

## DATA JOURNALISM SUSTAINABILITY

### An outlook on the future of data-driven reporting

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*During its period of rapid growth, data journalism was poised to position journalism as society's watchdog once again. But despite eager predictions, its rate of adoption outside large news organisations remains low, limiting the consolidation of data journalism to a normative practice. Through Scenario Network Mapping, this article seeks to outline the possible futures of data journalism practice by determining its sustainability in the current climate of journalism austerity. Results suggest three possible scenarios: 1) As a skillset, data journalism will soon be regarded as essential for every professional journalist 2) As a genre, data journalism will remain a niche storytelling format but will ultimately find its way into smaller newsrooms due to decreasing limitations 3) Due to financial and personnel limitations, data journalism will be abandoned by the mainstream media, who will outsource data analysis to non-legacy actors. Within this context, it remains to be seen whether data journalism can continue innovating in order to remain competitive in the constantly evolving ecosystem of today's news production.*

KEYWORDS: Data journalism; evolution; future; sustainability; scenario network mapping; data journalism research

#### Introduction

On May 21, 2009, US web developer and data journalism guru Adrian Holovaty bluntly voiced his opinion on the long-lasting debate on the role of computer programming in journalism. Despite the disapproval of many within the emerging community of data reporters, Holovaty offered a definitive, two-part answer to the question: Is data journalism? "1. Who cares? 2. I hope my competitors waste their time arguing about this as long as possible" (Holovaty, 2009).

Eight years later, data journalism as a concept remains at the epicentre of professional and academic dispute, overlapping with notions such as computer-assisted reporting (CAR), data-driven journalism, precision journalism, computational journalism, programming journalism, algorithmic journalism, or explanatory journalism. Yet, as a practice, data journalism has steadily grown within legacy organisations, who arguably see it as one of their strategies to regain public trust.

Since the late 2000s, data journalism gained prominence in the United States and the United Kingdom following the emergence of WikiLeaks and the UK parliamentary expenses scandal. Mainstream media organisations, such as *The New York Times* and *The*

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*Guardian*, decided to spearhead the development of the practice by establishing data journalism units within their newsrooms.

Others rapidly followed suit in the US (*Huffington Post*, the *Chicago Tribune*, *ProPublica*), the UK (*Financial Times*, *BBC*, and the Bureau of Investigative Journalism), Argentina (*La Nación*), France (*Le Monde*), Germany (*Der Spiegel*, *Deutsche Welle*, *Zeit Online*), Norway (*Verdens Gang*), Sweden (*SVT*), and Finland (*Helsingin Sanomat*); laying the foundations of a healthy ecosystem that has now reached a level of sophistication worthy of scholarly attention.

Over the last decade, data journalism has found a niche within journalism practice, and has become a valuable asset in several newsrooms within legacy organisations. Paradoxically, within the main strongholds of the practice in the US and Europe, data journalism seems to be failing to expand in a significant way beyond those mainstream organisations based in large urban areas, which calls into question the ability of data journalists to hold the powerful to account at local level.

During a period of uneven consolidation that has seen data journalism slowly prospering beyond the West (whilst also confronted with new political challenges in media ecosystems like those of China, Russia, Vietnam, and Africa), this article aims to present, for the first time in the field of data journalism research, a set of potential futures of data journalism, and reflect on whether this practice continues to be sustainable. By carrying out Scenario Network Mapping (SNM), this article intends to: a) examine data journalism's reflexive and performative nature, with special emphasis on the type of literacies that shape the competence framework of data journalists; b) assess data journalism's ability to expand beyond a niche specialism within mainstream news organisations; and c) understand the role of non-legacy actors and organisations in shaping both the data journalism skillset and its knowledge base.

## **Methodology**

Scenario Network Mapping is a novel scenario planning method developed by List (2007), and it is used in future studies to outline possible alternative futures. A scenario usually consists of event trees with "a hierarchy of causes (the roots), and a hierarchy of outcomes (the branches)" (List, 2007:80). In contrast to conventional methods of scenario building, SNM assumes that different scenarios can overlap and are by no means mutually exclusive, and underlying event trees can be interlinked. In practical terms, we defined a starting point and outlined possible scenarios as future outcomes. We then arranged short-term prospects around the starting point, thereby creating a so-called futures wheel. To connect beginning and end, we used backcasting (Robinson, 1988); backtracking possible events, causes and outcomes from future scenarios and linking them with the starting point's futures wheel, thereby delineating an event map.

In order to create this futures wheel, we carried out a close reading of historic events recorded in the media or academic research, to acknowledge that the current status quo and all possible future outcomes are rooted in the past and present.

We then conducted a series of in-depth interviews (that lasted on average an hour) with three groups of key informants that shaped the contours of data journalism globally over the last decade: a) Academics with expertise in data journalism (Aron Pilhofer, Paul Bradshaw, Alberto Cairo, Emily Bell, David Herzog); b) Non-legacy experts (Simon Rogers,

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Mirko Lorenz, Brigitte Alfter); and c) Data journalists (Helena Bengtsson, Christina Elmer, Nicolas Kayser-Bril, Alexandra Kohler, and Julian Schmidli).

The main research questions focused on aspects we identified as parameters for our future prospects:

RQ1. What is the future of data journalism?

RQ2. Is data journalism sustainable in the current climate?

RQ3. What are key determinants that hinder a widespread and equal adoption of data journalism across the globe?

RQ4. What are the limiting factors associated with human and technical resource requirements?

RQ5. What is the role of non-legacy organisations in the development of data journalism practice?

The following section presents a comprehensive summary of our close reading of historic events.

### **From ‘*Is Data Journalism?*’ to ‘*Data Journalism is the new punk*’ and other professional and academic reflections (The story so far)**

*Precision Journalism: A Reporter's Introduction to Social Science Methods* by Philip Mayer, first published in 1973, was the first rigorous attempt to systematise (mainframe) computer-assisted news work. In his text, Meyer showed, for the first time, the sets of stages that data journalists currently employ to perform data analysis (collection, storage, retrieval, analysis, reduction, and communication). Notably, he also introduced operations, such as model testing (Meyer, 2002), that anticipated the relevance that programmatic and computational thinking would have in today's data journalism.

Following the consolidation of computer-assisted reporting into a normative journalistic method, Investigative Reporters and Editors (IRE) founded the National Institute for Computer-Assisted Reporting (NICAR) in 1989.

However, it was not until the mid-2000s that the professional conversation around computerised news work started to shift towards a need to embed more complex computer programming techniques into the news production workflow (Holovaty, 2006; O'Reilly 2007). Adrian Holovaty, an early proponent of this view, argued, in his popular essay *A fundamental way newspaper sites need to change* (2006), that newspaper organisations were collecting a wealth of valuable structured information that remained unused most of the time. When structured data was used, it was repurposed into a news story (which Holovaty called a “big blob of text”), losing its structure. He explained that newsrooms' content management systems reinforced this story-centric hegemony by making it impossible to structure news articles as data. Holovaty categorised news production into three stages – gathering, distilling and presenting information – and saw automation as a valuable asset in making these stages more dynamic and efficient (Niles, 2006).

With the launch of *The Guardian's* Data Blog in 2009, Simon Rogers popularised data journalism and made it mainstream. Rogers argued that data journalism was nothing new, as dealing with data was part of journalism ethos since its inception (2011). Additionally, he disregarded the need for journalists to learn programming, claiming that anyone could do it by relying on openly available data and collaboration (2011).

During 2010 and 2011, in the same way as ideals such as the inverted pyramid and editorial independence became staples of journalistic professionalism in 1920s, Mirko

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Lorenz (2010) developed the iconic Data-Driven Journalism Process during his time at Deutsche Welle, and Paul Bradshaw (2011) devised his popular Inverted Pyramid of Data Journalism. Whilst Lorenz's process described four simple stages (Data, Filter, Visualise, Story), Bradshaw's pyramid described a more complex set of steps (Compile, Clean, Combine, Context, Communicate: Visualise, Narrate, Socialise, Humanise, Personalise, Utilise). Bradshaw also made a distinction between data-driven and question-driven approaches, and emphasised the importance of context, and the usefulness of programming skills (2010).

As these developments fostered stimulating discussions, academics in the US made a start on problematising and critically examining what they called computational journalism (Hamilton and Turner, 2009; Cohen, et al, 2011; Flew, et al, 2012; Diakopoulos, 2012; Royal, 2012; Anderson 2013). These studies attempted to build a body of work that studied the methods of computational journalism, its potential for innovation, and its capacity to foster interaction between reporters and their audiences. Moreover, they examined the pervasive nature of computing logics and algorithms in news work, explored the opportunities emerging from collaborations with non-legacy organisations such as enterprises and universities, and researched newsroom cultures and professional dynamics.

Whilst the identity of data journalism continued to take shape, important questions were raised. For instance, Legrand, highlighting the increasing complexity of the digital world and the pervasiveness of data in public and corporate life, wondered "Can professional communicators such as journalists really do their job without learning how the digital world works?" (2010). Thibodeaux, being a proponent of programming skills to automate processes, emphasised the importance of non-legacy entities, such as NICAR, Stack Overflow, and Hacks/Hackers, in advancing data journalism practice (2011). During this period, Lorenz, Kayser-Bril, and McGhee published the influential document *Media companies must become trusted data hubs*. By signalling the transformations brought about by data and data-driven machines, the authors suggested the need to rethink the news-media business model, and proposed a shift of emphasis from the information market to the trust market (2011).

2011 also saw the publication of the very influential *The Data Journalism Handbook*, edited by Gray, Bounegru, and Chambers (2012), followed in 2012 by the launch of the *Data Journalism Awards* competition by the Global Editors Network.

Scholars continued to consolidate a body of knowledge on data journalism practice through a series of national and institutional case studies in the U.S. (Parasie and Dagiral, 2013; Fink and Anderson, 2015; Parasie, 2015, Uskali and Kuutti, 2015), Norway (Karlsen and Stavelin, 2014), Sweden (Appelgren and Nygren, 2014), Belgium (De Maeyer et al., 2015), Canada (Tabary et al., 2015; Hermida and Young, 2017) and the UK (Mair, et al, 2013; Borges-Rey, 2016). Simultaneously, a series of explorations of the epistemology of data journalism were published (Parasie and Dagiral, 2013; Gynnild, 2014; Coddington, 2015; Parasie, 2015; Lewis and Westlund, 2015; and Borges-Rey, 2017). Overgeneralising, these studies introduced a series of issues, such as the now common conceptual and organisational ambiguity of the trade, and analytical challenges: the organisational and editorial pressures that data journalists face; the significance of open source logics and internal and external collaboration; and the ever-present uncertainty around data journalism skills, which are in constant flux between journalistic and data science approaches to data.

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This period of data journalism activity was also met with scepticism from Schrager (2014), Cairo (2014), Bounegru (2014) and O'Connor (2015), who formulated solid critiques advocating more rigorous data analysis; removing biases; not over-relying on graphic design, infographics and established sources; proper contextualisation; sampling and population; avoiding misinterpretation and manipulation of data; more resources; more transparency and gender balance, and critical awareness of the fallibility of numbers.

By 2015, data journalism was solidly established in mainstream organisations and academic circles in North America and Europe. The Global Investigative Journalism Network (GIJN), the Centre for Investigative Journalism (CIJ), and the European Journalism Centre (EJC) developed, and made widely available, toolkits, MOOCs and other resources, for free.

In 2016 the Panama Papers showed the world the true potential of data journalism, after the International Consortium of Investigative Journalists (ICIJ) exposed twelve national leaders, another 131 politicians, their families, and close associates, for using offshore tax havens.

At present, as a call for chapters for a second edition of *The Data Journalism Handbook (2.0)* has been put out by Simon Rogers (2017) with the support of Google News Labs and the European Journalism Centre, and Ausserhofer, et al (2017) publish their interactive meta-analysis of the extant literature on the field (thus contributing to mapping the existing research gaps), data journalism practice seems to be growing more consistently in small organisations that are able to generate great impact (Rogers, 2016). As data journalism enters this new and unpredictable period, initiatives such as *Code for Africa* (Arenstein, 2015), 4M Asia (CFI, 2017), and the *Manual de Periodismo de Datos Iberoamericano* (Perry and Paz, 2015) seek to expand the reach of data journalism practice to the Global South, exploring new socio-political contexts and professional cultures.

### **What's next: the future of Data Journalism**

In conjunction with the close reading of historic events, the in-depth interviews provided a very granular context, not only for the identification of current trends, but more importantly, for the construction of potential scenarios. Due to space constraints in this article, we will focus on only three of those possible scenarios and not on their interlinks. Events that lead to a certain scenario also bear consequences for other scenarios, thus creating interlinked event trees and, ultimately, links between scenarios allowing for various scenarios to unfold in parallel.

*Scenario 1: As a skillset, data journalism will soon be regarded as basic and essential for every professional journalist, as well as journalism education.*

The question of whether data journalism should be adopted as an essential knowledge base in professional journalism has been a contentious one. Extant research has often recorded testimonies from professionals that resist furthering their level of numeracy, let alone learn coding. Drawing on the idea that public and private institutions are increasingly mediated by data and algorithms, this first scenario's premise is that data journalists should be able to engage and derive insight from data infrastructures. Bell anticipates that:

Every company in every field, and every organisation, whether they are corporate or public sector, will have to think about how they reorient themselves around AI in

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exactly the same way that 20 years ago they had to think about the way they reoriented themselves around web technologies. (Bell, 2017).

This generalised adaptation to data cultures and ecosystems requires, in the view of Cairo, that both journalists and their publics have at least “a basic, elementary understanding of arithmetic and more importantly an elementary understanding of probability.” (Cairo, 2017). Bell shares the view that, as every discipline converges with computer science, *predictive journalism* is another potential development within data journalism. As journalists acquire these skills and become fluent in data analysis, programmatic thinking, machine learning, natural language processing, network analysis, data scraping, and extracting sense or objects for reporting from large datasets (Bell, 2017), they could efficiently automate low-end tasks, such as scraping and visualisation, which are performed on a regular basis, or that do not necessarily require sophisticated intervention (Bradshaw, Elmer, Bengtsson). As data journalists are freed up from these tasks, they can concentrate on looking for alternative ways of obtaining data to bypass dependence on public data (Bengtsson, Bradshaw).

The underlying discussion remains, though: Will data journalism continue to be a specialist skillset or will it become a basic knowledge base for all journalists? Bell believes that at present, data journalism remains marginal to the core of journalism, but that we should see a movement from the margin to the core. Schmidli considers data journalism “a special area of expertise that is slowly pouring in general journalistic practices.” (2017) Cairo, Alfter, Elmer, and Schmidli agree that at least data awareness should be axiomatic in the journalism of the future. Others, like Herzog and Elmer, are rather sceptical about this potential scenario, and believe that data journalism will remain a specialist area commissioned to perform data analysis when needed. In the same vein, Cairo identifies dogmatic journalism education programmes as pivotal: “The fact that numeracy is not part of journalism education in many places actually shows how misguided we have been for many years.” (2017). Cairo, Pilhofer, Kayser-Bril, and Bradshaw believe that a certain degree of advanced data specialisation will still be required within newsrooms to tackle particularly complex projects; as Rogers, puts it “No major news publication will be without a practising data journalist” (2017).

*Scenario 2: As a genre, data journalism will remain a niche storytelling format but will ultimately find its way into smaller newsrooms due to decreasing limitations.*

At present, data journalism cultures are present in only a small portion of journalism practice, predominantly in large urban areas and within mainstream news organisations. Therefore, data journalism adoption has been, so far, rather uneven at local and hyperlocal level. Naturally, this asymmetry has created a breeding ground with infinite potential for the development of a healthy hyperlocal data journalism ecosystem (Bradshaw, Cairo, Lorenz). Kayser-Bril (2017) argues:

You have plenty of very small newsrooms that do data journalism (...) *Le Télégramme* (...) *Heilbronner Stimme* (...) we are basically talking about one person or half a full-time position, and I think any smallish newsroom can afford [this] (...) If you look at the investments that are required to do data journalism, it's basically zero because everything is open source and free. So, I don't see any theoretical argument that would be a resource limitation to data journalism.

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Kayser-Bril's claim is in marked contrast with the generalised argument that there is a strict resource limitation that constricts data journalism. Simon and Bradshaw agree with this view; on this matter Rogers argues "Budget is really an excuse. The tools are free - spreadsheets, visual tools etc. Much of the training can be done online. It's a terrible reason not to do it." (2017). Along the same lines, Cairo sees small news organisations stepping out of the shadow of major renowned outlets; as he puts it:

It's not that you need a lot of money in order to do these kinds of things. It's just training and locating those who are reporters who are predisposed to using numbers in their stories and then just giving them the free tools and training to get them started (2017).

Bell agrees with Cairo that the emphasis should be on upskilling personnel, as the news organisations that are thriving have invested more in computational thinking at every level (2017).

Lorenz and Rogers believe that local data journalism will create the environment to make global processes more tangible and relatable for local readers. For instance, by using data that signals changes of global transcendence, or planning at municipal or federal level, data journalists will be able to explain to local audiences "how it affects them, therefore embedding it [data] into local narration" (Lorenz 2017), which ultimately helps them to better understand where they live. Providing more amenable context to data can also help overcome public distrust. Cairo remarks that there are ways of reaching people who distrust the media "in a more empathetic and emotional manner [...] When presenting facts, when presenting data, I do believe we need to stop using just charts and pure numbers, we need to combine that, organically, with humane stories" (2017). Bengtsson agrees, explaining that, to reach this emotional public, "we might have to be a little more passionate as data journalists" (2017).

*Scenario 3: Due to financial and personnel limitations, data journalism will be abandoned by the mainstream media, who will outsource data analysis to non-legacy actors.*

As organisations such as ProPublica, BuzzFeed or Google gain prominence within data journalism, this last scenario considers the role of non-legacy actors and organisations in shaping data journalism practice. Collaboration with non-legacy organisations has been, to date, vital for the development of data journalism. In many cases the skills required to produce data outputs are not found in-house, and news organisations have had to outsource professional expertise (Schmidli, Lorenz). The fact that currently there are not enough qualified data journalists (Pilhofer), and outsourcing programmers tends to be rather expensive (Schmidli), has forced news professionals to be creative and collaborate with third-party specialists to develop data-driven projects.

Bradshaw and Kayser-Bril foresee that data journalism will increasingly come from organisations outside news media, as they mention examples such as mySociety, Full Fact, Fundación CIVIO, CORRECT!V, or Journalism++ (2017).

Notably, many of these organisations operate on a non-profit basis, but others, like Google, which is increasingly involved in funding and supporting data journalism activities, are corporations that are not subject to same type of accountability as news media organisations are. On this matter, Bradshaw believes that in the near future, data journalism will engage with emerging forms of power enabled by data:

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I said before that data in itself is a form of power, and what data is collected, and what data isn't, how that is used, resilience, and things such as the different ways our lives are constrained and enabled by algorithms, I think data journalism obviously will have a role to play in holding that to account (2017).

As the power of data brokers grows and their political influence becomes ever more pervasive, Bell argues that news organisations have been prevented from accessing data flows that are essential for them to create new technologies, or to make interventions to refine and improve products. She believes this dynamic is unsustainable, and thinks that "in the next five years, maybe even sooner than that, we will see major stories that come out of Google or Facebook because somebody has leaked a significant dataset anonymously to the public" (Bell, 2017). Rogers seems to agree with transparency and openness when he states:

I think you have a role of helping and assisting in the spread of information that should really be transparent and published. For example, the search data that I work with at Google gives us incredible insights into what we care about and how we care about it. Shouldn't that be public? (2017)

In the future we will see an increase in the participation of non-legacy entities in shaping data journalism. These non-legacy entities, in turn, are going to be reshaped from within by journalists or whistle-blowers working for them, challenging, in some cases, their secrecy cultures.

### **Data Journalism in the Post-Fact Era: closing remarks**

With this article, we attempt to outline what data journalism can achieve in the future if journalists and audiences commit to enhancing their data competence framework. Having interviewed actors that are part of a North-American/European data journalism ecosystem, presented us with rather homogenous worldviews and scenarios, which tended to regard favourably a further advancement of data journalism. Future research on this field may want to consider more heterogeneous groups for their analyses.

As the practice engages more closely with predictive modelling and automation, the implications of having more data-literate news professionals and publics are enormous for society, particularly at local level and in the Global South.

In order to counteract rising public distrust and disenfranchisement, our analysis suggests that data journalists must engage their publics through more emotive reporting, without losing sight of its factual strength.

Looking ahead, elementary data journalism skills are likely to become essential for news professionals, whilst advanced data science skills are likely to remain a specialist competence.

Finally, data journalism is likely to become increasingly susceptible to the mediations of non-legacy organisations. Some of these organisations are likely to become essential outsourcers of data news for legacy organisations, whilst others, like Google, will have to become more open and transparent if they want to continue collaborating with data journalism units and professionals.



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## REFERENCES

Anderson, Christopher W. 2013. "Towards a sociology of computational and algorithmic journalism." *new media & society* 15(7): 1005-1021.

Appelgren, Ester, and Gunnar Nygren. 2014. "Data Journalism in Sweden: Introducing New Methods and Genres of Journalism into 'Old' Organizations." *Digital Journalism* 2 (3): 394-405

Arenstein, Justin. 2015. "\$4.7 Million Data Journalism Initiative Launched in Africa." *Medium*, August 13. <https://medium.com/code-for-africa/4-7-million-data-journalism-initiative-launched-in-africa-189856fa68d4>.

Ausserhofer, Julian, Robert Gutounig, Michael Oppermann, Sarah Matiasek, and Eva Goldgruber. 2017. "The datafication of data journalism scholarship: Focal points, methods, and research propositions for the investigation of data-intensive newswork." *Journalism*: 1464884917700667.

Bradshaw, Paul. 2010. "How to be a data journalist." *The Guardian*, October 1. <https://www.theguardian.com/news/datablog/2010/oct/01/data-journalism-how-to-guide>.

Bradshaw, Paul. 2011. "The inverted pyramid of data journalism." *Online Journalism Blog*, July 7. <https://onlinejournalismblog.com/2011/07/07/the-inverted-pyramid-of-data-journalism/>.

Borges-Rey, Eddy. 2016. "Unravelling Data Journalism: A Study of Data Journalism Practice in British Newsrooms." *Journalism Practice* 10 (7): 833-843.

Borges-Rey, Eddy. 2017. "Towards an epistemology of data journalism in the devolved nations of the United Kingdom: Changes and continuities in materiality, performativity and reflexivity." *Journalism*. <http://dx.doi.org/10.1177/1464884917693864>.

Bounegru, Liliana. 2014. "What data journalists need to do differently." *Harvard Business Review*, May 20. <https://hbr.org/2014/05/what-data-journalists-need-to-do-differently>.

Cairo, Alberto. 2014. "Alberto Cairo: Data journalism needs to up its own standards." *Nieman Lab*, July 9. <http://www.niemanlab.org/2014/07/alberto-cairo-data-journalism-needs-to-up-its-own-standards/>.

CFI. 2017. "Data journalism training for media organizations in ASEAN countries" February 17. <http://www.cfi.fr/en/news/data-journalism-training-media-organizations-asean-countries>

Coddington, Mark. 2015. "Clarifying Journalism's Quantitative Turn: A Typology for Evaluating Data Journalism, Computational Journalism, and Computer-Assisted Reporting." *Digital Journalism* 3(3): 331-348.

[Type here]

Cohen, Sarah, Chengkai Li, Jun Yang, and Cong Yu. 2011. "Computational Journalism: A Call to Arms to Database Researchers." In *Proceedings of the 5th Biennial Conference on Innovative Data Systems Research* edited by CIDR, 148-151. Asilomar, California, USA: ACM.

De Maeyer, Juliette, Manon Libert, David Domingo, François Heinderyckx, and Florence Le Cam. 2015. "Waiting for Data Journalism: A Qualitative Assessment of the Anecdotal Take-Up of Data Journalism in French-Speaking Belgium." *Digital Journalism* 3(3): 432-446.

Diakopoulos, Nicholas. 2012. "Cultivating the Landscape of Innovation in Computational Journalism." Tow-Knight Center for Entrepreneurial Journalism.

[http://www.nickdiakopoulos.com/wp-content/uploads/2012/05/diakopoulos\\_whitepaper\\_systematicinnovation.pdf](http://www.nickdiakopoulos.com/wp-content/uploads/2012/05/diakopoulos_whitepaper_systematicinnovation.pdf)

Fink, Katherine, and C.W. Anderson. 2015. "Data Journalism in the United States. Beyond the 'Usual Suspects'." *Journalism Studies* 6(4): 467-481.

Flew, Terry, Christina Spurgeon, Anna Daniel, and Adam Swift. 2012. "The Promise of Computational Journalism." *Journalism Practice* 6(2): 157-171

Gray, Jonathan, Liliana Bounegru, and Lucy Chambers. 2012. *The data journalism handbook: how journalists can use data to improve the news*. Sebastopol, CA: O'Reilly Media.

Gynnild, Astrid. 2014. "Journalism Innovation Leads to Innovation Journalism: The Impact of Computational Exploration on Changing Mindsets." *Journalism* 15(6): 713-730

Hamilton, James T., and Fred Turner. 2009. "Accountability through Algorithm: Developing the Field of Computational Journalism." Center for Advanced Study in the Behavioral Sciences. Accessed September 12.

<https://web.stanford.edu/~fturner/Hamilton%20Turner%20Acc%20by%20Alg%20Final.pdf>

Hermida, Alfred, and Mary Lynn Young. 2017. "Finding the data unicorn: A hierarchy of hybridity in data and computational journalism." *Digital Journalism* 5(2): 159-176

Holovaty, Adrian. 2006. "A fundamental way newspaper sites need to change." *Holovaty.com*, September 6. <http://www.holovaty.com/writing/fundamental-change/>.

Holovaty, Adrian. 2009. "The definitive two-part answer to "is data journalism?"." *Holovaty.com*, May 21. <http://www.holovaty.com/writing/data-is-journalism>.

Karlsen, Joakim, and Eirik Stavelin. 2014. "Computational Journalism in Norwegian Newsrooms." *Journalism Practice* 8(1): 34-48

Legrand, Roland. 2010. "Why Journalists Should Learn Computer Programming." *MediaShift*, June 2. <http://mediashift.org/2010/06/why-journalists-should-learn-computer-programming153/>.

[Type here]

- Lewis, Seth C., and Oscar Westlund. 2015. "Big data and journalism: Epistemology, expertise, economics, and ethics." *Digital Journalism* 3(3): 447-466
- List, Dennis. 2007. "Scenario network mapping." *Journal of Futures Studies* 11(4): 77-96.
- Lorenz, Mirko. 2010. "Data driven journalism: What is there to learn?" Paper presented at IJ-7 Innovation Journalism Conference, Stanford, CA, June 7-9.
- Lorenz, Mirko; Nicolas Kayser-Bril, and Geoff McGhee. 2011. "Media Companies Must Become Trusted Data Hubs." *European Journalism Centre*, March 2. <http://ejc.net/magazine/article/media-companies-must-become-trusted-data-hubs#.WbUxyq2ZNE4>.
- Mair, John, Richard Lance Keeble, Paul Bradshaw and Teodora Beleaga. 2013. *Data Journalism: Mapping the Future*. UK: Abramis.
- Meyer, Philip. 2002. *Precision journalism: A reporter's introduction to social science methods*. 4<sup>th</sup> ed. Oxford: Rowman & Littlefield.
- Niles, Robert. 2006. "The programmer as journalist: a Q&A with Adrian Holovaty." *Online Journalism Review*, June 5. <http://www.ojr.org/the-programmer-as-journalist-a-qa-with-adrian-holovaty/>.
- O'Connor, Sarah. 2015. "Jobs and politics: the perils of data journalism." *The Financial Times*, May 6. <http://ig-legacy.ft.com/content/5d2785ec-dce6-3220-81c5-80c60eebb3a5>.
- O'Reilly, Tim. 2007. "Journalism Through Computer Programming." *Tools of Change for Publishing*, March 13. <http://toc.oreilly.com/2007/03/journalism-through-computer-pr.html>.
- Parasie, Sylvain, and Eric Dagiral. 2013. "Data-Driven Journalism and the Public Good: 'Computer-Assisted-Reporters' and 'Programmer-Journalists' in Chicago." *New Media & Society* 15(6): 853-871
- Parasie, Sylvain. 2015. "Data-Driven Revelation? Epistemological tensions in investigative journalism in the age of 'big data'." *Digital Journalism* 3(3): 363-380.
- Perry, Felipe, and Miguel Paz. 2015. *Manual de Periodismo de Datos Iberoamericano*. Santiago de Chile: Escuela de Periodismo de la Universidad Alberto Hurtado de Chile.
- Robinson, John B. (1988). "Unlearning and backcasting: Rethinking some of the questions we ask about the future". *Technological Forecasting and Social Change* 33(4): 325-338.
- Rogers, Simon. 2011. "Data journalism at the Guardian: what is it and how do we do it." *The Guardian*, July 18. <https://www.theguardian.com/news/datablog/2011/jul/28/data-journalism>.

[Type here]

Rogers, Simon. 2016. "Data Journalism Awards 2016: what the winners tell us about the state of the data nation." *Medium*, June 16. <https://medium.com/google-news-lab/data-journalism-awards-2016-what-the-winners-tell-us-about-the-state-of-the-data-nation-ffe79f343768>.

Rogers, Simon. 2017. "A new data journalism handbook." *Medium*, June 29. <https://medium.com/@smfrogers/a-new-data-journalism-handbook-c3ed8aca94a3>.

Royal, Cindy. 2012. "The Journalist as Programmer: A Case Study of The New York Times Interactive News Technology Department." *#ISOJ The Official Research Journal of the International Symposium on Online Journalism* 2(1): 5-24.

Schrager, Allison. 2014. "The problem with data journalism." *Quartz*, March 19. <https://qz.com/189703/the-problem-with-data-journalism/>

Tabary, Constance, Anne-Marie Provost, and Alexandre Trottier. 2015. "Data Journalism's Actors, Practices and Skills: A Case Study from Quebec." *Journalism* 17(1): 66-84

Thibodeaux, Troy. 2011. "5 tips for getting started in data journalism." *Poynter*, October 6. <https://www.poynter.org/news/5-tips-getting-started-data-journalism>.

Uskali, Turo I., and Heikki Kuutti. (2015) "Models and streams of data Journalism." *The Journal of Media Innovations* 2(1): 77-88.

Young, Mary Lynn, Alfred Hermida, and Johanna Fulda. 2017. "What Makes for Great Data Journalism? A Content Analysis of Data Journalism Awards Finalists 2012–2015." *Journalism Practice*: 1-21. doi:10.1080/17512786.2016.1270171.