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WEB FORM PAGE IN MOBILE DEVICES:

OPTIMIZATION OF LAYOUT WITH A SIMPLE GENETIC ALGORITHM

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WEB FORM PAGE IN MOBILE DEVICES

- Context
  - *"A well–designed form is barely noticeable. But does not mean the design process is".* [Wroblewski, L.: Web Form Design: Filling in the Blanks (2008)]
  - *The importance of being usable*:
    - A usable interface brings many benefits: users are able and willing to use the various features and services supplied by the operators, the need for customer support decreases, and above all, user satisfaction improves.
  - Considering a mobile device: The display size represents one of the main constraints in designing and organizing interface elements. Some designer's issues:
    - Selecting the proper number and typology of elements
    - How to arrange them and splitting them in two or more pages.
- Aim
  - Starting from the screen size, the semantic relations between fields and past user interactions, a Genetic Algorithm optimizes the fields distribution on the screen.
- Real-world applications
  - e-commerce application
  - On-line form (registration form, payment form, on-line money order,…)

Designing and Optimizing a Form

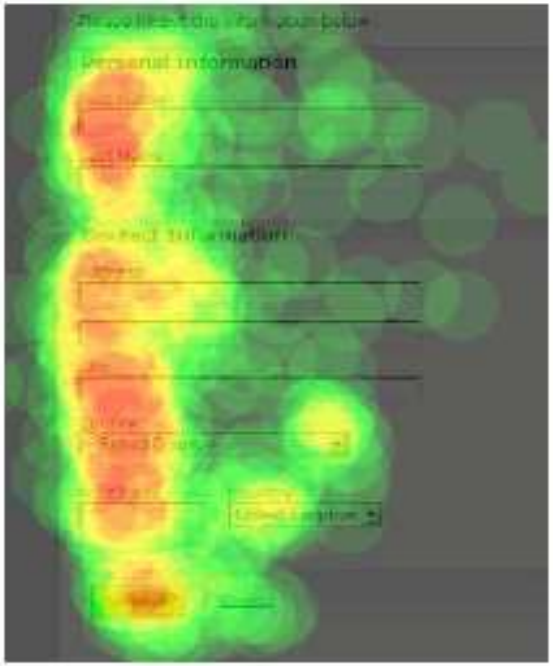
- Designers have to consider many aspects including:
  - How effectively functionalities are retrieved and activated
  - What standard guidelines suggest (Mobile Web Best Practices)
  - What are the preferences of users and how improve usability

- These aspects are often conflicting and make menu system design a combinatorial optimization problem as it depends on the arrangement of each field in different positions onto the different pages

- In our work we show the application of GA as a viable approach to arrange the field in a form

Heuristics

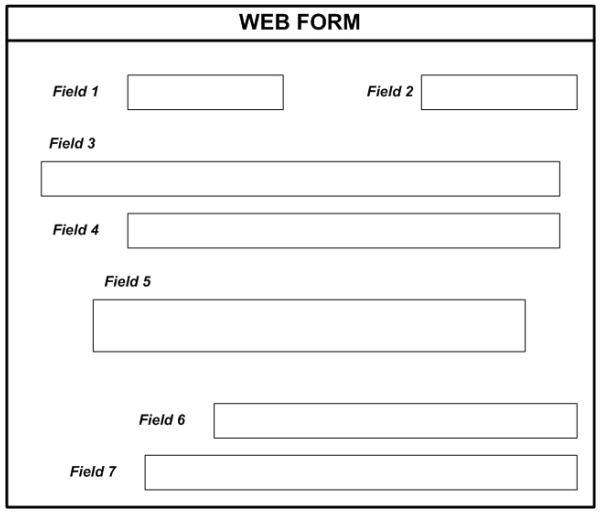
- A typical web form and its heat map (Wroblewski,2008)
  - Heat maps and fixations are analyzed in order to better understand which factors affect usability

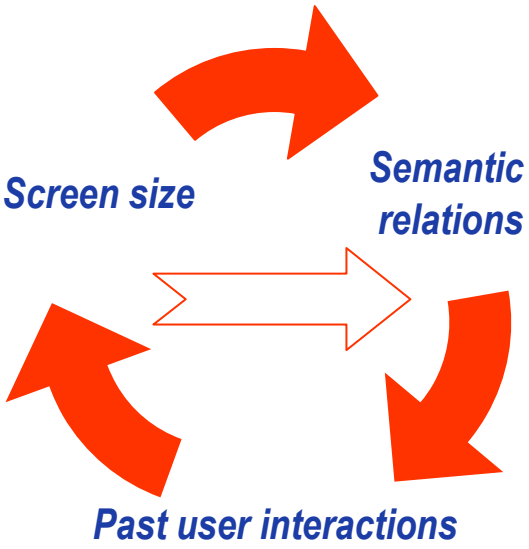


- An excessive distance between labels and the related input fields requires more time to users for completing the form.
- Labels on the top of fields allow the user to capture both labels and input fields with a single eye movement, entailing a lower completion time

Aim

- Visualization Problem: Exceeding dimension
  - A typical usability issue consists in a form exceeding the display height so the user is forced to scroll vertically the whole page in order to fill out the form
- Focus: Organize automatically the form in different pages



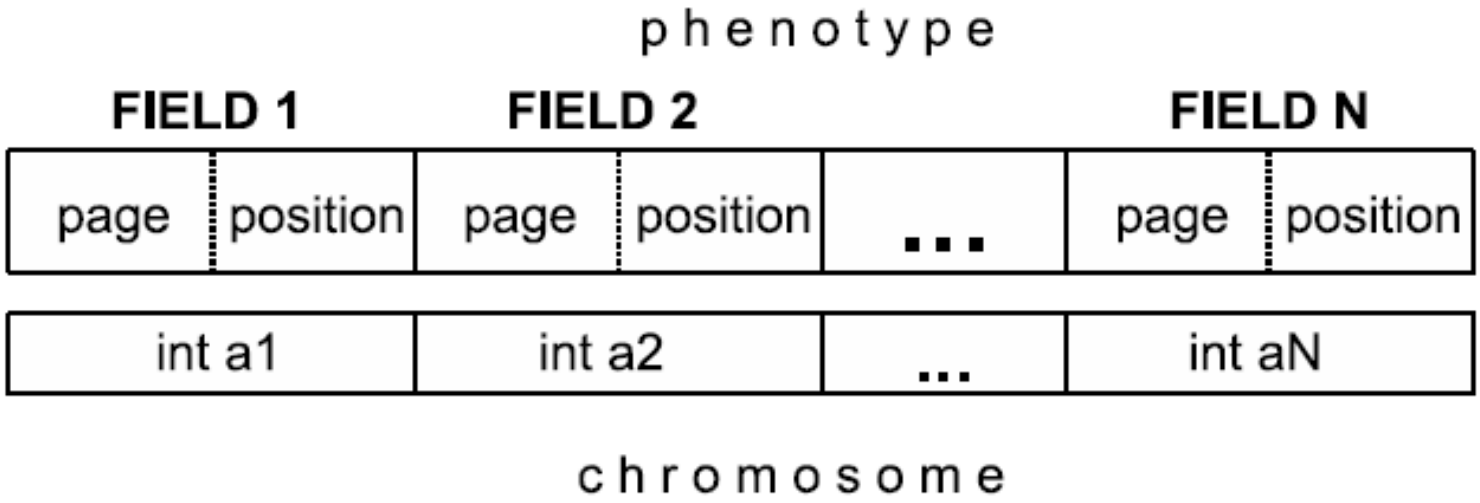


- Which do fields place on each page?
- In which order do you insert the fields?
- How could you optimize form-layout?
- How could you improve usability?
- How do you make user save his time?

Algorithm

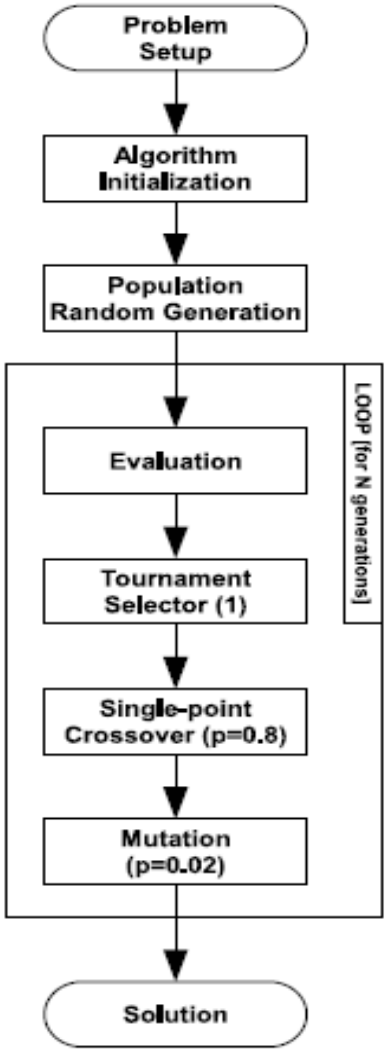
- Chromosome Structure
  - Each gene represents a field to fill out
  - Each gene is encoded by an integer → $a_i \in [0, (N * Q - 1)]$
    - N: Number of fields
    - Q: Number of available positions in a page
  - A gene codes the number of page (p) of the specified field and the position in the page (q)

$$p_i = a_i / Q$$
$$q_i = a_i \% Q$$



In our experimentation phenotype is made by: Sender Name, Receiver Name, Address, ZIP code, City, Amount, Number of checking account and Description.

➔ Cross Over and Mutation



- The problem is setup in terms of
  - Fields
  - Layout preferences
  - Display requirements
- The initial population is randomly generated
- Evaluation: a fitness score is assigned to each population
- Genetic processing: Individuals are genetically processed by
  - Tournament Selection
  - Single-point crossover
  - Mutation
- Solution: The individual whose phenotype guarantee an optimized layout of form fields on different pages according to the specified mobile device constraints

Algorithm

➔ Fitness

$$Fitness(x) = \sigma \cdot P(x) + (1-\sigma) \cdot C(x)$$

- P : Degree of predictability ⟶ measure of prediction power of a specified disposition

$$P(x) = \begin{cases} P_1(x) & \text{predictability within the page} \\ P_2(x) & \text{predictability across the pages} \\ \frac{P_1(x)+P_2(x)}{2} & \text{predictability within and across pages} \end{cases}$$

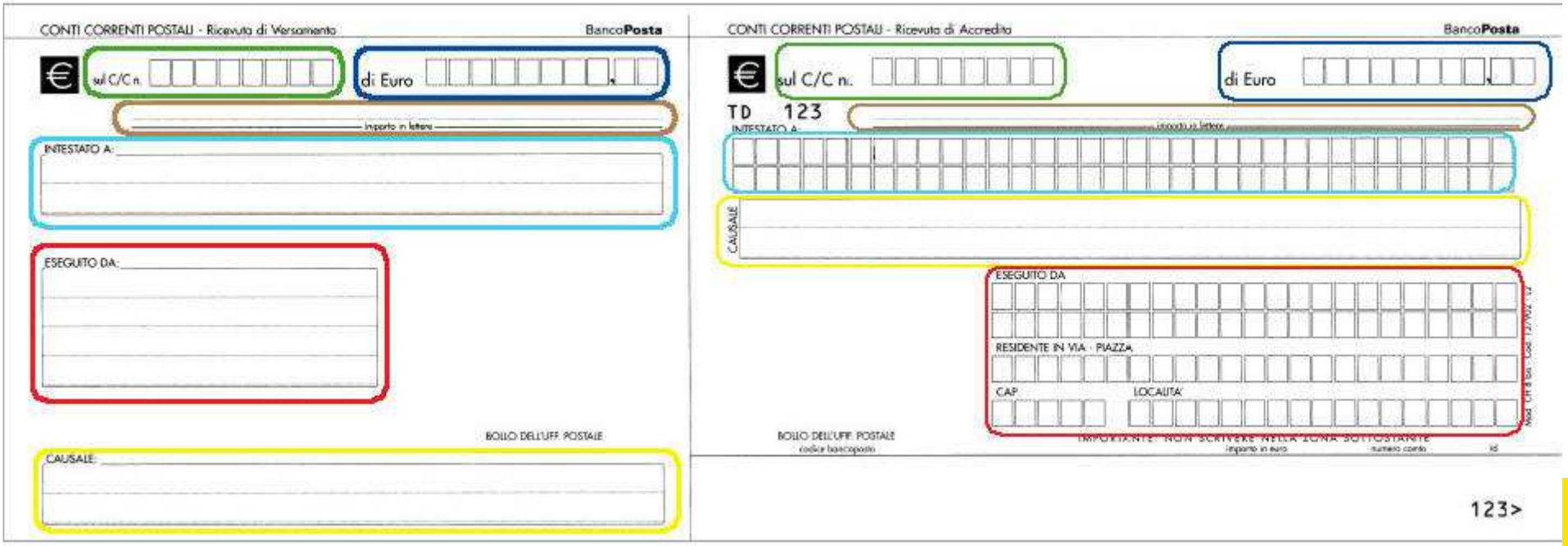
- C : Degree of constraints' compliance.
  - ***Number of Pages*** *(min, max)* → defines the min and max number of pages
  - ***Semantic Requirements*** *(field1, field2)* → defines if a specific field *field1* must be coupled with another field *field2* in the same page
  - ***Preferred Position*** *(field, atBeginning):* if *atBeginning* is equal to "*true*"/ "*false*", *field* should be in the first/last position,
  - ***Preferred page*** (*field, atBeginning*): field should be in the first/last page of form (*atBeginning = "true/false"*)
  - ***Dimension Requirements*** *(dimension):* defines the height of each field

$$C(x) = \frac{\sum_{j=1}^{m} w_j \cdot c_j(x)}{\sum_{j=1}^{m} w_j}$$

➔ Example of application

- ❑ Considering a money order service of Poste Italiane
- ❑ User has to fill out 8 different fields:

1. Amount expressed in euros (translated as “Importo”)
2. Number of Checking account (translated as “CC”)
3. Receiver Name (translated as “Intestatario”)
4. Description of the transaction (translated as “Causale”)
5. Sender First Name and Sender Last Name (translated as “Esecutore”)
6. Address (translated as “Indirizzo”)
7. City (translated as “Località”)
8. ZIP code (translated as “CAP”)



➔ Constraints:

- ❑ Number of pages has to be between 2 and 4
- ❑ Number of Checking account and Receiver Name have to belong to the same page
- ❑ City and ZIP Code have to belong to the same page
- ❑ Inserting Description on the latter pages, preferably in the last one
- ❑ Placing Amount on the bottom of page
- ❑ Placing Sender Name on the top of page
- ❑ No scrolling in the page
- ❑ Minimizing blank areas
- ❑ Top fields of each page have to be the most predictive ones within the page, and at the same time, the whole fields of first pages have to be more predictive than fields in remaining pages

Experimental Results

- Prediction contribution

⇩

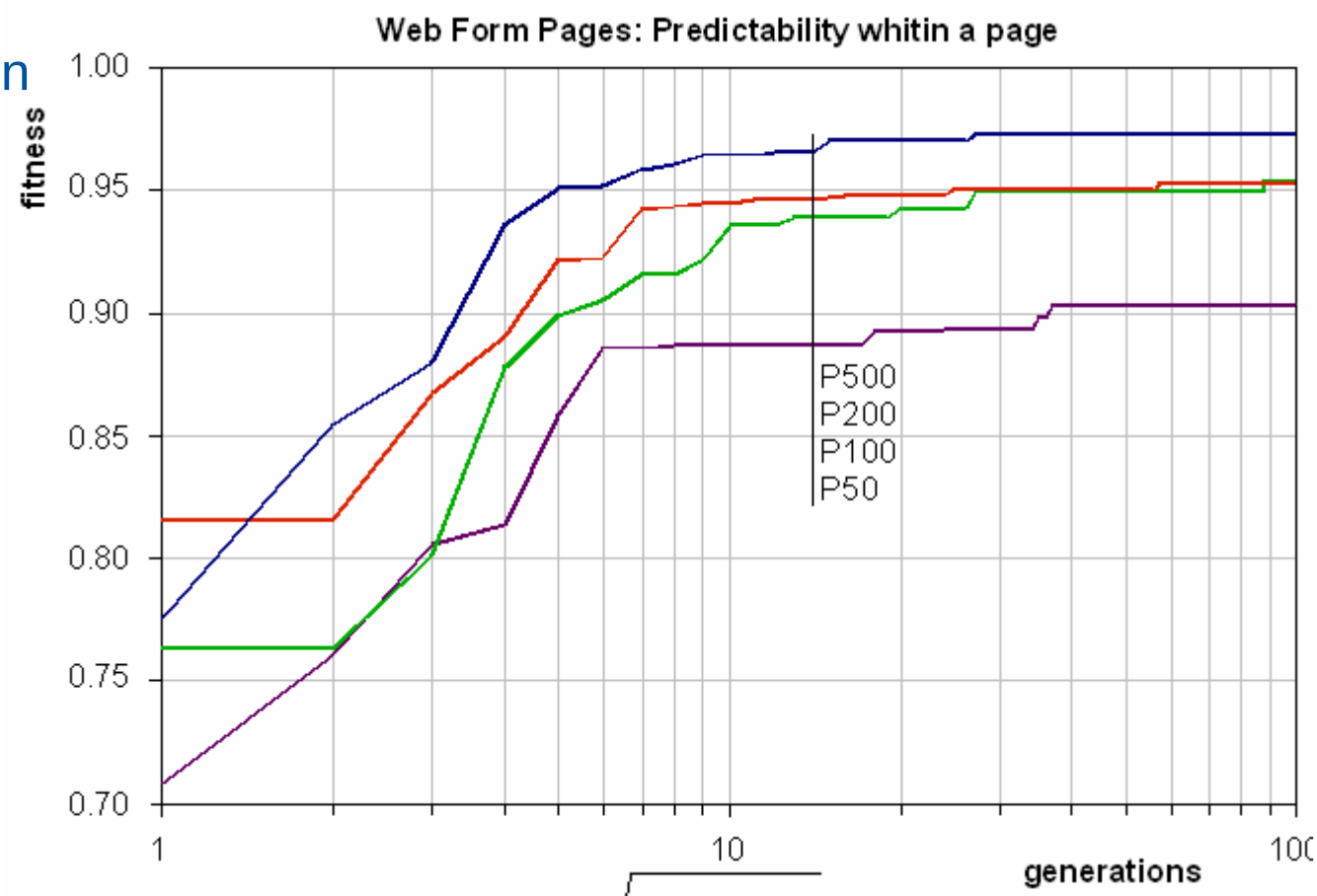
Prediction power provided by the first control of each page for the remaining controls within the page

⇩

Fields on the top of each page are the most predictive one within the page.

⇩

Reduction of user-inputs



$$P_1(x) = \frac{1}{G} \cdot \sum_{i=1}^{G} \sqrt{\frac{p_i^2 + r_i^2}{2}}$$

G = number of pages of individual x
p_i = precision
r_i = recall

Experimental Results

➔ Prediction contribution

⇩

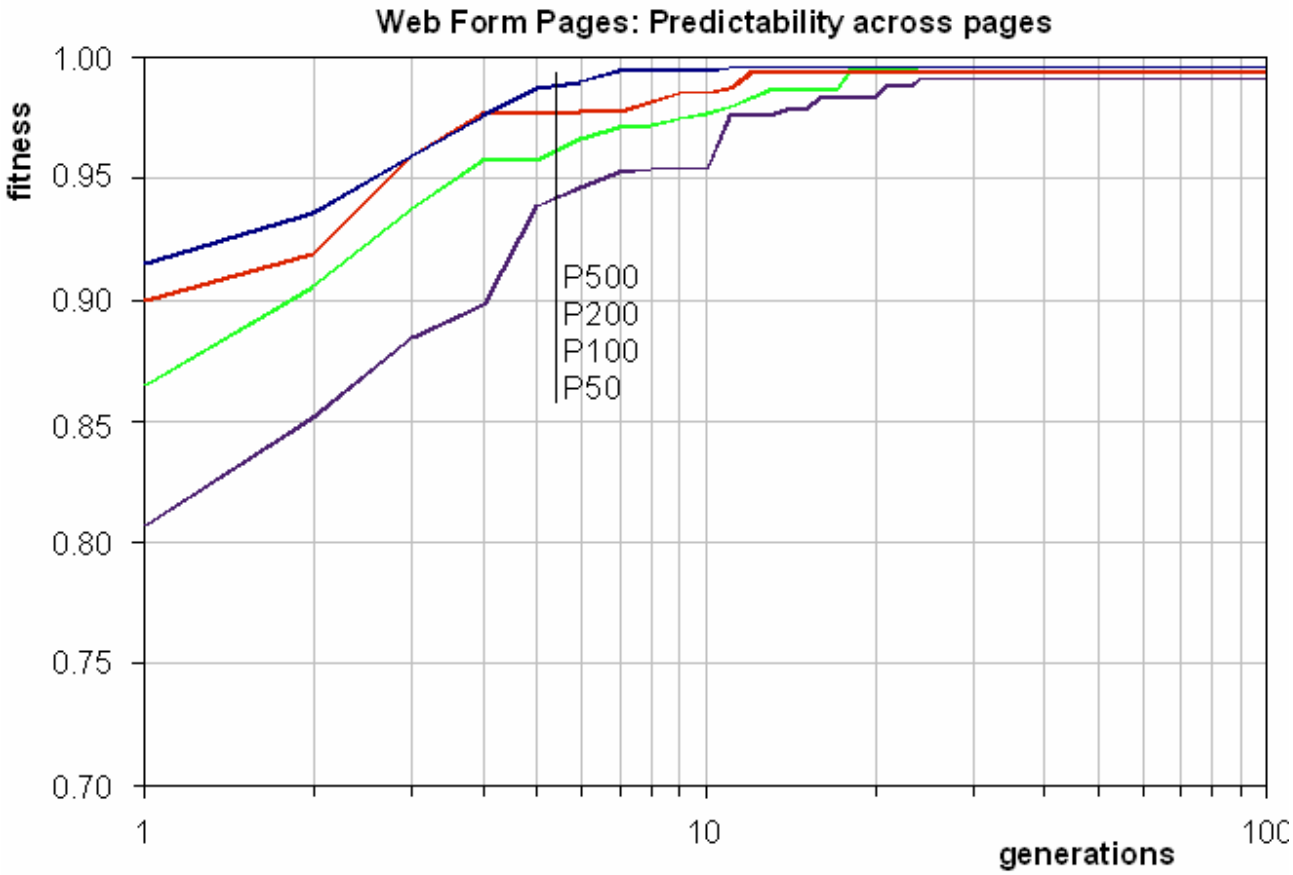
Prediction power provided by controls of a page for the fields of following pages

⇩

Fields on the first page are the most predictive.

⇩

Reduction of number of pages to fill out

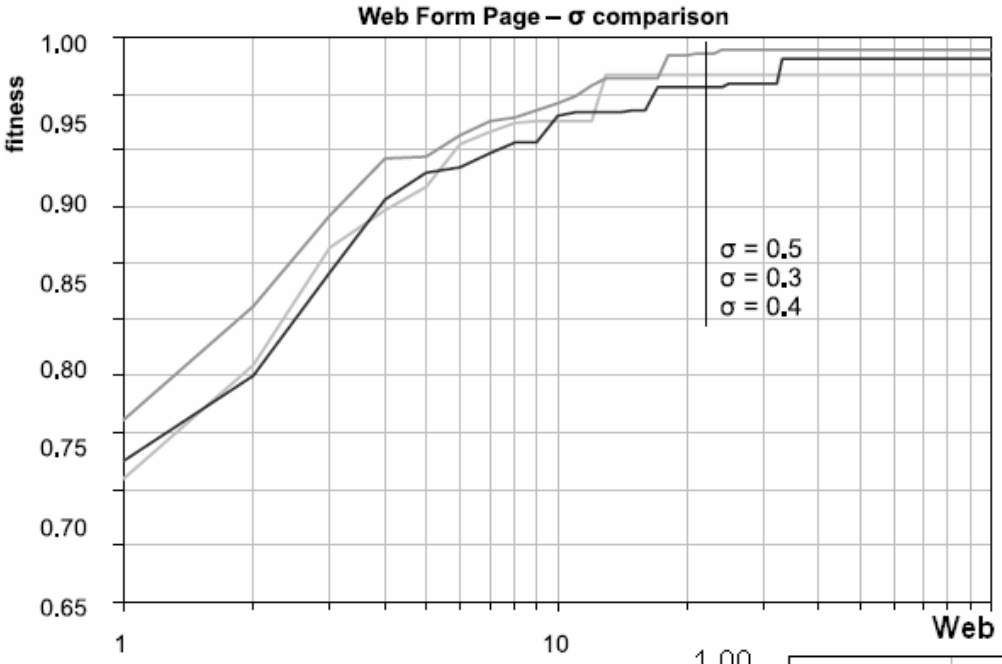


$$P_2(x) = \frac{1}{G-1} \cdot \sum_{i=1}^{G-1} \sqrt{\frac{p^2(e_i,t_i) + r^2(e_i,t_i)}{2}}$$

e_i = *set of evidences of the pages {1,2,…,i}*
t_i = *Fields to test in pages {i+1,…,G}*
G = number of pages of individual x
$p(e_i; t_i)$ = *precision evaluated considering*

evidence set e_i

testing set t_i



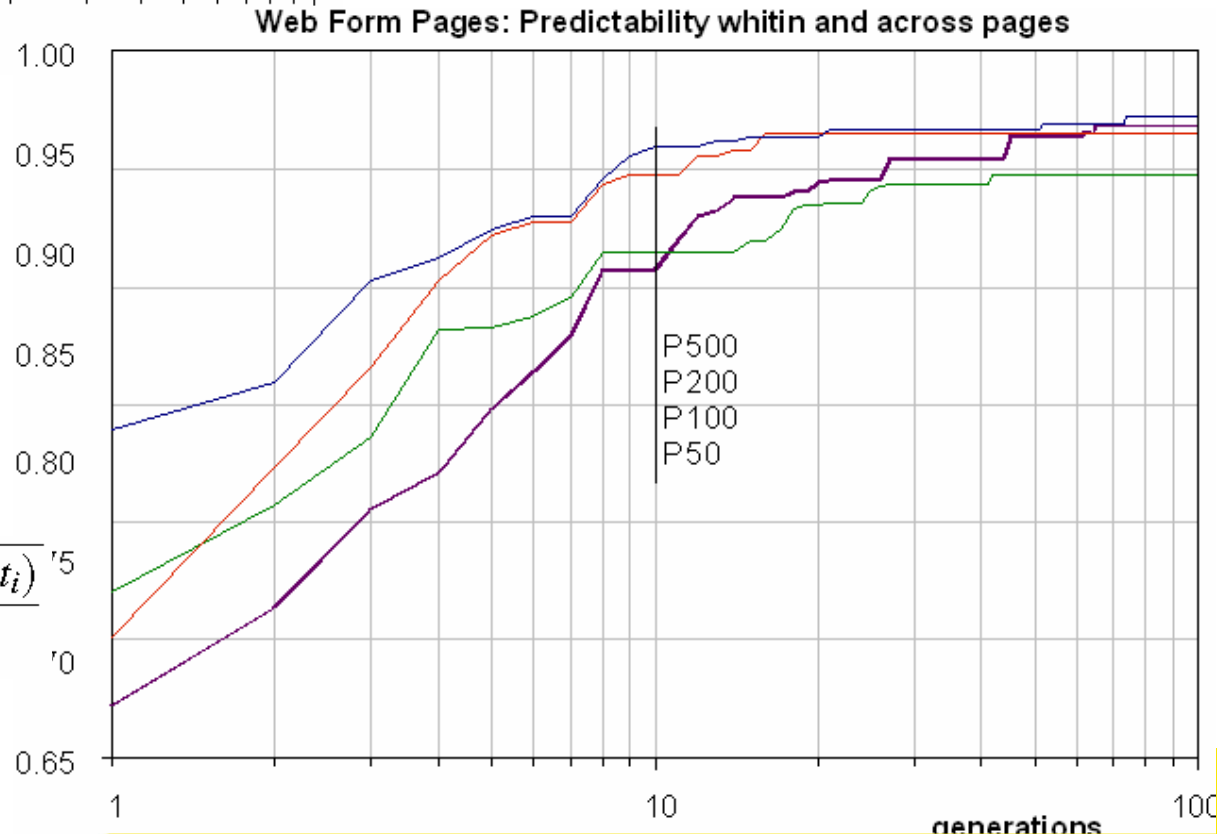
Fitness trend varying the value of σ:

- Population size = 100 individuals
- Elitism = 5 individuals

$$P(x) = \frac{P_1(x) + P_2(x)}{2}$$

$$P_1(x) = \frac{1}{G} \cdot \sum_{i=1}^{G} \sqrt{\frac{p_i^2 + r_i^2}{2}}$$

$$P_2(x) = \frac{1}{G-1} \cdot \sum_{i=1}^{G-1} \sqrt{\frac{p^2(e_i,t_i) + r^2(e_i,t_i)}{2}}$$



Example of application

➔ Solution

❑ The imposed constraints are satisfied

- Pridictability within and across pages
- 100 individuals
- Elitism = 5 individuals
- 100 generations

Conclusions and Future Work

- Conclusions
  - We have designed a genetic algorithm for optimizing the layout of Web Form Page for mobile, keeping into the account:
    - ***Predictability***
    - ***Guidelines***
    - ***Semantic Preferences***
    - ***Usability***

- Future Work
  - Exploring the optimization of more general Web pages for mobile devices using genetic algorithms and meta-heuristics
  - Generative approach for UI design
  - Automatic organization of a UI for mobile device