

Identifying Major Causes of Construction Accidents

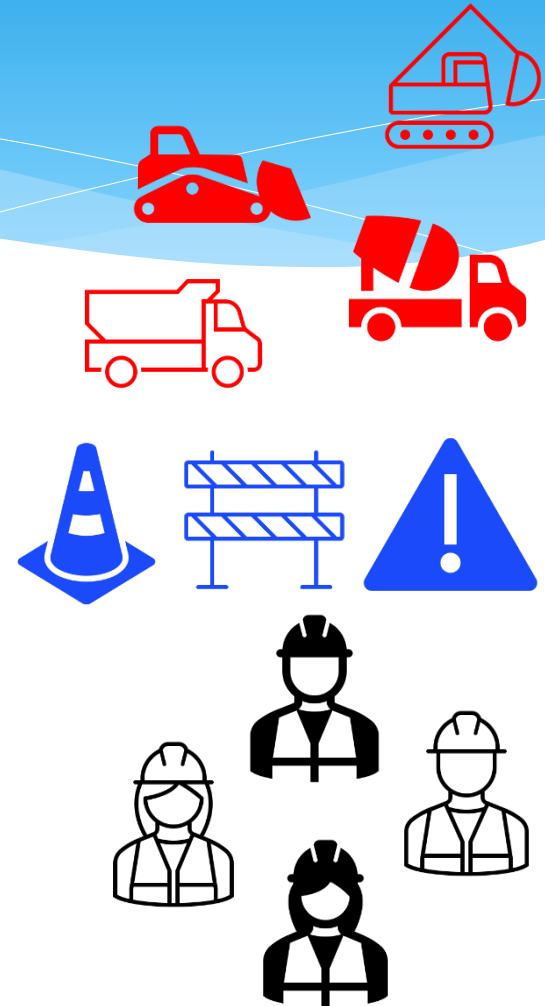
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IRISE ANNUAL MEETING

MAY 17, 2023

Acknowledgments

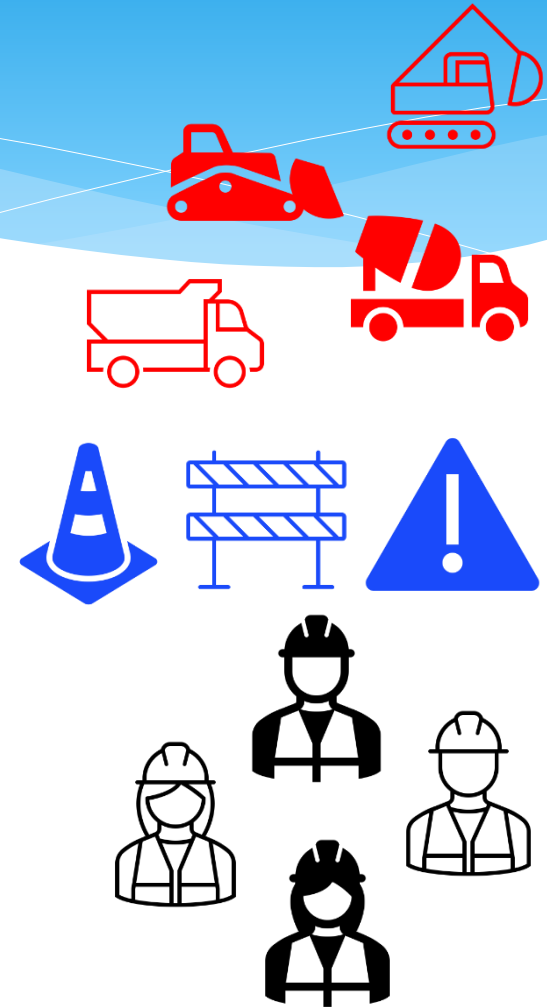
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- * Jim Foringer, Michael Baker
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The Problem

❑ Accidents, health hazards, and near-misses in construction work zones are complex events caused by a variety of issues

❑ Research is heavily focused on building construction



Project Objectives

- ❑ Identify the very specific activities and scenarios that cause accidents, health hazards and near-misses in the highway industry
- ❑ Develop safety database to inform safety-related actions

Data Collection

- National and State agencies
- Insurance companies
- Contractors
- Unions
- Construction associations

Literature Review: Accident Characteristics

OSHA Categories: Struck-by, Falls, Electric Shock, Caught In/Between, Other

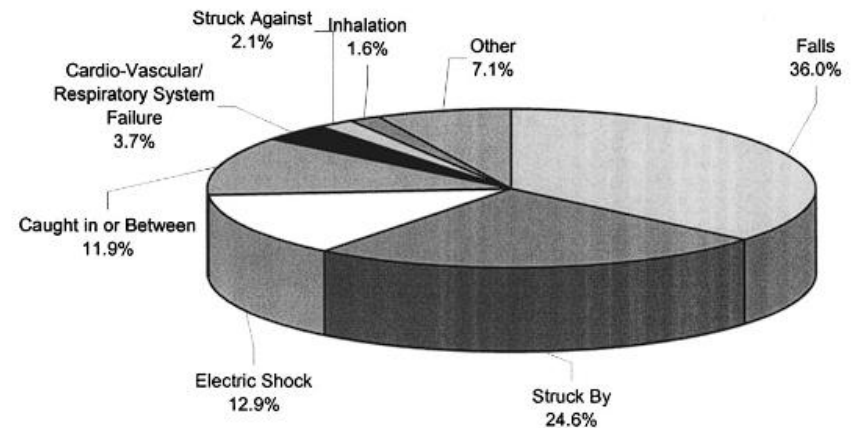
Falls

- More applicable to building construction

Other

- Caught-In/Between
- Electric Shock
- Physiological injuries?

Not found as prevalent in highway construction – may need further investigation



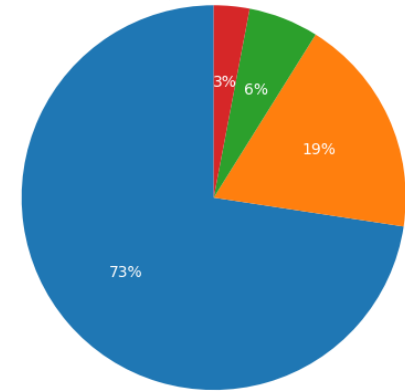
Type of Construction Injuries 1997-2000 (Hinze, Huang, & Terry, 2005)

Literature Review: Accident Characteristics

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Struck-by!!!!

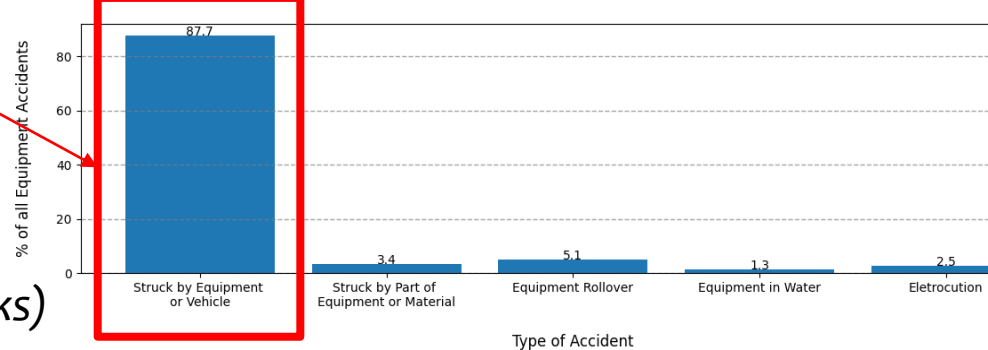
- High frequency on highways construction projects
- Fatalities **increased 34%** from 2010 to 2015 (Kim et al. (2019))



Travel direction

High % of equipment accidents are struck-by

Percent of Fatalities based on Vehicle Travel Direction (Hinze & Teizer, 2011)



Percent of Equipment Accidents vs. Type of Accident (Hinze & Teizer, 2011)

- (~49%) Traffic Vehicular (43% Cars & 47% Trucks)
- (~51%) On-Site Vehicular and Equipment (Heavy Vehicle)

Existing Databases - OSHA



UNITED STATES
DEPARTMENT OF LABOR

OSHA Severe Injury Reports ***Recently updated to May 2022**

<https://www.osha.gov/severeinjury>

Event Titles

Database (2015-2021)

- Approx. 70,000 entries of all NAICS codes across US
- 1,032 with 237310 NAICS code
- 78 with 237310 specific to PA

Available Data

- Hospitalization and/or Amputation status
- Zip code
- Semi-detailed accident description
- Overall accident category
- Among others

- Struck by powered vehicle tipping over-nontransport
- Jack-knifed or overturned, roadway
- Struck by falling object or equipment, n.e.c.
- Pedestrian struck by vehicle in roadway, unspecified
- Pedestrian struck by vehicle in nonroadway area, unspecified
- Struck by object or equipment rolling freely
- Fall from collapsing structure or equipment less than 6 feet
- Pedestrian vehicular incident, unspecified
- Caught in running equipment or machinery during regular operation
- Struck or run over by rolling powered vehicle
- Fall on same level due to slipping
- Excavation or trenching cave-in
- Struck by discharged object or substance
- Contact with hot objects or substances
- Struck by swinging or slipping object, other than handheld, unspecified
- Struck by falling object or equipment, unspecified
- Other fall to lower level, unspecified
- Etc.

Existing Databases - OSHA

Example incident description

An employee sustained a serious leg injury while he was attempting to dismount a CAT paving machine. The employee was in the process of dismounting the equipment, slipped and suffered a puncture to the knee from a bolt protruding on the machine. The employee was hospitalized and required surgery.

EventDate	Employer	Address	City	State	Zip	Latitude	Longitude	Primary	Hospitalized	Amputated	Inspected	Final	Nature	Part_of	Part_of	Event	EventType	Source	Source	Second	Second	Source	
1/28/2015	Traffic Control Services, LLC	3682 Irish Valley Road	ELYSBURG	PENNSYLV	17824	40.85	-76.53	237310	1	0		At approx	111 Fractures	5189 Multiple l	2412 Pedestrian	840 Highway vehicle, motorized, unspecified							
3/9/2015	New Enterprise Stone & Lime	3247 Pennington Road	TYRONE	PENNSYLV	16686	40.68	-78.18	237310	1	0		An emplo	1972 Soreness,	513 Lower leg	4111 Slip on surface	562 Bodily motion	9273 Ice, sleet, snow						
3/11/2015	Golden Triangle Construction	8555 Old Stubenville	IMPERIAL	PENNSYLV	15126	40.45	-80.24	237310	1	0		An emplo	1972 Soreness,	510 Leg(s), un	6220 Struck by	4133 Beams-unattached metal							
3/30/2015	Trumbull Corporation	38 Denny Estates	PITTSBURGH	PENNSYLV	15238	40.53	-79.82	237310	1	0	1050737	An emplo	10 Traumatic	9999 Nonclassifi	4336 Other fall	9999 Nonclassifiable							
4/22/2015	JD Eckman, Inc.	Rt 23 Pickering Creel	PHOENIX	PENNSYLV	19453	40.14	-75.51	237310	1	0	1058681	An emplo	1972 Soreness,	510 Leg(s), un	6241 Struck by	6391 Guardrails	3211 Backhoes, trackhoes						
4/28/2015	Granna Brothers Stone and Asphalt	PA Turnpike Mile Me	HOLIDAY	PENNSYLV	16648	40.43	-78.37	237310	1	0		An emplo	10 Traumatic	9999 Nonclassifi	20 Trapped	640 Highways, motorized, unspecified							
8/6/2015	E.J. Breneman, L.P.	Lake Dr	NESQUEHEON	PENNSYLV	18240	40.85	-75.84	237310	1	0		An emplo	133 Puncture	512 Knee(s)	433 Other fall	3252 Asphalt and concrete paving machines							
8/13/2015	NEW ENTERPRISE STONE & LIME COMPANY, INCORPORATED	Turnpike 176 Carlisle	CARLISLE	PENNSYLV	17013	40.21	-77.19	237310	1	0		An emplo	111 Fractures	582 Foot (feet)	433 Other fall	631 Bridges, dams, locks							
8/18/2015	GREGORI CONSTRUCTION & ENGINEERING, INC	355 Perryopolis Road	BELLE VER	PENNSYLV	15012	40.11	-79.81	237310	1	0	1094585	An emplo	111 Fractures	5830 Ankle(s) a	433 Other fall	631 Bridges, dams, locks							
8/24/2015	Russell Standard Corporation	3580 Wheelertown	WATERFORD	PENNSYLV	16441	41.9	-79.93	237310	1	0	1109170	On August	1839 Fractures	38 Multiple t	2410 Pedestrian	8429 Truck-motorized freight hauling and							
8/28/2015	Trumbull Corporation	PA Turnpi Milepost 4	PITTSBURGH	PENNSYLV	15232	40.45	-79.93	237310	0	1		An emplo	1311 Amputati	4429 Finger(s),	642 Compress	6551 Girders, beams, structural steel							
9/3/2015	John J. Dougherty & Son, Inc.	The Navy Yard, 1200	PHILADELPHIA	PENNSYLV	19112	40	-75.15	237310	1	0		On Septe	160 Intracran	111 Brain	4210 Fall on surface	660 Floors, walkways, ground surfaces, un							
9/19/2015	HRV Conformance Verification Associates	JVS22 Wilten Road	LIGONIER	PENNSYLV	15658	40.24	-79.22	237310	1	0		An emplo	132 Cuts, lacer	135 Jaw, chin	429 Fall on surface	6630 Ground, unspecified							
10/5/2015	Golden Triangle Construction Company	Route 50 & Penn Dot	BRIDGEVIEW	PENNSYLV	15017	40.34	-80.11	237310	1	0		An emplo	1972 Soreness,	899 Multiple	2729 Nonroad	8619 Off-road	69 Structures and su						

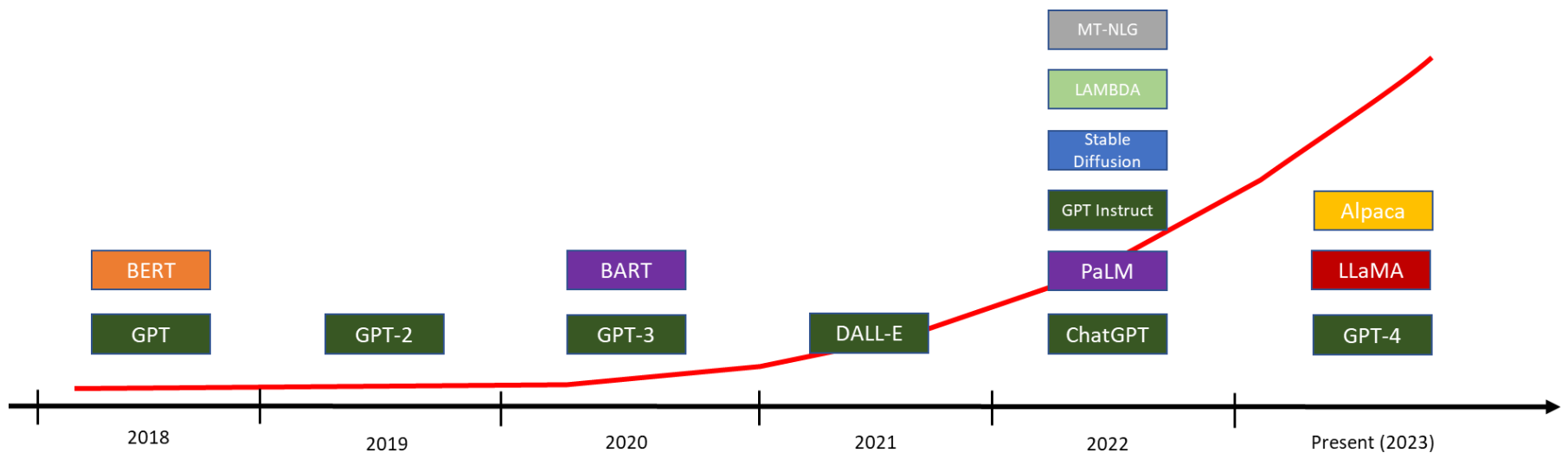
An employee was working on a truck. He was going to back it out of the shop when he exited the truck to hook up something beneath it. When he hooked up the wires under the truck, the truck began rolling backwards and rolled over the employee. He was pinned under the

Event type

Activity source

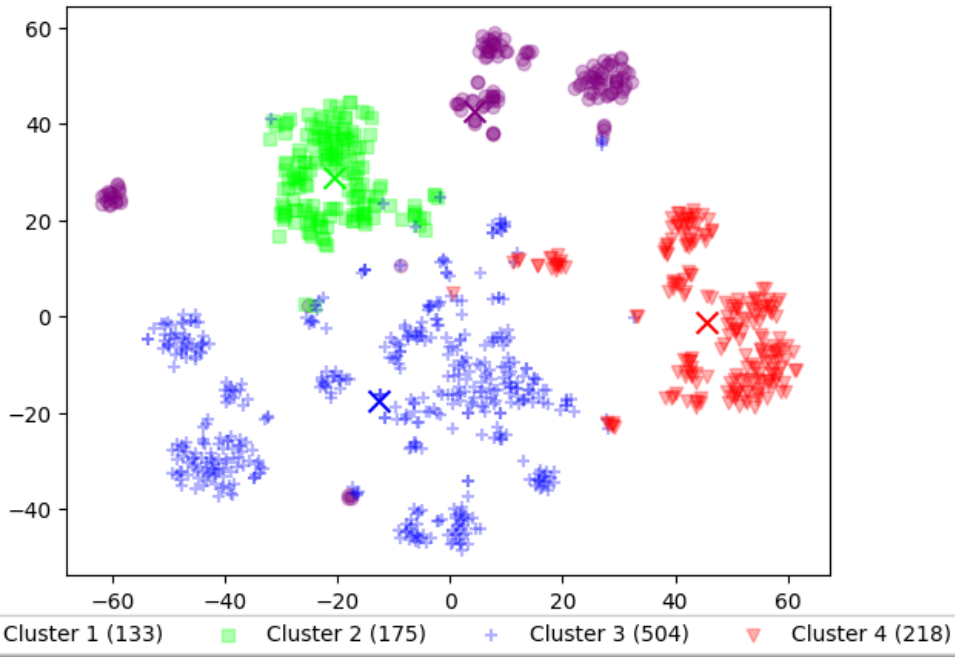
AI Large Language Models (LLM)

- 2018 Google created LLM architecture
- Massive training data invoked more capable LLMs

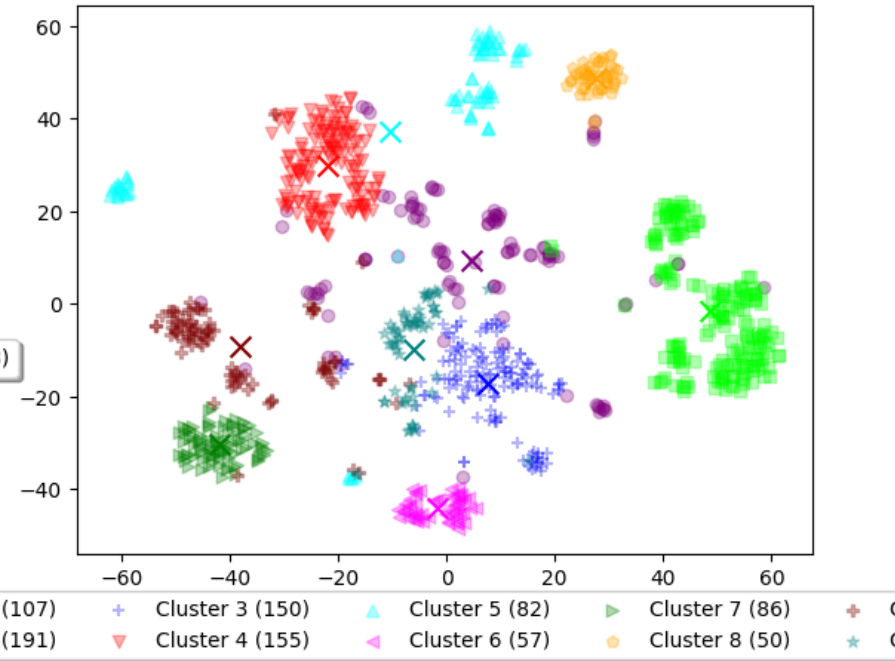


Data Analysis – Clustering with LLM

4 clusters identified in road construction incidents (t-SNE)



10 clusters identified in road construction incidents (t-SNE)



Summarization of Clusters

- * **Cluster 1 Summary:** This category involves incidents that cause injury or harm to employees working in the construction zone. The incidents encompass a wide range of scenarios, including exposure to heat, contact with hot objects or substances, indirect exposure to electricity, explosions, overexertion, exposure to harmful substances or environments, and physical altercations. The focus here is on employee safety measures and training to prevent such incidents.
- * **Cluster 3 Summary:** Incidents in this category involve physical harm or injury to employees and are connected to equipment, machinery, and vehicles commonly used in road construction. Examples include accidents with saws, cranes, backhoes, and dump trucks, where employees may be caught in running equipment or machinery during operation or maintenance. The emphasis is on training, safety protocols, and equipment maintenance to prevent accidents and injuries.

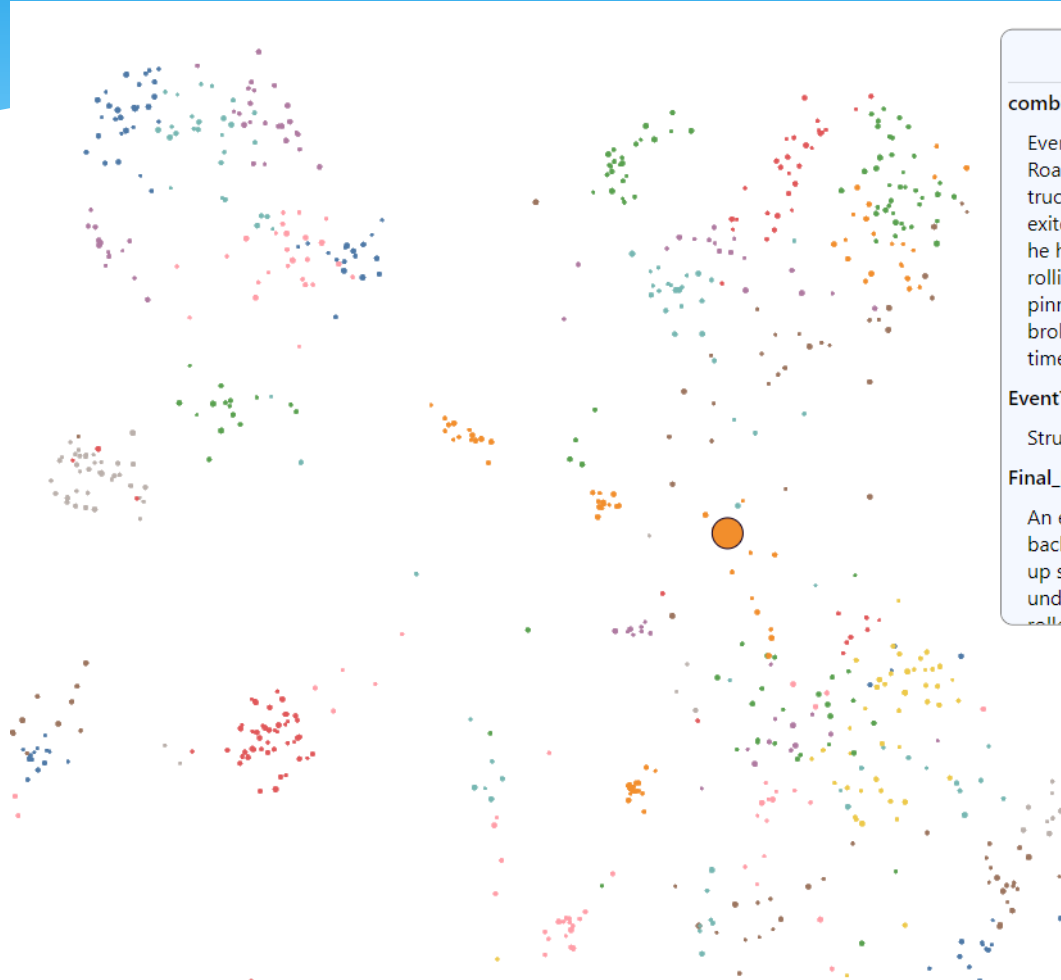
LLM Derived Causes (example)

Cluster 1 top 10 major causes:

1. Contact with hot objects or substances
2. Exposure to environmental heat
3. Indirect exposure to electricity, greater than 220 volts
4. Ignition of vapors, gases, or liquids
5. Vehicle or machinery fire
6. Explosion of pressure vessel, piping, or tire
7. Explosion, n.e.c.
8. Overexertion involving outside sources, unspecified
9. Exposure to harmful substances or environments, unspecified
10. Hitting, kicking, beating, shoving

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Data Discovery- Nomic



combined >

Event Title: Struck or run over by rolling powered vehicle;
Road construction incident: An employee was working on a truck. He was going to back it out of the shop when he exited the truck to hook up something beneath it. When he hooked up the wires under the truck, the truck began rolling backwards and rolled over the employee. He was pinned under the vehicle, suffering head injuries and broken bones. The truck was running and in reverse at the time of the incident.

EventTitle >

Struck or run over by rolling powered vehicle

Final_Narrative >

An employee was working on a truck. He was going to back it out of the shop when he exited the truck to hook up something beneath it. When he hooked up the wires under the truck, the truck began rolling backwards and rolled over the employee. He was pinned under the

Data Discovery- Nomic

heat 500 combined 🔍

Example

- Identified cases related to "heat"

