2.2. Schedule and deliverables

Each participant to the project will engage her/himself in producing some publications to be submitted to international journals and/or leading editors in the field. Between the first and the final project-wide workshop seminar we will also write a collective book, to be submitted to the series *Theory and Decision Library* (Springer Verlag, see <http://www.springer.com/series/6616>)

	Object.	Sub-Obj.	year 1			year 2			year 3		
			I	II	III	IV	V	VI	VII	VIII	IX
Project-specific Workshops (W)											
Task 1. Deliberation towards aggregation.											
1a. Deliberative pitfalls - analysis and prevention.	O1	a	W								
		b						W			
1b : The dynamics of epistemic deliberation	O2	a		W							
		b									W
Task 2. Aggregation from deliberation.											
2a: Aggregation of beliefs	O3	a		W							
		b									
	O4	a									
		b									W
2b: Aggregation of preferences under uncertainty	O5	a	W								
		b									
		c									
		d								W	
Task 3. Philosophical foundations and application.											
3a. Case study: IPCC.	O6	a			W						
		b									W
3b. Integration: Philosophical Perspective on deliberation and aggregation	O7	a				W					
		b									W
Project-Wide Workshops											
Opening Workshop - France											
Closing Workshop - Germany											
Project-funded staff											
Postdoctoral researcher 1, French side											
Postdoctoral researcher 2, French side											
Postdoctoral researcher 1, German side											

Character count (with spaces), section 2 to 3.2.2.: 55923

3.3. References

3.3.1. Work cited: members and associate members of the Project

- Aczél, J., Ng, C. T., & Wagner, C., (1984), “Aggregation Theorems for Allocation Problems”, *SIAM Journal on Algebraic and Discrete Methods* 5: 1-8.
- Aczél, J., & Wagner, C., (1980), “A characterization of weighted arithmetic means”, *SIAM Journal on Algebraic and Discrete Methods* 1: 259-260.
- van Benthem J, Girard P, Roy O., (2009), “Everything else being equal: A modal logic for ceteris paribus preferences”, *Journal of philosophical logic*.38:83–125.
- Blackorby, C., Donaldson, D., Mongin, P., (2004), “Social aggregation without the expected utility hypothesis”, Manuscript.
- Bommier, A., Zuber, S., (2008), “Can preferences for catastrophe avoidance reconcile social discounting with intergenerational equity?”, *Social Choice and Welfare*, 31, 415-434
- Bonnay, D., (2008), “Logicity and Invariance”, *Bulletin of Symbolic Logic*, vol. 14: 29-68
- Bonnay, D., (2012), “Consequence Mining”, with Dag Westerståhl, *Journal of Philosophical Logic*, vol. 41: 671-709
- Bonnay, D., (2014), “Logical Constants”, *Philosophy Compass*, vol. 9, 54-65
- Bonnay, D., (forthcoming), “A Clustering-Based Approach to Collective Beliefs”, to appear in Thomas T. Boyer-Kassem et alii, *Scientific Collaboration and Collective Knowledge*, Oxford UP.
- Bonnay, D. & Cozic, M., (2016a), “La vie sociale des bayésiens”, in Drouet, I. (ed.), *Les approches et méthodes bayésiennes, pratiques et fondements*, Paris: Matériologiques (forthcoming).
- Bonnay, D. & Cozic, M., (2016b), “Weighted averaging as a revision rule”, in preparation
- Bonnay, D. & Cozic, M., (2016c), “Jeffrey conditioning and Weighted averaging”, in preparation
- Bonnay, D. & Egré, P., (2009), “Inexact Knowledge with Introspection”, *Journal of Philosophical Logic*, vol. 38: 176-227
- Bonnay, D. & Egré, P., (2010), “Vagueness, Uncertainty and Degrees of Clarity”, *Synthese*, vol. 174: 47-78
- Bozbay, I., Dietrich, F., & Peters, H., (2014), “Judgment aggregation in search for the truth”, *Games and Economic Behavior* 87: 571-590
- Bradley, R., (2006), “Taking Advantage of Difference in Opinion”, *Episteme*
- Bradley, R, Helgeson, C & Hill, B (2016), “Climate Change Assessments: Confidence, Probability and Decision”, *HEC Paris Research Paper No. ECO/SCD-2016-1131*.
- Bradley, Seamus, (2011), "Scientific uncertainty: A user's guide", *Grantham Institute on Climate Change and the Environment Working Paper 56*
- Coulhon, T. Mongin, P., (1989), "Social Choice Theory in the Case of Von Neumann-Morgenstern Utilities", *Social Choice and Welfare*, 6, 175-187
- Cozic, M., (2011a), “Imaging and Sleeping Beauty”, *Journal of Approximate Reasoning* (Springer), 52, pp. 137-43
- Cozic, M., (2011b), “Confirmation et induction” in Barberousse & ali. (eds.), *Précis de philosophie des sciences*, Vuibert, Paris
- Cozic, M., (2011c), “Probabilistic Unawareness”, *Cahiers de Recherche de l’IHPST, Série DRI, DRI-2011-03*
- Cozic, M., (2012), “Economie ‘sans esprit’ et données cognitives”, *Revue de philosophie économique*, 13(1), pp. 127-153

- Cozic, M., (2015), "Philosophy of Economics" in Barberousse & ali. (eds.), *Handbook in Philosophy of Science*, Cambridge: Cambridge University Press (forthcoming)
- Danan, E., Gajdos, T., Hill, B., and Tallon, J-M., (forthcoming), "Robust Social Decisions", *American Economic Review*.
- Dégremont C, Roy O., (2012), "Agreement Theorems in Dynamic-Epistemic Logic", *Journal of Philosophical Logic*.1–30.
- De Meyer, B., Mongin, P., (1995), "A note on affine aggregation", *Economics Letters*, 47, 177-183
- Dietrich, F., (2006), "Judgment aggregation: (im)possibility theorems", *Journal of Economic Theory* 126(1): 286-298.
- Dietrich, F., (2007), "A generalised model of judgment aggregation", *Social Choice and Welfare* 28(4): 529-565.
- Dietrich, F., (2010), "Bayesian group belief", *Social Choice and Welfare* 35(4): 595-626.
- Dietrich, F., (2013), "Judgment aggregation and agenda manipulation", *Working paper, CNRS*.
- Dietrich, F., (2014), "Scoring rules for judgment aggregation", *Social Choice and Welfare* 42(4): 873-911.
- Dietrich, F., & List, C., (2007a), "Arrow's theorem in judgment aggregation", *Social Choice and Welfare* 29(1): 19-33.
- Dietrich, F., & List, C., (2007b), "Strategy-proof judgment aggregation", *Economics and Philosophy* 23: 269-300.
- Dietrich, F., & List, C., (2007c), "Judgment aggregation by quota rules: generalizing majority voting", *Journal of Theoretical Politics* 19(4): 391-424
- Dietrich, F., & List, C., (2008), "A liberal paradox for judgment aggregation", *Social Choice and Welfare* 31(1): 59-78
- Dietrich, F., List, C., (2010), "The aggregation of propositional attitudes: towards a general theory", *Oxford Studies in Epistemology* 3: 215-234 (with "Corrigendum" on the authors' webpages).
- Dietrich, F., & List, C., (2013a), "Opinion pooling generalized – Part one: general agendas", *Working paper*, London School of Economics.
- Dietrich, F., & List, C., (2013b), "Opinion pooling generalized – Part two: premise-based opinion pooling", *Working paper*, London School of Economics.
- Dietrich, Franz and Christian List, (2013), "A reason-based theory of rational choice", *Nous* 47 (1): 104-134,
- Dietrich, F., & List, C., (forthcoming), "Probabilistic opinion pooling", In: C. Hitchcock and A. Hajek (eds.), *Oxford Handbook of Probability and Philosophy*, Oxford University Press
- Dietrich, F., & Mongin, P., (2010), "The premise-based approach to judgment aggregation", *Journal of Economic Theory* 145(2): 562-582
- Dietrich, F., & Spiekermann, K., (2013), "Independent opinions? On the causal foundations of belief formation and jury theorems", *Mind* 122(487): 655-685, 2013
- Drouet, I., "Les approches et méthodes bayésiennes, pratiques et fondements" (ed), *Matériologiques* (to appear).
- Drouet, I., (2012b), "Causal reasoning, causal probabilities and theories of causation" *Studies in history and philosophy of biological and biomedical sciences* 43 761-768.
- Drouet, I., (2012a), "Propensions popperiennes et puissances aristotéliennes. De l'interprétation des probabilités à la métaphysique" *Philosophie* 114 50-73.
- Drouet, I., (2011), "Propensities and conditional probabilities", *The International Journal of Approximate Reasoning* 52.2 153-165
- Dryzek, J. S., & List, C. (2003), "Social choice theory and deliberative democracy: a reconciliation",

British Journal of Political Science 33.01 1-28.

Egré, P., & Barberousse, A. (2014), "Borel on the Heap", *Erkenntnis*,

Egré, P., P. Cobreros, D. Ripley and R. van Rooij, (2012), "Tolerant, Classical, Strict", *Journal of Philosophical Logic*

Egré, P., I. Douven, R. Dietz and L. Decock, (2013), "Vagueness: a conceptual spaces approach", *Journal of Philosophical Logic*,

Egré, P. and N. Klinedinst (eds)., (2011), *Vagueness and Language Use*, Palgrave Macmillan

Egré, P. & Bonnay, D. (2012) "Metacognitive perspectives on unawareness and uncertainty" in M. Beran, J. Brandl, J. Perner and J. Proust eds., *Foundations of Metacognition*, 321-342, Oxford University Press

Fleurbaey, M., (2009), "Two variants of Harsanyi's aggregation theorem", *Economics Letter*, 105: 300-302

Fleurbaey, M., (2010), "Assessing risky social situations", *Journal of Political Economy*, 118, 649-680

Fleurbaey, M., Gajdos, T., Zuber, S., (2015), "Social rationality, separability, and equity under uncertainty", *Mathematical Social Science*, 73, 13-22

Fleurbaey, M., Mongin, P., (2011), "The Utilitarian relevance of the aggregation theorem", *Cahiers de recherche du groupe HEC*, No 955

Fleurbaey, M., Zuber, S., (2013), "Inequality aversion and separability in social risk evaluation", *Economic Theory*, 54, 675-692

Fleurbaey, M., Zuber, S., (2015), "Fair management of social risk", *CES Working Paper No 2014.16R*

Friedman, M., *Kant and the Exact Sciences*, (1992), Harvard University Press,

Frigg, R., Bradley, S., Du H. and Smith, L.A., (2014), "Laplace's Demon and the Adventures of his Apprentices", *Philosophy of Science*

Hansen, P.G. and Hendricks, V., (2014), *Infostorms*, Springer,

Hendricks, V. and Rendsvig, R., "Social Proof in Extensive Games", forthcoming in *Studia Logica*.

Hendricks, V. and Lundorff-Rasmussen, *DOWNFALL! The Financial Crisis and Philosophy*, (forthcoming)

Hill, B., (2010), "Awareness Dynamics", *Journal of Philosophical Logic*, 39(2):113-137

Hill, B., (2012a), "Confidence in preferences", *Social Choice and Welfare*, 39(2), 273-302.

Hill, B., (2012b), "Unanimity and the Aggregation of Multiple Prior Opinions", *Cahiers de Recherche GREGHEC 959/2012*.

Hill, B., (2013), "Awareness and Equilibrium", *Synthese*, 190(5): 851-869

Hill, B., (2013), "Confidence and Decision", *Games and Economic Behavior*, 82, 675-692

Grossel, G., Lyon, A., Nunn, M. (forthcoming), T. Walshe (ed.), *Open-Intelligence Gathering and Analysis for Biosecurity, Risk-Based Decisions for Biological Threats*, Cambridge University Press.

Ivanova, Milena and Paternotte, Cédric, (2013), "Theory choice, good sense and social consensus", *Erkenntnis* 78(5):1109-1132.

Klein, D (2015) "Social interaction, a formal exploration", PhD thesis in Philosophy, Tilburg

Klein D and Marx, (2015), The Dynamics of trust -- Emergence and Destruction, *Proceedings of the 17th international workshop on trust in agent societies*, forthcoming

Lahidji, R., (2015), "Maîtrise des incertitudes à long terme : Développement d'un outil méthodologique de représentation des incertitudes et de leur propagation", Report, International Law and Policy Institute, Oslo.

Lahidji, R., (2012a), "Incertitude, causalité et décision : le cas des risques sociaux et du risque nucléaire en particulier", PhD thesis in Management science, Ecole des Hautes Etudes

Commerciales, Paris.

Lahidji, R., (2012b), "Climate change mitigation strategies", Discussion paper, Bellona, Oslo

List, C., (2003), "A possibility theorem on aggregation over multiple interconnected propositions", *Mathematical Social Sciences*, 45, p. 1-13.

List, C., (2004), "A model of path-dependence in decisions over multiple propositions", *American Political Science Review*, 98, p. 495-513

List, C., (2011), "Group Communication and the Transformation of Judgments: An Impossibility Result", *Journal of Political Philosophy*, 19(1), pp. 1-27

List, C., R. C. Luskin, J. S. Fishkin, and I. McLean, (2013), "Deliberation, Single-Peakedness, and the Possibility of Meaningful Democracy: Evidence from Deliberative Polls", *Journal of Politics*, 75: 80–95

List, C. and P. Pettit, (2002), "Aggregating Sets of Judgments: An Impossibility Result", *Economics and Philosophy*, 18(1): 89–110

List, C. and P. Pettit, (2002), "Aggregating Sets of Judgments: An Impossibility Result", *Economics and Philosophy*, Vol. 18, pp. 89-110.

List, C., and P. Pettit, (2011), *Group agency: The possibility, design, and status of corporate agents*. Oxford: Oxford University Press,

Lyon, A., (forthcoming), "Collective Wisdom", *Journal of Philosophy*.

Lyon, A., Wintle, B., Burgman, M., (2015), "Collective Wisdom: A Study of Some Simple and Complex Methods of Confidence Interval Aggregation", *Journal of Business Research*, Volume 68, Issue 8.

Lyon, A., Pacuit, E., (2014), "The Wisdom of Crowds: Methods of Human Judgement Aggregation," *Springer Handbook for Human Computation*

Lyon, A., Gossel, G., Burgman, M., Nunn, M., (2013), "Using Internet Intelligence to Manage Biosecurity Risks: A Case Study for Aquatic Animal Health," *Diversity and Distributions*, 19(5-6):640–650.

Lyon, A., Mooney, A., Gossel, G., (2013), Using AquaticHealth.net to Detect Emerging Trends in Aquatic Animal Health, *Agriculture*, 3(2), pp. 299-309.

Lyon, A., Fidler, F., Burgman, M., (2012a), "Judgement Swapping and Aggregation", *AAAI Fall 2012 Technical Report on Machine Aggregation of Human Judgment*, AAAI Press.

Lyon, A., Nunn, M., Gossel, G., Burgman, M., (2012b), Comparison of Web-Based Biosecurity Intelligence Systems: BioCaster, EpiSPIDER, and HealthMap, *Transboundary and Emerging Diseases*, 59(3):223-32.

Lyon, A., (2011), "Distributed Surveillance: When Social Media Meets Social Epistemology, Theory and Practice", *World Philosophy Day Proceedings*

Marx, J. and Klein, D., (2014), "The Dynamics of Trust, Emergence and Destruction", *Proceedings of the 17th International Workshop on Trust in Agent Societies, CEUR*

Mongin, P., (1995), "Consistent Bayesian aggregation", *Journal of Economic Theory*, 66, 313-351.

Mongin, P., (1997), "Spurious unanimity and the Pareto principle", forthcoming in *Economics and Philosophy*

Mongin, P., (1998), "The paradox of the Bayesian expert and state-dependent utility theory", *Journal of Mathematical Economics*, 29, 331-361.

Mongin, P., (2008), "Factoring Out the Impossibility of Logical Aggregation", *Journal of Economic Theory* 141: 100-113

Mongin, P., (2011), "La théorie de la décision et la psychologie du sens commun", *Information sur les sciences sociales/Social Science Information*, 50, 351-374.

- Mongin, P., d'Aspremont, C. (1998). "Utility theory and ethics", in Barberà, S., Hammond, P.J., Seidl, C. (Eds.), *Handbook of Utility Theory - Volume 1: Principles*, Dordrecht: Kluwer Academic Publishers, 371-481
- Mongin, P., & Dietrich, F. (2010) "Un bilan interprétatif de la théorie de l'agrégation logique", *Revue d'Economie Politique* 120: 929-72
- Mongin, P., Pivato, M., (2015), "Ranking multidimensional alternatives and uncertain prospects", *Journal of Economic Theory*, 157, pp.146-171.
- Mongin, P., Pivato, M., (2016), "Social choice under uncertainty: beyond *ex ante* and *ex post*" (preprint).
- E. Pacuit and O. Roy., (2011), "A dynamic analysis of interactive rationality", In H. van Ditmarsch, J. Lang, and S. Ju, editors, *Logic, Rationality, and Interaction*, pages 244–257. Springer,.
- Paternotte, Cédric, (2014), "Minimal Cooperation", *Philosophy of the Social Sciences* 44(1):45-73.
- Paternotte, Cédric, (2015), "The epistemic core of weak joint action", *Philosophical Psychology* 28(1):70-93.
- Paternotte, Cédric and Grose, Jonathan, (2013), "Social Norms: Repeated Interactions, Punishment and Context Dependence", *Public Reason* 5(1):19-30.
- Paternotte, Cédric and Grose, Jonathan, (2013), "Social Norms and Game Theory: Harmony or Discord?", *British Journal for the Philosophy of Science* 64:551-587.
- Pivato, Marcus (2016) "Epistemic Democracy with Correlated Voters", *Mimeo*, Université de Cergy-Pontoise
- Romeijn, Jan-Willem, (2014), "Opinion pooling as a Bayesian update," Manuscript
- Romeijn, Jan-Willem, and Roy, Olivier, (2014), "They all agreed: Aumann meets DeGroot" Manuscript
- Romeijn, Jan-Willem, and Roy, Olivier, (2015), "Symposium on Deliberation", Special Issue of *Economics and Philosophy*, Volume 31, Issue 01
- Wagner, C., (1982), "Allocation, Lehrer Models, and the Consensus of Probabilities", *Theory and Decision* 14: 207-220.
- Wagner, C., (1985), "On the Formal Properties of Weighted Averaging as a Method of Aggregation", *Synthese* 62: 97-108.
- Wagner, C. G., (1989), "Consensus for belief functions and related uncertainty measures", *Theory and Decision*, 26(3), 295–304. doi:10.1007/BF00134110
- Wintle, B., Mascaro, S., Fidler, F., McBride, M., Burgman, M., Flander, L., Saw, G., Twardy, C., Lyon, A., Manning, B., (2012), "The Intelligence Game: Assessing Delphi Groups and Structured Question Formats", *Proceedings of the 5th Australian Security and Intelligence Conference*
- Zuber, S., (2016), "Harsanyi's theorem without the sure-thing principle: On the consistent aggregation of Monotonic Bernoullian and Archimedean preferences", *Journal of Mathematical Economics*, 63, 78–83.

3.3.2. Other work cited:

- Ackerman, M. & Ben-David, S., (2008), "Measures of Clustering Quality: A Working Set of Axioms for Clustering", *Advances in Neural Information Processing Systems*, 21, p. 121-128.
- Anscombe, F.J., Aumann, R.J., (1963), "A definition of subjective probability", *Annals of Mathematical Statistics*, 34, 199-205.
- Arrow, Kenneth J., (1951/1963), *Social choice and individual values*. Vol. 12. Yale University Press,
- Arrow, Kenneth J., and Sen, A. K., and Suzumura, Kotaro, eds., (2002, 2010), *Handbook of Social Choice & Welfare*, Vol. 1 and 2. Elsevier,

- Aumann, R., (1976), "Agreeing to Disagree", *The Annals of Statistics*, vol. 4 (6), pp. 1236-1239
- Austen-Smith, David, and Timothy J. Feddersen, (2006), "Deliberation, preference uncertainty, and voting rules." *American Political Science Review* 100.02: 209-217.
- Bacharach, M., (1985), "Some extensions of a claim of Aumann in an axiomatic model of knowledge", *Journal of Economic Theory*, 37(1), 167–190.
- Baker, K. (1975), *Condorcet. From Natural Philosophy to Social Mathematics* Chicago
- Baltag, Alexandru, Lawrence S. Moss, and Slawomir Solecki, (1998), "The logic of public announcements, common knowledge, and private suspicions", *Proceedings of the 7th conference on Theoretical aspects of rationality and knowledge*, Morgan Kaufmann Publishers Inc.,
- Baltag, A and S. Smets, (2009), "Group belief dynamics under iterated revision: Fixed points and cycles of joint upgrades", in A. Heifetz, editor, *Proceedings of the 12th Conference on Theoretical Aspects of Rationality and Knowledge*, pages 41–50. ACM, 2009.
- Baltag, Alexandru et al, (2013), *Logical Models of Informational Cascades Studies in Logic*, Volume 47, pp.405-432
- Bicchieri, Cristina, (2006), *The Grammar of Society*, Cambridge UP
- Black, D., (1958), *The Theory of Committees and Elections*, Cambridge
- Ben Porath, E., Gilboa, I., Schmeidler, D., (1997), "On the measurement of inequality under uncertainty", *Journal of Economic Theory*, 75, 443–467.
- Bewley, T. F., (2002), "Knightian decision theory. Part I", *Decisions in Economics and Finance*, 25(2), 79–110
- Black, D., Newing, R. A., McLean, I., McMillan, A., & Monroe, B. L., (1958), *The theory of committees and elections* (pp. 174-176), Cambridge: University Press.
- Bohman, James and Rehg, William, Edward N. Zalta (ed.), (2011), "Jürgen Habermas", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.)
- Bovens, Luc and Stephan Hartmann, (2003), *Bayesian Epistemology*, Oxford University Press
- Boubourides, Moses A., (2004), "A Review of Networking Theories on the Formation of Public Opinion", *La Revue Electronique de Communication* Vol 14, 3 and 4, accessed under: <http://www.cios.org/EJCPUBLIC/014/3/01434.html>
- Bradley, Richard, (2007), "Reaching a consensus", *Social choice and welfare* 29.4: 609-632.
- Brams, S.J. & Fishburn, P.C., (1983/2007), *Approval Voting*, 2nd ed., New York: Springer
- Broome, J., (1991), *Weighing Goods. Equality, Uncertainty and Time*, Oxford: Blackwell.
- Burgman, M., M. McBride, R. Ashton, A. Speirs-Bridge, L. Flander, B. Wintle, F. Fidler, L. Rumpff, and C. Twardy, (2011), "Expert Status and Performance", *PLoS One* 6(7), e22998.
- Condorcet, Marie Jean Antoine Nicolas Caritat, Marquis de. *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix* (Paris 1785; repr. New York 1972).
- Chambers, C., (2007), "An ordinal characterization of the linear opinion pool", *Economic Theory* 33(3): 457-474.
- Chambers, C.P., Hayashi, T., (2006), "Preference aggregation under uncertainty: Savage vs. Pareto", *Games and Economic Behavior*, 54, 430-440.
- Colomer, J. & McLean, I., (1998), "Electing popes: approval balloting and qualified-majority rule", *Journal of Interdisciplinary History*, XXIX(I), pp. 1-22
- Cristiano, Thomas, (1996), *The Rule of The Many: Fundamental Issues in Democratic Theory*, Boulder, CO: Westview Press
- Crosby, Ned et al., (2005), "Citizens juries: Creating a trustworthy voice of the people", *The deliberative democracy handbook: Strategies for effective civic engagement in the twenty-first century* (2005): 111-119.

- Crès, H., Gilboa, I., & Vieille, N., (2011), "Aggregation of multiple prior opinions", *Journal of Economic Theory*, 146, 2563–2582
- Daston, Lorraine, (2009), "Science studies and the history of science." *Critical Inquiry* 35.4: 798-813.
- Darley, J. M. and B. Latané, (1968), "Bystander intervention in emergencies: diffusion of responsibility", *Journal of Personality and Social Psychology* 8 (4), 377–383.
- Dean, Walter, and Rohit Parikh, (2011), "The logic of campaigning", *Logic and Its Applications*. Springer Berlin Heidelberg, 38-49.
- Deffuant, Guillaume, (2006), "Comparing Extremism Propagation Patterns in Continuous Opinion Models", *Journal of Artificial Societies & Social Simulation* 9.3 (2006).
- De Groot, M., (1974), "Reaching a consensus", *Journal of the American Statistical Association*, 69(345), pp. 118-121
- Dekel, E., Lipman, B. & Rustichini, A., (1998), "Standard State-Space Models Preclude Unawareness", *Econometrica*, 66(1), pp. 159-173
- Dempster, A. P., (1967), "Upper and Lower Probabilities Induced by a Multivalued Mapping", *Annals of Mathematical Statistics*, 38, 325–339
- Diamond, P.A., (1967), "Cardinal welfare, individualistic ethics, and interpersonal comparison of utility: comment", *Journal of Political Economy*, 75, 765–766.
- van Ditmarsch, Hans, Wiebe Van Der Hoek, and Barteld Kooi, (2007), *Dynamic epistemic logic*, Vol. 1. Heidelberg: Springer.
- Dokow, E., & Holzman, R., (2010), "Aggregation of binary evaluations", *Journal of Economic Theory* 145(2): 495-511
- Dryzek, J., (2000), *Deliberative Democracy and Beyond*, Oxford: Oxford University Press
- Dryzek, John S., and Christian List, (2003), "Social choice theory and deliberative democracy: a reconciliation", *British Journal of Political Science* 33.1 (2003): 1-28.
- Dryzek, John S., and Valerie Braithwaite, (2000), "On the Prospects for Democratic Deliberation: Values Analysis Applied to Australian Politics", *Political Psychology* 21.2 (2000): 241-266.
- van Eijck and Verbrugge, "Formal Approaches to Social Procedures", *Stanford Encyclopedia of Philosophy*, (forthcoming)
- El Hakim, S., (1978), "The Structure and Dynamics of Consensus Decision-Making", *Man*, 13(1), pp. 55-71
- Ellsberg, D., (1961), "Risk, Ambiguity, and the Savage Axioms", *Quart. J. Econ.*, 75, 643–669
- Elster, Jon, (1997), "The market and the forum: three varieties of political theory", in *Deliberative democracy: Essays on reason and politics* : 3-34.
- Elster, Jon (1997), *Deliberative Democracy*, Cambridge: Cambridge UP
- Epstein, L.G., Segal, U. (1992). "Quadratic social welfare functions", *Journal of Political Economy*, 100, 691-712.
- Farrar, Cynthia, et al. (2003), "Experimenting with deliberative democracy: effects on policy preferences and social choice", *Presentation at the ECPR Conference*, Marburg, Germany. 2003.
- Fishburn, P.C., (1984), "On Harsanyi's utilitarian cardinal welfare theorem", *Theory and Decision*, 17, 21-28.
- Fishkin, James S., (1997), *The voice of the people: Public opinion and democracy*, Yale University Press.
- Fitelson, Branden, (2006), "Logical Foundations of Evidential Support", *Philosophy of Science* 73.5: 500-512
- Friedman, Michael, (1993) "Remarks on the history of science and the history of philosophy", in: P.

- Horwich (ed.), *World Changes: Thomas Kuhn and the Nature of Science*, Cambridge MA & London: MIT Press, pp. 36-54.
- Gajdos, T., Maurin, E., (2004), "Unequal uncertainties and uncertain inequalities: an axiomatic approach", *Journal of Economic Theory*, 116, 93–118.
- Gajdos, T., & Vergnaud, J.-C., (2011), "Decisions with conflicting and imprecise information"
- Galton, F., (1907a), "Letters to the Editor: The Ballot-Box", *Nature* 75, 900–1.
- Galton, F., (1907b), "Vox Populi", *Nature* 75, 450–1.
- Geanakoplos, J. & Polemarchakis, H., (1982), "We Can't Disagree Forever", *Journal of Economic Theory*, vol. 28 (1), pp. 192-200
- Genest, C., (1984a), "A characterization theorem for externally Bayesian groups", *Ann. Statist.* 12, p. 1100-1105.
- Genest, C., (1984b), "Pooling operators with the marginalization property", *Canadian Journal of Statistics* 12: 153-63.
- Genest, Ch. & Zidek, J. (1986), "Combining Probability Distributions: A Critique and an Annotated Bibliography", *Statistical Science*, vol.1(1), pp. 114-148
- Gibbard, A., (1973), "Manipulation of voting schemes: a general result." *Econometrica*, 41: 587–601
- Gilboa, I., Postlewaite, A. & Schmeidler, D., (2009), "Is it always rational to satisfy Savage's axioms?", *Economics and Philosophy*, 25(3), 285–296
- Gilboa, I., Samet, D., Schmeidler, D., (2004), "Utilitarian aggregation of beliefs and tastes", *Journal of Political Economy*, 112, 932-938.
- Gilboa, I., & Schmeidler, D., (1989), "Maxmin expected utility with non-unique prior", *J. Math. Econ.*, 18(2), 141–153. doi:http://dx.doi.org/10.1016/0304-4068(89)90018-9
- Good, I. J., (1952), "Rational Decisions", *Journal of the Royal Statistical Society, Series B* (Methodological), 14(1), 107–114
- Graham, Jesse, Jonathan Haidt, and Brian A. Nosek, (2009), "Liberals and conservatives rely on different sets of moral foundations", *Journal of personality and social psychology* 96.5 (2009): 1029.
- Grant, S., (1995), "Subjective probability without monotonicity: Or how Machina's Mom may also be probabilistically sophisticated", *Econometrica*, 63, 159–189.
- Grant, S., Kajii, A., Polak, B., Safra, Z., (2010), "Generalized utilitarianism and Harsanyi's impartial observer theorem", *Econometrica*, 78, 1939-1971.
- Habermas, J., (1981), *Theorie des kommunikativen Handelns*. Vol. 1: *Handlungsrationalität und gesellschaftliche Rationalisierung*. Vol. 2: *Zur Kritik der funktionalistischen Vernunft*. Frankfurt am Main: Suhrkamp.
- Habermas, J., (1992), *Faktizität und Geltung. Beiträge zur Diskurstheorie des Rechtes und des demokratischen Rechtsstaats*. Frankfurt am Main: Suhrkamp.
- Hammond, P.J., (1982), "Ex post optimality as a dynamically consistent objective for collective choice under uncertainty", in Pattanaik, P., Salles, M. (eds.), *Social Choice and Welfare*, Amsterdam North-Holland.
- Harsanyi, J.C., (1955), "Cardinal welfare, individualistic ethics and interpersonal comparisons of utility", *Journal of Political Economy*, 63, 309-321.
- Harsanyi, J.C., (1975), Nonlinear Social Welfare Functions. Do Welfare Economists Have a Special Exemption from Bayesian Rationality?," *Theory and Decision*, 6, 311-332.
- Hartigan, J., (1975), *Clustering Algorithms*, Wiley & Sons
- Hartmann, S., Martini, C. & Sprenger, J., (2009), "Consensual Decision Making Among Epistemic Peers", *Episteme* 6, pp. 110-129
- Hegselmann, Rainer, and Ulrich Krause, (2002), "Opinion dynamics and bounded confidence models,

analysis, and simulation”, *Journal of Artificial Societies and Social Simulation* 5.3

Hegselmann, Rainer, and Ulrich Krause, (2009), "Deliberative exchange, truth, and cognitive division of labour: A low-resolution modeling approach", *Episteme* 6.02: 130-144.

Heifetz, A., Meier, M. & Schipper, B., (2006), 'Interactive unawareness', *Journal of Economic Theory* 130, pp. 78-94.

Henry, Claude, (2010), "Decision-Making under Scientific, Political and Economic Uncertainty", in The Beijer Institute at the Royal Swedish Academy of Sciences, *Bringing Ecologists and Economists Together: The Askö Meetings and Papers*, Springer Verlag, Munich

Howson, Colin and Peter Urbach, (1989), *Scientific reasoning, The Bayesian approach*, Open Court

Inglehart, Ronald, and Christian Welzel, (2005), *Modernization, cultural change, and democracy: The human development sequence*, Cambridge University Press, 2005.

Jackson, Matthew O., (2008), "Average distance, diameter, and clustering in social networks with homophily." *Internet and Network Economics*. Springer Berlin Heidelberg, 4-11.

Jehle, D., & Fitelson, B., (2009), "What is the "Equal Weight View"?. *Episteme*, 6(03), 280-293.

Joyce, J. M. (2011), "A Defense of Imprecise Credences in Inference and Decision Making", In T. S. Gendler & J. Hawthorne (Eds.), *Oxford Studies in Epistemology* (Vol. 4). OUP

Kerr, N.L. & Tindale, R.S., (2011), "Group-based Forecasting ? A Social Psychological Analysis", *International Journal of Forecasting*, 27, pp. 14-40

Kitcher, Philip, (2011), "Epistemology without history is blind", *Erkenntnis* 75, pp. 505-524.

Kleinberg, J., (2002), "An Impossibility Theorem for Clustering", *Advances in Neural Information Processing Systems*, 15, p. 446-453.

Klibanoff, P., Marinacci, M., & Mukerji, S., (2005), "A Smooth Model of Decision Making under Ambiguity", *Econometrica*, 73(6), 1849–1892. doi:http://dx.doi.org/10.1111/j.1468-0262.2005.00640.x

Konieczny, Sébastien, and Ramón Pino Pérez, (2002), "Merging information under constraints: a logical framework", *Journal of Logic and Computation* 12.5: 773-808.

Kornhauser, Lewis A., and Lawrence G. Sager, (1993), "The one and the many: Adjudication in collegial courts." *California Law Review*: 1-59.,

Laughlin, P., (2011), *Group Problem Solving*, Princeton: Princeton University Press

Lehrer, K. & Wagner, C., (1981), *Rational Consensus in Science and Society*, Dordrecht: Reidel

Lempert, R. J., Nakićenović, N., Sarewitz, D. and M. Schlesinger, (2004), "Characterizing climate-change uncertainties for decision-makers", *Climatic Change*, 65: 1-9.

Levi, I., (1980), *The Enterprise of Knowledge. An Essay on Knowledge, Credal Probability and Chance*, Cambridge, MA: MIT Press

Levine, J. M. & Smith, E.R., (2013), "Group Cognition: Collective Information Search and Distribution" in D. Carlston (Ed.), *Oxford handbook of social cognition* (pp. 616-633). New York: Oxford University Press

Lewis, David, (1980), "A subjectivist's guide to objective chance", in Richard C. Jeffrey (ed.), *Studies in Inductive Logic and Probability*, University of California Press: 83-132.

Linstone, H. A. and M. Turoff, (1975), *The Delphi Method: Techniques and Applications*, Addison-Wesley.

Liu, Fenrong, Seligman, Jeremy and Girard, Patrick, (2014), "Logical Dynamics and Belief Change in the Community", *Synthese*, 191, pp. 2403-2431

Machina, M., (1989), "Dynamic consistency and non-expected utility models of choice under uncertainty", *Journal of Economic Literature*, 28, 1622–1668.

Madansky, A., (1964), "Externally Bayesian groups", *Technical Report RM-4141-PR*, RAND Corporation

- Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe, and F.W. Zwiers, “Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. Intergovernmental Panel on Climate Change (IPCC)”, available here: <http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf>.
- McLean, I. S. and Hewitt, F., (1994), *Condorcet. Foundations of Social Choice and Political Theory*, Aldershot
- Miller, D., (1999) “Deliberative Democracy and Social Choice”, *Political Studies*, XL pp. 54-67
- Modica, S. & Rustichini, A., “Unawareness and Partitional Information Structures”, *Games and Economic Behavior*, 27, pp. 265-298
- Monderer, Dov, and Dov Samet, (1989), "Approximating common knowledge with common beliefs." *Games and Economic Behavior* 1.2: 170-190.
- Muldoon, Ryan, et al., (2014), “On the emergence of descriptive norms”, *Politics, Philosophy & Economics* 13.1: 3-22.
- Nehring, K., & Puppe, C., (2010), “Abstract Arrovian Aggregation”, *Journal of Economic Theory* 145(2): 467-494
- Olsson, Erik J., (2013), "A Bayesian simulation model of group deliberation and polarization", *Bayesian argumentation*, Springer Netherlands, 113-133.
- Ottaviani M. and P. Sorensen, (2001), "Information aggregation in debate: who should speak first?", *Journal of Public Economics*, 81(September), pp.393-422
- Page, S., (2008), *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies* (New Edition). Princeton University Press.
- Parikh, Rohit, (2002), "Social software", *Synthese* 132.3: 187-211.
- Parikh, Rohit, and Paul Krasucki, (1990), "Communication, consensus, and knowledge", *Journal of Economic Theory* 52.1: 178-189.
- Paternotte, Cédric, (2015) “The epistemic core of joint action”, *Philosophical Psychology*, 28(1); 70-93.
- Pivato, Marcus (2016) “Epistemic Democracy with Correlated Voters”, *Mimeo*, Université de Cergy-Pontoise
- Riker, William, (1982), *Liberalism against populism*
- Rowe, G. & Wright, G., (1999), “The Delphi Technique as a Forecasting Tool: Issues and Analysis”, *International Journal of Forecasting*, 15, pp. 353-375
- Samet, Dov., (2010), "Agreeing to disagree: The non-probabilistic case", *Games and Economic Behavior* 69.1: 169-174.
- Satterthwaite, M., (1975), “Strategy-proofness and Arrow's conditions: existence and correspondence theorems for voting procedures and social welfare functions”, *Journal of Economic Theory*, 10: 187–217
- Savage, L.J., (1954), *The Foundations of Statistics*, New York: Wiley.
- Schmeidler, D., (1989), “Subjective Probability and Expected Utility without Additivity”, *Econometrica*, 57(3), 571–587
- Seligman, J., Liu, F. and Girard, P., (2011), "Logic in the community". *Logic and Its Applications*. Springer Berlin Heidelberg, 178-188.
- Sen, A., (1970), *Collective Choice and Social Welfare*, San Francisco: Holden-Day
- Sen, A.K., (1977), “Nonlinear social welfare functions: A reply to Professor Harsanyi”, in Butts, R., Hintikka, J. (Eds.), *Foundational Problems in the Special Sciences*, Dordrecht: Reidel.
- Sen, A.K., (1986), “Social choice theory”, in Arrow, K.J., Intriligator, M.D. (Eds.), *Handbook of*

Mathematical Economics - Volume III, Amsterdam: North Holland.

Shafer, G., (1976), *A Mathematical Theory of Evidence*, Princeton: Princeton University Press

Skyrms, B., (1980), "Higher order degrees of belief", In D. H. Mellor (Ed.), *Prospects for pragmatism. Essays in memory of F. P. Ramsey* (pp. 17–25), Cambridge University Press

Tindale, R. S., Kameda, T., & Hinsz, V. B., (2003), "Group decision making" in J. Cooper & M. Hogg (Eds.) *Sage Handbook of Social Psychology* (pp. 381 - 403), London: Sage Publications

Smith, C. (1961), "Consistency in Statistical Inference and Decision" *Journal of the Royal Statistical Society. Series B*, 23(1), 1–37

Steele, K., (2012), "Testimony as Evidence: More Problems for Linear Pooling", *Journal of Philosophical Logic*, pp. 983-999

Stone, M., (1961), "The Opinion Pool", *Annals of Mathematical Statistics* 32(4): 1339-1342

Sunstein, C., (2011), "Deliberating groups versus prediction markets" (or Hayek's challenge to Habermas), In *Social Epistemology: Essential Readings*, pp. 314 – 337.

Swart, Rob, et al., (2009), "Agreeing to disagree: uncertainty management in assessing climate change, impacts and responses by the IPCC", *Climatic change* 92.1-2 (2009): 1-29

Urfalino, Ph., (2012), "Reason and Preferences in Medicine Evaluation Committees", in Landemore, H. & Elster, J. (eds) *Collective Wisdom*, Cambridge: Cambridge University Press, pp. 173-202

Walley, P., (1991), *Statistical reasoning with imprecise probabilities*. London: Chapman and Hall

Weitzman, Martin, (2009) "On Modeling and Interpreting the Economics of Catastrophic Climate Change", *Review of Economics and Statistics*, 91.1 (2009): 1-19.

Weymark, J. A., (1991), "A reconsideration of the Harsanyi-Sen debate on Utilitarianism", in Elster, J., Roemer, J.E. (eds.), *Interpersonal Comparisons of Well-Being*, Cambridge and Paris: Cambridge University Press and Maison des Sciences de l'Homme

Williamson, Jon, (2013), "How uncertain do we need to be?", *Erkenntnis* doi: 10.1007/s10670-013-9516-6

Williamson, Jon, (2011), "An objective Bayesian account of confirmation", in Dennis Dieks, Wenceslao J. Gonzalez, Stephan Hartmann, Thomas Uebel, Marcel Weber (eds), *Explanation, Prediction, and Confirmation. New Trends and Old Ones Reconsidered, The philosophy of science in a European perspective* Volume 2, Springer: 53-81.

Williamson, Jon, (2010), *In defence of objective Bayesianism*, Oxford University Press

Williamson, Jon, (2009), "Aggregating judgements by merging evidence" *Journal of Logic and Computation* 19.3: 461-473.

Xu, R. & Wunsch C.D., (2009), *Clustering*, Wiley & Sons