

Applying artificial intelligence through prompts for choosing mining transport

Aplicación de la inteligencia artificial a través de *promts* para la elección de transporte minero

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Abstract: This research proposes the use of prompt engineering to solve mining transport selection problems through conversational generation. A customized set of prompts applicable to solving mining transport problems at an academic level is established. Parameters such as the use of natural language, clear objectives specification, examples use, and results evaluation were followed to achieve prompts effectiveness. The proposed set of prompts covers a wide range of mining transport problems, enabling problem-solving in this branch.

Keywords: interactive chatbots, mining process optimization, mining productivity

Resumen: En la presente investigación se propone el uso de la ingeniería de instrucción para solucionar, a través de la generación conversacional, problemas de selección de transporte minero. Se establece un conjunto personalizado de *prompts* aplicables a la solución de problemas de transporte minero a nivel académico. Para la efectividad de los *prompts* se siguieron parámetros como uso de lenguaje natural, especificación de objetivos claros, utilización de ejemplos y evaluación de los resultados. El conjunto de *prompts* propuesto cubre una amplia gama de problemas de transporte minero, lo que permite la resolución de problemas en esta rama.

Palabras clave: chatbots interactivos, optimización de procesos mineros, productividad minera

Introduction

The changes humanity has experienced for several years are significant. Just as most of human activity areas have got transformed due to technology and constant development, mining must also evolve and integrate with the on-going transformations and changes.

Mining transport, whether open-pit or underground, is one of mining fundamental pillars and an important activity for company performance. The selection of parameters and the type of transport are vital to achieve optimal mining processes. Arango, Gil & Zapata (2009) point out the application of transport process optimization methods in the mining sector. In Cuba, the most common approach to addressing transport selection problems is the traditional calculations methodology, with the occasional use of softwares.

Artificial intelligence (AI) is defined as the development of algorithms and systems capable of performing tasks that would require human intelligence such as machine learning and decision-making (Alastruey, 2021; Erazo-Luzuriaga *et al.*, 2023; Villagomez, 2025). AI's ability to analyze large volumes of data and learn from them allows engineers to make knowledgeable decisions and adapt designs more quickly and effectively to changing needs (Enríquez *et al.*, 2024; Naula-Flores, Robles-García & Campuzano-Vásquez, 2025).

AI constitutes a wide field of scientific and technological research with the potential to revolutionize engineering, accelerate and change social, economic, technical, and everyday relationships. It is essential for business competitiveness by stimulating operational efficiency and cost reduction through advanced technologies (Sánchez, Lozada & Asmat, 2024). According to Gurbaxani & Dunkle (2019), process automation helps task accuracy and redirects resources towards value-added activities. In this sense, interactive chatbots are economically profitable, generate revenues, and replace administrative and marketing functions in companies (Gordon, 2023).

In the field of mining, the use of AI has improved efficiency in resource extraction optimization (Ramírez, Alegría & Muñoz, 2022; Contreras Medina *et al.*, 2023; Chen, Chung & Correa (2023); Peña Ramírez, Ríos Muñoz y Espinoza Brito (2024). It reduces operational costs and improves workers safety (Romao de Souza, Pedrosa &

Alvarez, 2024). In addition, it favors competitiveness and mineral transport optimization in mining environments (Park & Choi, 2021; Herrera *et al.*, 2025).

According to Zapata, Vélez & Arango (2020), achieving efficient transport activities management requires the development of strategic, tactical, and operational plans while making adequate use of resources such as infrastructure, equipment, and technology. Artificial intelligence shows a gradual trend in transport and logistics management (Santos *et al.*, 2023) and drives predictive models, maximizing operational efficiency (Helmold, 2020).

This research proposes the use of prompt engineering to solve, through conversational generation, mining transport selection problems.

Materials and Methods

A prompt is an instruction or indication provided to a language model to generate a response (Guide, 2023; OpenAI, 2023). Results validity is determined by the way prompts are crafted (De Angelis *et al.*, 2024). To achieve effectiveness of the proposed prompts, parameters such as natural language utilization, clear objectives specification, use of examples, and results evaluation were followed.

To interact with a chatbot, the basis of the conversation, the outcome, the general objectives to be addressed, and the proposed limits are established. The general problem to be solved is formulated as a need, the subject or profession to work on is declared, and an appropriate role that offers a sort of mentorship to the proposer is provided. After establishing this, the specific problem is introduced.

Architecture of a chat aimed at solving mining transport problems

To develop the first prompt, a declaration-of-intent-oriented semantics is recommended, which includes essential initial data such as mine type, initial working data concerning the form of response, and annotations or limitations related to accumulated experience and the exchanges history on the topic dealt.

Initiation or opening prompt

Prompt objective: Preparation for data incorporation.

Mine type: Open-pit mine

Objective: Inserting the data and creating a database

Data: Company, work zone, mineral to be extracted, plant location, daily productivity, exploitation depth, minefield details, number of benches, distance from the face to the trench, loader to be used, mineral extraction method, number of work shifts.

Recommendations: It is important to separate the data with a hyphen, to place a period at the end of each idea, and to highlight important items, such as names, specific data, or any representative symbology (#).

Prompt: Determination of the access type and trench length

The access type depends on the mine characteristics. Taking this group of parameters into account, the best variant should be requested by following the methodology below.

Objective: Determination of access type, trench length

Data: Incorporated a priori into the database

Context: The access type is selected based on the deposit geometric characteristics and the minefield extent.

Where:

i: trench slope; (%)

Lt: trench length. This slope varies between (8 % and 16 %)

H: bench height

Note: if the slope is expressed in %, it must not be multiplied by 100, but if it is expressed in decimals, it is multiplied by 100, i.e., 8 % is not multiplied, but 0.08 or the tangent of the angle is multiplied.

Formula: $Lt = (h/i) * 100$

Recommendations: Formulas must be clear, add an explanatory note for (i), explaining why a value or another is used. In case of having calculation extensions, then data sequence compatibility with the extension call interface must be achieved.

Prompt: Selection of truck type by determining the load capacity

Objectives: Obtaining the real load capacity (qc), expressed in tons, as well as the real load volume (vc), expressed in m³.

Objectives: Finding and calculating (qc), (vc).

Format: Task order

1. Real load capacity
2. Real load volume

Tone: Engineering response

Excavator type: The one used in the mine

Context: the volumetric and load capacity utilization ratio should not be greater than 1.02 to 1.08 times the theoretical capacity. It must be known beforehand the excavator's capacity in m³.

Ve: m³

KII: Filling coefficient 0.7

Ke: Swell factor

g: Material density; t/m³

Formulas:

$$Ve = (E * KII)$$

$$qe = ((E * KII) / Ke) * g$$

Technique: Let's think step by step

Recommendations: The user must provide the model with the corresponding data; if not, they will be requested to manufacturers, or will be located in catalogs, or free access databases. The parameters for the calculation must be sought; to increase its effectiveness, it is advised to apply the step-by-step technique. A solution order must be established as response quality depends on this.

Prompt: Selection of truck type

Objective: Selection of truck type

Format: Task order

1. Bucket capacity
2. Number of buckets

Context: The following proportions between the truck box capacity and the excavator bucket capacity must be met. The proportions to be met are: (3 >nc< 5) or (7 >nc< 9).

nc: Number of buckets

qcc: Theoretical load capacity of the truck box or bed; (t)

vcc: Theoretical or catalog volumetric capacity of the truck; (m³)

Formulas: There are two variants.

$$nc = (qcc)/(qe)$$

$$nc = (vcc/ve)$$

Technique: Let's think step by step.

Recommendations: The step-by-step solution technique can be added to obtain a better response. The result of nc must be presented in whole numbers.

Prompt: Truck selection

Based on the technical characteristics established in the previous step, the model and type of truck to be used are established in the form of a direct question.

General instruction: Propose a truck model.

Objective: Determine the truck model

Tone: Should be an engineering response

Recommendations: Once the prompt is set, it is recommended to choose one model from those provided by the AI. Some limitations are also incorporated to prevent generalization.

Prompt: Selected truck data and/or determination of the actual rock mass in the truck dump body

Truck data are clearly documented in each manufacturer's technical specification sheet and are freely and easily accessible.

Objectives: Obtaining the proposed data and determine the actual rock mass in the truck.

Data:

Truck's curb weight or tare mass (mp); (t)

Theoretical (load and volumetric) capacity of the truck (qcc/vc).

Speed limit (v_{max} 55 km/h).

Truck engine power in KW

Formula: $qcr = nc * qe$

Context: (qcr): is expressed in tons.

Prompt: Determination of the actual load volume in the truck box (vcr)

In this step, (vcr) is calculated, the load capacity use coefficient (Kuq) and the volumetric capacity use coefficient (Kuv) are evaluated.

Structure:

Objective: Determination of the actual load volume in the truck box (vcr).

Context: Using (truck chosen by the engineer), the load capacity's utilization ratio (Kuq) and/or the volumetric capacity's utilization ratio (Kuv) will be evaluated.

Format:

1. Load capacity utilization coefficient (Kuq)
2. Volumetric capacity utilization coefficient (Kuv)
3. Determination of (vcr)

Fórmula: $Kug = qcr/qcc$

$Kuv = vcr/vc$

$Vcr = nc*ve$

Recommendations: It is recommended to propose a question mark at the end of each situation whose answer is unknown.

$Kuv = ?$, $Kug = ?$, $Vcr = ?$

Prompt: Determination of truck productivity knowing the length and transport speed

This step is to determining the productivity of a truck knowing the transport's length and speed. To reach this step, several parameters must be calculated. This prompt will serve as a guide to calculate them.

Objective: Lay the foundations to calculate truck productivity.

Context: Qt , is expressed in T/h.

Where:

$Kut=0.8-0.92$

The availability of the trucks and the utilization of the excavator are considered.

Qcc : theoretical load capacity of the truck bowl or bed

Tv : Truck travel time or cycle time (min)

Qt : Truck productivity, expressed in T/h

Formula: $Q t = ((60 * qcr) / Tv) (*Kut)$

Recommendations: It is important to note that this is a preparation prompt to calculate Tv , a value necessary in the general formula for truck productivity. This limitation must be established so that the AI does not provide wrong data; therefore, an unknown is established in the data it does not have.

Prompt: Determination of truck travel time

To determine the truck travel time, it is necessary first to establish the loading time, loaded travel time, empty travel time, and maneuvering time.

General instruction: To determine the (selected) truck's travel time.

Objective: To calculate T_v

Format: Task order

1. Determine T_c
2. Determine T_{rc}
3. Determine T_{rv}
4. Determine T_d
5. Determine T_m

Formula:

$$T_c = (n_c * t_c) / 60$$

$$T_{rc} = (60 * l_{rc}) / (v_{rc})$$

$$T_{rv} = (60 L_c) / v$$

$$T_m = (T_c + T_d) / 2$$

Context: Determination of unloading time T_d . This varies and one is chosen from (1.5-3 min).

T_c , T_{rc} , T_{rv} , T_m , T_v . All are expressed in minutes.

Technique: Let's think step by step.

Prompt: Truck productivity and the number of trucks needed

Objective: Obtaining Q_t and N_{trucks} .

Format:

- 1- Calculate Q_t
- 2- Calculate N_{trucks}

Context: Truck productivity Q_t . And then, based on the quarry or mine hourly productivity, the number of trucks needed to guarantee the required productivity is determined.

$$\text{Formula: } Q_t = (60 * q_{cr}) / T_v (*K_{ut})$$

$$N_{trucks} = \text{Mine hourly productivity} / Q_t \text{ of the truck}$$

Once the number of trucks needed to transport the mineral is established, the size of the truck fleet must be considered. This is because the fleet size can affect the operation's productivity, costs, and safety.

Comparison of the proposed method and the traditional way of choosing transport for a mine

Tables 1-5 show the results obtained for the selection of mining transport by the traditional method and by applying the use of artificial intelligence.

Table 1. Determination of the access type and the trench length

	Traditional	Chatbot Response
Trench length (m)	80	80
Access type	Successive trenches	Successive trenches with recommendations to use another access type

The load capacity of the excavator (q_e) and the actual load volume were established, guaranteeing the applicable data that were not provided by searching for them in external manufacturer databases (Table 2).

Table 2. Selection of truck type by determining the load capacity

	Traditional	Chatbot Response
Real load capacity (t)	4.63 t	11,91 t
Real load volume (m^3)	3.71 m^3	5,035 m^3

Table 3. Characteristics of the selected truck

	Traditional	Chatbot Response
Number of buckets	4	2,51 \approx 3
Determination of the actual rock mass in the truck box (q_{cr})	18,55 t	35,73 t
Determination of the actual load volume in the truck box (v_{cr})	14.84 m^3	15,105 m^3
Load capacity utilization ratio (K_{uq})	0,74	1,02
Volumetric capacity utilization ratio (K_{uv})	1,037	1,07
Recommended truck	MAZ 525	Volvo A60H

Table 4. Truck productivity and travel time in one cycle

	Traditional	Chatbot Response
Truck productivity (Q_t).	38.051t/h	35,73 t/h
Truck travel time or cycle time (min)	23.2 min	37,17 min
Excavator t_c cycle time (T_c)	3min	1min
Determination of loaded travel time (T_{rc})	7.2 min	15min
Determination of empty travel time (T_{rv})	7.2 min	16,67min
Determination of maneuvering time (T_m)	3 min	1,5 min

Table 5. Number of trucks needed to guarantee productivity

	Traditional	Chatbot Response
Number of trucks	42	18

The proposed method manages to reduce the solution time for mining transport selection to just 10 minutes. When comparing the traditional method and the AI-based resolution method, optimal results are obtained that endorse the use of prompts for this task.

Conclusions

A customized set of prompts applicable to solving mining transport problems has been established.

A logical structure is proposed that takes into account selection criteria, tests, limitations, and operational substitutions. The presented structure allows for progressive advancement in knowledge and skills in the use of prompt engineering, adapting to specific needs and contexts.

The proposed set of prompts covers a wide range of mining transport problems, enabling the development of innovative and creative solutions.

Bibliographic references

- Alastruey, C.F. (2021). Estado de la cuestión de la inteligencia artificial y los sistemas de aprendizaje autónomo. *Sociología y tecnociencia. Revista digital de sociología del sistema tecnocientífico*, 11(2), 182-195. https://doi.org/10.24197/st.Extra_2-2021.182-195
- Arango, M.D., Gil, H., & Zapata, J.A. (2009). Logística esbelta aplicada al transporte en el sector minero. *Boletín de Ciencias de la Tierra*, 25, 121-136. <https://revistas.unal.edu.co/index.php/rbct/article/view10866/>
- Contreras Medina, K.X., Hurtado, E., Lazo, W.J., & Torres, M. M. (2023). *Efecto mediador de la Sostenibilidad en la Inteligencia Artificial y la Optimización de Procesos Mineros* (Master Degree Thesis, Pontificia Universidad Católica del Perú). <http://hdl.handle.net/20.500.12404/24857>
- Chen, C., Chung, E., & Correa, N. (2023). La inteligencia Artificial y su Impacto en la Industria de la Ingeniería. *Revista Especializada en Ingeniería y Ciencias de la Tierra*, 3(1), 2641. <https://doi.org/10.48204/reict.v3n1.3948>

De Angelis, S., Perillo, L., Aubert, E. Cherbavaz, M.C., & Andreoli, S. (2024). Estrategias de enseñanza con IAGen como oportunidades de catalización de la integridad académica. *Trayectorias Universitarias*, 10(19), 1-16. <https://doi.org/10.24215/24690090e169>

Enríquez, P., Lascano, W., Lizano, M., & Altamirano, J. (2024). Ingeniería de diseño y simulación asistida por inteligencia artificial. *Reincisol*, 3(6), 2494-2521. [https://doi.org/10.59282/reincisol.V3\(6\)2494-2521](https://doi.org/10.59282/reincisol.V3(6)2494-2521)

Erazo-Luzuriaga, A.F., Ramos Secaira, F.M., Galarza-Sánchez, P.C. & Boné-Andrade, M. F. (2023). La inteligencia artificial aplicada a la optimización de programas informáticos. *Journal of Economic and Social Science Research*, 3(1), 48-63. <https://doi.org/10.55813/gaea/jessr/v3/n1/61>

Gordon, R.D. (2023). Chatbots e inteligencia artificial: aportes, innovaciones y aplicación en el desarrollo de sistemas de información empresarial. *Visión Antataura*, 7(1), 132-147. <https://doi.org/10.48204/j.vian.v7n1.a3930>

Guide, P. (2023). *Prompt Engineering Guide*. <https://www.promptingguide.ai/es>

Gurbaxani, V. & Dunkle, D. (2019). Gearing up for successful digital transformation. *MIS Quarterly Executive*, 28(6), 209-220. <https://aisel.aisnet.org/misqe/vol18/iss3/6>

Helmold, M. (2020). Lean Management in Operations. In *Lean Management and Kaizen: Fundamentals from Cases and Examples in Operations and Supply Chain Management*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-46981-8_7

Herrera, G., Salcedo, G., Blanco, J., Cabarca, A.D., & Doria, J. (2025). Revisión de Literatura sobre Gestión de la Producción: Tendencias, Desafíos y Oportunidades para la Ingeniería Industrial. *Boletín de Innovación, Logística y Operaciones*, 7(1), 67-79. <https://doi.org/10.17981/bilo.7.1.2025.07>

- Naula-Flores, Z.D., Robles-García, N.Y., & Campuzano-Vásquez, J.A. (2025). La inteligencia artificial en el sector grandes empresas de la provincia de El Oro-Ecuador período 2023-2024. *Portal de la Ciencia*, 6(2), 247-261. <https://doi.org/10.51247/pdlc.v6i2.536>
- OpenAI. (2023). *ChatGPT prompt engineering*. <https://openai.com/blog/chatgpt-prompt-engineering>
- Park, S. & Choi, Y. (2021). Bluetooth beacon-based mine production management application to support ore haulage operations in underground mines. *Sustainability*, 13(4), 2281. <https://doi.org/10.3390/su13042281>
- Peña Ramírez, C., Ríos Muñoz, F., & Espinoza Brito, L. (2024). Pequeños proyectos de empresas contratistas frente a la minería 4.0 en Chile: ¿Cuán riesgosa es la implementación de la Industria 4.0 para ellas? *Revista de gestión tecnológica e innovación*, 19(1), 79-109. <http://dx.doi.org/10.4067/S0718-27242024000100079>
- Ramírez, C.P., Alegría, H., & Muñoz, F.R. (2022). Modelo de análisis de riesgos de contratos en minería ante Industria 4.0. *Journal of Management & Business Studies*, 4(1), 1-16. <https://doi.org/10.32457/jmabs.v4i1.1689>
- Romao de Souza, J., Pedrosa, R., & Alvarez, E. (2024). O impacto da automação na eficiência e segurança das operações de mineração. *Revista Foco*, 17(10), 1-10. <https://doi.org/10.54751/revistafoco.v17n10-138>
- Sánchez, D.S., Lozada, V., & Asmat, G. (2024). Impacto de la inteligencia artificial en la competitividad logística: el megapuerto de Chancay en Perú como conector entre la República Popular China y América Latina. *Revista de Análisis y Difusión de Perspectivas Educativas y Empresariales*, 4(9), 9-28, <https://doi.org/10.56216/radee032024dic.a01>

Santos, K.E., Pilamunga, E.A., Villarreal, D.C. & Ortiz, L.A, (2023). *Integración de tecnologías emergentes en el diseño industrial para una gestión más eficiente del transporte y la logística*. *Polo del Conocimiento*, 8(9), 1204-1218.
<https://doi.org/10.23857/pc.v8i9.6077>

Villagomez, A.H. (2025). El impacto de la inteligencia artificial en la sociedad: Una revisión sistemática de su influencia en Ámbitos Sociales, Económicos y Tecnológicos. *Ciencia Latina Revista Multidisciplinar*, 9(1), 8150-8172.
https://doi.org/10.37811/cl_rcm.v9i1.16468

Zapata, J. A., Vélez, Á. R., & Arango, M.D. (2020). Mejora del proceso de distribución en una empresa de transporte. *Investigación Administrativa*, 49(126).
<https://doi.org/10.35426/iav49n126.08>