Pragmatic comparison of constructive cost-effective models on an AI based Image manipulation application.

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Abstract:

Developing Artificial Intelligence (AI) based applications can be a challenging and costly process for companies, as it can be difficult to accurately predict the cost of creating such applications. Many organizations find that they go over their allocated budget while developing AI applications, which can be a significant issue. To address this problem, this research paper aims to delve into the creation of a practical and cost-effective model for AI application development. The goal of this model is to provide a reference for future development teams, so they can better anticipate the cost of their AI projects and make more informed decisions about their development process.

To illustrate the usefulness of this model, we will take an example of an AI application and apply various cost-effective models to it. This will allow us to provide a practical cost estimate for the development lifecycle of the AI application. By following the guidelines outlined in this paper, companies can effectively plan their budgets and resources when developing a new AI application, as they will have a prior understanding of the expected cost based on the case study project discussed in the research. Overall, this research paper aims to provide a helpful resource for organizations looking to effectively develop AI applications by providing a cost-effective model for planning and budgeting purposes.

Application overview:

The project will be a complete platform where users can register for an account by signing in. After successfully registering, they will be able to use the Neural Style Transfer technique for image manipulation. Firstly, they will provide a content image (an image on which the style will be eventually transferred) and a style reference (whose style will be applied on the content image). For Style Reference, they can either specify their own style reference or they can also use any of the platform provided style presets which will be based on different artists and themes.

These two images will be sent to the NST model to analyze the style and content of both images and generate a new image that combines the content of the first image with the style of the second image. The stylized image, generated by the model will a merger of both content and style reference images having style features of the style refence to be mapped on the user provided content image.

Furthermore, the platform will provide additional feature such as creation of artwork galleries which could be edited, deleted and renamed. The platform will provide the sharing feature to the users so that they can share their artwork and gallery with others on the social platforms like Twitter, WhatsApp and Facebook.

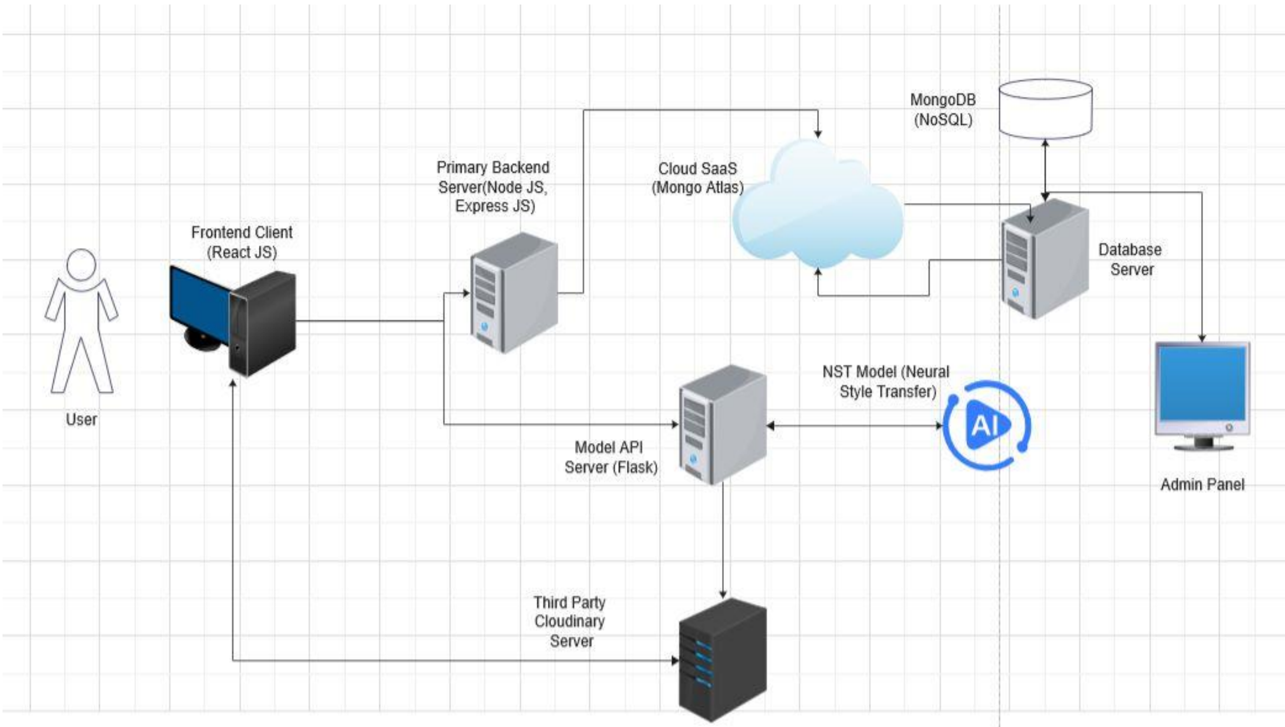

Figure 1 Software Architecture of AI based application

Application Description:

A Research based Project with estimated 400 KLOC was developed. It was a Product based Project with high product complexity, very high memory constraints due to Machine learning model training, high Programming Language and Frameworks experience and Nominal use of Software Tools. Identify the efforts, development time, average staff size and productivity of the newly programmed software.

Software Project Type	a		b		c	d
	B	I	B	I		
Organic	2.4	3.2	1.05	1.05	2.5	0.38
Semi-detached	3.0	3.0	1.12	1.12	2.5	0.35
Embedded	3.6	2.8	1.20	1.20	2.5	0.32

Figure 1: Coefficients for Basic & Intermediate CoCoMo

Approximation with COCOMO (Basic)

Firstly, lets calculate the projected price for this project using CoCoMo 1- basic:

The effort can be calculated using the formulae:

$E = a\ (KLOC)^{b}$

Using the coefficient values of our project in above formulae, it calculated out to be 3712 PM

$E = 2.8 * (400)^{1.2}$

E = 3712 PM

The Development time can be calculated using the formulae:

$D = c * (E)^{d}$

Using the coefficient values of our project in above formulae, it calculated out to be 34.7 Months

$D = 2.5 * (3712)^{0.32}$
D = 34.7 Months

The Staff size required for the execution and completion of this project is calculated using the following formulae:

SS = E/D

Using the calculated value of effort and development time form above calculations we can calculate the required staff size for this project to be 107 persons:

SS = 3712/34.7
SS = 107 Persons

Finally, the productivity involved in this project can be calculated by these formulae:

P = KLOC/E

Using the calculated value of effort form above calculations we can calculate the required staff size for this project using the KLOC to be 0.108 KLOC/PM:

P = 400/3712

P = 0.108 KLOC/PM

Surmising of expenses with COCOMO (Intermediate)

Cocomo1 intermediate is actually Cocomo1 basic but with EAF (Effort Adjustment Factors).

Cost Drivers	Ratings					
	Very Low	Low	Nominal	High	Very High	Extra High
Product attributes						
Required software reliability	0.75	0.88	1.00	1.15	1.40	
Size of application database		0.94	1.00	1.08	1.16	
Complexity of the product	0.70	0.85	1.00	1.15	1.30	1.65
Hardware attributes						
Run-time performance constraints			1.00	1.11	1.30	1.66
Memory constraints			1.00	1.06	1.21	1.56
Volatility of the virtual machine environment		0.87	1.00	1.15	1.30	
Required turnabout time		0.87	1.00	1.07	1.15	
Personnel attributes						
Analyst capability	1.46	1.19	1.00	0.86	0.71	
Applications experience	1.29	1.13	1.00	0.91	0.82	
Software engineer capability	1.42	1.17	1.00	0.86	0.70	
Virtual machine experience	1.21	1.10	1.00	0.90		
Programming language experience	1.14	1.07	1.00	0.95		
Project attributes						
Application of software engineering methods	1.24	1.10	1.00	0.91	0.82	
Use of software tools	1.24	1.10	1.00	0.91	0.83	
Required development schedule	1.23	1.08	1.00	1.04	1.10	

Figure 2 Cost Drivers for Effort Calculation

Since this project has 400 KLOC, it will be an embedded system with Co-efficient values as:

a = 2.80, b = 1.20, c = 2.50, d = 0.32

The effort adjustment factors according to our Project are: High Complexity (1.15), Very High Memory Constraints (1.21), High Programming Language Experience (0.95), Nominal use of Software Tools (1.00). These product of these effort adjustments factors gives us the final amount of EAF which in our case is calculated to be 1.32.

The effort can be calculated using the formulae:

$$E = a\ (KLOC)^{b} * EAF$$

Using the coefficient values of our project in above formulae, it calculated out to be 4900PM

$$E = 2.8 * (400)^{1.2} * 1.32$$

$$E = 4900\ PM$$

The effort can be calculated using the formulae:

$$D = c * (E)^{d}$$

Using the coefficient values of our project in above formulae, it calculated out to be 37.91 Months

$$D = 2.5 * (4900)^{0.32}$$
$$D = 37.91\ Months$$

The Staff size required for the execution and completion of this project is calculated using the following formulae:

$$SS = E/D$$

Using the calculated value of effort and development time form above calculations we can calculate the required staff size for this project to be 130 persons:

$$SS = 4900/37.91$$
$$SS = 129.25$$
$$SS = 130\ Persons$$

Finally, the productivity involved in this project can be calculated by these formulae:

$$P = KLOC/E$$

Using the calculated value of effort form above calculations we can calculate the required staff size for this project using the KLOC to be 0.082 KLOC/PM:

$$P = 400/4900$$
$$P = 0.082\ KLOC/PM$$

Deductive estimation of COCOMO (Detailed)

CoCoMo 1 – Detailed is an extension of CoCoMo 1-intermediate in which we calculate Effort and schedule fractions in each phase of project lifecycle:

Effort and schedule fractions occurring in each phase of lifecycle

Mode and code size	Plan and requirement	System design	Detail design	Module code and test	Integration and test
Lifecycle Phase Value of μ_b					
Organic Small S ≈ 2	0.06	0.16	0.26	0.42	0.16
Organic Medium S ≈ 32	0.06	0.16	0.24	0.38	0.22
Semidetached Medium S ≈ 32	0.07	0.17	0.25	0.33	0.25
Semidetached Large S ≈ 128	0.07	0.17	0.24	0.31	0.28
Embedded Large S ≈ 128	0.08	0.18	0.25	0.26	0.31
Embedded Extra Large S ≈ 320	0.08	0.18	0.24	0.24	0.34
Lifecycle Phase Value of $\sqcup_b$					
Organic Small S ≈ 2	0.10	0.19	0.24	0.39	0.18
Organic Medium S ≈ 32	0.12	0.19	0.21	0.34	0.26
Semidetached Medium S ≈ 32	0.20	0.26	0.21	0.27	0.26
Semidetached Large S ≈ 128	0.22	0.27	0.19	0.25	0.29
Embedded Large S ≈ 128	0.36	0.36	0.18	0.18	0.28
Embedded Extra Large S ≈ 320	0.40	0.38	0.16	0.16	0.30

Figure 3 Effort and schedule fractions in each phase of project lifecycle

In detailed CoCoMo we first calculate the intermediate CoCoMo, then we assess the impact of cost drivers in each phase of project lifecycle.

So, the Effort and Development Time will become different as in case of CoCoMo-intermediate, which was Effort (4900 PM) and Development Time (37.91 Months).

Now Effort will be calculated as:

$$E_p \text{ (Total Effort)} = \mu_p * E$$

$$E_p = 0.08 * 4900$$

and Development time will be calculated as:

$$D_p \text{ (Total Development Time)} = \tau_p * D$$

$$D_p = 0.40 * 37.91$$

Analysis of impact with COCOMO II:

COCOMO II is basically a revised and more effective version of COCOMO I. There are three stages of COCOMO II Stage 1,2 and 3 which are used for estimation during the early prototyping, early designing and post architecture stage of the project respectively.

Now let's apply COCOMO II Model to our FYP which is at the early designing stage.

The complexity and reliability of the project is high, so its value is taken as 1.33

Personnel Capability is low, so its value is taken as 1.00

Personnel Experience is low, so its value is taken as 1.12

Schedule Pressure is high, so its value is taken as 1.00

Effort can be calculated using the following formula.

Effort = Constant * (size)^ Scale Factors * Effort Multipliers

Let that constant be 2.4

Now the value of effort Multipliers can be calculated by multiplying all the effort multipliers. So,

*Effort Multipliers = 1.33*1.00*1.12*1.00*

Effort Multipliers=1.4869

Scale factors =0.91+0.01 [sum of Scale Factors]*

Scale Factor	CMM Level 1 (Lower)	CMM Level 1 (Upper)	CMM Level 2	CMM Level 3	CMM Level 4	CMM Level 5
	VL	L	N	H	VH	EH
Precedentedness (PREC)	6.2	4.96	3.72	2.48	1.24	0.00
Development Flexibility (FLEX)	5.07	4.05	3.04	2.03	1.01	0.00
Risk Resolution (RESL)	7.07	5.65	4.24	2.83	1.41	0.00
Team Cohesion (TEAM)	5.48	4.38	3.29	2.19	1.10	0.00
Process Maturity (PMAT)	7.80	6.24	4.68	3.12	1.56	0.00

Sum of scale factors= 0.02+0.02 +0.03+0.04

Sum of scale factors= 0.11

*Scale factors =0.91+(0.01*0.11)*

Scale factors=0.91+0.0011

Scale factors=0.9111

*Effort =2.4(400) ^ 0.911*1.4869*

Effort=838.655

In conclusion, this research paper has presented a case study on the development of an AI based application and applied various cost estimation models to it. By comparing the results of these models, including the well-known CoCoMo model, we have provided a practical and cost-effective approach for companies to plan and budget their AI application development projects. The results of this study demonstrate that there is no one-size-fits-all solution for cost estimation in AI projects, and it is important for organizations to consider a range of models to get a more accurate estimate. By following the guidelines outlined in this paper, companies can better anticipate the cost of their AI projects and make more informed decisions about their development process.