Parte 1: creacion de variables, histogramas, kernels y resumen de la base de datos final

In [148…

```
df_04 = pd.read_stata('usu_individual_T104.dta')
df_24 = pd.read_excel('usu_individual_T124.xlsx')

t_df_04 = df_04[df_04['region'] == 'Patagónica']
t_df_24 = df_24[df_24['REGION'] == 44]

t_df_04.columns = t_df_04.columns.str.upper()
t_df_24.columns = t_df_24.columns.str.upper()


df_merged = pd.concat([t_df_04, t_df_24])

df_merged['REGION'] = df_merged['REGION'].replace({44: 'Patagónica'})
df_merged['ESTADO'] = df_merged['ESTADO'].replace({1: 'Ocupado', 2: 'Desocupado', 3
df_merged['CH04'] = df_merged['CH04'].replace({1: 'Varón', 2: 'Mujer'})
df_merged['CH12'] = df_merged['CH12'].replace({1: 'Jardín/Preescolar', 2: 'Primario
df_merged['CH13'] = df_merged['CH13'].replace({1: 'Sí', 2: 'No'})
df_merged['CH14'] = df_merged['CH14'].str.strip()
df_merged['CH14'] = pd.to_numeric(df_merged['CH14'], errors='coerce')

df_merged
```

Out[148…

	CODUSU	NRO_HOGAR	COMPONENTE	H15	ANO4
42025	125122	1.0	1.0	Sí	2004.0
42026	125969	1.0	1.0	Sí	2004.0
42027	125969	1.0	2.0	Sí	2004.0
42028	126757	1.0	1.0	Sí	2004.0
42029	126757	1.0	2.0	Sí	2004.0
...	...	...	...	...	...
46028	TQRMNOQWXHJMKOCDEOHCH00803080	1.0	1	1	2024.0
46029	TQRMNOQWXHJMKOCDEOHCH00803080	1.0	2	1	2024.0
46030	TQRMNOQWXHJMKOCDEOHCH00803080	1.0	3	1	2024.0
46031	TQRMNOQXQHJMKOCDEOHCH00794205	1.0	1	1	2024.0
46032	TQRMNOQXQHJMKOCDEOHCH00794205	1.0	2	1	2024.0

8791 rows × 181 columns

Crear variable edad2 = edad² //edad = edad?

Panel A: Histograma de edad

Panel B: Gráfico de densidad kernel para empleados vs. desempleados

In [149…

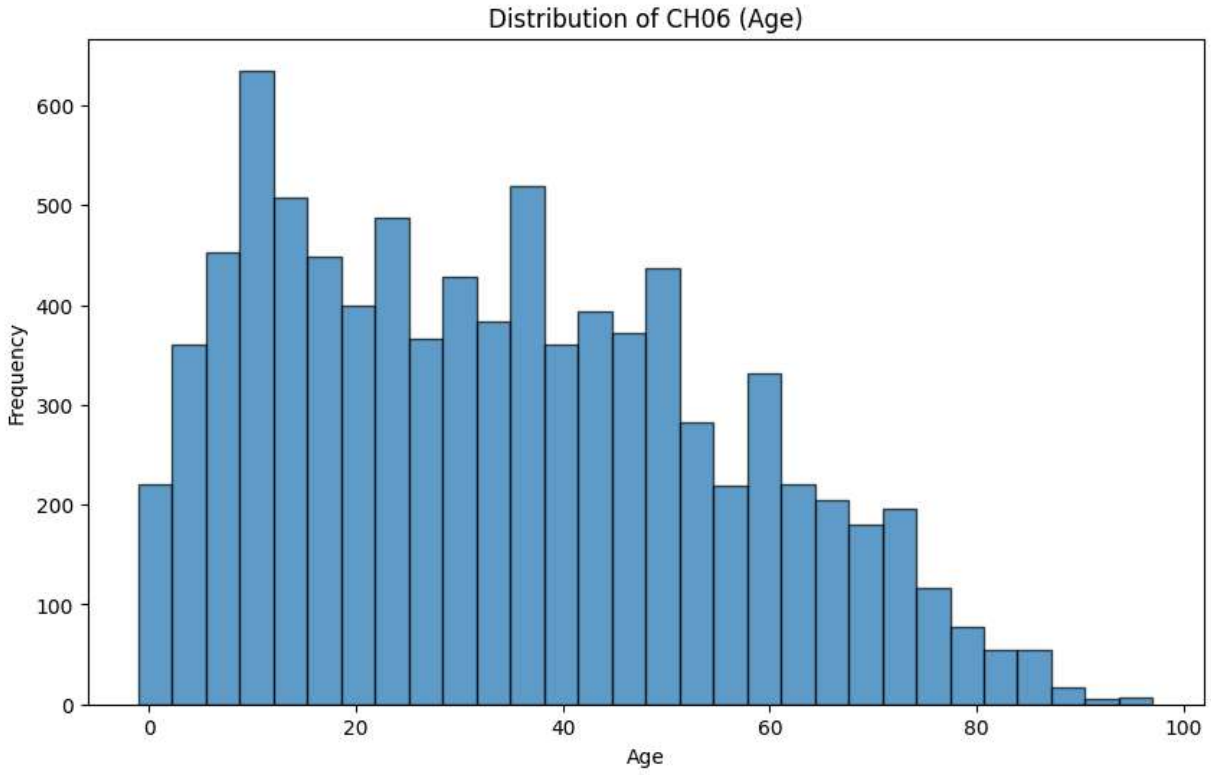
```
#removing extremes
df_merged = df_merged[df_merged['CH06'] != 'Menos de 1 año']
df_merged = df_merged[df_merged['CH06'] != '98 y más años']
```

```
df_merged['CH06'].astype(float)
df_merged['EDAD2'] = df_merged['CH06'].apply(lambda x: x**2)
df_merged['EDAD'] = df_merged['CH06']
```

```
/tmp/ipykernel_40/436315002.py:6: PerformanceWarning: DataFrame is highly fragmente
d.  This is usually the result of calling `frame.insert` many times, which has poor
performance.  Consider joining all columns at once using pd.concat(axis=1) instead.
To get a de-fragmented frame, use `newframe = frame.copy()`
  df_merged['EDAD2'] = df_merged['CH06'].apply(lambda x: x**2)
/tmp/ipykernel_40/436315002.py:7: PerformanceWarning: DataFrame is highly fragmente
d.  This is usually the result of calling `frame.insert` many times, which has poor
performance.  Consider joining all columns at once using pd.concat(axis=1) instead.
To get a de-fragmented frame, use `newframe = frame.copy()`
  df_merged['EDAD'] = df_merged['CH06']
```

In [150…

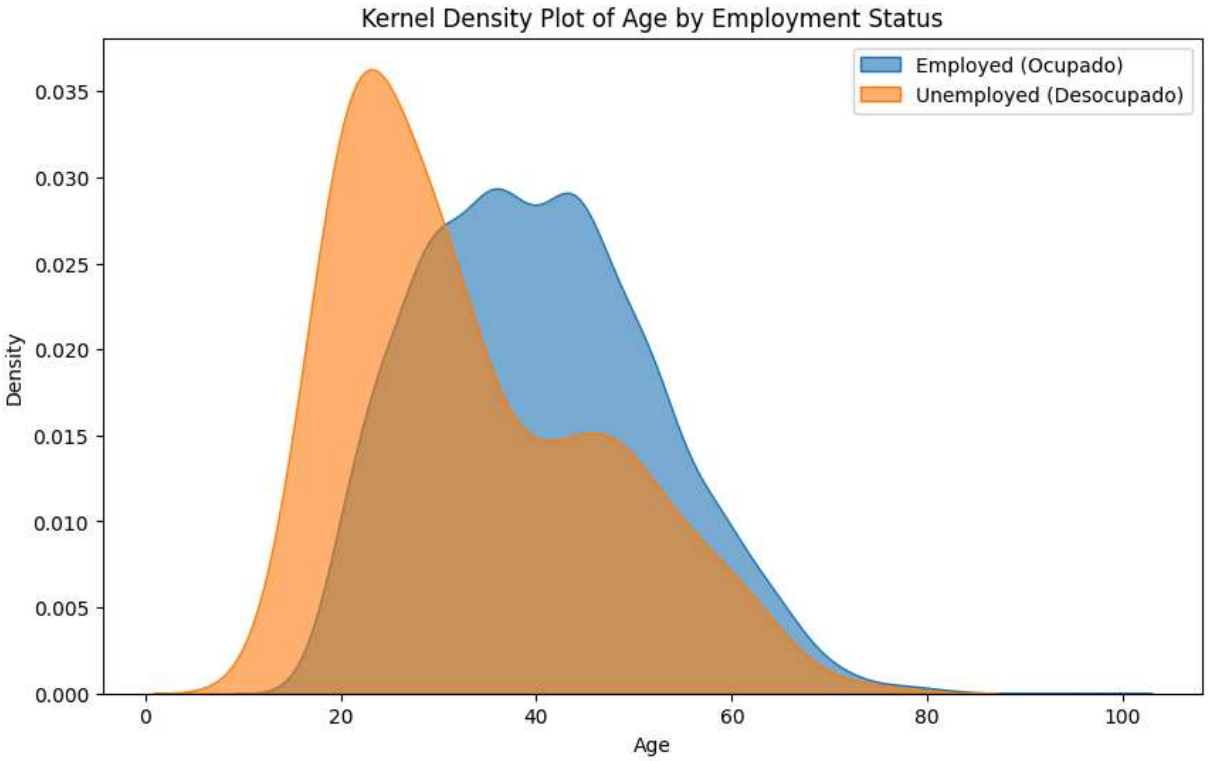
```
plt.figure(figsize=(10, 6))
plt.hist(df_merged['CH06'].dropna(), bins=30, edgecolor='black', alpha=0.7)
plt.title('Distribution of CH06 (Age)')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```



In [151…

```
df_employed_unemployed = df_merged[df_merged['ESTADO'].isin(['Ocupado', 'Desocupado


plt.figure(figsize=(10, 6))
sns.kdeplot(df_employed_unemployed[df_employed_unemployed['ESTADO'] == 'Ocupado']['
            label='Employed (Ocupado)', fill=True, alpha=0.6)
sns.kdeplot(df_employed_unemployed[df_employed_unemployed['ESTADO'] == 'Desocupado'
            label='Unemployed (Desocupado)', fill=True, alpha=0.6)
plt.title('Kernel Density Plot of Age by Employment Status')
```

```
plt.xlabel('Age')
plt.ylabel('Density')
plt.legend()
plt.show()
```



Crear la variable educ como años de educación

Utilice las variables CH12, CH13, CH14 para interpretar el nivel educativo

Ejemplo: Si completó “secundaria” (CH12), “sí” en CH13, el año pasado = 6 → educ = 12

In [152…

```
def calculate_years_of_education(row):
    # Default value if no education
    years = 0


    level = row['CH12']
    completed = row['CH13']
    last_year = row['CH14']


    if pd.isna(level) or level == 0.0:
        return 0


    if isinstance(level, (int, float)):
        level = str(level)


    if level == 'Jardín/Preescolar' or level == '1':
```

```
        years = 0
        if completed == 'Sí' or completed == '1':
            years = 0

    elif level == 'Primario' or level == '2':

        if completed == 'Sí' or completed == '1':
            years = 7
        else:

            years = min(int(last_year), 7) if not pd.isna(last_year) and last_year

    elif level == 'EGB' or level == '3':

        if completed == 'Sí' or completed == '1':
            years = 9
        else:

            years = min(int(last_year), 9) if not pd.isna(last_year) and last_year

    elif level == 'Secundario' or level == '4':

        if completed == 'Sí' or completed == '1':
            years = 12
        else:

            years = 7 + min(int(last_year), 5) if not pd.isna(last_year) and last_y

    elif level == 'Polimodal' or level == '5':

        if completed == 'Sí' or completed == '1':
            years = 12
        else:

            last_polimodal = int(last_year) if not pd.isna(last_year) and last_year
            years = 9 + min(last_polimodal, 3)

    elif level == 'Terciario' or level == '6':

        if completed == 'Sí' or completed == '1':
            years = 15
        else:

            tertiary_years = int(last_year) if notel == '8':

        if completed == 'Sí' or completed == '1':
            years = 19
        else:

            postgrad_years = int(last_year) if not pd.isna(last_year) and last_year
            years = 17 + min(postgrad_years, 2) pd.isna(last_year) and last_year no
            years = 12 + min(tertiary_years, 3)

    elif level == 'Universitario' or level == '7':

        if completed == 'Sí' or completed == '1':
```

```
            years = 17
        else:

            university_years = int(last_year) if not pd.isna(last_year) and last_ye
            years = 12 + min(university_years, 5)

    elif level == 'Posgrado Universitario' or lev

    elif level == 'Educación especial (discapacitado)' or level == '9':

        years = int(last_year) if not pd.isna(last_year) and last_year not in [98,

    return years
```

In [153…
```
df_merged['educ'] = df_merged.apply(calculate_years_of_education, axis=1)
df_merged[['CH12', 'CH13', 'CH14', 'educ']]
```

```
/tmp/ipykernel_40/664819721.py:1: PerformanceWarning: DataFrame is highly fragmente
d.  This is usually the result of calling `frame.insert` many times, which has poor
performance.  Consider joining all columns at once using pd.concat(axis=1) instead.
To get a de-fragmented frame, use `newframe = frame.copy()`
  df_merged['educ'] = df_merged.apply(calculate_years_of_education, axis=1)
```

Out[153…

	CH12	CH13	CH14	educ
42025	Secundario	No	1.0	8
42026	Primario	Sí	NaN	7
42027	Primario	Sí	NaN	7
42028	Secundario	No	3.0	10
42029	Secundario	No	2.0	9
...	...	...	...	...
46028	Universitario	No	NaN	12
46029	Secundario	No	NaN	7
46030	Primario	No	NaN	0
46031	Terciario	Sí	NaN	15
46032	Terciario	Sí	NaN	15

8740 rows × 4 columns

Crear variable salario_semanal = P21 / 40

Límpielo filtrando valores poco realistas

Crear estadísticas descriptivas (media, desviación estándar, mínima, p50, máxima)

In [154…
```
df_merged['salario_semanal'] = df_merged['P21'] / 40
```

```
df_merged = df_merged[(df_merged['salario_semanal'] > 0)] # filter out negative and

df_merged['salario_semanal'].describe()
```

```
/tmp/ipykernel_40/4144347529.py:2: PerformanceWarning: DataFrame is highly fragmente
d.  This is usually the result of calling `frame.insert` many times, which has poor
performance.  Consider joining all columns at once using pd.concat(axis=1) instead.
To get a de-fragmented frame, use `newframe = frame.copy()`
  df_merged['salario_semanal'] = df_merged['P21'] / 40
```

Out[154…

```
count      3233.000000
mean       6809.690094
std        9601.973100
min           0.500000
25%          23.500000
50%        5000.000000
75%       10000.000000
max      250000.000000
Name: salario_semanal, dtype: float64
```

Crear variable horastrab = total de horas trabajadas

Suma de PP3E_TOT + PP3F_TOT

Proporcionar estadísticas descriptivas

In [162…

```
df_merged['horastrab'] = df_merged['PP3E_TOT'] + df_merged['PP3F_TOT']
df_merged['horastrab'].describe()
```

```
/tmp/ipykernel_40/1070884795.py:1: PerformanceWarning: DataFrame is highly fragmente
d.  This is usually the result of calling `frame.insert` many times, which has poor
performance.  Consider joining all columns at once using pd.concat(axis=1) instead.
To get a de-fragmented frame, use `newframe = frame.copy()`
  df_merged['horastrab'] = df_merged['PP3E_TOT'] + df_merged['PP3F_TOT']
```

Out[162…

```
count    3233.000000
mean       37.423755
std        19.692637
min         0.000000
25%        25.000000
50%        40.000000
75%        48.000000
max       126.000000
Name: horastrab, dtype: float64
```

Calcular el tamaño del conjunto de datos por región

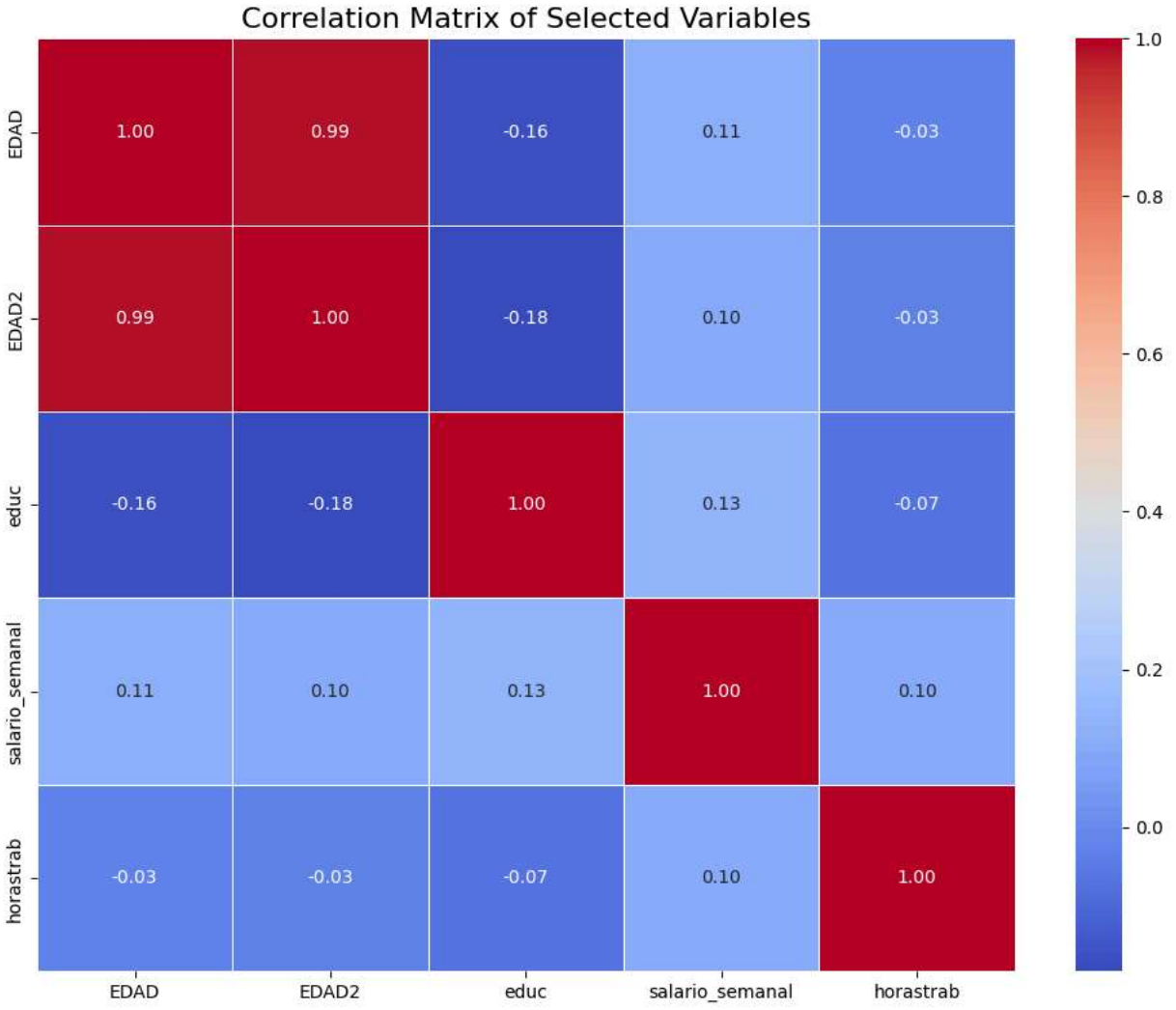
Completar la Tabla 1: recuento de observaciones en 2004/2024, valores faltantes, número de variables limpias

Parte II: Métodos No Supervisados

Crear matriz de correlación con:

edad, edad2, educ, salario_semanal, horastrab

In [165…
```
variables = ['EDAD', 'EDAD2', 'educ', 'salario_semanal', 'horastrab']
correlation_matrix = df_merged[variables].corr()


plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f', linewidths=
plt.title('Correlation Matrix of Selected Variables', fontsize=16)
plt.tight_layout()
plt.show()
```



Aplicar PCA a las 5 variables

Estandarizarlas primero

Mostrar el primer y segundo componente

In [168…
```
X = df_merged[variables].copy()
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

```
pca = PCA()
principal_components = pca.fit_transform(X_scaled)


pca_df = pd.DataFrame(data=principal_components[:, 0:2],
                      columns=['PC1', 'PC2'])


print("\nComponent loadings (variable contributions):")
component_loadings = pd.DataFrame(
    pca.components_.T,
    columns=[f'PC{i+1}' for i in range(pca.n_components_)],
    index=variables
)
print(component_loadings.iloc[:, 0:2])  # Show only first two components
```

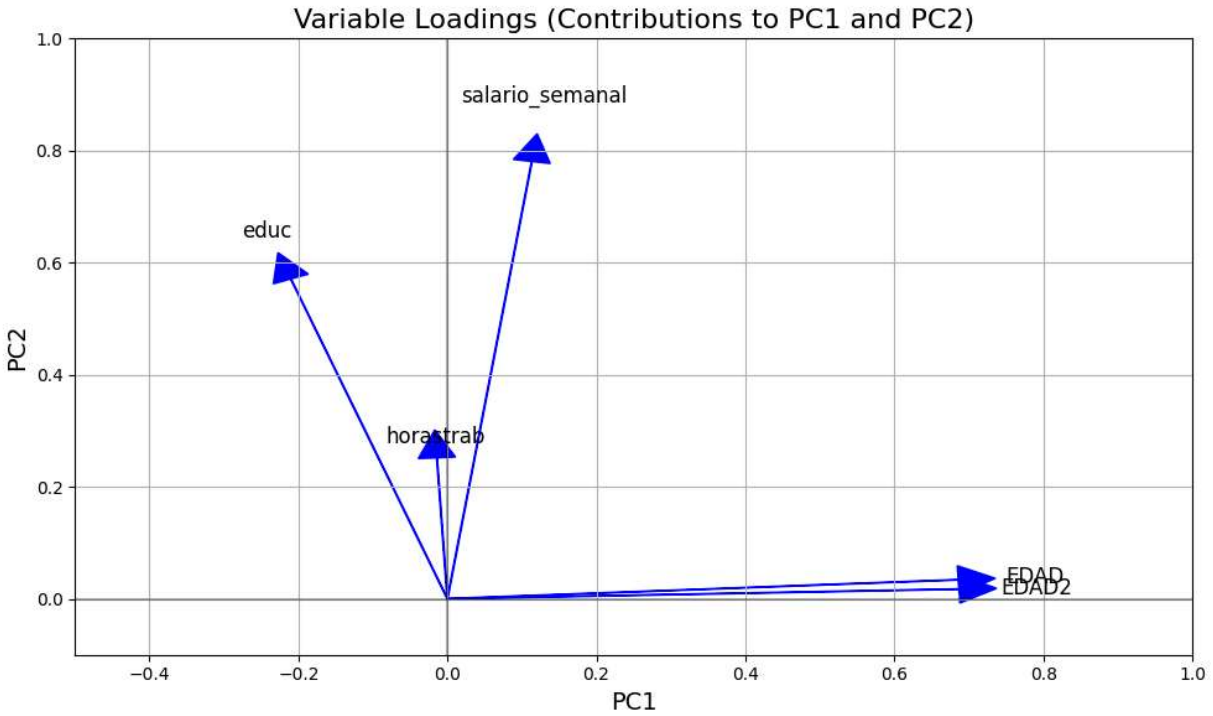
```
Component loadings (variable contributions):
                     PC1       PC2
EDAD            0.685813  0.033926
EDAD2           0.687339  0.017262
educ           -0.210222  0.570894
salario_semanal  0.113287  0.780569
horastrab      -0.014088  0.251680
```

Cargas gráficas (contribuciones de las variables a los componentes)

In [186…

```
plt.figure(figsize=(10, 8))
loading_matrix = pd.DataFrame(
    pca.components_.T,
    columns=[f'PC{i+1}' for i in range(pca.n_components_)],
    index=variables
)


plt.figure(figsize=(10, 6))
for i, var in enumerate(variables):
    plt.arrow(0, 0, loading_matrix.iloc[i, 0], loading_matrix.iloc[i, 1],
              head_width=0.05, head_length=0.05, fc='blue', ec='blue')
    plt.text(loading_matrix.iloc[i, 0]*1.15, loading_matrix.iloc[i, 1]*1.15,
             var, color='black', ha='center', va='center', fontsize=12)

plt.grid(True)
plt.axhline(y=0, color='k', linestyle='-', alpha=0.3)
plt.axvline(x=0, color='k', linestyle='-', alpha=0.3)
plt.xlim(-0.5, 1)
plt.ylim(-0.1, 1)
plt.xlabel('PC1', fontsize=14)
plt.ylabel('PC2', fontsize=14)
plt.title('Variable Loadings (Contributions to PC1 and PC2)', fontsize=16)
plt.tight_layout()
plt.show()
```

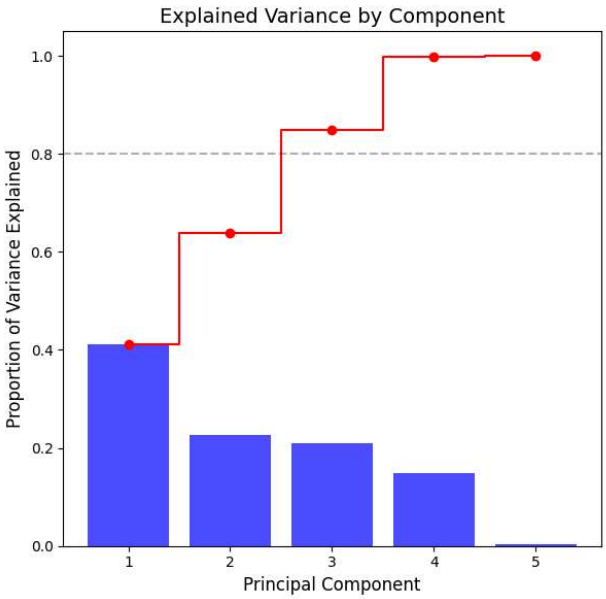
```
<Figure size 1000x800 with 0 Axes>
```

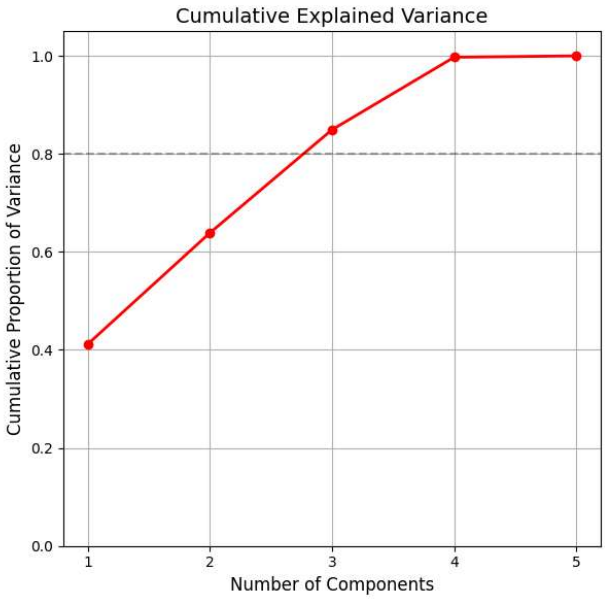


Grafique la proporción de varianza explicada por componente

In [189…

```
plt.figure(figsize=(12, 6))


plt.subplot(1, 2, 1)
plt.bar(range(1, len(explained_variance) + 1), explained_variance, alpha=0.7, color
plt.step(range(1, len(explained_variance) + 1), cumulative_variance, where='mid', c
plt.axhline(y=0.8, color='k', linestyle='--', alpha=0.3)
plt.title('Explained Variance by Component', fontsize=14)
plt.xlabel('Principal Component', fontsize=12)
plt.ylabel('Proportion of Variance Explained', fontsize=12)
plt.xticks(range(1, len(explained_variance) + 1))
plt.ylim(0, 1.05)


plt.subplot(1, 2, 2)
plt.plot(range(1, len(explained_variance) + 1), cumulative_variance, 'o-', linewidt
plt.title('Cumulative Explained Variance', fontsize=14)
plt.xlabel('Number of Components', fontsize=12)
plt.ylabel('Cumulative Proportion of Variance', fontsize=12)
plt.xticks(range(1, len(explained_variance) + 1))
plt.axhline(y=0.8, color='k', linestyle='--', alpha=0.3)
plt.grid(True)
plt.ylim(0, 1.05)

plt.tight_layout()
plt.show()
```





Clustering

Algoritmo K-medias:

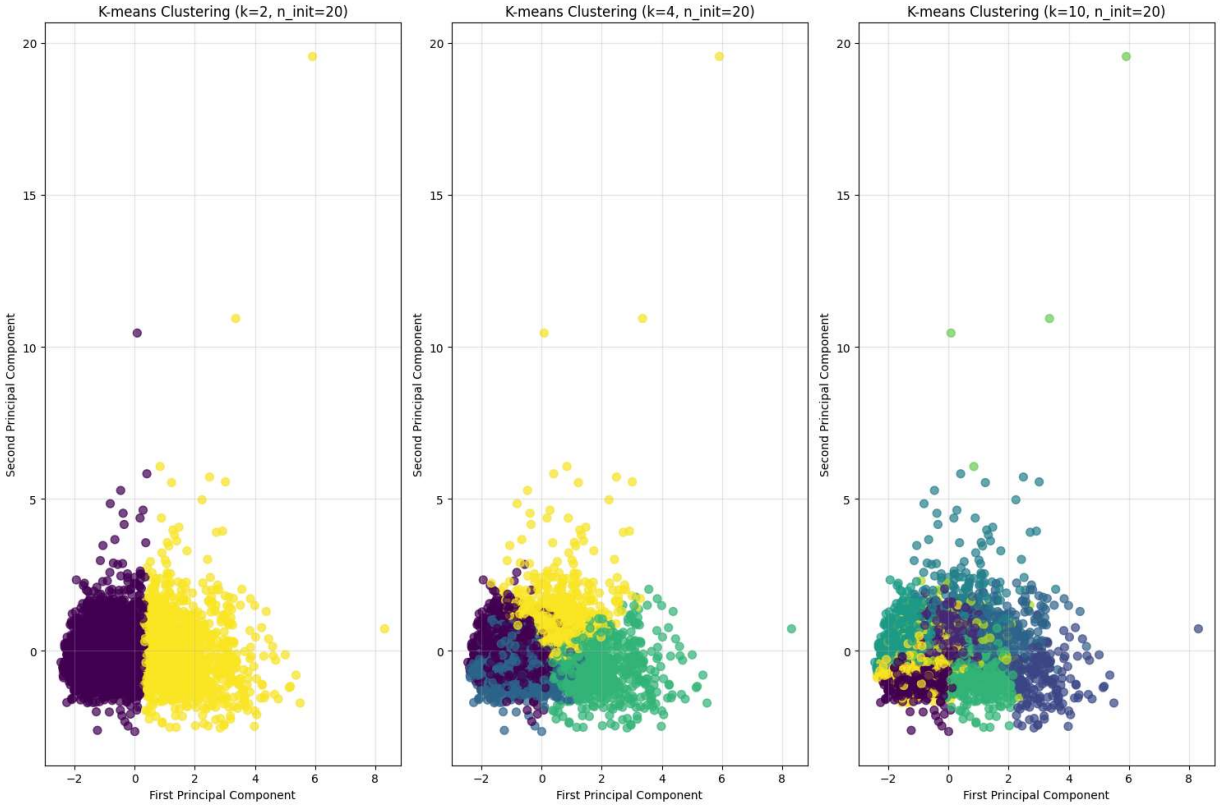
Run con k = 2, 4, 10 y n_init = 20

Graficar los resultados con 2 predictores e interpretarlos

In [198…

```
X = df_merged[variables].copy()
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)



pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_scaled)


k_values = [2, 4, 10]


plt.figure(figsize=(15, 10))
for i, k in enumerate(k_values):

    kmeans = KMeans(n_clusters=k, n_init=20, random_state=42)
    labels = kmeans.fit_predict(X_scaled)


    if k == 2:
        kmeans_k2_labels = labels


    plt.subplot(1, 3, i+1)
    plt.scatter(X_pca[:, 0], X_pca[:, 1], c=labels, cmap='viridis', s=50, alpha=0.7
    plt.title(f'K-means Clustering (k={k}, n_init=20)')
```

```
    plt.xlabel('First Principal Component')
    plt.ylabel('Second Principal Component')
    plt.grid(alpha=0.3)

plt.tight_layout()
plt.show()
```



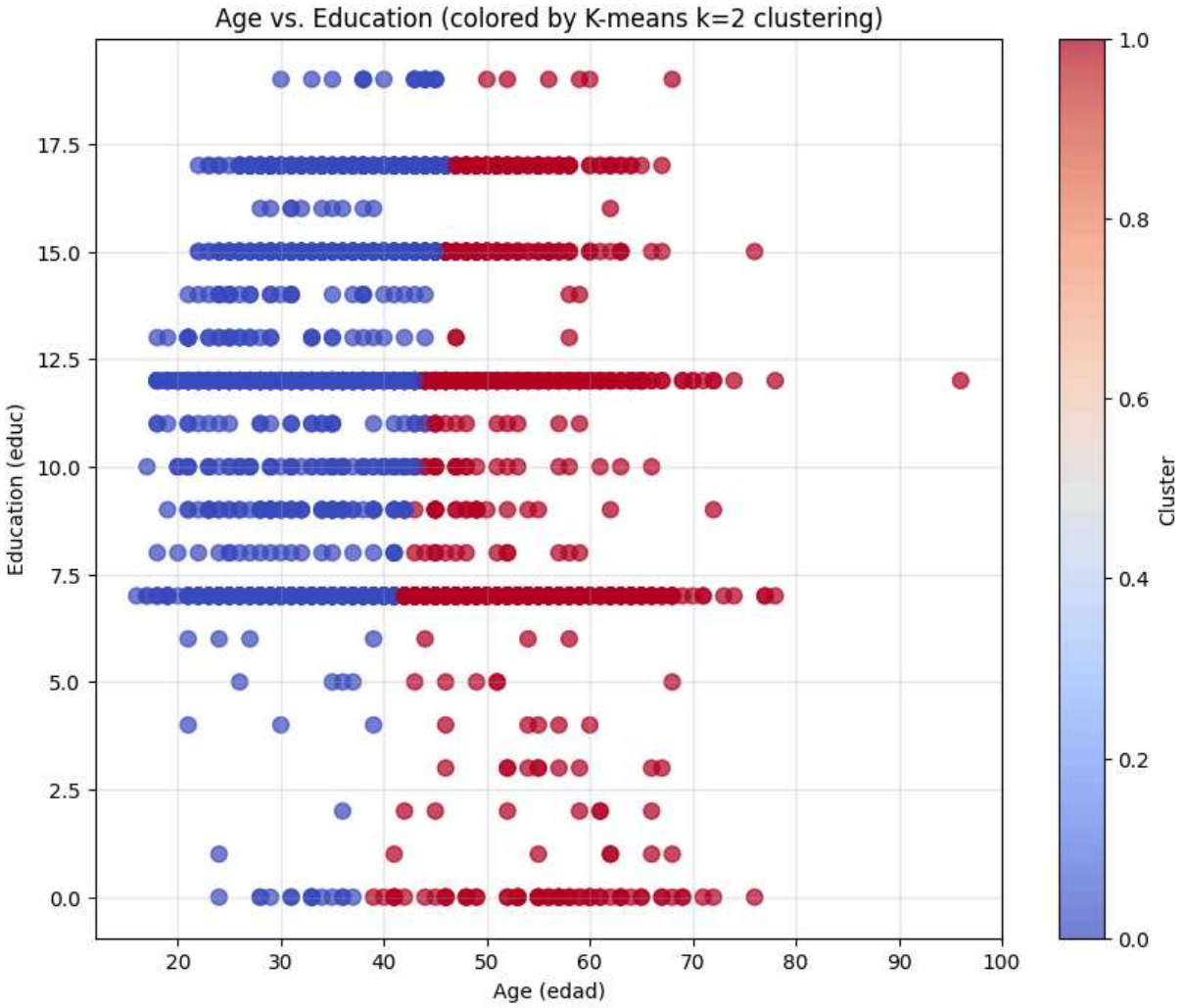
Representación gráfica de la edad frente a la educación con resultados k = 2

Utilice el color para empleados/desempleados

Evaluar si la agrupación las separó bien

In [210…

```
plt.figure(figsize=(10, 8))

plt.scatter(df_merged['EDAD'], df_merged['educ'], c=kmeans_k2_labels,
            cmap='coolwarm', alpha=0.7, s=60)
plt.title('Age vs. Education (colored by K-means k=2 clustering)')
plt.xlabel('Age (edad)')
plt.ylabel('Education (educ)')
plt.grid(alpha=0.3)
plt.colorbar(label='Cluster')
plt.show()
```



Agrupamiento jerárquico:

Usa las mismas variables

Crear e interpretar un dendrograma

In [213…

```
Z = linkage(X_scaled, method='ward')


plt.figure(figsize=(12, 8))
plt.title('Hierarchical Clustering Dendrogram')
plt.xlabel('Sample index')
plt.ylabel('Distance')


if X_scaled.shape[0] > 100:
    dendrogram(
        Z,
        truncate_mode='lastp',
        p=30,
        leaf_rotation=90.,
        leaf_font_size=12.,
        show_contracted=True
```

```
    )
else:
    dendrogram(Z)

plt.tight_layout()
plt.show()
```