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WHEN REPORTERS GET HANDS-ON WITH ROBO-WRITING: Professionals Consider Automated Journalism's Capabilities and Consequences

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Abstract

The availability of data feeds, the demand for news on digital devices, and advances in algorithms are helping to make automated journalism more prevalent. This article extends the literature on the subject by analysing professional journalists' experiences with, and opinions about, the technology. Uniquely, the participants were drawn from a range of news organizations—including the BBC, CNN, and Thomson Reuters—and had first-hand experience working with robo-writing software provided by one of the leading technology suppliers. The results reveal journalists' judgements on the limitations of automation, including the nature of its sources and the sensitivity of its "nose for news". Nonetheless, journalists believe that automated journalism will become more common, increasing the depth, breadth, specificity, and immediacy of information available. While some news organizations and consumers may benefit, such changes raise ethical and societal issues and, counter-intuitively perhaps, may increase the need for skills—news judgement, curiosity, and scepticism—that human journalists embody.

KEYWORDS algorithmic journalism, automated journalism, computational journalism, journalism ethics, media economics, news production, professional skills, robot journalism

Introduction

In recent years, there has been increasing discussion about the use of computation in journalism practice (Anderson 2012; Örnebring 2010). With the advent of algorithms and the availability of big data, the ways in which journalists search for, analyse, and distribute information are changing, giving rise to technical, cultural, economic, political, and ethical questions (Flew et al. 2012; Coddington 2015; Saurwein, Just, and Latzer 2015; Örnebring and Ferrer Conill 2016; Thurman 2011). These technical developments have also impacted news writing. Using structured data, algorithms are generating news reports on crime statistics, sports matches, and company results. For example, the Associated Press uses natural language generation[1] technologies to automate up to 3,700 quarterly earnings reports for US and Canadian companies (AI n.d.). Until recently, software providers—like Arria, Narrative Science, AX Semantics, Retresco, and Automated Insights—have mostly developed bespoke products for their journalistic clients. However, this business model is now being complemented by a self-service offer, which makes the technology available via web-based interfaces, APIs, and plug-ins for tools such as Microsoft Excel. Potential users include other industries—such as e-commerce, financial services, and customer communication—as well as smaller organisations unable to afford custom-made software.

While most of the research into this so-called "automated journalism"[2] (Graefe 2016; Montal and Reich 2016) has focused on audience perceptions of automated content (e.g. Clerwall 2014; Graefe et al. 2016), on societal or economic implications (Latar 2015; Dörr 2016), or on ethics (Diakopoulos and Koliska 2016; Dörr and Hollnbuchner 2016; Montal

and Reich 2016), there has also been some focus on the micro level, with the journalist as research object. Van Dalen (2012) analysed journalistic reactions to the launch of StatSheet, a network of machine-written sport websites, by looking at reporting in 68 blog posts and newspaper articles. Carlson (2014) mimicked this method by examining how journalists wrote about text generation software released by Narrative Science for use in journalism.

Although these studies provide useful analyses of the popular discourse around automated journalism, the journalists quoted had little or no practical experience using the technology. One exception was a study by Young and Hermida (2015) who interviewed seven employees of the *LA Times*'s Data Desk about the history, workings, and rationale behind its "The Homicide Report" website, which includes elements of automated reporting. Such studies are valuable for the insights they provide—from a professional, expert perspective—on issues such as the use of technology, changes to journalistic role conceptions, and labour and economic issues (Weischenberg, Malik, and Scholl 2006; Spyridou et al. 2013; Djerf-Pierre, Ghersetti, and Hedman 2016).

This study investigates the views of journalists on automated journalism by conducting workshops with professional practitioners. Ten British journalists from a range of media outlets and journalistic beats and with differing levels of responsibility and technical expertise were given the opportunity to work with software developed by one of the leading companies in natural language generation. The software, which the company made available for use in this study, provides various tools that enable journalists to create templates and thus automate news from structured data. The workshops were observed and semi-structured interviews carried out with the participants.

In summary, the purpose of this qualitative, exploratory study is to elicit, report, and analyse the testimonies and opinions of a range of editors and journalists about automated journalism. These opinions were, in part, stimulated by giving the participants training and hands-on experience with software, from a leading provider, used to automate data-driven news texts. We follow Carlson's (2014) definition of automated journalism as "algorithmic processes that convert data into narrative news texts with limited to no human intervention beyond the initial programming."

To help organize the presentation of this study's results and the related contextual preamble, this article uses a framework consisting of three concepts: Expertise, Economics, and Ethics.[3]

Literature Review

Expertise

The concept of expertise involves a consideration of professionals and their individual skills (Lewis and Westlund 2015, 454). Journalists are regularly required to revise their skills in the light of institutional, economic, and technological change (Willnat, Weaver, and Choi 2013). With the increased application of computing in journalism, certain skills, such as data analysis, programming, and visualization, have become more important (Mayer-Schönberger and Cukier 2013). Whereas traditional skills for investigative or interpretative reporting have long been part of journalism education (Hallin 2000), specific computational skills have been added to curricula relatively recently, if at all. It is, therefore, often the responsibility of employers or journalists themselves to provide or acquire the

skills needed for contemporary news production (Lewis and Usher 2014; Deuze, Neuberger, and Paulussen 2004).

Some argue that journalists tend to accept rather than resist technologically driven change to job requirements and skills, seeing it as part of the natural evolution of their profession (Deuze 2007; Örnbering 2010; Creech and Mendelson 2015). However, others have highlighted the concerns that exist about the pressure to acquire new skills related to digitization and the introduction of new technologies (Willnat, Weaver, and Choi 2013).

Natural language generation software could lead to a fragmentation of work tasks, an increase in management control, and the deskilling (or upskilling) of workers (Örnebring 2010, 60; Rottwilm 2014, 13). Although early research has shown that the software is not yet able to fully interpret or contextualize factual information (Graefe 2016; Dörr 2016), it may replace or augment some core journalistic skills such as accuracy and speed (Cleary and Cochie 2011, 24).

In light of the potential that natural language generation has to change the mix of skills required in the newsroom, and the uncertainty around journalists' reactions to its introduction, a number of related questions were included in the interviews.

Economics

Media economics has been defined as the study of "how media operators meet the informational and entertainment wants and needs of audiences, advertisers and society with available resources" (Picard 1989, 7). Media organizations, especially in journalism, are suffering from a shrinking advertising base, fragmenting audiences, and rising competition from mobile, social, and digital media (Picard 2010; Anderson 2012). Latzer et al. (2016) show that in the wider network economy the application of algorithms can have an economic impact in emerging, as well as existing, markets. They identify—amongst other applications—the economic potential of automated text generation, noting that algorithms can limit transaction costs for journalistic text production and lead to efficiency gains. Örnebring (2010) too writes of how technology "relieves" journalists of work that can be done by relatively inexpensive workers (including algorithms), an assessment shared by van Dalen (2012). A drive to reduce labour costs isn't new to journalism, but with the increasing use of automation and algorithms in news production, it is acquiring a new dimension. While in earlier research the economic implications of automated journalism were covered from a provider and market-driven perspective (Dörr 2016), this study evaluates the potentials and implications from the perspective of those who have first-hand professional experience of the settings in which the technology would work and in making the product it produces.

Ethics

Media ethics are a form of applied ethics focusing on the mass media system with its daily routines and professional practices (Horner 2013). Within media ethics, journalism ethics serve as a guide to approved societal moral values as well as helping to define journalists' work as professionals (Ward 2010; Lewis and Westlund 2015, 459).

Research shows that journalists feel digitization and automation complicate news production and make it more difficult to follow normative standards (Creech and

Mendelson 2015, 149; Spyridou et al. 2013). The influence of algorithms and the increasing use of digital data raise new ethical questions, for example on:

- How journalists acquire, validate, and use digital data in news production (Bradshaw 2014; Zion and Craig 2014).
- The possibility of bias in the algorithms that power automation (Shirky 2009; Carlson 2014; Gillespie 2014; Thurman et al. 2016).
- Whether algorithms can "reason": draw appropriate conclusions in all contexts (Young and Hermida 2015).
- The transparency of code and data (Diakopoulos 2015; Diakopoulos and Koliska 2016; Thurman et al. 2016).

These questions have begun to be addressed in the literature. For example, Dörr and Hollnbuchner (2016) identify, frame, and discuss ethical challenges around automated text production with regard to professional, organizational, and societal levels of responsibility in journalism. Complementing this conceptual approach, Montal and Reich (2016) analysed how 12 news websites bylined the automated news stories they published, concluding with a call for full disclosure.

To cover the ethical challenges of automated journalism from a professional perspective, questions on authorship, objectivity, and transparency were included in this study's interview framework and other ethical issues were discussed with respondents as they arose.

Methodology

Journalists' opinions were investigated qualitatively, as befitted this study's exploratory nature. Semi-structured interviews were conducted with ten journalists who were given, in advance, training in, and an opportunity to work independently with, software that enables journalistic texts to be generated automatically. The journalists were observed by the researchers during these workshops, both to inform the conduct of the interviews and as a means of triangulating their responses.

Sample Selection

Automated news writing has found real-world application in a number of journalistic contexts. Beats such as sport, finance, and crime, where structured streams of data are readily available, and where reporting can be relatively formulaic, lend themselves to automation (Podolny 2015). Although automated news writing is not restricted to these beats, it was decided, when building the sample of journalists, to purposefully include journalists working in these areas. Journalists working in certain media (for example magazines and radio) and outside an institutional framework (for example freelancers) were excluded. Automated news writing is less likely to be implemented in these contexts, due, for example, to the types of journalism, and forms of presentation, utilized in radio and magazine journalism, and to the resource constraints under which freelancers operate. Journalists were identified using a commercial database and a total of 641 journalists selected to receive an email invitation to participate. Because both the workshops and

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interviews were to be conducted in London, only journalists from Greater London were contacted.

Table 1: The sample of journalists used in this study, showing their beat, employer, and professional position.

Code	Beat	Media outlet	Position
A	Sports	CNN	Sports journalist in executive position
B	Sports	Thomson Reuters Television	Sports journalist in executive position
C	Sports	Thomson Reuters	Sports journalist in executive position
D	Data	Trinity Mirror	Data journalist
E	Data	BBC	Data journalist
F	General News	BBC	News reporter/journalism trainer
G	Crime	The Sun	News reporter
H	Finance	Thomson Reuters	Financial journalist in executive position
I	Finance	Thomson Reuters	Financial journalist, correspondent
J	Finance	BBC	News reporter, working in R&D

A total of 22 journalists expressed an interest in participating. The final sample of ten journalists was constructed purposefully in order that a variety of beats, levels of seniority, technical expertise, and a mixture of those working for private and public institutions were represented (see table 1). Having journalists at different levels of seniority was considered important because of the divergent opinions they might exhibit. For example, senior managers may view the technology positively because of its potential for reducing labour costs and for increasing control over employees and processes. Conversely, rank-and-file journalists might consider the technology as a threat to their jobs. Journalists from the BBC were purposefully included in the sample, not only because the BBC is the UK's largest news organization, but also because journalists from such a well-resourced public service broadcaster might be in a better position to experiment with new technologies because of its relatively secure funding model. A range of technical expertise was sought because the

technology might, simultaneously, deskill some, while providing the opportunity for others to be upskilled, with corresponding differences in opinions. With the exception of Journalist E, none of the participants had experimented with this kind of software before.

Workshop Content and Format

The software workshops and interviews were held on the 12th and 13th of May 2016 at the Interaction Lab of City, University of London. Each workshop accommodated a maximum of three journalists who worked on their own PC, learning how to use the software and, ultimately, creating a template that could produce news reports in an automated fashion. Each of the four workshops lasted approximately two and a half hours, and was led by a native English speaker (one of the authors of this article).

The software used in the workshop is an online application for generating journalistic texts from structured data. Access was provided by one of the leading companies in the field who service a variety of large journalistic clients. In order that an appropriate level of technical instruction could be given, the researchers were trained by the company twice and pre-tested the workshop format with a group of students. Due to non-disclosure and anonymity agreements, neither the company, the software platform, nor the journalists can be identified.

To use the software the journalists uploaded structured data. Next, they constructed a template using a graphical user interface that utilizes the variables in the data to generate the news texts. At a simple level, variables from the data file can be inserted directly. For example:

```
[Westminster] recorded the highest number of offences for
any London borough with [3,899].
```

Where `[Westminster]` and `[3,899]` are the variables that are replaced in each new story produced by the template. The formatting of variables can be modified, for example their capitalization, the number of decimal places, and so on. If the data does not contain all the variables a journalist might wish to use as part of the template, new ones can be created by transforming existing variables using simple mathematical functions. In order to add variability to the final outputs, individual words in the template can be assigned an unlimited number of synonyms that are picked at random when the texts are generated. Finally, branching offers the ability for words, sentences, or whole paragraphs to be inserted depending on certain conditions. For example, if one variable is equal to, greater than, or less than another. Data variables and synonyms can be used within branches and branches themselves can contain branches making it possible to create templates of great complexity.

In the workshops, the journalists were grouped according to their beat. The data sets used took inspiration from examples provided by The Company and were collated by the researchers. The first data set, for the finance journalists, used employment data on the UK released by the Office for National Statistics. The second, for the general news reporters, consisted of crime statistics relating to London boroughs released by London's Metropolitan Police. The third, for the sports journalists, consisted of data relating to several English Premier League soccer matches.

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The employment data set consisted of 22 separate variables, such as: "non UK nationals in employment". The crime data set had more variables (52), such as: "total drug offences 11 month average". The sports data set consisted of 61 variables, such as: "scorer of first home team goal". Some of the variables were taken directly from the original data sources, and others were the result of transformations made to the data that would be useful to journalists; for example, so that they could make comparisons across time periods or see outlying values.

Data Collection and Analysis

The journalists were observed during the workshops by three researchers (including two of this article's authors) from behind a one-way mirrored wall. Although the journalists were aware of this set-up beforehand, they could not see or interact with the observers during the workshops. As well as being able to see the journalists' body language through the mirror, the observers had an audio feed of proceedings and could see how the journalists were interacting with the software via screens that echoed the output of each participant's computer monitor. Notes were taken during the observations.

Immediately following the completion of each workshop, participants were interviewed by the observers. Each interview lasted between 37 and 60 minutes and was digitally recorded and transcribed verbatim. The coding and analysis followed a fairly standard process, such as described by Weiss (1994, 151–182) and Creswell (1994), of iterative issue identification, mark-up, and theme development. Quotations used in this article have been edited for concision and clarity, while preserving the meaning. The questions that made up the semi-structured interview plan were written following a literature review and grouped into overarching themes that, broadly, fitted within this article's conceptual framework of Expertise, Economics, and Ethics.

Results

Expertise

There was a significant amount of comment on the constraints imposed by the technology, in particular its reliance on single, isolated data streams and the necessity to predict news angles (or "top lines"[4]) in advance. Journalists felt these constraints meant that items produced in this way would lack the context, complexity, and creativity of traditional reporting.

Sourcing

As mentioned, journalists believed that one of the technology's main constraints, even in areas such as sports, crime, and finance reporting, where automation has been considered to have the most potential, was its reliance on single, isolated data streams. A data feed[5] about a single English Premier League soccer game of the type that could be used to power an automated match report can contain "2,000 detailed events", from the result down to very granular data (Opta n.d.). That data, however, relates to what happened on the pitch, which, a senior sports journalist at CNN (A) said, might be "largely irrelevant" to

the story a journalist covering a fixture might want to write. Other "big issues" off the pitch could be more important, he said, giving the example of a game between West Ham and Manchester United in May 2016. In that match the "riot before the game", the fact that by losing Manchester United were unlikely to be able to qualify for the Champions League, and the fixture's place in history as the last West Ham would play at their Upton Park ground after 112 years were more important than the events that took place on the turf. These contextual factors, the journalist thought, "can't be programmed in", meaning that the data might only present "10 per cent of the story".

A journalist at Thomson Reuters (I) made a similar point, giving the example of a financial story based around a data release from the European Central Bank (ECB). While a data feed might communicate that the ECB had kept interest rates unchanged, it couldn't, he said, convey the "semantics" of the announcement, for example how the ECB's president "answers questions". Furthermore, "a lot of the really important stuff", he said, "is being briefed off-the-record by bankers to journalists".

Other respondents (A, F, and B) also mentioned that using multiple sources is a characteristic of good journalism and that such sourcing, for example from "the front line of a war zone", often has to be done in the analogue world, by a real human being (H).

Interrogating the Data

The workshop provided an illustration, for some participants, of how, even within a single data set, it can take "a human" (G) to spot irregularities that could have important implications for how the story is told. One of the data sets used in the workshop, scraped from the website of the Metropolitan Police, was on crimes in London. It showed total crimes for February 2016 were 58,175 (down from 60,269 in January), a figure that, on the surface, "looks much better" than the previous month, said Journalist C. An automated, data-driven news item based on these numbers might have chosen to highlight this fall. However, as both C and G spotted, February had two fewer days than January meaning the average number of crimes per day in February was actually higher.

Both journalists said they would have used this anomaly as a starting point for further enquiries, with the crime reporter at *The Sun* (G) suggesting that a failure to mention the daily average in any data release might be indicative of an attempt by the police to "manipulate the figures". This ability to interrogate is, thought a news reporter/trainer at the BBC (F), what "any good journalist will do". Even the data journalist at Trinity Mirror (D) agreed that "there's always going to be things within data feeds that will stand out more to a human than it will to a computer".

The Human Angle

The lack of a human angle in the texts generated by data-driven automation was a concern for some. One journalist (G) said that even when reporting on companies—a high profile use of this type of technology (AI n.d.)—the City desk at his newspaper, *The Sun*, would "always look for the human angle", an approach he didn't believe was confined to tabloids. He gave the example of the collapse of the British retailer BHS. Although there was a "numbers" side to the story, people wanted to know about the "flamboyant lifestyle and arrogance" of the former owner, Sir Philip Green, and the effects on the company staff and

pensioners of the "awful way the company was run". Unless stories are about humans "they are pretty dull", he said. Other journalists (C, J, and F) agreed, with one (F) saying that "journalism is about telling stories" that involve human beings whose lives are not easily quantifiable into programmable data.

Known Unknowns

The requirement to template stories in advance was seen as a drawback. A BBC journalist (J) realized, after using the software, "how limiting writing everything in advance is. You can't get a reaction to those numbers, you can't explain or interrogate them, because you wrote it all before the numbers came out." His colleague (F) at the BBC agreed: "news comes out of the blue sometimes. I am not sure if you can write up in advance something you didn't expect to happen." Predictably given his technical expertise, the data journalist at Trinity Mirror (D) was more confident that, given sufficient development, templates could account for multiple outcomes; however, this would still be "very, very complicated" to achieve, he said.

Playing with the Data

Traditional data journalism is often about using data to produce a single story, sometimes from multiple sources.[6] The software the participants used in the workshop is different. Although also data-driven, it exists to output multiple news items from a single source. Some journalists expressed frustration with the software's functionality, perhaps because they were evaluating it against the more investigative styles of data journalism. For example, J found it "quite frustrating" because he wanted "to be able to play around with these data sets much more, looking for the story in the numbers, not just take the numbers and turn them into a templated story".

This reporter summarized the limitations of automated news text generation by contrasting it with the multi-sourced, interrogated, and contextualized journalism humans can produce. "Journalism is about finding out stuff that other people are not able to find out about. It is about asking difficult questions. It is about putting things together to understand what is really going on."

Perhaps unsurprisingly, when evaluating the output generated in the workshop by the software, some participants were less than impressed. A senior sports journalist at CNN (A) said that a fully manually written story would have been "much better". He thought the output was "throw away, repetitive, not particularly interesting. There is no nuance or creativity." J agreed, saying: "I would never, ever, ever have written a story like that. Where is the analysis, context, and quotes from participants or experts?"

Despite the limitations identified by the journalists, respondents did believe the technology could have a role in augmenting their work.

Opening Narrative Seams

One of the journalists who thought that automation might have a role in helping spot stories in data, C, gave the example of a soccer data feed which showed that Leicester City could win a match with just 30 per cent ball possession. This had, he said, "opened up a rich

seam to be mined for a narrative", prompting questions about how a team could be successful with far less possession than "accepted wisdom" suggests is required. A data journalist at Trinity Mirror (D) agreed that the technology might be useful as a way of "creating internal briefing notes" from data feeds to highlight information that journalists might want to follow up, sentiments shared by journalists F and G.

There were conflicting opinions about whether the technology would, in the long run, help journalists cope with the increasing amount of data being released. A data journalist at Trinity Mirror (D) thought that "software could make data more intuitive for people". On the other hand, a BBC reporter (J) felt that this particular approach, using technology to turn numbers into words, might undermine efforts to make journalists more numerate.

Pleasure and Propensities

For several journalists, the experience of creating news items this way was difficult, irritating, and did not utilize their innate abilities. A senior sports journalist at CNN (A) "didn't find [the software] that intuitive to use" and the process didn't provide him with the occupational rewards he was accustomed to. "What gives me pleasure as a journalist is the use of language and creativity and [this software] is the complete opposite." A BBC reporter (J) went further. "I can't tell you how bored I was. It is essentially computer programming and I hate computer programming." Other journalists (C and F) also alluded to a mismatch between the skills required to produce data-driven news and the skills journalists often identified within themselves. Journalist F did acknowledge, however, that resistance could, in part, be "generational". He thought that for "digital natives" the "idea of a software program writing a story" isn't as "outrageous" or "frightening" as it is for older journalists. Of course, in most real-world implementations of the technology, journalists would be unlikely to develop automation processes without technical assistance.

Complementarity

A number of journalists discussed the technology as complementary to their work. Two senior sports journalists at Thomson Reuters (B and C) suggested that in "the first stage of the news cycle, the straightforward facts could be automated", with the human journalist coming in "further up the value chain" to focus on what "warrants further exploration" (C). These sentiments were echoed by journalists G, I, and H. The data journalist at Trinity Mirror (D) thought that, because of the current limitations of the technology, it may be better for software to produce "the body of the article" and then for "the introductions" to be written by a human afterwards in order to "pull out the top line".

Economics

A significant number of the interviewees believed that automated news writing had the potential to reduce costs, increase speed, and serve more clients with more individualized content, advantages that have also been identified in popular and academic discourse around the technology (Carlson 2014; Dörr 2016). Some of the respondents in executive positions were aware of projects currently underway in their news organizations

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to roll out automation, including in the production of multimedia content. However, journalists believed that the technology, in its current form, only had application in limited contexts and was unlikely to fundamentally change the economic dynamics of the industry.

Reducing Costs

Journalists at CNN and Thomson Reuters thought that the technology offered an opportunity to "reduce costs" (A) by replacing "expensive staff" (C) who were doing "fairly simplistic and time-consuming work" (C). They believed there was an inevitability to these developments, in part because of the "[financial] conditions in the industry currently" (C). Although, as will be shown later, journalists believed application of the technology was limited, it was considered that there was a market for what it could produce: "Some customers are happy with an unsophisticated product. And if we can derive that instantly at a low cost, then clearly that's the way we are going to go," said a senior sports journalist at Thomson Reuters (C).

Increasing Speed

Journalists (C, H, and B) saw the technology as having potential to increase the speed with which they could deliver material to their audience. For example, a senior sports journalist at Thomson Reuters (C) saw the question of whether to use automation as a "speed decision", explaining that, as a global news agency, they had to be "very fast and accurate and automating is one way to improve both those things".

Expanding Coverage

Journalists at a range of news organizations saw the technology as having potential to expand the volume of material produced and to cater to different devices—such as mobile phones—different geographical markets, and individualized content needs.

At least three journalists thought that automated news writing might have utility in the production of content for mobile platforms. A senior sports journalist at Thomson Reuters (C) explained that: "People don't want to read five thousand words on their phone. They want a really nice picture and two or three paragraphs on what's happened. This is what we're thinking currently about our automated future."

This same journalist saw potential to tailor the text of a story for different markets: "You could automatically generate a story about, for example, Leicester vs Liverpool [soccer match] and send a different version of the story to Liverpool and Leicester, and have a third one for neutrals".

A data journalist at Trinity Mirror (D) envisaged addressing different demographics rather than geographical markets, using different styles of language in order, for example, to version the same story for tabloid and middle-market readers.

Other journalists thought that it would be possible to use the technology to produce textual content that was even more personalized. A BBC journalist (J) thought that stories personalized to "a reader's street or neighbourhood would be of potential use. It's about re-

versioning, a big thing at the BBC and in the industry. How do you re-version with no money and give a more personalized service?"

The BBC data journalist (E) thought that the technology might even be able to write stories that provided "context and background" appropriate to the level of information an individual needed, with reference to, for example, what the person had already read.

A journalist (H) at Thomson Reuters had the most concrete ideas for how automation could expand coverage. "It gives us an opportunity to grab massive amounts of data and package it up in a way our clients can use." Packaging that data might mean, he suggested, taking "economic data released in Turkey in Turkish" and automatically writing a story in English incorporating that data. The same principle could apply, he said, for any other combination of the "50 languages" Reuters operated in.

Roll Out

The opportunities for reducing costs, increasing speed, and expanding coverage that the respondents identified are compelling enough for projects to already have got underway in at least two of the news organizations represented by our interviewees. A senior sports journalist at Thomson Reuters (C) said that **"**we are working with an American company on a project to cover US college sports, something we wouldn't have the resources to cover manually". A second project at Thomson Reuters also involves sport, but this time extends automation beyond text and into multimedia. The same journalist explained that for "big sports" like the US NBA basketball league, a product was being developed "mainly for mobile devices". With this product, produced in partnership with a US-based technology provider, slide-show-style videos would be created automatically from photos with a narration "extracted" from an "automated three-paragraph story". Thomson Reuters' developments in automation are not, however, limited to sports reporting. A financial journalist at Thomson Reuters (I) said that already "quite a lot of 'snaps' [short news alerts that are sent out before a full story is published] are automated". Another financial journalist (H) at the firm confirmed that they were "looking extensively" at automation in the finance sector; indeed, the senior sports journalist (C) said, "we're looking at it in all parts of the company".

Although projects are underway at Reuters, representatives of other news organizations were less enthusiastic about immediate adoption. A senior sports journalist at CNN (A) said that "from what I saw I wouldn't want to" adopt the technology, but rather "use that money to employ a person". These sentiments were shared by some journalists from the BBC. One (F) didn't think it was "scalable to the BBC", and his colleague (J), working in BBC research and development, left the workshop "less impressed than I was before today". He continued: "Before the workshop I was wondering whether we should put some effort in researching on robot journalism, and after today my conclusion might be 'No'." As it happened, however, one of the other participants from the BBC, a data journalist (E), had already been involved in at least one project, seemingly off the radar of the other BBC journalists in our sample, which utilized automation. The example given involved automatically producing short updates on sports results as part of the BBC's online coverage of the London 2012 Olympics.

Limited Potential

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Although some journalists spoke about the economic opportunities and current plans for automation, there was, for the most part, consensus that applications were limited at the current time. Sports and finance were the most frequently mentioned areas of application (F, B, and G), with weather, crime (F), election results (G) and "anything where there is a big data set" (F) also suggested. Even the BBC data journalist acknowledged that "there is lots of reporting that you can't really template out". For the crime reporter at *The Sun* (G), the limitations were as much to do with the style that automation imposes as they were to do with the requirements for structured data. He considered the output to be "too bland for our readers" who wanted a "ribald" and "hard-edged" approach that plays with language.

There were wider concerns that the technology was adding little value and was unlikely to increase the appeal of news outlets in a way that would make any significant difference to their audience share. A sports journalist with Thomson Reuters Television (B) said, "I don't know how much value is in this kind of content. Is it attractive to consumers? Not really. It is boring." The CNN journalist agreed, adding that "people want something a little bit more creative", such as, a BBC reporter (F) suggested, "stories about human beings, with proper top lines, written by proper journalists who know what a story is".

Although the software was considered a "niche product" (H) with limited potential, some journalists acknowledged that automation was still in its infancy and "nobody knows if it will be able to cover more topics in the future" (H). Indeed, there was a feeling among most respondents that automation would become more common.

Ethics

Participants discussed a range of ethical issues concerning automated news writing, including: transparency, bias and balance, verification, as well as wider societal concerns.

Transparency

Respondents held mixed views about whether and how automated news should be labelled, indicative, perhaps, of the complex history of authorship and bylining in journalism (see, for example, Reich [2010]) and the novelty of thinking about such issues in the context of non-human actors. Overall, however, a majority came out strongly or conditionally in favour of transparency. For example, a senior Thomson Reuters journalist (C) thought that there was an obligation to be transparent, in part because audiences were likely to be unaware that a story might be "data-driven", but also because of normative expectations that information would be provided about a news item's provenance.

The form that such transparency might take prompted discussion about whether a simple byline—for example, "This story was written by a computer"—was sufficient. The BBC data journalist (E) thought not, proposing that a fuller "methodology" be posted. Another BBC journalist (F) agreed, saying that news organizations should "show [their] workings and give people as much information as they can handle" in order that readers could be informed to make decisions on partiality.

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However, the nature of automated, data-driven news, relying, as it does, on decisions made, and data generated, by both humans and software routines, raises questions about what the "methodology" or "workings" would reveal. A BBC news reporter (J) talked about the complexity of determining authorship when "bots are part human and part bot", even going further by calling into question the extent to which automated news was, in fact, autonomous: "it is written by a human being in the first place". A crime reporter from *The Sun* (G) and a Thomson Reuters journalist (I) also discussed how the level of technological involvement in the production of a news item would influence how an item was labelled, with only something "entirely written by computer" (G) needing to be labelled as such.

Despite broad consensus on transparency and labelling, two of the respondents did not think that it was necessary to flag to the audience that a piece had not been written by a human. One, a data journalist with Trinity Mirror (D), justified this view using similar reasoning to the BBC news reporter (J), saying that "at some level, a journalist has built the structure for the story".

Bias and Balance

Three journalists suggested that processes of automation and "datafication" had the potential to reduce bias in reporting. One, from Thomson Reuters Television (B), acknowledged "bias" in "human journalism" and suggested that "there is a lack of bias in technology". A reporter from *The Sun* (G) also talked about "manipulation" in human journalism and thought that so-called "robo-news" could "present the facts and the figures as they are", which "could be quite a good tool for democracy". Similar sentiments were espoused by a BBC journalist (F) who contrasted what he believed to be the "hatchet job" the *Daily Mail* had been doing on Jeremy Corbyn, the leader of Britain's Labour Party, "every day" with the "black and white" of data-driven news, given, of course, that the "data is complete and accurate".

However, another BBC News journalist (J) took a different stance, concerned about the possibility that the volume of media content it is possible to produce through automation could mean that the "prejudices" of a single individual or organization, encoded into an algorithm, were widely disseminated. He suggested this could happen either via news items published by the mainstream media, or through social media posts directly consumed by the audience or used by journalists as a source. "More and more news organizations are following what is trending on social media. If someone can get enough stuff out, they can influence the news agenda and get their views into the mainstream."

Accuracy and Verification

Two Thomson Reuters journalists (C and H) felt that automation had the potential to "eliminate human error" (C), in particular because of the speed with which news items had to be produced and published within a news agency context, although they did acknowledge that "automation is only as good as the data" (H).

Although an algorithm might be less likely to make a simple mechanical error than a human reporter, there was concern that automation would make verification less likely and oversight harder. A CNN journalist (A) questioned whether a computer program could do

what journalists do and "test whether the information was true", a sentiment echoed by a Thomas Reuters Television journalist (B) who said that because the data may be "deliberately corrupted" the "human instinct" for detecting the "many glitches" that could happen was still required. Indeed, he went as far as to say that he did not believe that the output of automated news "could be trusted to go out unchecked at the moment". The two data journalists in the sample were, predictably, more confident that, albeit with "editorial oversight", "validation rules", and trust in the data source (E), automation didn't present "too much of a problem" (D) in terms of verification.

Personal and Societal Consequences

The journalists' ethical concerns were mostly focused at the level of journalistic routines; however, one (F), from the BBC, expressed concern that the technology would contribute to information overload, making it harder for journalists and the public to pick out what was important from the sea of information:

> What this software does is put more information out there. Is that a good thing? Neo-liberal theory would say yes, because we all want as much choice as possible. But do we? Sometimes it is very difficult to work out whether something is true. It is the job of a journalist to be the filter and get a simple story out that people can understand.

Conclusion

This article extends the growing body of literature on automated journalism by eliciting and analysing professional journalists' and editors' experiences with, and opinions about, the technology. Uniquely, the participants were drawn from a range of news organizations and had—at the very least—first-hand experience working with robo-writing software from one of the leading suppliers.

The study provides insights into how some large news and information providers now use automation, and gives insights into initiatives we can expect to appear in the near future. For Thomson Reuters, those initiatives include using automation to cover beats it would otherwise be uneconomical to cover, such as US college sports, and utilizing the technology to produce not only text but also short audiovisual reports. At the other news organizations represented in this study, where there is less emphasis on high volumes of fast, factual reporting and more emphasis on analysis and entertainment, automation was far less evident.

Beyond such factual findings, this study's key contributions are in its documentation and analysis of journalists' judgements on the potentials and limitations of automation in the context of the variety of roles they perform and outputs they produce, and on the wider ethical and societal implications. Six main limitations of automated journalism were identified:

1. Its reliance on single, isolated data streams.
2. The one-dimensional nature of the quantitative data feeds it relies on.
3. The difficulties of interrogating that data.

4. The lack of human angles in the texts generated.
5. The requirement to template stories—predicting "top lines"—in advance.
6. The difficulty of working creatively with the data in the templating process.

As the participants recognized, the technology is still at a relatively early stage of development and some of these limitations may, ultimately, be moderated. For example, the "Chief Visionary Officer" of one service provider, AX Semantics, explained that:

- their technology includes "a meta-database, called 'World Knowledge store'", which can be utilized to provide additional context to automated stories;
- given sufficient technical expertise, it was possible to "draw complex conclusions" from the data and modify it in various ways;
- they provided functionality to detect whether "data is well-shaped", "missing crucial information" or "exceeds certain thresholds"; and
- extra dimensions (such as "image recognition") are likely to be added "within the next year" (Frank Feulner, personal communication, 27 October 2016).

However, even such developments, and others that may follow, are unlikely to overcome what we believe to be some fundamental limitations with automated journalism. For example, secondary "meta-level" data streams may be able to provide historical background and static facts but are less likely to be able to provide the contemporaneous context that is essential to much reporting. Even when systems have, as Feulner predicts, the ability to "analyse sentiment and soft facts" around topics and "identify irregular or deviant data points", they are unlikely to be able to understand all the nuances of human expression that help determine how events are reported or consistently recognize the most important news angle, the "top-line".

This said, it seems clear that automated journalism will be used increasingly to produce simple factual reports, to increase the speed with which such reports are published, to cover topics currently below the threshold of reportability (such as minority/minor league sports), to re-version or adapt content for specific devices (such as mobile phones) or individual tastes, and to help journalists spot stories in data.

Such a future may bring financial benefits to news organizations although not, in the short term, to the workers who are likely to be replaced.[7] Our respondents provided some insights into the ethical questions that arise from such changes in news production. While recognizing automation's potential to reduce bias and inaccuracy in human reporting, they also saw challenges in maintaining standards of verification and balance and deciding who, or what, should be credited and held accountable for the output.

The consequences for society more widely are also double-edged. On the one hand, some consumers may extract value from the depth, breadth, specificity, accessibility, and immediacy of the information produced by automated journalism. For others, however, such changes are likely to increase the difficulties of navigating a world already saturated with information. In the context of news and information, then, automation may actually increase the need for the very human skills that good journalists embody—news judgement, curiosity, and scepticism—in order that we can all continue to be informed, succinctly, comprehensively, and accurately, about the world around us.

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Limitations

The results of this exploratory study should, of course, be interpreted in the light of its constraints. Firstly, the participants, although sampled purposefully to include a range of ages, skills, and professional experience, do not constitute a representative cross section of journalists. Nevertheless, their number, ten, exceeds McCracken's guidance that for "many research projects" based on qualitative semi-structured interviews, "eight respondents will be perfectly sufficient" (1988, 17). Secondly, the software used by the participants, although provided by a technology company that is one of the leaders in the field and has high-profile journalistic clients, is one of a number of platforms available. The participants' opinions on the potentials and limitations of automated journalism have, therefore, been coloured by their experience of this particular platform. Thirdly, although the participants were introduced to the platform in small groups (a maximum of three), the limited time (150–180 minutes) they spent using the software meant that those who were less technically proficient had only a limited opportunity to explore, independently, the software's capabilities. The time was sufficient, however, for several of the participants to be able to iterate at least one story template that utilized a high proportion of the available functionality.

Notes

1. Natural language generation is defined as software and computer systems, which automatically produce human (natural) language from a computational representation of information (Reiter and Dale 2000).
2. The terms "algorithmic journalism" (van Dalen 2012; Dörr 2016) and "robot journalism" (Carlson 2014) are also used to describe the phenomenon.
3. This framework takes inspiration from Lewis and Westlund's (2015) article on big data in journalism.
4. Defined by *The Oxford English Dictionary* as "the headline of a newspaper", but used more widely by journalists when referring to the most newsworthy aspect of a story.
5. Such as those provided by Opta, the "Official Media Data Partner of the Premier League", http://www.optasports.com/events/premier-league.aspx.
6. For example the award-winning *What if the Syrian Civil War Happened in Your Country?* by Public Radio International that uses data from the United Nations, the Syrian Observatory for Human Rights, and the World Health Organization.
7. For example, one of our respondents (I) identified the work being done by the four hundred Thomson Reuters employees in Bangalore—such as producing reports on "share price moves in the morning"—as "very, very easy" to automate.

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