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THE CHALLENGE OF EQUITABLE ALGORITHMIC CHANGE

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Iconic yellow public school buses pass through streets all across the United States every day, performing a complex choreography of crisscrossing routes and school handoffs. It turns out that school districts have only very recently acquired the computational heft to optimally design bus traffic.[1]

Algorithms and big data have now made it possible to redo public school busing in ways that cut costs, improve the environment, and better serve students, teachers, and parents. Taking advantage of these tools, the Boston public school system proposed an overhaul of bus routes and school schedules for the 2018 to 2019 school year with the possibility of saving up to $15 million per year.[2]

What happened next should teach public officials everywhere—especially in regulatory agencies—something about how algorithmically derived policy can go sideways even when it promises greater efficiency and equity.

Algorithms are useful in solving any complex regulatory problem with a difficult computational component, such as a carbon tax, congestion pricing, pollution allowances, dynamic zoning codes. But there is a growing literature on the things we might worry about *in the model* that makes up the algorithm, including unfairness, opacity, and a lack of due process.[3] These issues have been easiest to see where human life and liberty are on

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[1] David Scharfenberg, *Computers Can Solve Your Problem. You May Not Like the Answer*, BOSTON GLOBE, Sept. 21, 2018, https://apps.bostonglobe.com/ideas/graphics/2018/09/equity-machine/.

[2] Dimitris Bertsimas et. al., *From School Buses to Start Times: Driving Policy with Optimization*, Jan. 2019, https://adelarue.github.io/files/school-buses-to-bell-times.pdf.

[3] *See* Solon Barocas & Andrew D. Selbst, *Big Data's Disparate Impact*, 104 CAL L. REV. 671 (2016); FRANK PASQUALE, THE BLACK BOX SOCIETY: THE SECRET ALGORITHMS THAT CONTROL MONEY AND INFORMATION (2015); Danielle Keats Citron & Frank A. Pasquale, *The Scored Society: Due Process for Automated Predictions*, 89 WASH L. REV. 1 (2014).

the line, as in policing and sentencing by algorithm.[4] But more technocratic forms of regulation, like congestion pricing, can also raise pressing public interest questions.[5] An algorithm tuned to maximize efficient traffic flows may result in inequitable or disruptively unpredictable costs for drivers. Even if equity is factored in, members of the public may resist because they do not understand the systems or prefer other tradeoffs.

Although Boston Public Schools adopted an algorithmic solution to bus routing, it rejected the more ambitious algorithmically generated changes to school start times after the public revolted against change that was too much, too fast.[6] The overhaul was introduced with insufficient explanation or opportunity for citizen interaction with the model. With its demise, the school system forfeited up to $15 million in annual savings, better health for high school students starting school well before 8 a.m., and a more equitable distribution of the most desirable schedules.[7]

Of all the concerns raised about algorithmic systems, scholars have focused most closely on these systems' potential for bias. In the case of the paired algorithms prepared for the Boston schools, the developers recognized the dangers of building a new system that perpetuated the inequalities of the old: Minority and poorer families on average got the less desirable school schedules.[8] The developers took pains to design the new model to *redress* systemic bias.[9] And yet the public, including representatives of the historically disadvantaged groups the algorithm was intended to benefit, roundly denounced the changes to school start times. The school district's experience became a story about algorithmic scapegoating, in which opposition to comprehensive and disruptive change focused on the computational agent of that change. Press reports said the *algorithm* had "flopped."[10]

As significant as the risks are of biased algorithms, there is also a risk that public backlash and opaque implementations will burn trust where these technologies could do good. The failure in Boston to roll out improved

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[4] *See* Ali Winston, *Palantir Has Secretly Been Using New Orleans to Test its Predictive Policing Technology*, THE VERGE, Feb. 27, 2018, https://www.theverge.com/2018/2/27/17054740/palantir-predictive-policing-tool-new-orleans-nopd; Ellora Thadaney Israni, *When an Algorithm Helps Send You to Prison*, N.Y. TIMES, Oct. 26, 2017, https://www.nytimes.com/2017/10/26/opinion/algorithm-compas-sentencing-bias.html.

[5] *See* Fahri Soylemezgiller, Murat Kuscu & Deniz Kilinc, *A Traffic Congestion Avoidance Algorithm with Dynamic Road Pricing for Smart Cities*. 2013 IEEE 24TH INT'L SYMPOSIUM ON PERSONAL, INDOOR AND MOBILE RADIO COMM. 2571 (2013).

[6] Richard W. Walker, *Boston School Bus Project Underscores the Value of Data Analytics*, EDSCOOP, Oct. 2, 2017, https://edscoop.com/boston-school-bus-project-underscores-the-value-of-data-analytics/; Spencer Buell, *Boston Public Schools Won't Change Start Times in 2018*, BOSTON MAGAZINE, Dec. 22, 2017, https://www.bostonmagazine.com/education/2017/12/22/boston-public-schools-reverse-start-time-change/; Scharfenberg, *supra* note 1.

[7] Bertsimas et. al., *supra* note 2, at 6, 10.

[8] VIRGINIA EUBANKS, AUTOMATING INEQUALITY: HOW HIGH-TECH TOOLS PROFILE, POLICE, AND PUNISH THE POOR (1st ed. 2018); Scharfenberg, *supra* note 1.

[9] Scharfenberg, *supra* note 1.

[10] *Id.*

bus routes paired with school start times shows that good science is not enough to overcome bad politics. In Boston, the school system made significant efforts to engage the public in what they wanted out of bus transportation and school starts in the abstract. But there was almost no engagement with the model itself, insufficient transparency about the algorithm's tradeoffs, and no opportunity to adjust it.

The Boston public school system spends more than 10 percent of its budget on busing kids to and from school.[11] In 2016, the schools spent $120 million to bus nearly 30,000 students to about 230 schools on 650 buses.[12] The annual cost per student, which is just below $2,000, is the second highest in the United States and more than five times the average of the largest public school districts.[13] Reducing the costs of public school busing by optimizing routes and fleets can allow districts to roll those funds off the street and into education.

Furthermore, when new bus routes are paired with new school schedules, the twin changes can improve student health and safety by creating later starts for teenagers and earlier dismissals for grade schoolers. Early school starts have been linked to serious teenage health issues, such as decreased cognitive ability and increased obesity and depression while late school starts for elementary school children mean that younger children have to travel home in the dark.[14]

At the same time, changing bus routes and schedules can be hugely disruptive. More than half of all American K–12 students use public school buses for transportation to and from school every day, and, naturally, their families build work and childcare schedules around the bus times.[15] Making any significant change district-wide requires balancing "competing objectives" and values, such as student health, special education programs, extracurricular activities, and student, parent, and staff schedules.[16]

This balancing raises difficult computational challenges.[17] Most school districts use handmade, ad hoc solutions to manage their bus fleets and have

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[11] Bertsimas et. al., *supra* note 2, at 2.

[12] *MIT's "Quantum Team" Wins First-Ever BPS Transportation Challenge with Revolutionary Computer Model*, BOSTON PUBLIC SCHOOLS (July 25, 2017), https://www.bostonpublicschools.org/site/default.aspx?PageType=3&DomainID=4&ModuleInstanceID=14&ViewID=6446EE88-D30C-497E-9316-3F8874B3E108&RenderLoc=0&FlexDataID=12431&PageID=1&GroupByField=DisplayDate&GroupYear=2017&GroupMonth=7&Tag; Walker, *supra note* 6.

[13] Boston Public Schools, Transportation Challenge: Solving Routing and Bell Times [PowerPoint presentation] (Apr. 1, 2017), https://www.bostonpublicschools.org/cms/lib07/MA01906464/Centricity/Domain/2263/17.04.01%20Transportation%20Challenge%20Kickoff%20Presentation%20v9.F.pdf [hereafter Kickoff Presentation]; Boston Public Schools, Transportation Challenge: Solving Routing and Bell Times (2017), https://www.bostonpublicschools.org/cms/lib07/MA01906464/Centricity/Domain/2263/17.04.01%20BPS%20Transportation%20Overview%20Challenge%20v2.F.pdf.

[14] *See supra* notes 1-2 and accompanying text.

[15] Bertsimas et. al., *supra* note 2, at 2; Scharfenberg, *supra* note 1.

[16] Bertsimas et. al., *supra* note 2, at 1-2.

[17] John Hanlon & Will Eger, *Boston Public Schools' Transportation Challenge Brings Data to Buses*, MICROSOFT NEW ENG. BLOG (Apr. 13, 2017), https://blogs.microsoft.com/

only been able to tackle this inherently systemic task in piecemeal fashion.[18] Boston's approach in the past included staggering the start and end times of different schools so that buses could make multiple trips throughout the day.[19] The result was that there was a high variance of school start times, with the burden of the earliest start times falling on high school students, often before 8 a.m.[20] Not surprisingly, the wealthier and whiter schools in the district have benefitted from later start times, with poorer and minority households disproportionately burdened by earlier ones.[21]

More than two generations of Boston kids have passed through the school system since the city last restructured start times in 1990.[22] In late 2016, the Boston public school system began the process of making significant improvements to its bus routes and school start times throughout the district by initiating a public engagement process aimed at discerning community values.[23] Through this process, the district identified two overarching goals: "create an algorithm that will optimally route all of our buses, producing efficient routes and improving on-time performance," and "create a series of bell times that are equitably and efficiently balanced, reducing transportation costs and accommodating community feedback."[24]

The school district wanted a combination of equity and efficiency. But what does equity mean in this context? Should the less popular earlier start times be equally distributed among demographic groups? Or should disruption from the status quo be distributed equally? Or should start times be distributed in a way that takes into account differential needs for earlier or later start times?

The Boston public school district recognized in an equity impact statement that change might be especially hard for lower income families, implicitly acknowledging the tradeoff between short-term disruption and longer-term benefits.[25] Quantifying these tradeoffs may be hard or even impossible, so it is not surprising they were not visually represented or communicated effectively by school officials. Nor is it surprising that these officials did not get to the bottom of contesting conceptions of equity, which are a central problem to be worked out in the implementation of algorithmic systems.[26]

In addition to these top-level goals, there were subsidiary objectives to increase the number of high school students starting school after 8 a.m.,

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newengland/2017/04/13/boston-public-schools-transportation-challenge-brings-data-to-buses/.

[18] Bertsimas et. al., *supra* note 2, at 2.

[19] Kickoff Presentation, *supra* note 13.

[20] Bertsimas et. al., *supra* note 2, at 2, 4.

[21] *Id*. at 1, 8.

[22] *Id*. at 2, 8.

[23] *Id*. at 10.

[24] Kickoff Presentation, *supra* note 13.

[25] Memorandum from Boston Public Schools, regarding Equity Impact Statement (Nov. 15, 2017), https://www.bostonpublicschools.org/cms/lib/MA01906464/Centricity/Domain/162/BPS%20Start%20Times%20Equity%20Statement%20v4F.pdf.

[26] *See* Tafari Mbadiwe, *Algorithmic Injustice*, THE NEW ATLANTIS (2018), https://www.thenewatlantis.com/publications/algorithmic-injustice; *Perspectives on Issues in AI Governance*, GOOGLE, https://ai.google/static/documents/perspectives-on-issues-in-ai-governance.pdf.

decrease the number of elementary school students dismissed after 4 p.m., accommodate special needs students, and reduce the cost of busing generally.[27] In its public presentation to the Boston Schools Committee, school administrators reported that these subsidiary goals had won out against other possible contenders, including "minimizing overall change in the system."[28]

Obviously, there would be a tradeoff between stability and change. Given that the baseline distribution of school start times was inequitable, a move towards maximal equity might entail maximal disruption. Sacrificing some equity for stability would be one tradeoff that the public—including people who stood to gain from change in the longer term—might endorse. Ultimately, a phase-in of the plan, a more compelling explanation of why any model privileging equity and efficiency might entail significant disruption, and a better explanation of the equity story might all have helped to smooth acceptance of what was to come.

The Boston public school district decided that, rather than go through traditional procurement, it would solicit developers through a contest. In the spring of 2017, the school district announced a hackathon-style competition called the Boston Public Schools Transportation Challenge, consisting of two phases with $15,000 in prize money for both a bus routing program and bell schedule program optimizing the articulated goals.[29] Notably, the challenge was entirely technical. Competitors were tasked with building an algorithmic system but nothing in the challenge concerned presentation, communication, or tools that would allow the public to interrogate the model.[30] That absence of emphasis on the socio-political implementation of the system would prove decisive in the controversy to follow.

After the Boston public school system decided in 2017 to redesign the city's school bus schedule using algorithms, it held an open transportation challenge inviting computer scientists to develop the new system. The "Quantum Team" from the Massachusetts Institute of Technology (MIT) Operations Research Center won both phases of the challenge.[31] Professor Dimitris Bertsimas, co-director of the Operations Research Center, along with PhD students Arthur Delarue and Sébastien Martin, would build the model.[32] With respect to the bus routing, they solved what is known as the "traveling salesman problem" of mapping the most efficient way to cover a

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[27] Bertsimas et. al., *supra* note 2, at 10.

[28] *November 15, 2017 Presentations and Materials*, BOSTON PUBLIC SCHOOLS (Nov. 15, 2017), https://www.bostonpublicschools.org/site/default.aspx?PageType=3&DomainID=162&ModuleInstanceID=13111&ViewID=6446EE88-D30C-497E-9316-3F8874B3E108&RenderLoc=0&FlexDataID=13390&PageID=253.

[29] *Transportation Challenge: Solving Routing and Bell Times*, BOSTON PUBLIC SCHOOLS, https://www.bostonpublicschools.org/transportationchallenge; Kickoff Presentation, *supra* note 13.

[30] *Transportation Challenge*, *supra* note 29.

[31] *MIT Team Wins Boston Public Schools Transportation Challenge*, WICKED LOCAL ROSLINDALE (July 27, 2017, 8:03 PM), https://roslindale.wickedlocal.com/news/20170727/mit-team-wins-boston-public-schools-transportation-challenge.

[32] *MIT's "Quantum Team" Wins, supra* note 12.

route without doubling back, while also accounting for road surfaces, traffic, and many other variables.[33] Using public data and data from the school district, they designed an algorithm to reduce the number and footprint of bus routes, reconfigure bus stops, maximize the number of passengers on each bus, and reduce the use of empty buses.[34]

In addition to delivering cost savings, the system would reduce bus travel, eliminating some 20,000 pounds of carbon emissions per day and cutting up to 1 million bus miles per year.[35] The algorithm factored in the needs of wheelchair-friendly buses for disabled students, as well as those students who required home pick-ups.[36] The new bell schedule optimized for later school start times for high school students.[37] The model also optimized for equity in accordance with the school district's guidelines to reduce the disparity between white and minority students with respect to start times.[38]

David Scharfenberg of the *Boston Globe* called the algorithm "a marvel" that sorted through "1 novemtrigintillion options—that's 1 followed by 120 zeroes."[39] It made these computations in approximately thirty minutes, as opposed to the grueling multi-week undertaking that had been typical.[40]

This marvelous machine enacted significant change. To achieve the school district's equity and health objectives, system officials reported that "the majority of schools and students must change their bell times, and some must shift earlier or later by two hours or more."[41]

In fact, the bell schedule algorithm shifted 84 percent of school start times to commence high school later and end elementary school earlier for more students.[42] In conducting a disparate impact analysis, Boston Public Schools officials found that the MIT plan managed to distribute advantageous start times equally across major racial and ethnic groups, while

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[33] Max Larkin, *2 MIT Engineers Use Math to Plot a Path for Boston's School Buses*, WBUR (July 27, 2017), https://www.wbur.org/edify/2017/07/27/mit-quantum-boston-bus-routes.

[34] *MIT's "Quantum Team" Wins, supra* note 12.

[35] *Id.*

[36] Kara Baskin, *Creating Better Bus Routes with Algorithms*, MIT SLOAN (July 31, 2017), http://mitsloan.mit.edu/newsroom/articles/creating-better-bus-routes-with-algorithms/.

[37] *MIT's "Quantum Team" Wins, supra* note 12; *November 15, 2017 Presentations and Materials, supra* note 39.

[38] Bertsimas et. al., *supra* note 2, at 25.

[39] Scharfenberg, *supra* note 1.

[40] Larkin, *supra* note 33.

[41] Memorandum from Steven Chen, Senior Equity Manager of Boston Public Schools, John Hanlon, Chief of Operations of Boston Public Schools, and Becky Shuster, Assistant Superintendent of Equity for Boston Public Schools to Tommy Chang, Superintendent of Boston Public Schools, regarding 2018-2019 School Bell Times Equity Impact (Dec. 11, 2017), https://www.bostonpublicschools.org/cms/lib/MA01906464/Centricity/Domain/2389/Equity%20Analysis.pdf.

[42] James Vaznis, *Parents Protest New School Start Times*, BOSTON GLOBE, Dec. 13, 2017, https://www.bostonglobe.com/metro/2017/12/13/parents-protest-new-school-start-times/rI0UIOTY4EkFwFwvtmpaML/story.html.

substantially improving them for students in all of those groups.[43] Under the status quo, white students were the only group with a plurality that enjoyed the desirable 8 to 9 a.m. start time, and that plurality was only 39 percent.[44] Under the MIT plan, a *majority* of all students would start in the 8 to 9 a.m. slot, and that benefit was spread almost exactly equally across major racial and ethnic groups, with around 54 percent of students in each group enjoying it.[45]

In the months following the transportation challenge, the MIT team continued to work closely with the city and participated in the school district's ongoing community engagement process, making adjustments in response to feedback.[46] In the end, the consultation process touched about 10,000 students, family members, and staff through 17 community meetings and other outreach.[47]

This process sounds like a lot of outreach. It is perhaps for that reason that the MIT team was not prepared for the backlash that ensued when families saw how the changes would affect them. The consultations had not effectively described how the start time shifts in particular would change students' schedules and they had not given families opportunities to play with the model.

Politics killed the algorithm. In December 2017, the Boston Public Schools voted in principle to adopt an algorithmically devised bus route and bell schedule.[48] The new school schedule was released in December 2017, only nine months before it was due to be implemented in the fall of 2018.[49]

The public pushback was strong and swift. Some parents who perhaps in principle accepted earlier start times for elementary school students were confronted with dramatic shifts from 9:30 a.m. to 7:15 a.m.[50] Families with children of different ages suddenly found themselves facing a 90-minute launch time for their kids and juggling as many as three different bus schedules.[51] Parents argued that the new schedule would deprive students of sleep, force families to spend more money on after-school programs, and "tear apart families."[52] Others complained that their high school kids, because

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[43] Memorandum, *supra* note 41.

[44] *Id*.

[45] *Id*.

[46] Joi Ito, *What the Boston School Bus Schedule Can Teach Us About AI*, WIRED, Nov. 5, 2018, https://www.wired.com/story/joi-ito-ai-and-bus-routes/.

[47] Boston School Committee, Official Minutes of the School Committee Meeting (Dec. 6, 2017), https://www.bostonpublicschools.org/cms/lib/MA01906464/Centricity/Domain/162/SC%20Min%2012-6-17.pdf.

[48] *Id*.

[49] Boston Public Schools, School Bell Times: 2018-2019 School Year, https://www.bostonpublicschools.org/cms/lib/MA01906464/Centricity/Domain/2389/New%20School%20Bell%20Times%202018-2019.pdf; Jeff Saperstone et. al., *Boston School Committee Approves New Start and End Times*, NECN (Dec. 8, 2017), https://www.necn.com/news/new-england/Boston-School-Committee-Approves-New-Start-and-End-Times-462492453.html.

[50] Scharfenberg, *supra* note 1.

[51] Vaznis, *supra* note 42.

[52] *Id*.

of later start times, would now end school too late for work or extracurricular activities and that the work schedules of parents would be severely disrupted.[53]

The disgruntled parents quickly generated an online petition, which garnered over 8,000 signatures, and then they protested at an "emotionally charged" school committee chamber, turning the plan into one of "the biggest crises of Mayor Marty Walsh's tenure."[54] Parents at the school committee meeting carried signs reading, "Families over algorithms," "Students are not widgets," and "Stop the Lies."[55] Describing the situation as "an absolute disaster for Boston families," one commenter argued that although algorithms can help "a shipping company move packages efficiently," they are not as useful when it comes to figuring out how to move children.[56]

Some 80 parents, students, politicians, and other interested parties testified against the new schedule.[57] Protestors drowned out then-superintendent Tommy Chang's attempts at reassurance. Five city councilors sent a letter to the school committee urging committee members to delay changes and formulate a better plan.[58]

At the school committee meeting where protesters massed, MIT team members noticed that "most of the critics hailed from wealthier sections of the city."[59] From photos of the protests, it appears that most were white. But representatives of the minority communities—who were supposedly helped by the more equitable distribution of start times—were also opposed to the changes. The National Association for the Advancement of Colored People and the Lawyers' Committee for Civil Rights and Economic Justice ended up opposing the plan on the ground that lower income households, having less flexibility to begin with, would find it difficult to adjust to the proposed schedule.[60]

The algorithmic process itself became a scapegoat for community rage about both substantive change and its suddenness. More explanation about the tradeoffs, including visuals and tools enabling people to themselves play with the model, might have helped. This is the view of MIT Professor Joichi Ito, who noted:

> While I'm not sure privileged families would give up their good start times to help poor families voluntarily, I think that if

[53] Official Minutes of the Sch. Comm. Meeting, *supra* note 47; Scharfenberg, *supra* note 1.

[54] Jane Miller, *Stop Immediate Changes on School Start Times in Boston*, CHANGE.ORG, https://www.change.org/p/tommy-chang-and-mayor-walsh-stop-immediate-changes-on-school-start-times-in-boston; Vaznis, *supra* note 42; Scharfenberg, *supra* note 1.

[55] Vaznis, *supra* note 42.

[56] Doug Woodhouse (@doug_woodhouse), TWITTER (Dec. 12, 2017, 1:22 PM), https://twitter.com/doug_woodhouse/status/940648153447059458.

[57] Vaznis, *supra* note 42.

[58] City Counselor Michael Flaherty, FACEBOOK (Dec. 14, 2017, 2:54 PM), https://www.facebook.com/flahertyfanpage/posts/please-see-the-letter-below-addressed-to-superintendent-tommy-chang-and-boston-s/1554868181264223/.

[59] Scharfenberg, *supra* note 1.

[60] *Joint Statement on Boston Public Schools' Proposed Bell Times*, LAWYERS FOR CIVIL RIGHTS, http://lawyersforcivilrights.org/our-impact/education/joint-statement-on-boston-public-schools-proposed-bell-times.

> people had understood what the algorithm was optimizing for—sleep health of high school kids, getting elementary school kids home before dark, supporting kids with special needs, lowering costs, and increasing equity overall—they would agree that the new schedule was, on the whole, better than the previous one.[61]

It is also possible that the proposed change, no matter how explained, was simply unacceptable to too many affected families. One of the benefits of algorithmic policy is that it is relatively easy to tweak. Had the MIT team been tasked with re-running the start time program, privileging stability to a greater degree, or doing so especially for families with children in different schools, they might have been able to produce a plan with more buy-in.

Boston quickly abandoned the project of changing school start times.[62] The city's school superintendent eventually resigned.[63] The district did adopt the algorithmically derived bus routes, eliminating close to 50 superfluous bus routes and saving the district an estimated $3 million to $5 million per year.[64] But when it walked away from the start time changes, it sacrificed a more equitable bell schedule and up to $15 million in savings.[65] The proposed bell schedule changes were radical and the rollout did not provide a process for public input and change. The protesting public blamed the algorithm—which could have been tuned to optimize for other objectives—for failures of political process.

It is probably inevitable that the "losers" of what is a redistributive process will object to change no matter how it is implemented or explained. The benefit of a data-driven model is that it can be tuned to optimize different objectives. Tradeoffs can be represented graphically. Tools can be built to allow people to interrogate the model and scenario play. Had stakeholders been engaged not only before release of the model, but also iteratively with the model in beta form, they might have prioritized stability over change. In this case, more stability would have meant less equity.

Another piece missing from Boston's algorithmic process was any added measure of due process for families unhappy with the results. Algorithmic generation of bus routes confers the authority of the machine on policy outcomes. "The machine says so" can be a powerful source of legitimacy. But it can also be a rebuke to the individual seeking flexibility or explanation. A model that can analyze 1 novemtrigintillion options in thirty minutes can also perhaps be instrumented with a way to represent how

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[61] Ito, *supra* note 46.

[62] *Read the Statement from Tommy Chang on New Start Times*, BOSTON GLOBE, Dec. 22, 2017, https://www.bostonglobe.com/metro/2017/12/22/read-statement-from-tommy-chang-new-start-times/1gEkL1rxYy7M5JW3j08uwN/story.html.

[63] Scharfenberg, *supra* note 1.

[64] Kara Baskin, *Creating Better Bus Routes with Algorithms*, MIT SLOAN (July 31, 2017), https://mitsloan.mit.edu/ideas-made-to-matter/creating-better-bus-routes-algorithms.

[65] Bertsimas et. al., *supra* note 2, at 6, 25.

changing individual or neighborhood outputs can impact the system and the tradeoff curves. Such a “due process tool” was not part of the school district’s transportation challenge, so there is no reason the winning team would have built one.

Procurement of algorithmic processes, whether by contest or otherwise, should have explanatory and due process components. Citizens may be able to accept algorithmic policy losses if they have more purchase on the rationales behind them and recourse to change them.