

Average Speeds and Road Safety in São Paulo

Application of Uber Movement's data

Presentation by Luis Fernando and Villaca Meyer, Cordial Institute, Brazil

Roundtable on Artificial Intelligence in Road Traffic Crash Prevention

10-12 February 2021



Average speeds and road safety in São Paulo

Application of Uber Movement's data



Cordial Institute is a think and do tank that works with **data science, territorial intelligence and intersectoral articulation** to strengthen networks and ground public and private decision making on data and evidence



**Special
projects**



**Articulation
initiatives**



**Local
engagement**

Average speeds and road safety in São Paulo

Application of Uber Movement's data

September 2020

Realization



Instituto
cordial

Partnership



Uber



Painel da Segurança Viária



Painel da Segurança Viária

The Road Safety Panel initiative establishes intersectoral forums of discussion, **articulating public and private organizations to deepen the debate on the relationships between traffic crashes and the design of urban streets.**

It monitors patterns and trends in the way crashes happen, seeking to contribute to the foundation and direction of actions and interventions aimed at road safety.



Cenário

monitoring public debates, conflicts e legislation about urban mobility and road safety



Actors

raising hypothesis together, evaluate results and thinking about solutions



Data

identifying data sources, pairing large databases and guiding absent data



Knowledge

analysing, monitoring trends and contributing to actions and interventions



Dissemination

bringing knowledge to different publics with different backgrounds



Painel da Segurança Viária

Realização

Instituto
cordial

Patrocinadores



Uber

Parceiros estratégicos





20 groups in 5 workshops
+70 representatives
50 organizations

141
hypotheses raised

Hypotheses raised by many hands

What kind of question?

“ When there is a bus lane on the left, there are fewer accidents, but more severe ones.

Hypotheses raised by many hands

What kind of question?

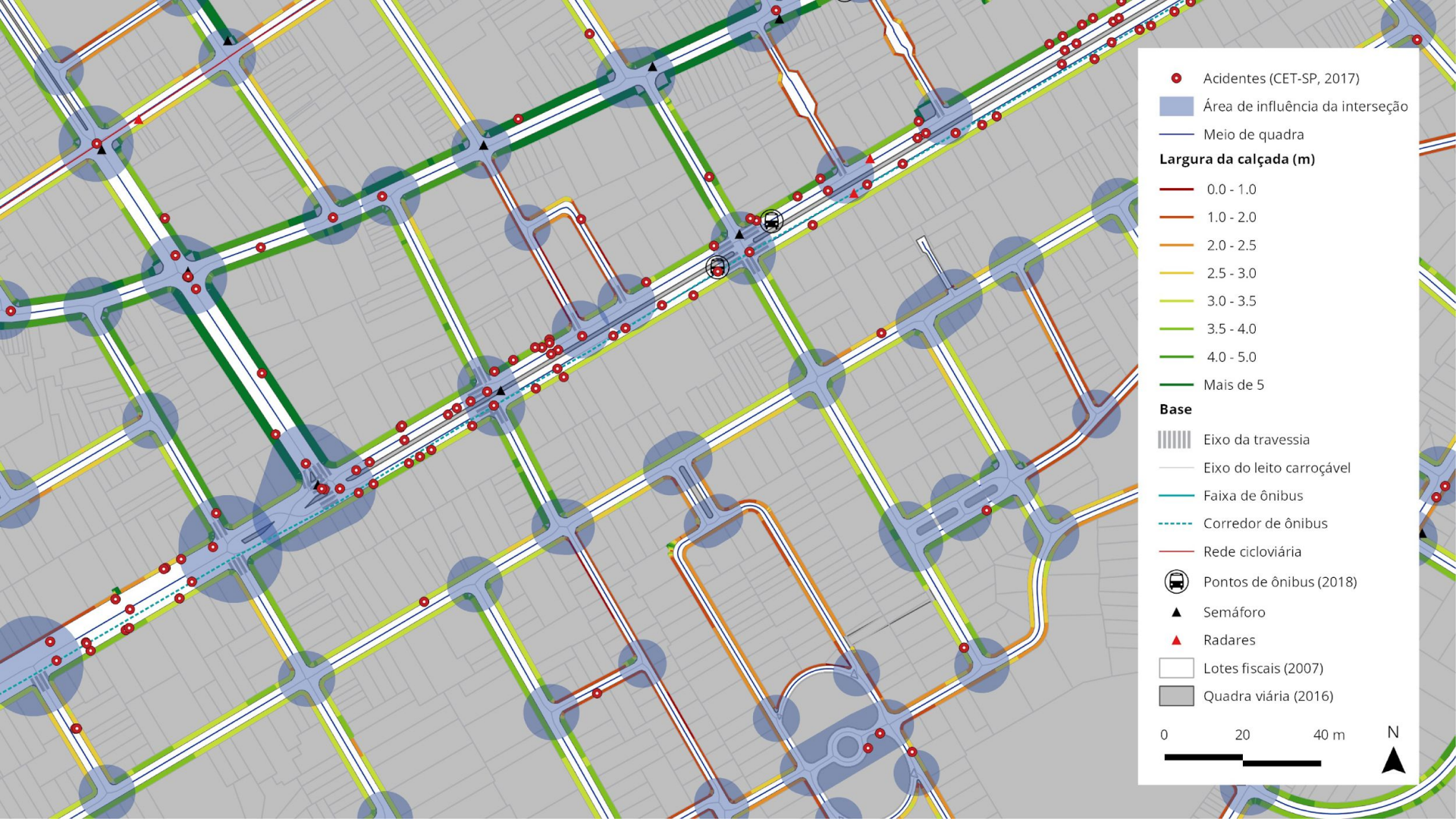
“ When there is a bus lane on the left, there are fewer accidents, but more severe ones.

Is that true?

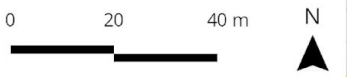
Methodology



```
1 bool Input::IsKeydown(UCHAR vkey) const
2 {
3     if (vkey < INPUT_KEY_ESCAPE)
4         return false;
5     else
6         return true;
7 }
8
9 bool Input::IsKeyReleased(UCHAR vkey) const
10 {
11     if (vkey < INPUT_KEY_ESCAPE)
12         return false;
13     else
14         return true;
15 }
16
17 void Input::Clear(UCHAR vkey)
18 {
19     using namespace InputMS;
20     if (vkey < KEY_ESC)
21         for (size_t i = 0; i < KEY_ARRAY_SIZE; i++)
22             m_IsKeydown[i] = false;
23     if (vkey < KEY_RELEASED)
24         for (size_t i = 0; i < KEY_ARRAY_SIZE; i++)
25             m_IsKeyReleased[i] = false;
26 }
```



- Acidentes (CET-SP, 2017)
- Área de influência da interseção
- Meio de quadra
- Largura da calçada (m)**
 - 0.0 - 1.0
 - 1.0 - 2.0
 - 2.0 - 2.5
 - 2.5 - 3.0
 - 3.0 - 3.5
 - 3.5 - 4.0
 - 4.0 - 5.0
 - Mais de 5
- Base**
 - ||||| Eixo da travessia
 - Eixo do leito carroçável
 - Faixa de ônibus
 - - - Corredor de ônibus
 - Rede cicloviária
 - 🚌 Pontos de ônibus (2018)
 - ▲ Semáforo
 - ▲ Radares
 - Lotes fiscais (2007)
 - Quadra viária (2016)



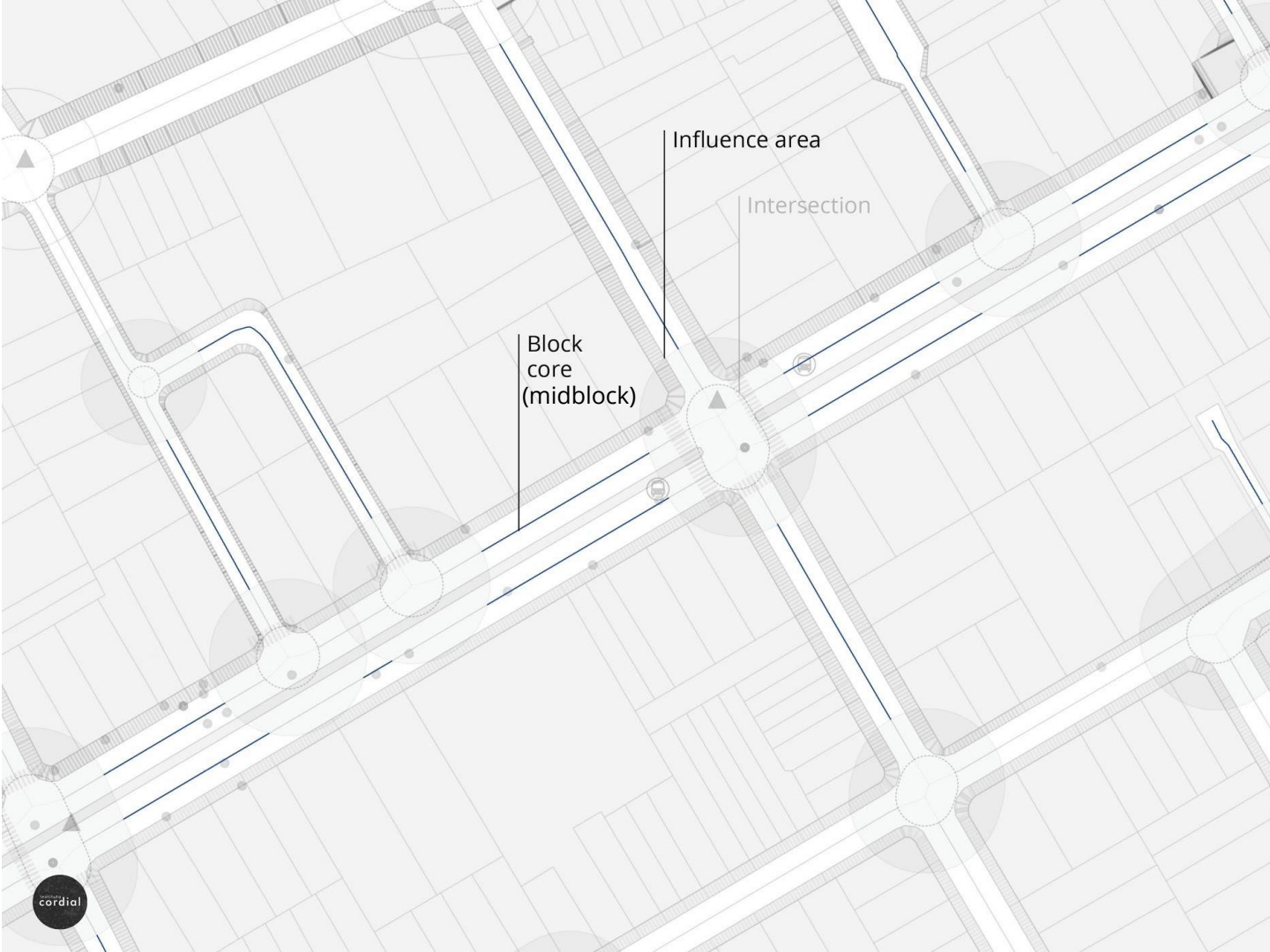


How do we understand
the road system

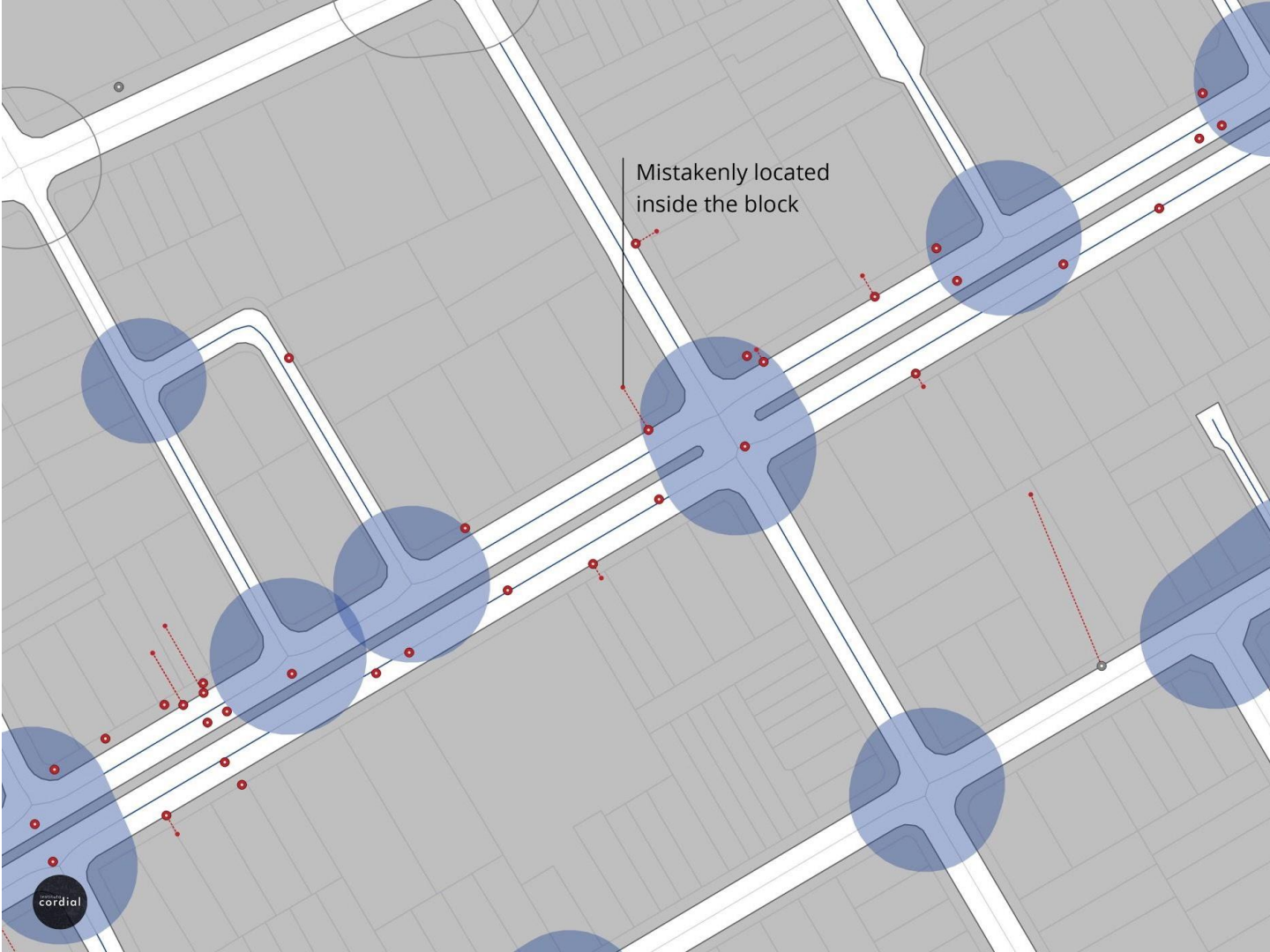
How do we understand the road system



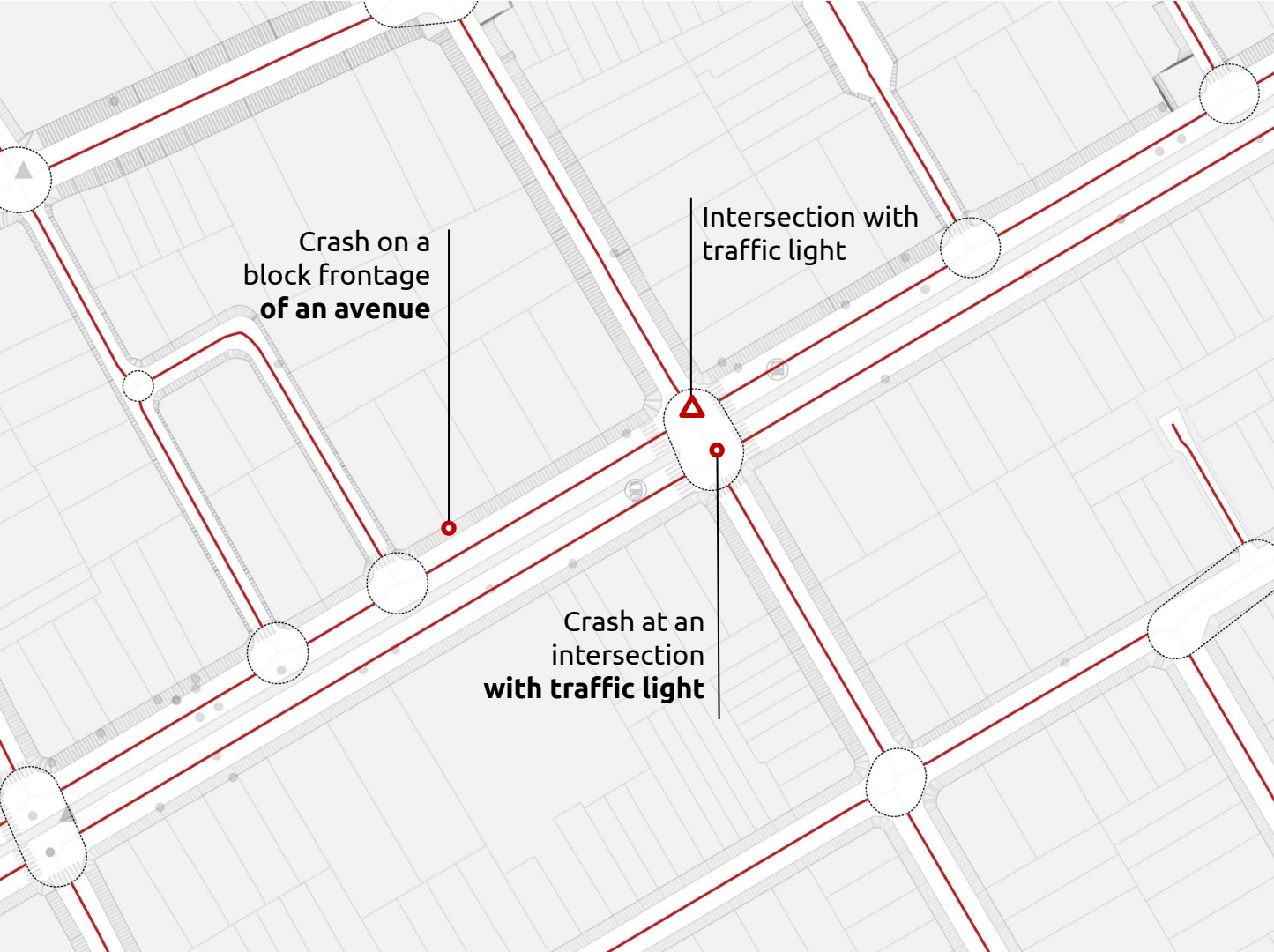
How do we understand the road system



How do we understand the road system



How do we understand the road system



But!

How about hypothesis like...

“ When there is traffic jam on the road, crashes are more frequent.

Lack of data

There are no public data available on the **speed of vehicles on the place and time where each crash happened**, much less if there was a traffic jam.

By pairing data, we now have information about the crashes, the **characteristics of the place and the average speed at the time of the crash**.



+



Painel da
Segurança
Viária

+

Uber

The study



```
File Edit Selection View Go Debug Terminal Help
C:\input C:\gameCommands C:\bld\imgui C:\inputgame
case 1 to 4 @ inputapp ? ...
bool Input::IsKeyDown(UCHAR vkey) const
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return false;
    return true;
}
bool Input::IsKeyPressed(UCHAR vkey) const
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return false;
    return true;
}
bool Input::IsKeyReleased(UCHAR vkey) const
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return false;
    return true;
}
void Input::Clear(UCHAR vkey)
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return;
    for (int i = 1; i <= INPUT32; i++)
        m_keyDown[i] = false;
}
void Input::Clear(UCHAR vkey)
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return;
    for (int i = 1; i <= INPUT32; i++)
        m_keyReleased[i] = false;
}
void Input::Clear(UCHAR vkey)
{
    if (vkey < INPUT32 || INPUT32 == vkey)
        return;
    for (int i = 1; i <= INPUT32; i++)
        m_keyPressed[i] = false;
}
```

Let's find smarter ways forward, together.

São Paulo



Uber Movement shares anonymized data aggregated from over ten billion trips to help urban planning around the world.

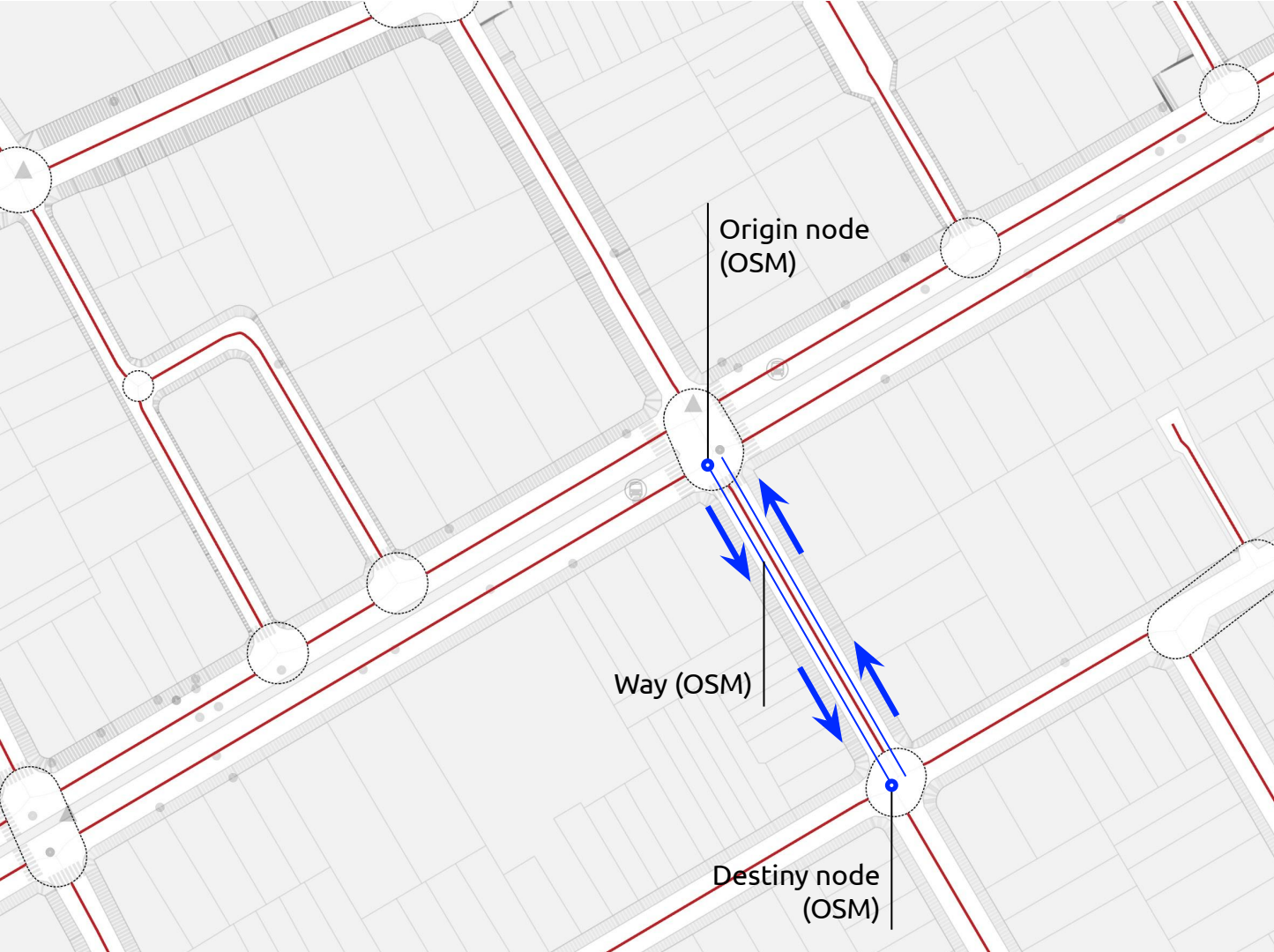


Pairing data and
aggregating to the
database

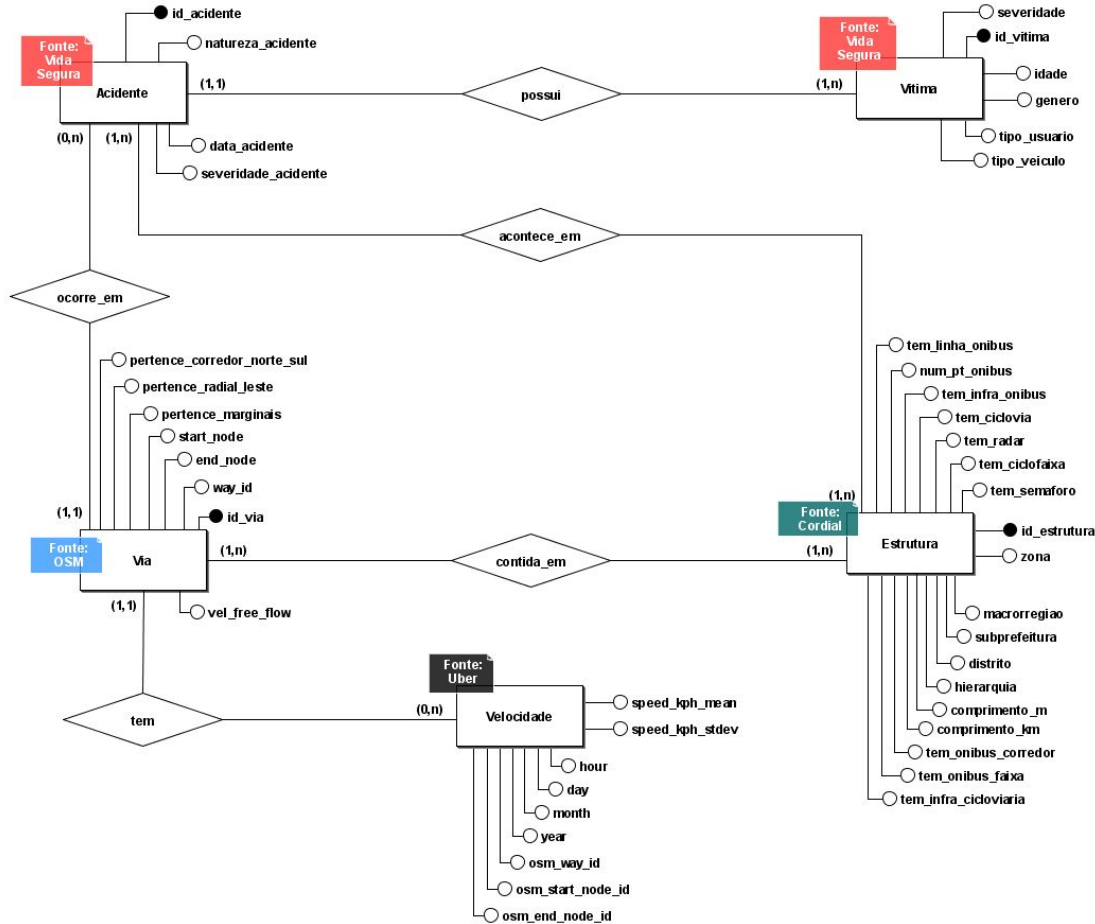
Pairing data and
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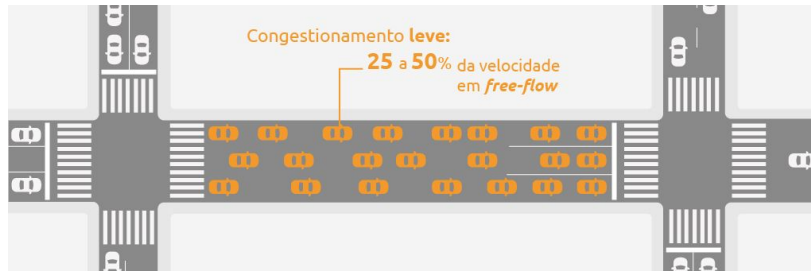
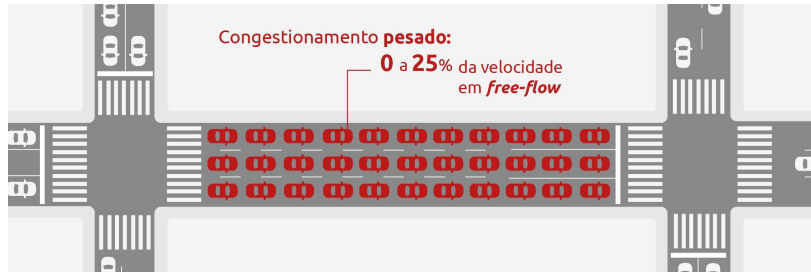
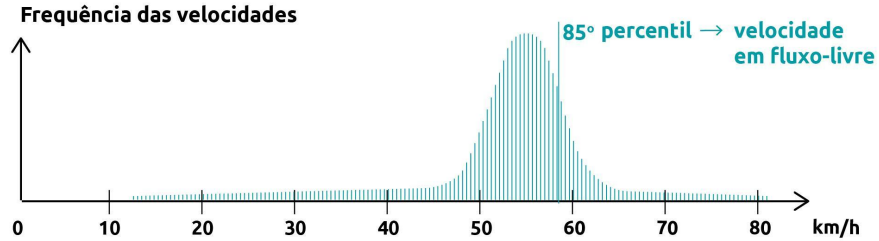


Pairing data and
aggregating to the
database



Pairing data and aggregating to the database





“Free-flow”?
“Traffic jam”?

The study

Analysis of **572 million records**
of Uber Movement average speed data

That allowed identifying the
average speed at the place and time of more than
6,500 crashes in 2018 (49.78% of the total) distributed in the **16
thousand kilometers** of roads in the city of São Paulo

Analyzed with various statistical models
Regressions, logit, tobit, two-stage estimation, fixed effects
Results reported with a 99% degree of statistical confidence
due to the high availability of data



Results

```
File Edit Selection View Go Debug Terminal Help
C:\input\ C:\gameCommon\ C:\bin\ C:\input\
case 1 to 1 InputApp ? ...
bool Input::IsKeyDown(UCHAR vKey) const
{
    if (vKey < INPUT_KEY::KEYS_ARROW_128)
        return !!(vKey & KEYS_ARROW);
    else
        return false;
}

bool Input::CrossKeyPressed(UCHAR vKey) const
{
    if (vKey < INPUT_KEY::KEYS_ARROW_128)
        return !!(vKey & KEYS_ARROW);
    return false;
}

bool Input::AnyKeyPressed() const
{
    for (size_t i = 0; i < INPUT_KEY::KEYS_ARROW_128; i++)
    {
        if (IsKeyPressed(i))
            return true;
    }
    return false;
}

void Input::ClearKeyPress(UCHAR vKey)
{
    if (vKey < INPUT_KEY::KEYS_ARROW_128)
        !!(vKey & KEYS_ARROW) = false;
}

void Input::Clear(UCHAR vKey)
{
    using namespace InputKey;
    if (vKey & KEYS_ARROW)
    {
        for (size_t i = 0; i < KEYS_ARROW_128; i++)
            !!(vKey & KEYS_ARROW) = false;
    }
    if (vKey & KEYS_PRESSED)
    {
        for (size_t i = 0; i < KEYS_PRESSED_128; i++)
            !!(vKey & KEYS_PRESSED) = false;
    }
}
```

Hypothesis 1: **CONFIRMED**

“When there is traffic jam on the road, crashes are more frequent ”

The occurrence of crashes is **much higher** when there is traffic jam on the street:

- The probability of a crash occurring in light jam is **3.7 times greater** than in free flow on average;
- In case of heavy traffic jam, the probability is **6.3 times greater** than in free flow.

Vehicle collisions are:

- **5 times** more frequent when there is mild jam
- **10 times** more frequent in heavy jam than in free flow.

Motorcycle run overs are:

- **22 times** more frequent in light traffic jam;
- Up to **90 times** more frequent in heavy traffic jams than in free flow.

Remembering

*Light traffic jam:
50% of free flow speed*

*Heavy traffic jam: 25% of
free flow speed*

*There is no vehicle flow data
to allow for weighting*

Hypothesis 2: **NOT CONFIRMED**

“Whenever the flow is free, there are more fatal crashes”

There is no evidence to support the hypothesis.

In fact, the occurrence of fatal crashes is greater in moments without traffic jam, however the models indicated that **other characteristics of the street or the moment of the crash refute the hypothesis** that there is a direct causal relationship of jam on the probability of fatal victims.

Characteristics that indicated greater explanatory power for the probability of death in traffic were:

- **Road hierarchy** (Fast Transit, Arterial, Collector or Local)
- **Time of day** (morning, afternoon, night, dawn)
- **Speed of free flow** of the road

Fatal crashes occur, above all, on **arterial roads** where **high speeds** are practiced, **at night** and outside peak hours. What increases the severity of crashes is not only if the vehicle is traveling without traffic jam, **but the speed that vehicles develop when there is no jam.**

Hypothesis 3: **CONFIRMED**

“When the block is longer, vehicles develop higher speeds”

The results of the analyzes pointed to a direct **interference of the court length in the average practiced speed, but this impact is small**.

For every additional 62 meters of block length, the annual average speed increases 1km / h.

Developed speed is more influenced by the following characteristics **than by the length of the block itself**:

- Road hierarchy (Fast Transit, Arterial, Collector or Local roads);
- Number of road lanes;
- Road lane width;
- Presence of radars;
- Presence of bicycle infrastructure;
- Presence of traffic lights;
- When dealing with one of the following routes: Marginal, North-South Corridor or East Radial

Hypothesis 4: **CONFIRMED**

“When the block is longer, the severity of crashes is greater”

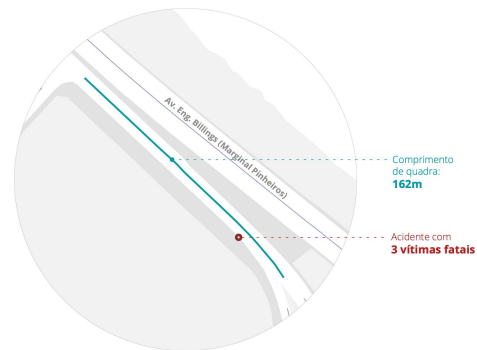
It was found that, indeed, longer blocks have more fatal crashes, and this effect occurs at least because of two consequences:

- **Increase of the number of running overs**
- **Increase of vehicles speeds**

The relationship between the length of the blocks and fatality occurs through these two effects and not the size of the block itself.

The hypothesis can be illustrated by a crash that occurred at dawn on October 15, 2018 at Av. Eng. Billings (Marginal Pinheiros) in which the driver, at high speed, lost control of the vehicle and hit a pole, killing 3 people.

The block length was 162 meters, 52 meters (or 47%) above the average for the same road hierarchy.



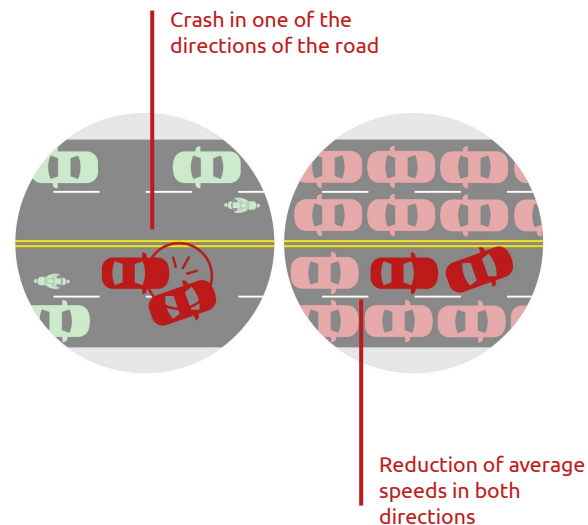
Hypothesis 5: **CONFIRMED**

“When a crash occurs, the average speed of the road reduces in both directions and for a considerable period of time”

It was possible to verify that, in all the groups tested, the occurrence of a crash caused some reduction of speed on the road, including in the opposite direction.

It was also found that, on **previously jammed roads, the reduction in speed is more expressive.**

When there is a crash, the average speed of the road is up to **32% lower** than in the next hour, compared to normal days, taking up to **3 hours to normalize.**



Hypothesis 6: **NOT CONFIRMED**

“When the speed of both road directions are too different, crashes are more frequent and severe, especially with motorcyclists”

The hypothesis considered the possibility of motorcyclists traveling against the traffic flow when there is congestion in the way that the user is traveling, increasing the severity of crashes.

However, **there is no evidence to support this hypothesis.**

Negative results like this one are important to support the degree of priority that should be assigned to any interventions in the road system related to a specific hypothesis.

Hypothesis 7: **CONFIRMED**

“Crashes with male drivers tend to be more severe”

The hypothesis starts from the assumption that, when they can drive on roads with higher speeds, men tend to be more reckless than women, **getting involved in more severe crashes**. This assumption proved to be true and it was still possible to verify that the probability of a crash being fatal **increases by 69.2%** when it involves only male individuals.

To deepen and qualify the analysis, factors associated with male individuals were added to the models:

- Driving motorcycles, buses and trucks;
- Night driving;
- Driving on roads with higher free flow speed.

In the model that controls the effect of these variables, the chance of fatality in crashes involving male individuals was **78.9% higher, jumping from 3.8% to 6.8%**.



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#NoChaoQueACidadeAcontece

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